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Re: Objection to the FEIS and Draft Record of Decision High Uintas Wilderness Domestic Sheep Analysis

Submitted Electronically To: https://www.fs.usda.gov/r04/ashley/projects/44503 and bethany.nickison@usda.gov

Forest Service:

This objection is filed in accordance with 36 CFR Part 218 on behalf of Yellowstone to Uintas Connection, Gallatin Wildlife Association, Sage Steppe Wild, Western Watersheds Project, Western Wildlife Conservancy, WildEarth Guardians, and Wilderness Watch. We have previously submitted scoping comments and comments in response to the Draft Environmental Impact Statement (DEIS) for the High Uintas Wilderness Domestic Sheep Analysis Project, which was released June 25, 2019, and the Supplemental Draft Environmental Impact Statement High Uintas Wilderness Domestic Sheep Analysis which was released in June 2023.

We find this FEIS and ROD violate the APA, NEPA, NFMA and the Wilderness Act. The remedy must be to cease future domestic sheep grazing in these project allotments and the adjacent West Fork Blacks Fork allotment, which is being used as part of the sheep driveway. There is no other option that will sustain bighorn sheep, or protect the already degraded soils, plant communities and wilderness values from driving, trailing and grazing tens of thousands of domestic sheep in this sensitive environment. Given the history and length of time of over a decade that this process has taken demonstrates that merely remanding this decision perpetuates the damage to the High Uintas Wilderness. In our Introduction, Dr. Kirk Robinson of the Western Wildlife Conservancy challenges the Forest Service for its neglect of wilderness

values and the elevation of commercial interests over wilderness values. This violates the Wilderness Act. The following sections detail the flaws in the purpose and need for the project, the inappropriate selection of alternatives, failure of the selected alternative to maintain the viability of bighorn sheep and sensitive plant species, failure to do an adequate capability analysis and stocking rate determination for domestic sheep, and failure to protect wilderness values.

1. HIGH UINTAS WILDERNESS CHARACTER vs. LIVESTOCK GRAZING
by Kirk Robinson, PhD

In the following, I argue that the Forest Service misunderstands the Wilderness Act due to an institutional bias toward resourcism together with a conception of resources that systematically ignores relationships among things (Earth, water, atmosphere, plants, animals, decomposers, etc.). As a consequence, when faced with the task of making decisions involving conflicting values, the FS tends to favor the anthropocentric values of resource extraction above all others. Those values are regarded as being of paramount importance and all competing values, such as wilderness character, are regarded as being of subordinate importance – contrary to the intent of the Wilderness Act of 1964. This bias is clearly evident in the Forest Service's management of the High Uintas Wilderness, where livestock grazing has first priority and other values, particularly wilderness character, are sacrificed for the benefit of a few private parties who operate commercial livestock grazing enterprises in the wilderness. The bias stems mainly from a fundamental misunderstanding of the meanings of two concepts that are central to the Wilderness Act: 'trammel' and 'impair' combined with an institutional bias of misplaced values.

Definition of wilderness & management of wilderness

The Wilderness Act of 1964 (WA) defines wilderness as ". . . areas where the earth and its community of life are untrammeled by man" and "retain their primeval character and influence . . ."

Wilderness areas within the National Wilderness Preservation System (NWPS), as the word *preservation* implies, are to be ". . . administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character."

Additionally, management agencies ". . . shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its wilderness character."

Summary

Wilderness areas within the NWPS, including their communities of life, shall be managed by the responsible agencies to preserve their *primeval* character and influence and shall not be *trammeled* by man. Furthermore, other management purposes, such as recreation and livestock grazing, must be managed so as to preserve this wilderness character. In accordance with this, there shall be no commercial enterprise in wilderness.

Analysis

Two concepts are of central importance to understanding wilderness character: 'trammel' and 'primeval':

1. Merriam-Webster defines 'trammel' as "a restriction or hindrance that impedes free action, movement, or progress."
2. The Oxford English Dictionary defines 'trammel' as "[to] deprive of freedom of action."
3. Merriam-Webster dictionary defines 'primeval' as "of or relating to the earliest ages (as of the world or human history) : ancient, primitive."
4. The Oxford Advanced Learner's Dictionary define 'primeval' as "from the earliest period of the history of the world, very ancient."

From these definitions it follows deductively, i.e., with logical necessity, that wilderness is essentially a place or area, including a community of life, where ancient natural *processes* are not impeded or hampered by humans. Clearly, this does not imply that conditions are static in wilderness, since static conditions cannot be impeded or hindered. (This is a definitional or logical truth, not a contingent empirical claim.) The important point is that change is driven predominantly by non-human forces – hence is untrammeled by humans.

In short, a unit of wilderness in the National Wilderness System must be administered and managed so as to preserve its wilderness character, which is a process that retains its primeval nature untrammeled by humans and unimpaired. The concepts of 'trammel' and 'impair' are related but differ in emphasis. To trammel something is to hinder or impede the natural flow (change) of something. To 'impair' something is to damage it by interfering with its natural functioning and expresses a valuation – a negative one. It is possible to impede a process, such as the erosive force of a stream with riprap, without necessarily damaging it or harming it in any respect. To say that the flow of the stream is impaired is to imply that its

proper functioning is damaged, harmed, or injured, which expresses a valuation. The fact that the WA emphasizes both without distinguishing between them suggests that, so far as the WA is concerned, land that has been trammeled by humans has to that extent been impaired.

Of course, human influence pervades the biosphere in our times, but importantly, wilderness is not "all or nothing." It is a matter of degree. Those areas that possess wilderness character to a high degree and are officially designated wilderness under the WA must be managed so as to preserve their wilderness character = the primeval character of the processes that constitute their wildness. Unfortunately, in the case of the High Uinta Wilderness (HUW), the Forest Service has repeatedly chosen to manage for values that compromise wilderness character. The science of wilderness character is ecology – not botany or zoology or geology per se, but ecology, which is the science concerned with how all the parts (soil, water, plants, animals, etc.) interact together. And interaction implies a process or many interrelated processes.

Rather than base management decisions on the appropriate and best available science – ecology - the science of ecology is entirely ignored in favor of granting highest priority to continued livestock grazing (cattle and sheep) in the HUW. In the case of domestic sheep, this amounts to 10,300 ewe-lamb pairs and 3,000 dry ewes on 10 allotments in the most biologically fragile areas of the HUW, totaling approximately 161,000 acres of predominantly alpine basins, or approximately 1/3 of the area of the HUW for about two months every summer – a practice stretching back in time for more than a century. The purpose of this is to support two families in Southwest Wyoming. There is nothing more to be said in its favor than that

Of subordinate importance is doing what can be done to keep domestic sheep away from the wild native Rocky Mountain bighorn sheep in order to minimize the threat of lethal disease transmission to the native sheep. (All other wilderness related values, such as the quality of the wilderness experience, are also thereby relegated to secondary importance.) In short, providing economic support for two families and their employees is valued more highly than the ecological integrity of the HUW, which would require removing the domestic sheep and allowing the reintroduced bighorn herd to expand.

What the FS fails to consider is the ecological effects on the *community of life* in the HUW. It's as though that simply does not matter, even though the WA mandates that wilderness areas and their communities of life remain trammeled by human activity and that wilderness character not be impaired. The WA also mandates that there be no commercial enterprise in wilderness areas. Livestock herding for the purpose of grazing, with the ultimate goal of producing income for a few private individuals and their families, is undeniably both a human activity and a commercial enterprise.

Evolution, ecology, and agency responsibility

Evolution is a process that is comprised of many sub-processes, including ecosystem processes. The evolutionary process, via natural selection, produces plant and animal organisms that tend to be optimally fitted for their roles in ecosystem processes. Thus, the central importance of primeval conditions and their value in the WA. Herbivory and predation are two such processes. The WA requires agencies to manage wilderness areas so as to protect and preserve these processes unimpaired. This means they are obligated to not interfere significantly in the lives of native herbivores and carnivores that are part of the community of life of a wilderness, lest the wild character of the wilderness be impaired by human trammeling.

Importantly, this doesn't mean that trammeling will be avoided if animal populations are managed so that the number of animals remains more or less constant from year to year. Numbers matter of course: populations should tend toward the natural carrying capacity of the land. But demographics also matter. For example, when dominant male mountain lions, which are the ones most prized as trophies, are removed from a population, it affects the fates and behaviors of all other mountain lions in the population – kittens, juveniles, subadults, and adults of both sexes. When many dominant males are removed from a population, the demographics of the population becomes skewed, cultural transmission is disrupted, and social chaos replaces relative order and stability. Research projects in the last 30 years have confirmed this repeatedly. And while the details differ, the same is true for other carnivore species as well, including bears, wolves, and coyotes. Removal of a dominant animal or a breeding pair can lead to the destruction of a family group, and consequently also disrupt natural ecological processes through trophic cascading effects.

When influential individual carnivores are removed from a population, not only are the social dynamics of the population upset, prey populations are adversely affected too, which in turn adversely affects the plant community. The effects ripple throughout the food web, as Aldo Leopold observed long ago in "Thinking Like a Mountain." The same basic story is also true for herbivorous species, such as Rocky Mountain bighorn sheep, elk, and mule deer. When a population of ungulates is decimated or extirpated, wilderness character, which includes a community of life, is impaired. Prey species and plant communities are adversely affected. 'Adverse impact' is any resulting condition that deviates substantially from the primeval norm that wilderness is supposed to be managed to preserve. And this primeval norm is not a static condition, but a process involving a multitude of interrelated processes. It is not something that land or wildlife managers, or anyone, gets to define, but an objective feature of reality as defined by the WA. Put a bit differently, it is not a matter of human valuing concerning good or bad, but an objective state or condition of the community of life that qualified it for wilderness designation in the first place. The less it has been subjected to human trammeling and consequent impairment, the better. Of course, implicit in this is the presupposition – or rather, the stipulation – that primeval character is in some sense optimal and therefore best. And this

simply means that fitness is good for organisms. The WA is responsive to this fact by recognizing that human trammeling reduces the fitness of native organisms.

This valuation encompasses the idea that restoration of impaired processes is also desirable. In other words, it is wrong to think that a wilderness that has already been trammeled and impaired by human activity (tie-hacking, trapping, mining, grazing, etc.) at the time of designation, can't or shouldn't be rehabilitated to improve its wilderness character. In fact, if we simply cease trammeling it, wilderness character will often return on its own, like the healing of a wound.

The question is, when have wild processes been trammeled by humans, and hence impaired? There is some room for informed discretion as to when impairment occurs, but it is tightly constrained by empirical facts. Discretion is not carte blanche permission. This means that land and wildlife managers have a professional obligation to be reasonably up to date on the relevant research concerning predator-prey interactions, and other ecological processes. There is no bright line between healthy and impaired, just as there is no definite demarcation between being bald and not being bald. That said, President Eisenhower was definitely bald and President Kennedy definitely was not. When it comes to administering and managing wilderness areas, informed unbiased judgment is essential.

Additional analogies: It is probably not harmful to your car to occasionally drive it 1,000 miles past the factory-recommended distance between oil changes; but to go 10,000 miles beyond the recommended limit would definitely be going too far, especially if it is done repeatedly. Similarly, having a single glass of wine with dinner each evening probably won't harm a healthy human adult, but drinking a gallon of wine every day most definitely will, especially if this goes on for many months or years.

Community of life

Unfortunately, the Forest Service exercises poor judgment in its management of the Uinta-Wasatch-Cache and Ashley National Forests by allowing domestic sheep grazing in 10 contiguous grazing allotments in the HUW, year after year, ongoing for over 100 years. What is missing is a consideration of the community of life that is an integral part of the wilderness and is, thanks to Aldo Leopold, a central concept of ecology. Instead, members of the community of life are viewed, perhaps unconsciously, as discrete entities having no significant causal interconnections with other members of the community. This almost necessitates reckoning health of a species in terms of abundance only – hence, the ludicrous idea that a minimum viable community of bighorn sheep or Canada lynx, is satisfactory. The community concept appears to be entirely missing from Forest Service analyses, planning, and decisions as regards livestock grazing in the HUW.

Ecology teaches us that a community of life is not just an aggregation of individual organisms of various kinds, like so many building blocks. It is the individual organisms plus their multifarious interactions, including reproduction of kinds. These interactions are far reaching, including proximate causal and remote causal relations, as well as a multitude of feedback loops, some positive and some negative. Moreover the abiotic environment is part of the causal network too. The interactions among the parts reverberate throughout the system.

The High Uintas Wilderness and domestic sheep grazing

The character of the High Uinta Wilderness has already been trammeled and impaired by the anthropogenic decimation of the original native bighorn sheep population via disease transmission from domesticated sheep; and the impairment has not yet been successfully repaired through reintroduction of bighorns. Yes, there are native bighorn sheep in portions of the Uintas, but they are almost nothing but museum pieces because their numbers and distribution do not begin to approximate what must have been the primeval situation. The reintroduced native bighorn sheep population has struggled to reach viability and natural distribution since the first transplants over 40 years ago. Non-native Rocky Mountain goats, which the Utah Division of Wildlife Resources transplanted to the Uintas, and non-native domesticated sheep, are not adequate ecological substitutes for the missing bighorn sheep. They are different species with different habits and dietary preferences, and different vulnerabilities to predation and other natural causes of mortality. In this connection, studies of the bison in northern Yellowstone National Park have revealed that the natural grazing regime of the bison does not harm the soil, but actually enriches it, making it more productive. The same cannot be said for the domestic sheep, numbering in the thousands, that concentrate for a few weeks each year in the fragile alpine basins of the HUP, scouring it of plant life, resulting in an impact to the plants, soil, and water that is much greater than occurs under the natural grazing regime of native species. The result is fewer native ungulates for native predators to hunt and eat, which in turn results in fewer predators and fewer native scavengers, with consequential adverse impacts to the soils, water, and plants. This is a human trammeling if there ever was one, since it all starts with the domestic sheep grazing that is permitted by the Forest Service and conducted by private individuals for their own economic advantage.

Commercial enterprise in the High Uintas Wilderness

Speaking of economics, domestic sheep grazing in the HWU is a commercial enterprise. It is not done as a hobby, nor is it not done for the benefit of the wilderness or its community of life. It is done by private individuals strictly for monetary gain. Selling the sheep at auction may be where the money transactions occur, but it is not all there is to the enterprise. An enterprise is a much bigger and more complicated thing than a transaction. The sheep must also be raised, and this means they must be fed – fed at a cost that the enterprise can bear. Hence the low grazing fees that are not sufficient to cover the cost of funding the federal grazing program. Never mind how it affects forest creatures such as the lynx, fox, fisher and wolverine, or hawks

and eagles. The FS seems to specialize in concocting ludicrous, woefully weak alternative explanations for the demise of these species where they were once abundant.

Sheep grazing in the HUW is an extractive commercial enterprise that inevitably hinders and impedes wilderness character (natural primeval processes) to some degree. And that is an impairment of wilderness character.

Illegal killing of native predators

The HUW is home to large native predatory animals, including black bears, mountain lions, Canada lynxes, and golden eagles. Grizzly bears, gray wolves, fishers, and wolverines were present historically. Are we to believe that sheep herders never kill these animals when they have a chance? This is evidently the position of the FS, ignoring the fact that sheepherders tend to carry guns (some of us have witnessed this first-hand), and the fact that it is unlikely that anyone would ever know about individual instances of predator killing that are not reported. Sheepherders have a motive for killing predators when chance provides opportunities, as well as a motive for not reporting the kills. While we may never know how many predatory animals are illegally killed by sheep herders, reason and common sense support the conclusion that it happens. Mere lack of concrete evidence of particular instances is not evidence that it doesn't happen. As David Hume noted, "A man who at noon leaves his purse full of gold on the pavement at Charing-cross, may as well expect that it will fly away like a feather, as that he will find it untouched an hour after." It is appropriate to point this out in the present context because incidental predator killing is another anthropogenic (not to mention illegal) assault on the character of the wilderness - on the integrity and stability of the community of life - that undoubtedly accompanies domestic sheep grazing.

In this connection, it bears noting that the FS tends to disregard hypotheses that scientists have not been able to confirm, regardless of how plausible they are and instead proposes alternative hypotheses that are no more plausible or credible. For example, it is at least plausible, even quite probable given historical documentation, that Canada lynx once thrived in the Uinta Mountains and surrounding areas. The Uinta Mountains alone may or may not have been capable of supporting a viable population of lynxes, but they certainly provided important habitat for lynxes as well as a movement corridor for them between the southern and the northern Rockies – a corridor that is almost certainly still used as of the reintroduction of lynxes to the San Juan Mountains of Colorado. In light of this, it is plausible as well to assume that breeding pairs of lynxes were not uncommon in the Uintas. Despite this, the FS and the USFWS, prefers to grant greater probability to the far less plausible hypotheses that lynxes only ventured into the Uintas during cyclic high periods of lynx reproduction farther north. They get away with this because they carry the authority of the label "scientist." But this isn't science by any stretch. In fact it is bullshit, making up a possibility and treating it as fact without serious regard whether it really is. For more on this, readers can consult previous documentation provided to the FS by the contributors to this document.

This same kind of intellectual dishonesty shows up in the assumption that a minimal viable herd size is good enough for bighorn sheep and its role in the ecosystem of the HUW, as well as in the hypothesis that pocket gophers, not domestic sheep, are the cause of alpine basins being denuded of plant cover, as well as the hypothesis that avalanches are responsible for the devastation of the West Fork Black's Fork stream channel and lack of native trout. This tendency to discount plausible hypotheses in favor of invented implausible ones that allow the FS to save domestic sheep grazing is morally and professionally reprehensible.

Livestock grazing in wilderness is conditionally permissible

"The grazing of livestock, where established prior to the effective date of this Act, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture."

Livestock grazing in wilderness is permitted subject to two conditions: where it was established prior to the effectiveness of the WA; and under reasonable regulations as deemed necessary by the Secretary of Agriculture.

Does this mean that whatever the Secretary says is automatically right? No. Otherwise any regulations, or even no regulations at all, will automatically be "reasonable" if the Secretary arbitrarily deems them necessary. The point is that potential regulations must be reasonable before they can rightly be judged necessary. Furthermore, what is necessary is itself a matter of fact, not preference. What is necessary cannot be optional, dependent only upon the fiat of land managers. That would be to rob the term 'necessary' of all meaning. So, what grazing regulations are both reasonable and necessary in the HUW?

Another part of the WA is responsive to this question: "Except as otherwise provided in this Act, each agency administering any area designated as wilderness shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its wilderness character."

Conclusion

Except as otherwise provided in the WA, wilderness must be managed so as to preserve its wilderness character, period. Does any part of the WA make an exception for livestock grazing, granting it greater importance than preserving the character of wilderness? This is the crux of the issue. After all, there can be no serious doubt that livestock grazing in wilderness, especially on the scale that occurs in the HUW, impairs wilderness character and is antithetical to the very idea of wilderness. So, does the provision that conditionally permits grazing in wilderness areas trump the mandate to manage wilderness areas so as to preserve their wilderness character? In short, does the WA mandate that where a conflict between wilderness character and livestock grazing exists, livestock grazing must take priority? Clearly not. The WA

plainly states that preserving the wilderness character of the wilderness must be given top priority under the WA, and all permitted uses of the wilderness, including livestock grazing, must be subordinate to it. This means that if there is going to be any compromise between the two, preserving the character of the wilderness is to be given top priority. Therefore, the Forest Service ought to elevate preserving the wilderness character of the HUW to the position of first importance and dramatically scale down or totally eliminate livestock grazing in the HUW.

2. Purpose and Need

The Draft ROD:9 states that: *"The primary purpose of this project is to comply with the November 7, 2013 settlement agreement resolving Western Watersheds Project et al. v. United States Forest Service, Case No. 10-cv-612 ELJ-REB. In conjunction with the primary purpose, the other main purpose of this project is to provide forage for permitted domestic livestock grazing…"*

This Purpose and Need is narrowly drawn by placing the issuance of permits to continue grazing domestic sheep above all other options. By doing this, the entire EIS and Decision process is biased towards this one goal. The result is the clear deflection around damage to the wilderness, watershed, soil, riparian, fish and wildlife values. It lacks the balance, sustainability and objectivity inherent in MUSYA and NFMA or the Wilderness Act.

The bias is clear when one reads specialists' reports or reviews monitoring data and photos provided by the Forest Service. Streambank scouring is the result of elk, who might be there in small numbers compared to thousands of domestic sheep. Then again, it is described as the result of an avalanche, which the stream bypasses and should have recovered from in the decades since. Or, the scouring was caused by tie-hacking a century ago, while ignoring that in the century since, the streams would have recovered. Bare soil is the result of gopher activity, yet thousands of sheep have little impact. There are numerous deflections in the range, hydrology, soils and other reports that amount to what appears to be willful blindness or deliberate misleading of the public. We have pointed these out in our past comments and will do so herein by reference and analysis of the specialists' reports and monitoring data provided with the FEIS and from our past FOIA requests. An egregious example of this narrow purpose and need is fully fledged in the Forest Plan amendment which is designed to do away with consideration of bighorn sheep as a sensitive species with viability requirements under NFMA, thus removing one of the biggest threats to domestic sheep grazing.

This narrowly drawn Purpose and Need *"preordains"* the decision to continue permitting domestic sheep at all costs. In WWP v Jewell (Case No. 08-cv-435-BLW) the court ruled: "BLM can't identify the purpose of the action so narrowly *"that the outcome of the decision is preordained,"* or, in the words of Judge Lodge, *"uncritical[ly] privilege[s]"* grazing over other uses. Rosenkrance, 2011 WL 39651, at *9; Nat'l Parks and Conservation Ass'n v. BLM, 606 F.3df 1058, 1070 (9th Cir. 2010).

The FEIS:9 describes compliance with NEPA in this way: *"We conducted this environmental analysis under the Forest Service's and the USDA's current regulations as well as in consideration of the CEQ regulations at 40 CFR 1500-1508 that were in effect at the time of project scoping (December 1, 2015). References to 40 CFR 1500-1508 in the DEIS and SDEIS refer to our consideration of those CEQ regulations that were in effect at that time. Because CEQ rescinded its regulations at 40 CFR 1500-1508, we removed references to those regulations in the FEIS and in this decision document."*

However, the Department of Agriculture Interim Final Rule[1] states: *"To ensure an orderly transition without undue impact on the USDA mission, USDA [agencies] have discretion to continue using the versions of USDA and agency-specific NEPA regulations in place before publication of this interim final rule, as well as the 2020 version of the CEQ NEPA regulations, where it makes sense for proposals that are at a certain stage in the applicable NEPA process... USDA [agencies] also have the discretion to begin applying the USDA NEPA regulations, as revised, effective immediately upon publication of this interim final rule where it akes sense to do so for new proposals and applications, or for existing proposals or applications that are in the early stages of the applicable NEPA process and can easily transition to using the revised USDA NEPA regulations."*

Here, the Interim Final Rule notes that this applies to projects in the *"early stages"* of the NEPA process. This project has been ongoing for a decade, hardly in its early stages. This removal of reference to important aspects of NEPA which the public has relied upon throughout this process demonstrates another rush to the decision in favor of the sheep permittees and in detriment to the wilderness, watershed, soil, riparian, fish and wildlife values that are intrinsic to the wilderness and in which domestic sheep are an outside influence.

It also needs to be recognized that 36 CFR § 220.4 requires proposed actions are subject to NEPA when the Forest Service has a goal and the effects can be evaluated, the *"action is subject to Forest Service control"*, can *"cause effects on the natural and physical environment and the relationship of people with that environment."*

The Public Interest, as opposed to the interests of two permittees, would be served best by restating the purpose and need as follows: **"In conjunction with the primary purpose, the other main purpose of this project is to evaluate whether permitting domestic livestock grazing is sustainable while protecting the principal and intrinsic values of wilderness, watershed, soil, riparian, fish, and wildlife."** This statement no longer makes permitting livestock an automatic decision to be defended at all costs. It places it in context with those values sacrificed due to its presence.

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[1] Federal Register Vol. 90, No. 126, July 3, 2025. P29644.

FEIS:xiii states that *"Since its early beginnings, livestock grazing in the area has been, and continues to be, an important factor supporting the economies and culture of local communities surrounding these two National Forests."* The assumed economic value of grazing the 10,300 sheep plus lambs on these allotments is summarized in FEIS Table 17 as $2,569,335 dollars. A major flaw with this analysis is that the sheep are only on these Forests for 2 out of 12 months, so the total should be one-sixth of that provided, or approximately $430,000. Another is that there are only two permittees, the JRB LLC and Sims as shown in the Annual Operating Instructions. JRB controls 9,750 mature sheep on nine of the allotments, while Sims has 1,300 on one allotment. The analysis did not place the value of grazing sheep on these 10 allotments within the context of the overall economies of the counties or states. While the FEIS:80 notes that *"the High Uintas are also used by residents and visitors for recreational purposes such as hunting, fishing, horseback riding, hiking, backpacking and wildlife viewing"* there was no summary of those values to place in context the relative importance of each economic resource.

Professor Tom Power of Montana State University provided a formula for evaluating the importance of grazing on federal lands.[2] It requires answering these four questions:

1. What portion of the value produced by cattle and sheep operations is associated with the feed used?
2. What portion of the feed for those cattle and sheep operations comes from grazing on federal lands?
3. What portion of the total agricultural activity involves raising cattle and sheep?
4. What part of the total economy is represented by agriculture?

Dr. Power determined the relative importance of Federal lands grazing on jobs and income for western states. In Utah, the percent of income derived from federal forage was 0.08%, while the percent of jobs derived from federal forage was 0.18% and the days of real income growth to replace income from federal forage for Utah was 7 days. This makes the grazing of domestic sheep on these allotments even more insignificant to the overall economy.

This narrow drawn purpose and need results in a decision which is a violation of the APA in the sense that APA requires a court to *"compel agency action unlawfully withheld or unreasonably delayed,"* 5 U.S.C. § 706(1), and to *"hold unlawful and set aside agency action, findings and conclusions found to be . . . arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law,"* 5 U.S.C. § 706(2)(A); San Luis & Delta-Mendota Water Auth. v. Jewell, 747 F.3d 581, 601 (9th Cir. 2014) (applying the APA to claims under NEPA). Agency action is arbitrary and capricious

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[2] Power, T. M. 2002. Taking Stock of Public Lands Grazing an Economic Analysis. In: Welfare Ranching the Subsidized Destruction of the American West. Island Press 374p.

where: *"the agency fails to consider an important aspect of a problem, . . . the agency offers an explanation for the decision that is contrary to the evidence, . . . the agency's decision is so implausible that it could not be ascribed to a difference in view or be the product of agency expertise, or . . . the agency's decision is contrary to the governing law."* Lands Council v. Powell, 395 F.3d 1019, 1026 (9th Cir. 2005) (citing Motor Vehicle Mfrs. Ass'n v. State Farm Mut. Auto. Ins. Co., 463 U.S. 29, 43 (1983) and 5 U.S.C. § 706(2)).

In the following sections and attachments we show by analysis of agency documents and data and our own data and observations that the narrow purpose and need led to massive deflection around the actual conditions on the ground in the High Uintas Wilderness. As stated above, the environmental effects depicted in the FEIS and Specialists' reports are *"so implausible that it could not be ascribed to a difference in view or be the product of agency expertise."* This is the bias we referred to in our opening paragraphs.

3. Alternatives

The FEIS analyzed two alternatives, Alternative 1 which would not permit domestic livestock, and Alternative 2 which was to continue permitting domestic livestock grazing and use of the 52-mile driveway under general management requirements and an MOU with UDWR. Given the narrow Purpose and Need, Alternative 1 was never going to be implemented because clearly it was not the purpose. FEIS:36 notes that "*We organized a team of resource specialists from both Forests, some of the cooperating agencies that represented agriculture, and some that had jurisdictional authority over wildlife to objectively consider a variety of alternatives and determine their feasibility*." The composition of this team would inevitably arrive at the desired conclusion because they are subject to the preferences of the agriculture industry, i.e. the Forest Service, a branch of the USDA, the DWR in Utah, and of course, the agriculture interests here, meaning the permittees. In this case there was no choice for the Forest Service but to continue permitting domestic sheep grazing at all costs, forgetting it's Public Trust duty.

The Forest Service cannot rely on the MOU between the Forest Service, the BLM, the State of Utah, and the domestic sheep permittees because the MOU was developed in violation of the Federal Advisory Committee Act (FACA), 5 U.S.C. App. II, §§ 2, 9-14. The inclusion of the permittees in the MOU discussions and as parties to the MOU removes any protections that would otherwise apply to intergovernmental communications.

There were additional alternatives considered but these were not analyzed because *"they either did not meet the purpose of and need for the project, did not substantially reduce a resource conflict, or were not implementable."* (FEIS:56) One of those alternatives was to close or modify two or three allotments to reduce the overlap between BHS and domestic sheep. That alternative was not considered for analysis for the reason BHS would still have contact with domestic sheep off the Forest, would create difficulties in allotment management for the remaining open allotments and *"create an economic hardship to the permittees and communities that rely on this area for domestic*

sheep grazing for income and employment." (FEIS:57). There are two permittees on these 10 allotments, so the benefit of these permits accrue to a small number of businesses. We address the flaws in the BHS argument about contact within other jurisdictions later in this objection.

Reasonable alternatives do not have to eliminate all risk of contact, but rather they must be evaluated for how they reduce risk within the Forest Service's control. Economic consequences are to be considered, disclosed, and weighed in the analysis, but do not constitute grounds to exclude alternatives. Furthermore, by defining the primary purpose as compliance with the 2013 settlement and "providing forage for permitted domestic livestock grazing," the agency constrained the decision space to continued authorization of sheep grazing. With that framing, any alternative such as closing the Gilbert Peak allotment, reducing AUMs, or converting allotments to cattle was deemed inconsistent with the Purpose and Need. By dismissing intermediary alternatives that could have reduced risk of contact and addressed viability, the Forest Service structured the analysis so that a plan amendment appeared necessary when other viable alternatives existed.

Another alternative that was considered, but not analyzed, was expanding the analysis to include the West Fork Blacks Fork (WFBF) allotment. This alternative was not addressed because it was analyzed with an EIS and Decision in 2009. That is almost a full Forest Planning period gone by, but the principle reason requested for its analysis besides the serious degradation we have documented on that allotment, BHS and other issues, is that historically sheep were driven up the West Fork Blacks Fork to the Ottoson and Lake Fork areas, then trailed back through the East Fork Blacks Fork or the reverse.

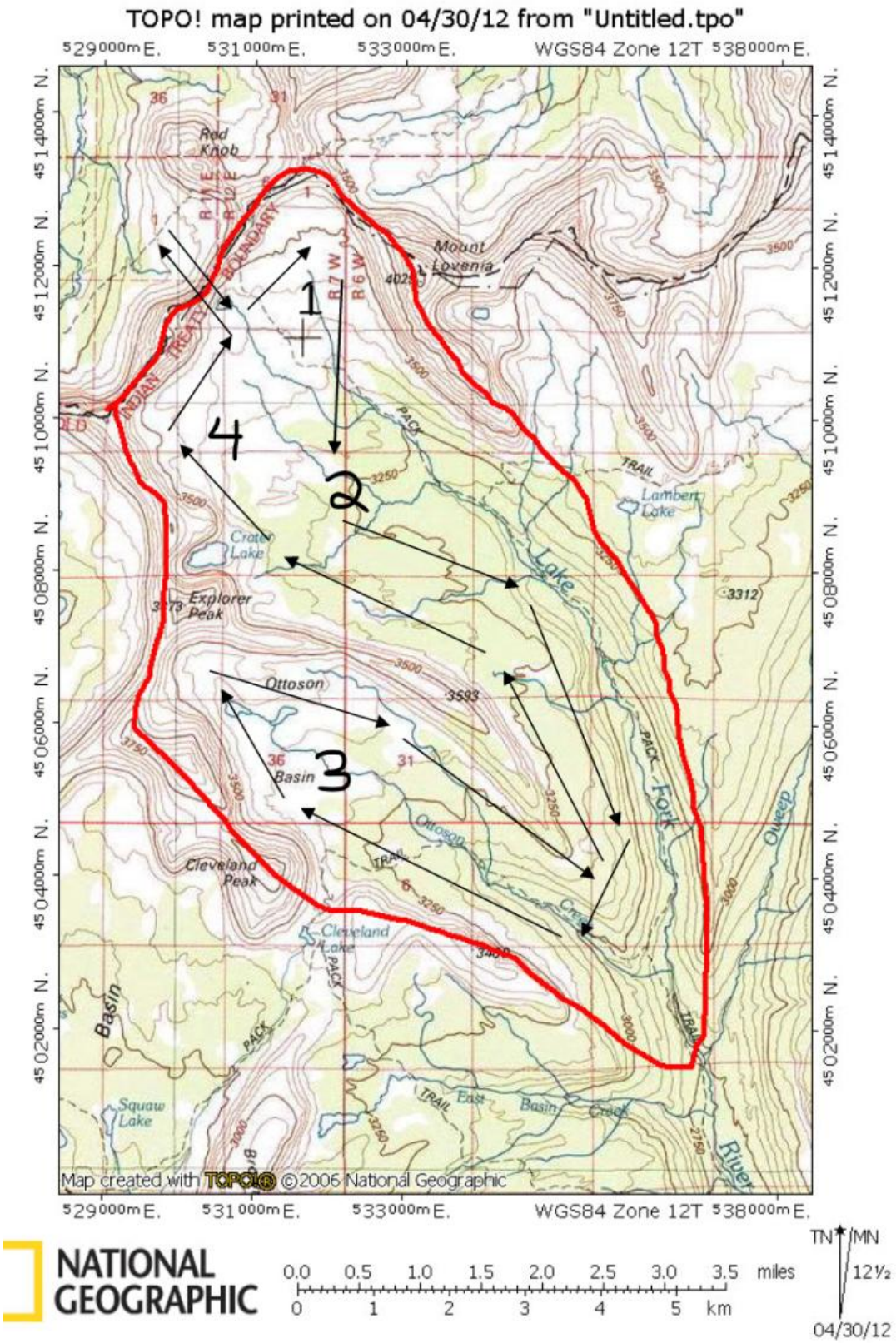
In our June 27, 2014 and July 13, 2014 Scoping Comments, as well as in our attached August 28, 2023 coalition comments (Attachment 1) on the SDEIS we requested the WFBF allotment be added to the analysis due to the trailing back and forth to the Ashley NF allotments, particularly the Ottoson allotment which is being analyzed in this current NEPA process.

Chapter 3 of the DEIS for the West Fork Black's Fork [3](2005) notes that *"Sheep Trailing – A sheep herd is permitted to trail across the allotment in the early summer as it travels to an allotment on the Ashley National Forest; this same herd trails across the allotment again in the fall as they travel home from the Ashley National Forest."* (WFBF DEIS:3-19). The 2025 AOI for the Ottoson Allotment shows sheep being trailed in and out of the West Fork Blacks Fork Allotment to the Ottoson Allotment. (Figure 1). Figure 2 shows the allotment boundaries of Ottoson, WFBF and EFBF. The historical trailing of sheep to and from the Ottoson allotment through the WFBF and in

[3] USDA Forest Service. 2005. Draft Environmental Impact Statement West Fork Blacks' Fork Allotment Management Plan.

recent years, if the AOIs are to be believed, sheep are trailed to and from Ottoson through the WFBF. Whether they travel through the EFBF is an open question that needs to be addressed by the Forest Service, but there can be no question that for the years we have AOIs for Ottoson, they are trailed into the WFBF. The WFBF is connected to this current project and must be included. Finally, the Fall Creek allotment has not been grazed by livestock since 1977. An alternative should have included permanent closure of this allotment since grazing ceased before the Utah Wilderness Act was in place.

Figure 1. Ottoson Allotment 2025 Grazing Sequence



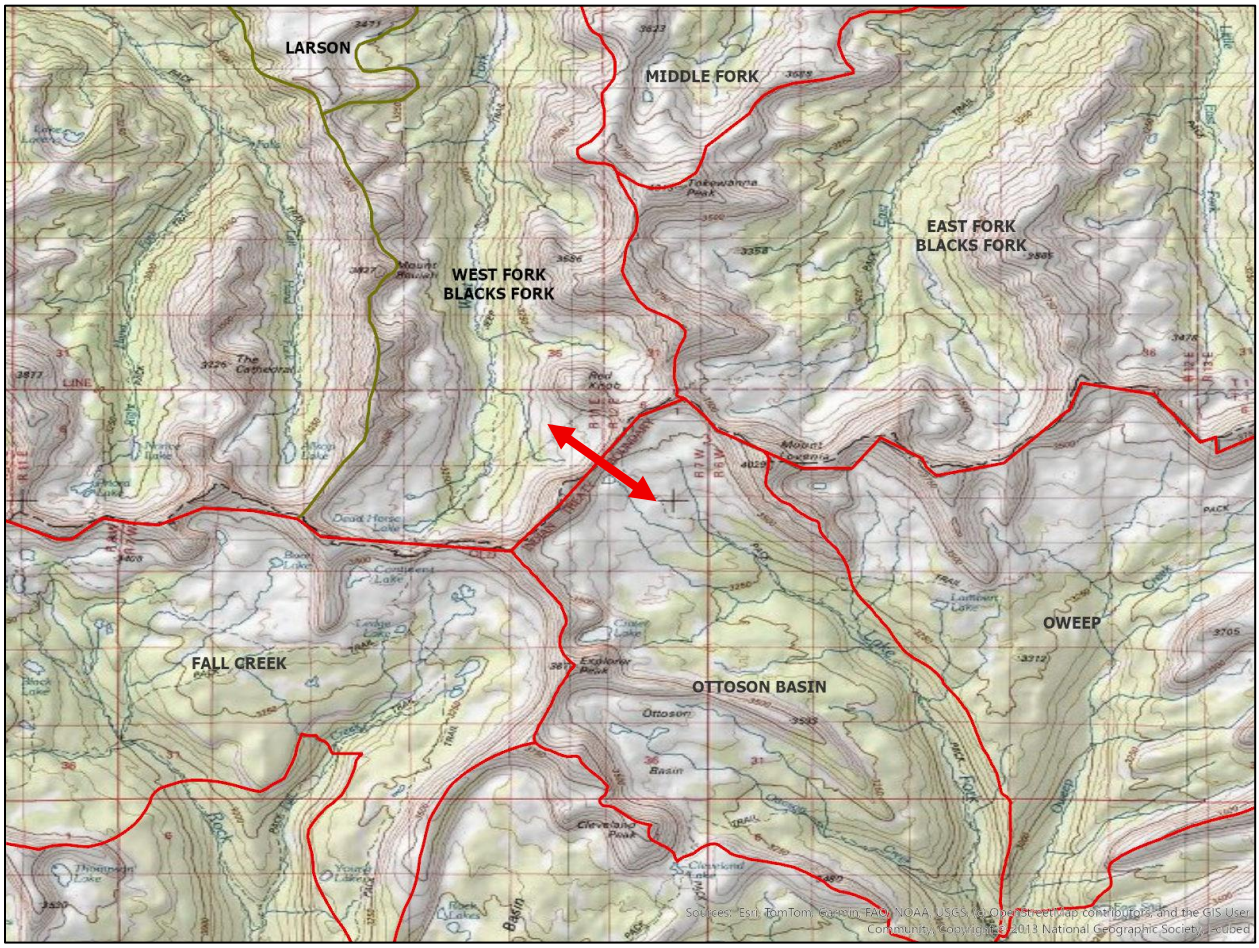


Figure 2. Allotment map with Ottoson trailing shown (red arrow)

4. Forest Plan Amendment and Bighorn Sheep

The Draft ROD:42 states that the *"amendment is necessary because the WC plan area alone cannot meet the WC viability subgoal in relation to BHS."* The Forest Service describes the five herds using both the Wasatch Cache and Ashley NFs *"are not by themselves a viable population but in combination with the other herds they interact with and the other lands that provide habitat, as well as with continued UDWR management of this species, we expect viability of BHS in the larger area will be maintained for the foreseeable future."* (DROD:42). The FEIS Appendix B describes the Forest Plan Amendment to *"ensure consistency"* between the two plan areas and applies to the Wasatch-Cache plan area. The project was developed for *"the other main purpose of this project … to provide forage for permitted domestic livestock grazing…"* (B-1).

The Forest Service, UDWR, Utah Department of Agriculture and two of the three grazing permittees finalized a memorandum of understanding in 2022. (B-3). The MOU identifies site-specific strategies to *"minimize the comingling risk between the species".* The Wasatch-Cache RFP:4-19 stated a goal to *"Manage Forest Service sensitive species to prevent them from being classified as threatened or endangered…"* citing FSM 2670.

FEIS:128 *"Bighorn sheep prefer open habitat types (high alpine to lower grasslands) with adjacent steep rocky areas for escape and safety (UDWR 2018d; Shackleton 1985). Habitat is characterized by rugged terrain including canyons, gulches, talus cliffs, steep slopes, mountaintops, and river benches (UDWR 2018d).'* Yet, the FEIS:149 states that *"BHS generally use the ridge tops and steep slopes for foraging, whereas domestic sheep generally use the valley bottoms."* Here, the Forest Service is at odds with itself and appears to not understand that domestic sheep are driven, trailed, and grazed from valley bottom to ridgetop by design. There is no separation between BHS and domestic sheep based on topography or vegetation.

FEIS: 129 *"A mountain goat harvested in 2018 was the first mountain goat to test positive with Mycoplasma ovipneumonia in the Uinta mountains and the prevalence of the pathogen in the mountain goat herds in the Uinta mountains is uncertain (UDWR 2019d)."* Here, the UDWR documents the result of its own introduction of mountain goats to the High Uintas Wilderness. We have observed them in lower elevations, particularly in the Uinta River and Painter Basin area. *"Other factors affecting BHS populations include habitat loss and disturbance, habitat condition, predation, forage competition, and climate/weather (USFS 2021; UDWR 2019c; UDWR 2018d)."* The presence of mountain goats is an additive risk affecting BHS.

FEIS:130 *"The allotments in this analysis occur in proximity to the area used by the North Slope Uintas BHS herds and BHS habitat occurs in all 10 allotments (USFS 2021; UDWR 2019c; UDWR 2018b). Bighorn sheep were recorded in the Uintas as early as 1849, but by 1930 it was evident that reproducing BHS in the Uintas did not exist (USFS 2021; UDWR 2019c; UDWR 2018b)". "…herd estimates have fluctuated over time. These fluctuations have been the result of disease, mountain lion predation, reintroductions, augmentations, removal, and culling (USFS 2021; UDWR 2019c; UDWR 2018d)."* Clearly, BHS were eliminated in the Uintas by 1930, and there is no logical explanation other than the domination of the landscape by domestic sheep in that era. Yet, the Forest Service is promoting the continuation of the practice that led to BHS demise. FEIS:131*"The combined herd total was still over 200 individuals when it started to decline again in 2013 due to disease (bronchopneumonia) (USFS 2021; UDWR 2019c)."*

FEIS:132 *"The UDWR has a large data set of local herd data (North Slope Uintas BHS data, including 225,000+ BHS locations), and we used that data in the ROC model and in estimating summer (May-October) and winter (November-April) CHHRs for the North Slope Uintas BHS herds (USFS 2021)."* As we note below, some 80,000 of those BHS locations were discounted and not used. Where were those BHS located?

Table 24 FEIS:133 uses a one-to-two-year overlap for its ROC based on the days domestic sheep are on the allotment. The number of days used for summer was 184 days and 181 for winter and dividing these into the days domestic sheep are present. This omits consideration of strays which we have observed long after the end of the summer grazing period and also does not take into account the presence of infectious products in the soil, water, and vegetation, and domestic sheep manure that will be there throughout the year for several years.

FEIS:144 *"…the results of the model indicate a "high" ROC (because of overlap with the CHHR) with two Forest Service allotments (Gilbert Peak and Painter Basin), one BLM domestic sheep allotment, and six private land mile sections; a "moderate" ROC with one Forest Service allotment (Hessie Lake-Henry's Fork); and a "low" or "no" ROC with the remaining Forest Service allotments, BLM allotments, and private lands with domestic sheep use (USFS 2021). " "All the overlap and nearly all the ROC that is on Forest Service lands occurs on the western edge of the CHHR (USFS 2021). Thus, nearly all the CHHR has no overlap with Forest Service domestic sheep allotments."* The FEIS discounts BHS forays up to 14 miles or more, stray domestic sheep, and contaminated environmental media.

FEIS:145 describes incomplete and unavailable information, including the lack of data from private lands, habitat disturbance from grazing *"would be considered substantial if it is determined that grazing would permanently displace wildlife, or if grazing would inhibit vegetative communities (habitats) on the allotments from meeting satisfactory/desired condition."* Then the FEIS relies on the vegetative monitoring studies to claim that *"plant composition, structure, and ground cover in all habitat types affected by grazing are in satisfactory condition…"* Here, reliance on the range and vegetation reports leads the wildlife discipline down the primrose path as we will show in the following sections. It appears the powers of observation are lacking among staff.

In our past scoping comments and comments on the DEIS (Attachment 2), we have addressed bighorn sheep issues. Review of the FEIS validates those points already made. These points were expanded in our August 28, 2023 comments on the SDEIS (Attachment 1). These are summarized here and referenced to the pages in those comments.

SDEIS Comment:21-24

- Bighorn sheep suitable habitat based on the UDWR 2014 model shows suitable habitat throughout the 10 allotments plus the WFBF.
- The WAFWA 9-mile buffer shows intermingling or contact possible in 7 of the project allotments.
- The WCNF RFP ROD lists seven of the project allotments plus the WFBF as suitable for closure.
- The SDEIS claimed separation of the domestic and bighorn sheep is maintained because the bighorns use ridge tops and steep slopes while domestic sheep use the valley bottoms. We refuted this based on our observations of domestic sheep on ridge tops and on steep slopes.

In addition, domestic sheep are trailed across the ridges from the UWCNF to the ANF allotments.

- We pointed out the historical trailing of domestic sheep through the WFBF to the ANF allotments, particularly Ottoson.

SDEIS Comment:37-42

- The premise that there is no need to address risks on Forest Service lands because there is also risk from other lands is faulty. The Forest Service has a duty under its own regulations to avoid contributing to the risk of disease transmission that could kill off one or more bighorn herds.
- Assumes because *M.ovipneumoniae* is present in bighorn herds there is no additional harm from transmission, but this omits the risk from other strains of *M.ovi*. In fact, there are many strains and infection by one does not imply protection from other strains.
- Cited Dr. Thomas Besser research wherein introduction of a new strain resulted in all bighorn sheep symptomatic and 30% died. There is no cross-strain immunity.
- The Forest Plan Amendment is flawed by failure to follow the 2012 NFMA regulations by not identifying and analyzing which substantive requirements from the regulations are directly related to the plan direction being removed.
- The interpretation that the Forest Service does not need to maintain viability of any wildlife population that uses non-Forest lands would then apply to all wildlife populations. The Forest Service must ensure that its actions maintain viability even if harm is caused off the Forest.
- Viability requires sufficient animals for a self-sustaining population in the long term. Augmenting populations is not self-sustaining.
- The Forest Plan amendment only applies to the Wasatch-Cache NF and not the Ashely NF which remains subject to the NFMA viability rule. The 1986 Forest Plan for the Ashley NF has a standard to maintain or improve diversity of fish and wildlife populations.
- The MOU is invalid because it was developed in violation of the Federal Advisory Committee Act by including the permittees in the MOU discussions.
- The MOU premise that BMPs will protect BHS is false as WAFWA has stated that *"management practices designed to reduce risk of association are not proven and therefore should not be solely relied upon…"*
- No scientific analysis of BMPs' effectiveness was provided.
- Stray domestic sheep are common in this rugged terrain, the delays between infection and disease onset, onset and death make it impossible to trace the origin of infection.
- BMPs are not legally enforceable to protect BHS, lack scientific support and don't meet the Forest Services' legal duty to maintain viability.
- The Risk of Contact Analysis is flawed.
- It did not consider stray domestic sheep.
    - The BHS 2021 assessment indicated the longest foray of BHS in summer was 14.3 miles, but this did not make it into the ROC analysis with the result that BHS risk

was determined moderate and low risk for the Hessie's Lake/Henry's Fork and Tungsten allotments even though BHS are documented at the eastern edge of both.
    - Our mapping analysis of WAFWA's 9-mile buffer showed overlap with most of the allotments under analysis.
    - The SDEIS analysis of ROC is almost four times higher than the Wild Sheep Working Group recommended rate.
    - Some 80,000 location data points for BHS were omitted from the analysis.
- The SDEIS only looked at risk by combining all BHS herds into one with the result there is no herd-level viability analysis and no analysis of what the impact to the meta-population would be if one or more herds were lost.
- Each herd only contains 20 – 30 individuals with the Hoop Lake herd at highest risk. A new strain of *M.ovi* could wipe out any of these herds.
- Closing these allotments would significantly reduce the risk to BHS Hoop Lake and other herds.
- The Range of Alternatives is flawed and should have included reducing the number of allotments with BHS exposure and another that would close the allotments within the 9-mile buffer.

The FEIS:xiii notes that *"We prepared the SDEIS because of new information that led to a need for specific changes or additions to the DEIS, including new data and results related to the risk of contact model regarding potential disease transmission from domestic sheep to Rocky Mountain bighorn sheep (BHS). This led to a need to revise the BHS analysis." "We added additional measures to the proposed action (to reduce the potential interaction and disease transmission between domestic sheep and BHS) based on the August 2022 memorandum of understanding (MOU) entitled Bighorn Sheep and Domestic Sheep Management – Nine Allotments in Gilbert Peak Area of the Uinta Mountain Range (UDWR et al. 2022)."*

We addressed the MOU above. It was a violation of FACA and is unenforceable and voluntary. The other management considerations included in Alternative 2 are also discretionary and without enforcement. This leaves the ROC. FEIS Table 2 describes the risk of Alternative 2 to bighorn sheep as high for Gilbert Peak and Painter Basin, Moderate for Hessie Lake-Henry's Fork, and low for Tungsten, Red Castle, East Fork-Blacks Fork, Middle Fork-Black's Fork, Oweep, and Ottoson. The ungrazed Fall Creek allotment is given a ROC of zero. Statistically, however, the probability of a bighorn sheep contacting the disease is either 0 or 1. Given the residence time of the bacteria in soil, vegetation, water or domestic sheep manure as we have observed, resting allotments for only one year does not alleviate the risk.

The SDEIS analysis assumed that because there is (1) already *M. ovipneumoniae* (hereinafter *"M.ovi"*) in the High Uintas bighorn herds, and (2) the Forest Service has no control over the high-risk BLM and private land allotments, there is no additional harm from transmission of

M.ovi from the National Forest allotments. But in fact, there are many strains of *M.ovi*, such that infection with one strain will not prevent future infection by another strain.[4]

In a 2017 study, the authors found that *"… introduction of a new genotype (strain) of M. ovipneumoniae into a chronically infected bighorn sheep population in the Hells Canyon region of Washington and Oregon was accompanied by adult morbidity (100%) and pneumonia-induced mortality (33%) similar to that reported in epizootics following exposure of naïve bighorn sheep. This suggests an immune mismatch occurred that led to ineffective cross-strain protection."*[5] Dr. Thomas Besser, one of the country's foremost experts on bighorn infectious disease research, goes on say about this study that *"In this paper we documented introduction of a new M. ovipneumoniae strain that triggered a dramatic change in the pattern of disease: all adult ewes developed signs of pneumonia (morbidity) and 30% died (mortality). The lambs again experienced a fatal pneumonia outbreak, primarily triggered by lung infections with the newly introduced M. ovipneumoniae strain. The finding of lack of cross-strain immunity has since been repeated elsewhere, confirming that the limited immunity that bighorn sheep may develop to a strain of M. ovipneumoniae with which they have been infected for years fails to consistently protect them from genetically novel strains that they may encounter."*[6]

Thus, despite claims to the contrary in the SDEIS or FEIS, the additional risk caused by any Forest Service domestic sheep allotment does indeed increase risk to the High Uintas bighorn herds—regardless of any other risk posed by domestic sheep grazing in BLM and private allotments.

In addition, the SDEIS suggested that sources other than domestic sheep may be at play in transmitting *M.ovi* to bighorn sheep. The science does not support that supposition: *"While M. ovipneumoniae has recently been reported in species other than sheep and goats (Caprinae), neither its ability to persist in these hosts for long periods of time, nor the ability of these non-Caprinae hosts to transmit the pathogen to bighorn sheep has been demonstrated, and the low carriage prevalence and the low genetic diversity of M. ovipneumoniae in non-Caprinae hosts are not consistent with them representing a separate reservoir for bighorn sheep infection."*[7] *"Domestic goats also pose a definite risk to bighorn sheep due to their M. ovipneumoniae reservoir status, although limited current data shows that goat sources tend to cause less severe and less persistent bighorn disease. In contrast, non-Caprinae species have not yet been shown to present any risk of transmitting M. ovipneumoniae to bighorn sheep."*[8] Moreover, *M.ovi* is extremely common in domestic sheep: the USDA National Animal Health Monitoring Service Sheep 2011 project, a national survey of domestic sheep operations, detected

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[4] Declaration of Dr. Thomas Besser, ¶ 40, February 26, 2021, filed in *WildEarth Guardians et al. v. Kristin Bail et al*., Case 2:20-cv-00440-RMP (E.Dist. WA). Attached as Exhibit 3.

[5] Cassirer EF, Manlove KR, Plowright RK, Besser TE. 2017. Evidence for strain-specific immunity to pneumonia in bighorn sheep. J Wildlife Mgmt 81(1)133-143. Attached as Exhibit 4.

[6] Declaration of Dr. Thomas Besser, ¶ 29.

[7] *Id.*, at ¶ 26.

[8] *Id.*

M.ovi infections in approximately 90% of domestic sheep operations sampled, including in all operations larger than 500 head involved in the study.[9]

In sum, the science is clear that allotments on the two National Forests are seriously problematic for the High Uinta's sheep herds irrespective of risks emanating from BLM-managed and private lands. And that risk cannot be downplayed through implications that bighorns might be contracting *M.ovi* from other animals. Once again, the risk must consider the foray distances for BHS, domestic sheep strays left behind, and contamination of environmental media.

The creative interpretation being attempted here—that the Forest Service does not need to maintain viability if any wildlife population also uses non-Forest Service lands and has threats on those lands—would conceivably apply to virtually all fish and wildlife populations. This proposed forest plan amendment is an unreasonable interpretation that the Forest Service is only applying to bighorn sheep and is contrary to prior long-standing interpretation by the agency. The Forest Service has the responsibility to ensure its own actions maintain viability even if other parties cause harm off of the forest.

Redefining viability at a "metapopulation" scale is not an application of 36 C.F.R. § 219.9, it is a waiver. Each plan is required to maintain viable populations of species of conservation concern within its own plan area. By striking Subgoal 3i for bighorn sheep and offering no new standards or guidelines to ensure viability, the Forest Service has reduced protections for bighorn sheep. In an example of the agency doing the opposite, the Payette National Forest in 2010 adopted an amendment that directly addressed bighorn viability. That amendment closed "high risk" allotments and modified management to reduce contact risk, and the Ninth Circuit later upheld it in Idaho Wool Growers v. Vilsack (2016). The court confirmed the agency's authority to amend a plan to meet the viability requirement rather than erase it, which is being done here. By removing the viability requirement rather than adjusting management to comply, the agency sets a precedent that undercuts NFMA's viability mandate as well as the 2012 Planning Rule itself.

By removing the plan provision, the Forest Service could take actions that would impair viability and yet wouldn't be inconsistent with Plan. That is a significant change that was not analyzed and does not meet the substantive requirements for ecological sustainability and diversity of plant and animal communities.

We also find it interesting that the forest plan amendment was proposed for only the Wasatch-Cache National Forest and not the Ashley National Forest. The Ashley Forest Plan dates to 1986 and is thus subject to NFMA's viability rule. In addition, the Ashley Plan contains a standard to

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[9] *Id.*, at ¶ 24.

manage fish and wildlife habitat to maintain or improve diversity and productivity.[10] That standard is not addressed in the SDEIS.

Moreover, the overarching concept of the MOU is that Best Management Practices (BMPs) will adequately protect bighorn from domestic sheep. They won't. The Western Association of Fish and Wildlife Agencies (WAFWA) Guidelines, 2009, specifically state on page 15: *"Effectiveness of management practices designed to reduce risk of association are not proven and therefore should not be solely relied upon to achieve effective separation."*

And even if BMPs were effective at maintaining separation (they aren't), the Forest Service must provide a scientific analysis of the effectiveness of the BMPs, which they haven't. Perhaps that is because it is not possible to do so. One U.S. District Court has already concluded that, in the absence of scientific analysis, BMPs could not be relied upon to maintain separation.[11]

There is also the practicality of enacting BMPs in such rugged and remote terrain. Herders cannot always watch every sheep, and strays are common. In addition, the delays between infection and disease onset, and between disease onset and death, make it impossible to identify the specific moment of transmission or the specific animals involved in a *M.ovi* transmission event.[12] Therefore, tracing any disease transmission event back to its origin is virtually impossible. In short, courts have found similar BMPs and MOUs that are not legally enforceable insufficient to protect bighorn sheep, lacking in scientific support, and thus not adequate to meet the Forest Service's legal duties to maintain viable populations of bighorns.

The Forest Service admits that the actions of UDWR, UDAF, and permittees are not part of the proposed action but are only "considered" in the wildlife analysis. So, the analysis evaluates outcomes as if those outside actions (beyond the agency's scope of authority) will occur. This exaggerates the level of protection secured by the amendment, while the plan itself has lost the binding viability requirement it once contained.

The risk analysis doesn't even mention, let alone consider, stray domestic sheep or contamination of environmental media domestic sheep waste. It is very common for strays to stay behind for days or even weeks after the primary domestic sheep herds are moved off the allotments. In one recent analysis on the Gunnison BLM District in Colorado, Colorado Parks & Wildlife documented 25 stray domestic sheep occurrences over just a few years. And those constituted only the documented occurrences. Unless the Forest Service is going to consider

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[10] USDA Forest Service. 1986. Ashley National Forest land and resource management plan, final environmental impact statement, and record of decision. At IV-32.

[11] *Western Watersheds Project v. Bureau of Land Management*, U.S. District Court for the District of Idaho, Civ. No. 09-0507-E-BLW, Decision and Order, October 14, 2009. https://casetext.com/case/western-watersheds-project-v-bureau-of-land-management-4

[12] Declaration of Dr. Thomas Besser, ¶ 34.

strays as an important factor in this analysis, we challenge the agency to demonstrate that strays are not an issue in this analysis area.

The Uinta's Bighorn Sheep Assessment from May 2021 indicates that the longest summer ram foray was 14.3 miles, while the longest winter ram foray was 5.6 miles. This data does not seem to have made it into the ROC analysis. Instead, the risk assessment somehow determined that the Hessie's Lake/Henry's Fork and Tungsten allotments are rated moderate and low risk even though bighorns are documented coming right up to the eastern edge of these two allotments. It is unreasonable, and contrary to agency practice and guidance, to only consider overlap with allotments as high risk to bighorn sheep. The ROC analysis shows the Hessie's Lake/Henry's Fork and Tungsten allotments are also high risk based on the contact rate and disease interval results from the model. As the Tenth Circuit recently found, diverting from the results of the model without scientific support is arbitrary and unreasonable. Note that opinion cites the Snow Mesa and Wishbone Sheep Allotments Volume II Assessment of Risk of Physical Contact between Rocky Mountain Bighorn Sheep and Domestic Sheep Allotments in the Snow Mesa and Wishbone Grazing Landscape where *"disease outbreaks of every 32 years or less would result in a bighorn sheep population that, although potentially in the initial stages of recovery [from 1990s outbreaks], would be constantly exposed to ongoing disease transmission events and resultant outbreaks."* (See Attachment 8 for the opinion). This is less than the 50 years recommended by the WSWG.

Using the 2014 UDWR habitat model for bighorn sheep, we mapped the Uinta Mountains and the project allotments. This shows high value bighorn sheep habitat occurs across the project area and not just on ridgetops. (Figure 3). In addition, we used the bighorn location data using WAFWA's suggested 9-mile buffer from the western-most documented bighorns, and that map (Figure 4) indicates substantial overlap with most of the allotments under analysis here.

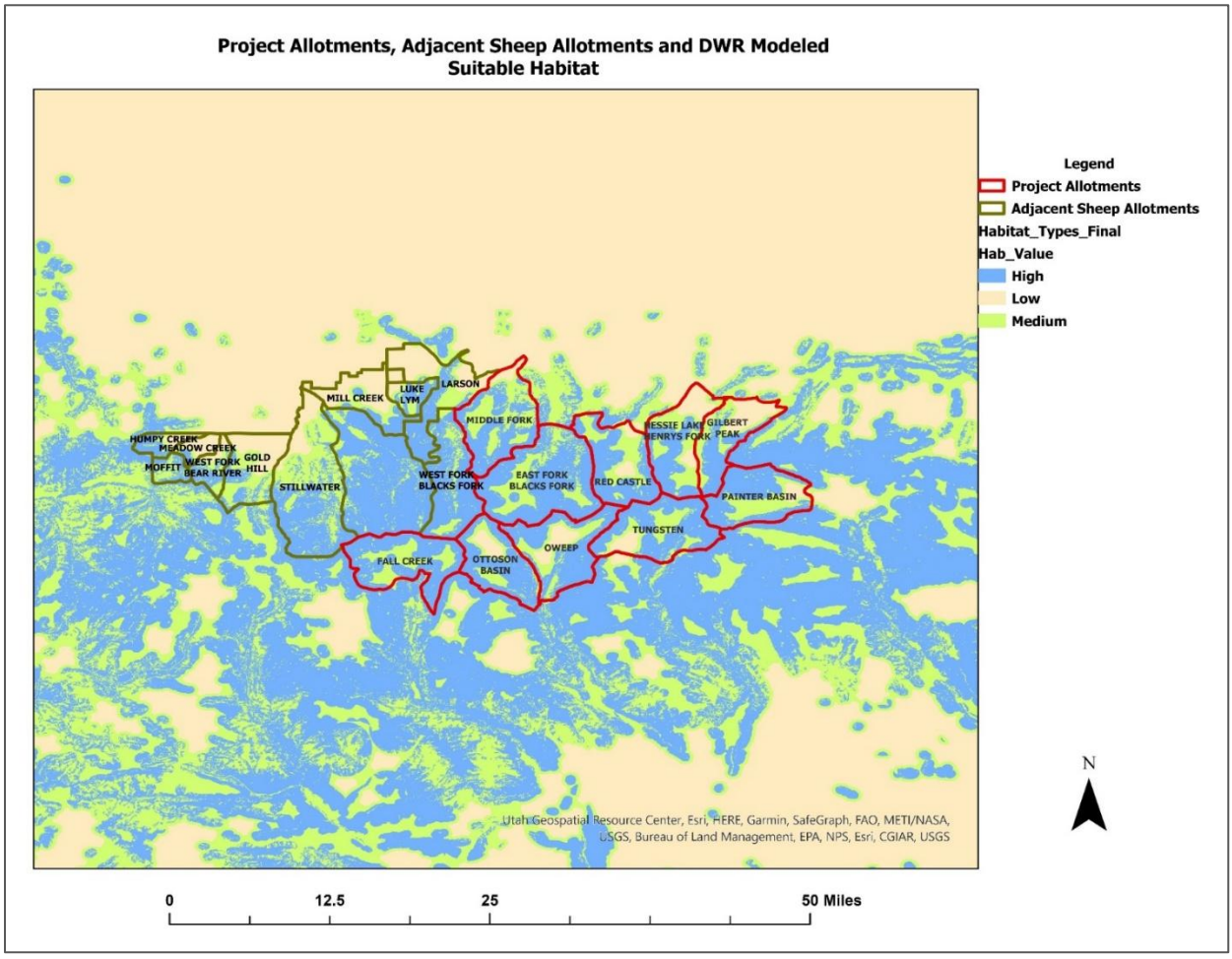


Figure 3. UDWR Model showing high value habitat for BHS across the project allotments.

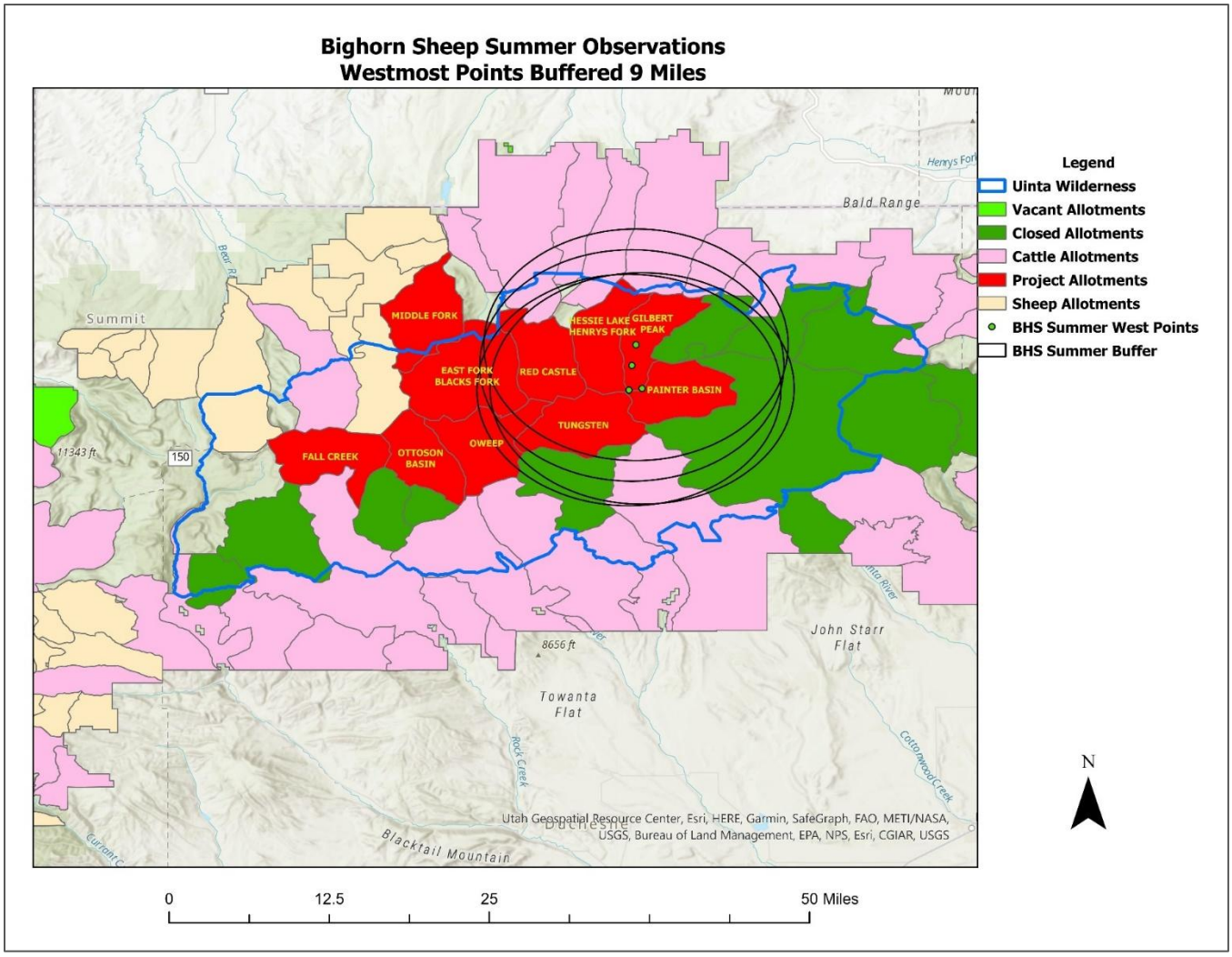


Figure 4. Project allotments with nine-mile buffer shown.

Keep in mind that our map uses a 9-mile buffer, not the 14.3-mile buffer that UDRW's own data indicates. Using the 14.3 miles would add additional allotments. The maps in the SDEIS at Figures 33 & 34 support our contention that the risk assessment artificially reduces the risk for all but 2 eastern allotments. Based on those two maps (Figure 3 and 4), at a minimum we should be discussing closure of 8 allotments: Gilbert Peak, Painter Basin, Hessie Lake/Henry's Fork, Tungsten, Red Castle, East Fork Blacks Fork, Oweep and likely Ottoson Basin.. Anything else is inconsistent with the analysis in the SDEIS and FEIS.

The Wild Sheep Working Group has advised that results of the Risk of Contact Tool may be interpreted as follows: *"Given the potential severity of die-off resulting from interspecies contact, we recommend management scenarios that allow for disease free intervals of at least 50 years. If we assume a moderate probability of contact with an allotment resulting in an interspecies contact that will result in a disease transmission outbreak event (0.25), then we would need to see a rate of contact of less than 0.08 contacts per year (or less than 0.8 contacts per decade)."* (WSWG 2012).[13] In addition, the ROC Tool as applied and approved by the court in the years of litigation over the Payette National Forest decision to curtail domestic sheep grazing provides more support for using the WSWG rate of contact. In the Payette analysis, the ROC Tool was also run using the same rate of contact (that is, 0.25, or 1 in 4) indicating an average outbreak period of 50 years.

Instead, the analysis determines that a cumulative contact rate of 0.304—or almost 4 times higher than the WSWG recommended contact rate—is adequate to maintain these herds. (And again, we question these ROC numbers since strays were not considered and the SDEIS maps are inconsistent with the risk ratings.) The SDEIS conclusions rely on arbitrary contact rates of "high," "medium," and "low" that have no basis in the scientific literature. And even if one accepted these arbitrary labels, there is no attempt at justifying why only the "high" risk allotments are being considered for closure when one "medium" risk allotment demonstrates a contact rate of .106 (Hessie Lake/Henry's Fork), which is well above the 0.08 recommended by WSWG.

The 0.304 contact rate equates to one bighorn contact with an allotment approximately every 3.3 years. Compare this to the WSWG recommendation that management should allow for disease free intervals of at least 50 years. The failure to use 80,000 bighorn location data points is suspicious. We do not comprehend how a collar can be placed on a bighorn without noting the sex of the animal, yet even if that is true those data points should've been tagged as female rather than deleted from the analysis.

The FEIS only looks at risk at the meta-population scale by combining all herds into one, but the record indicates there is one herd that is most at risk: Hoop Lake. There is no map of individual herd locations, but the FEIS discusses 5 herds, and one that is closest to the allotments. That would be the herd with overlap with 2 allotments and very close to 2 more, which means it is at the highest risk of disease. The FEIS does not discuss what the impact to meta-population would be from loss of that one herd in terms of reduction of geographic distribution and loss of

[13] See also Lyons et al. 2016. Final Report: Application of the Bighorn Sheep Risk of Contact Model on the Okanogan-Wenatchee National Forest. Washington Conservation Science Institute. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd512632.pdf

genetic diversity. In addition, there is no viability analysis at the herd level, just at the overall meta-population level.

All the impacted bighorn herds are very small. Even though the meta-population has about 150 animals, each herd only has about 20-30. Hoop Lake, at highest risk, has only about 20. And assuming the Hoop Lake herd is on the western end of the CHHR closest to the Forest Service allotments, it is not close to BLM land or private land. Thus, the Forest Service allotments are the greatest risk to that herd and are likely the cause of its continuing disease issues. Maintaining low numbers of animals for long time puts herd at risk of inbreeding or loss during stochastic events. All herds have experienced recurring disease which keeps them small and prevents full recovery, yet as discussed above, a new strain of *M.ovi* could wipe out any of these herds.

The meta-population approach minimizes the impacts to the Hoop Lake herd. That herd has had a stagnant growth rate and low numbers of animals for a decade because disease is likely suppressing growth. The Forest Service allotments are the main risk to this herd and closing those allotments would significantly reduce the risk. The FEIS identifies Gilbert Peak, a WCNF allotment, as "high risk," with the ROC model predicting one or more contacts per year. Because the Hoop Lake herd is the only herd occurring in the WCNF plan area, this risk affects the Hoop Lake herd. The record therefore documents a high risk of contact and pathogen transmission to the Hoop Lake herd inside the plan area.

5. Capability and Suitability

FEIS:32 "We evaluated range capability and suitability in separate reports. These reports were last updated in 2025 (see project record)." The Draft ROD states: *"We evaluated rangeland suitability and capability in separate reports and addressed comments on this in our responses to comments. The rangeland suitability and capability reports and maps were last updated in 2025 (see project record). The project complies with both the Ashley Forest Plan and the Wasatch-Cache Forest Plan regarding suitability and capability and the grazed portions of the project area are considered suitable for and capable of sustaining domestic livestock grazing."*

The FEIS:163 provided Figure 23 noting the *"late persisting snowbeds".* The photo was taken on July 27, 1995. (See Figure 5 below). This is after trailing and grazing has begun in these areas regardless of wet soils and new plant growth that is sensitive to defoliation during active growth.



Figure 23 - Aerial view of the head of Lake Fork drainage. Photo taken 27 July 1995 depicts numerous alpine plant communities influenced by topography, aspect, wind, and snow accumulation. Note the numerous late persisting snowbeds.

Figure 5. Illustration from the FEIS

The AOIs show sheep enter the project allotments two weeks before this and are trailed and grazed into the Ashley NF allotments within a few days. This means the soil is wet and easily damaged by trampling, while plant communities have either not begun growth or are in the very early stages of active growth. Grazing during this sensitive period places the plants at risk. On the driveway, tens of thousands of sheep are grazing and trampling the plants and soil during this period each year. There is no rest and as a well-known range management textbook notes: *"when a range is repeatedly overgrazed, the metabolic reserve is depleted, the root system shrinks, and ultimately the plant dies…"*[14]. (p126). Regarding soil erosion, they also note: *"The primary effect of hoof action is compaction of the soil surface. Removal of cover and soil compaction reduce water infiltration rates, increase runoff, and increase erosion."* (p379). These are well-known principles of range and soil science. As we will show, up until the early 1990s, range staff acknowledged the limitations and damage of grazing these sensitive areas. Since that time, the effort has lacked

[14] Holechek, J.L., Pieper, R.D., and Herbel, C.H. 2004. Range Management Principles and Practices. Fifth Edition.

ecological insight and has sought to deflect around the impacts of grazing tens of thousands of domestic sheep in these steep and erodible landcapes.

The WCNF RFP FEIS used the Region 4 Protocol[15] to identify the areas with the physical characteristics conducive to livestock grazing.[16] Appendix B-9 to the RFP FEIS detailed the process but omitted most characteristics present in the Protocol. As outlined in the Protocol, 36 CFR 219.20 requires a determination of rangeland capability and suitability. The factors include:

- Areas with less than 30% slopes for cattle and less than 45% slopes for sheep.
- Areas producing more than or having the potential to produce an average of 200 lbs. of forage/acre on an air dry basis over the planning period.
- Areas with naturally resilient soils (not unstable or highly erodible soils).
- Areas where ground cover (vegetation, litter, rock > ¾ in.) is sufficient to protect soil from eroise. The minimum percentage cover will be 60% unless local data is available for use in setting more specific ground cover requirements.
- Areas accessible to livestock (without such factors as dense timber, rock, or other physical barriers).
- Areas within 1 mile of water or where the ability to provide water exists.

The WCNF RFP analysis only used slope and a vegetation coverage as a surrogate for forage production that omitted coniferous vegetation types and barren areas. In 2016, we conducted on-ground forage data collection across the soil types in the project allotments and applied the Protocol to determine capable acres for the project area allotments. In 2018, this was presented to the UWCNF and Ashley NF Supervisors and staff in a Report[17] and a PowerPoint.[18] In 2020, our analysis was published in the Journal of Geographic Information Systems.[19] We recently received a letter from Editor of the Boston Research Journals which is an international research journal. The Editor wrote: *"I have recently read your research article titled Spatial Analysis of Livestock Grazing and Forest Service Management in the High Uintas Wilderness Utah. It is remarkable*

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[15] USDA Forest Service. 1998. Intermountain Region Protocol: Rangeland Capability and Suitability Determinations for Forest Plan Revisions. Intermountain Region Office. Ogden, UT.
[16] USDA Wasatch Cache National Forest. 2003. Final Environmental Impact Statement Summary Wasatch Cache National Forest. P3-349.
[17] Vasquez, E., Carter, J., and Jones, A. 2018. A Forage Capacity and Stocking Rate Determination for the High Uintas Wilderness Domestic Sheep Analysis. Wild Utah Project and Yellowstone to Uintas Connection. 94p. https://app.box.com/s/2c8dgun6na1v71zlew9oczpzq3nb27mo
[18] Vasquez, E., Carter, J., and Jones, A. 2018. Uinta Sheep Capability and Stocking Rates. Wild Utah Project and Yellowstone to Uintas Connection. https://app.box.com/s/u0rfho3iws7eiazquo16ou4pdsnwcbde
[19] Carter, J., Vasquez, E. and Jones, A. (2020) Spatial Analysis of Livestock Grazing and Forest Service Management in the High Uintas Wilderness, Utah. Journal of Geographic Information System, 12, 45-69. https://doi.org/10.4236/jgis.2020.122003

for its path-breaking and rational approach. Your research aptitude and in-depth understanding of the subject prompted me to discuss your paper with my team which is of the opinion that such research work can enlighten and inspire fellow researchers and scholars."

We analyzed current forage production (2016 samples) to that determined by the Forest Service in the 1960's finding that median forage production appears to have declined since the 1960's and was less than the 200 lb/acre criterion.

We applied the Protocol in a stepwise analysis as outlined:

1. USFS with slope <45%, minimum 200 lb/acre, without dense timber, rock or other physical barriers. Capable acres = 57,399.
2. USFS with slope <45%, minimum 200 lb/acre, without dense timber, rock or other physical barriers, and excluding water bodies. Capable acres = 36,695.
3. USFS with slope <45%, minimum 200 lb/acre, without dense timber, rock or other physical barriers, excluding water bodies and wetlands. Capable acres = 31,384.

These outcomes did not incorporate the forage production as we found and as was found in the Forest Service 1960's dataset. So, we ran the following analyses to include those:

1. 2016 Forage production, slope <45%, without dense timber, and excluding water bodies. Capable acres = 14,727.
2. 2016 Forage production, slope <45%, without dense timber, excluding water bodies and wetlands. Capable acres = 9,684.
3. 1960's Forage production, slope <45%, without dense timber, and excluding water bodies. Capable acres = 4,485.
4. 1960's Forage production, slope <45%, without dense timber, and excluding water bodies and wetlands. Capable acres = 2,888.

Allotment specific capable acres are tabulated and shown in maps in our Report and PowerPoint. These were presented in our prior comments on the DEIS [Attachment 2]. A look at the map provided in those comments and copied below illustrates the patchy nature of capable areas. (Figure 6). This map is for the maximum capable acres (57,399) using minimal criteria. As more area is excluded by accounting for water bodies, wetlands, the capable lands become smaller and even more patchy. This means that sheep will be grazing and trailing through huge swaths of non-capable areas which can include soil that lacks ground cover, is on steeper slopes, and is high to highly erodible. For example, the Soil Specialists' Report [20] provides a figure we have copied below as below showing the loss of soil cover and erosion from sheep grazing and trailing in a forested area on Red Pine Shale. (Figure 7). The

[20] Weems,S. and Leahy, S. 2024. High Uintas Domestic Sheep Updated Soil Resources Specialist Report.

photographs in our Report and PowerPoint illustrate the denudation of alpine areas, passes and slopes. The residual vegetation seen between the rocks shows that there is potential for significant plant cover. Trampling by sheep has disrupted and displaced the soils resulting in barren slopes.

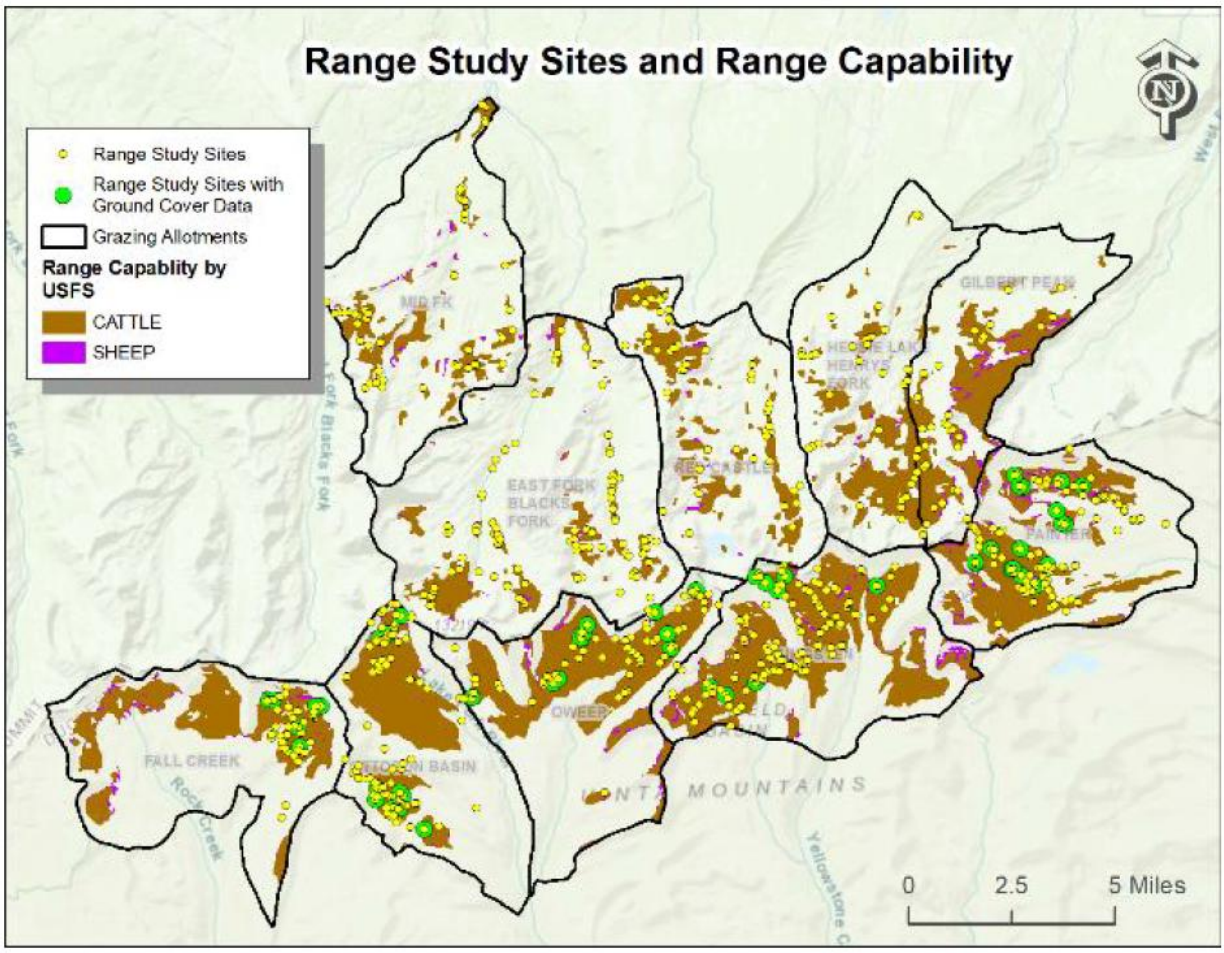


Figure 6. Patchy nature of capable areas shown here for the 57,339 acres using the minimal capability criteria.

We have reviewed the Forest Service monitoring files we obtained by FOIA in 2019. Figures 8 - 12 are extracted from that set of folders for location 08-26A taken in September 1991. Notes from the files are included. These show widespread devastation of the forest understory from sheep trailing that runs through the forested area to the ridge. Complete loss of vegetative cover has occurred because of the grazing and trailing of thousands of sheep in this area that should not be capable. This has resulted in bare soil, exposure of tree roots, and the development of rills and gullies. This damage can only be remedied by removing disturbance,

sheep grazing and trailing in these non-capable areas of erosive soils. For further illustration of this damage, **Figures from the driveway monitoring files received in that 2019 FOIA for location 08-26A follow.**



Figure 7. Copied from Soil Specialist Report Figure 5 showing a portion of the sheep driveway in a forested location. Loss of soil cover and severe erosion present with tree roots exposed. This is irreversible in the human lifespan time frame.

Figure 8. Site 08-26A Little or no ground cover where sheep trail up. Studies show less than 5% ground cover (p14) Tree roots severely exposed with trees dying and falling over. Photos 9/10/1991

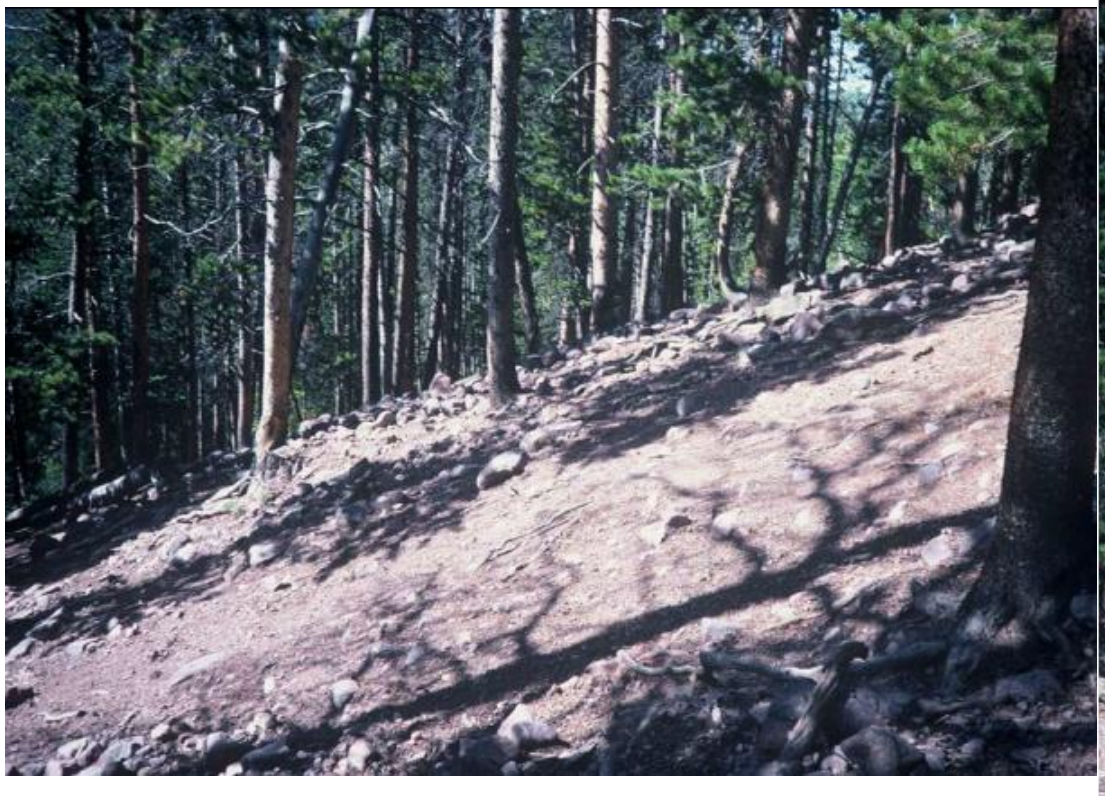




Figure 9. Site 08-26A contd. Severe soil loss, rilling taking place (p19)



Figure 10. Site 08-26A contd. Exhibit fresh soil movement, piled up behind logs (p22). Big gully developed (p23)





Figure 11. 08-26A contd. Near the top of the ridge or on top leading to Mansfield Meadows (p24). Extreme rilling, beginning of gully (p26)





Figure 12. 08-26A contd. Main draw completely blown out (p27). Additional photos show East Fork at bridge with no greenline, barren and eroding.





The Range Specialists' Report Capability Analysis for the Wasatch-Cache Allotments[21] summarized the capable acres from the 2003 Wasatch Cache NF RFP and the 1960's Range Analysis for the five allotments in the project area. The totals were 13,817 acres (16% of the project area) for the RFP analysis and 18,270 acres (21%) for the 1960's analysis. The analysis considered vegetation, slope and distance to water. Capability was ranked from Low to High within each category and for the allotments overall with the outcome that no lands were found to be not capable. The Range Report:2 notes that the 1960's analysis was more accurate than that for the Forest Plan.

The vegetation capability for the five allotments was determined using two factors. If the area had the potential to produce >200 lb/acre of forage it was given a High (1) rating and if it produces less, it was given a Low (0) rating. Similarly, if forested areas had a <30% canopy cover they were given a High (1) rating or if >30% it was given a Low (0) rating. The result was 57% of the allotments in the WCNF project area were rated as High, the remainder Low. Soil erosion hazard was not included and forested areas were assumed to produce >200 lb/acre forage. This contradicts the statement in the FEIS:132*"grouse whortleberry makes up most of the ground cover in the conifer stands on all the allotments."* The USDA plants database notes it is rated as fair for as browse for livestock.

Slope capability was based on four slope intervals ranging up to 10% High (1), 11 - 30% Moderate -High (0.7), 31 – 60% Moderate – Low (0.4), and >61% Low. The Regional Protocol limits capable lands for grazing domestic sheep to no more than 45% and there is no breakdown of lands above and below 45% in this current analysis. The analysis concludes that 89% of the WCNF is capable, but that includes areas that exceed the criterion of 45% slope in the Regional Protocol and does not account for soil erosion hazard.

Distance to water was divided into three categories of High (0 – 2 miles, rating of 1), Moderate (2.1 - 3 miles rating of 0.5) and Low (>3 miles, rating of 0). All classes exceed the 1-mile distance to water criterion from the Regional Protocol in arriving at 96% of the land being capable based on distance to water. There was no source cited that determined where water bodies were located, such as the USGS source we used in our analysis. Instead, the Range Report merely states, *"Across most of the project area, water is not a limiting factor."*

The Analysis concluded that 50% of the project area was Low in capability and did so by using these ratings categories that have no basis cited. In sum, the Regional Protocol criteria were violated by including slopes and distance to water that are not consistent with the Protocol, by including wetlands which are productive but avoided by sheep and not taking into account

[21] Cameron, A. 2025. Rangeland Capability – Suitability Report for Gilbert Peak Allotment, Hessie Lake – Henry's Fork Allotment, Red Castle Allotment, East Fork – Blacks' Fork Allotment, Middle Fork Blacks Fork Allotment.

soil erosion hazard. Similarly, the capability analysis by the Ashley NF[22] used the same process and criteria and arrived at 40% of the area as low capability.

The Soils Specialist Report in its Table 6 tabulates various soil properties for both the Ashley and WCNF allotments. These include acreage, soil texture, K factors, T factors and other information. By the K values in the table, the soils rank from low to moderate erodibility. The Soils Specialist Report:11 notes that the main property determining erodibility is soil texture. What is missing is the actual determination of erosion risk. USDA has RUSLE2 which is a tool to calculate erosion and determine whether soil tolerance will be exceeded. This is based on use of the Universal Soil Loss Equation, which incorporates factors of slope, texture as K factor, precipitation, and ground cover to calculate the soil loss. See the box below which is extracted from the USLE Erosion Prediction methodology by NRCS.[23] (Figure 13). That report is included as Attachment 3. That attachment also includes the USDA (1992) Wasatch-Cache Soil Survey descriptions for NS223 and NS502 soils used in our analysis.

We attempted an approximation of soil loss based on the USLE methodology. We looked up the annual precipitation for the EFBF Guard Station on the USU Climate Center website and found 24.5 inches annual precipitation. We entered this into the EPA Rainfall Erosivity Calculator to determine R = 23.06. This would be the lowest precipitation for the allotment as it will increase upslope to the summit. Then using Attachment (3) for K (0.1 -0.3) which covers the range reported in the Soil Specialist Report, slope length of 100 feet, slope of 30 - 60%, ground cover of 0% and 40% approximating ground cover we have observed on these high erosion hazard areas, we determined the tons per acre soil loss. (Table 1).

This calculation predicts that soil losses are likely much greater than the maximum 1 to 5 tons/acre soil loss tolerances provided in Table 6 of the Soil Specialists Report. While this is an approximation, it represents the potential (or actual) risk occurring in these allotments as sheep are grazed and trailed over these steep and erodible slopes. It would be useful to look at the annual snowfall and runoff during melt that creates sheet and rill erosion, but that is what the Forest Service analysis should have done.

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[22] High Uintas Wilderness Domestic Sheep Analysis Forest Plan Consistency for Grazing Suitability and Project Specific Capability/Productivity Analysis for Fall Creek, Ottoson Basin, Oweep, Tungsten, and Painter Basin Allotments Ashley National Forest.

[23] NRCS-IOWA. 2002. USLE Erosion Prediction.

A = R K L S C P

A = is the computed soil loss per unit area, expressed in the units selected for K and for the period selected for R. In practice, these are usually so selected that they compute A in tons per acre per year.

R = the rainfall and runoff factor, is the number of rainfall erosion index units in an average year's rainfall. "R" values in Iowa are 150 and 175. See Rainfall "R" Factor map (Figure 2), Page 27.

K = the soil-erodibility factor is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as a 72.6 ft. length of uniform 9 percent slope continuously in clean tilled fallow. See Table VI.

L = the slope length factor is the ratio of soil loss from the field slope length to that from a 72.6 foot length under identical conditions.

S = the slope-gradient factor is the ratio of soil loss from the field slope gradient to that from a 9 percent slope under otherwise identical conditions. The slope length and steepness factors are combined into a common factor referred to as the LS factor when using this formula. Obtain "LS" factor from Table II, Page 13.

C = the cover and management factor is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow. See Table IV a-e, Pages 18-22.

P = the support practice factor P in USLE describes the effect of contour or cross-slope tillage practices on sheet and rill erosion. This factor also considers the effect of other supporting practices including buffer strips, stripcropping, and terracing. See Table III a-d, Pages 14-15.

T = the soil tolerance expressed in tons per acre per year.

Figure 13. USLE Formula definitions

Table 1. Approximation of Soil Loss using USLE Factors

Slope %	K	Soil Loss No Ground Cover	Soil Loss 40% Ground Cover
30.0	0.1	8.2	1.8
40.0	0.1	13.1	2.9
50.0	0.1	18.5	4.1
60.0	0.1	24.0	5.3
30.0	0.2	16.5	3.7
40.0	0.2	26.3	5.8
50.0	0.2	37.0	8.2
60.0	0.2	48.0	10.7
30.0	0.3	24.7	5.5
40.0	0.3	39.4	8.8
50.0	0.3	55.5	12.3
60.0	0.3	72.1	16.0

This shows that, despite claims in the DROD that the project relied on the Best Available Data or Science, the Soils Specialist Report has failed to do this to determine damage to soils, while finding few isolated impacts. This lack of analysis of basic soil and watershed science principles violated NEPA and in doing so gives approval to the continued degradation of Wilderness and ecological values.

The Soil Specialist Report:34 referenced the soil survey used for the Wasatch Cache NF portion of the project area.[24] We requested that survey in our 2025 FOIA.[25] Using the GIS map files provided in that FOIA response, we mapped the soils for the EFBF for an example. There are two soil map units that are rated as having a high or very high hazard of water erosion. These are: the NS223 Duchesne Family 20 to 40% slopes with high erosion hazard, consisting of moraines with conifer and meadows; and the NS502 Talus-Rock-outcrop-Mirror Lake 40 to 80% slopes with very high erosion hazard with conifer and openings. We mapped these for the EFBF allotment (Figure 14). The NS223 soil totaled 4,252 acres and the NS502 soil totaled 8,690 acres. This amounts to 12,942 acres, or 51% of the EFBF allotment consisting of soil with high and very high erosion hazard.

Using the capability GIS files used in the Range Specialists reports, which we received from our FOIA, we overlaid the Forest Service capability map on the EFBF allotment as an illustration. Figure 15 shows the moderately high and low capable areas overlain on the NS223 and NS502 soil map units. The map shows the patchy nature of the capable areas that are contained within these two soil types, particularly the NS223 moraines. This means that sheep are trailed and grazed over these erodible soils to access the capable areas. Using ArcGIS Pro, we found that for the EFBF, the Range Specialists' analysis found 5,004 acres of the moderate capability class and 2,942 acres of the high capability class. This is only 31% of the 25,463 acres within the EFBF allotment.

Then, if we summarize how many of those acres are within these two soil types with high or very high erosion hazard, we find there are 4,252 acres within NS223 and 660 acres within NS502. If a proper capability analysis had been carried out, these acres would not have been included. So, if we subtract the total of these from the capable acres, this leaves 3,034 acres for the entire allotment, or 11.9 percent. This closely approximates the amount we found in our own previous analysis (see Exhibit 1 of Attachment 1). If the analysis were to include wetlands or wet meadow areas that the Forest Service admits sheep do not prefer, there are likely almost no capable acres in the EFBF or other allotments. The EFBF has seven pastures or units which

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[24] USDA Forest Service. 1992. Soil Survey Area UT647 North Slope Uinta Mountains Portion. Uncorrelated. Unpublished. On file at Vernal Ranger District Office, Ashley NF, Vernal, UT.
[25] USDA Forest Service. 2006. Extracted from Map Unit Descriptions Soil Survey Area UT867 North Slope Uinta Mountains Portion. Wasatch Cache National Forest of October 24, 2006.

should have also been analyzed to determine the amount and arrangement of capable acres and remove those areas of high and very high erosion hazard soils.

Figure 14

East Fork Blacks Fork Allotment with High and Very High Erosion Hazard Areas

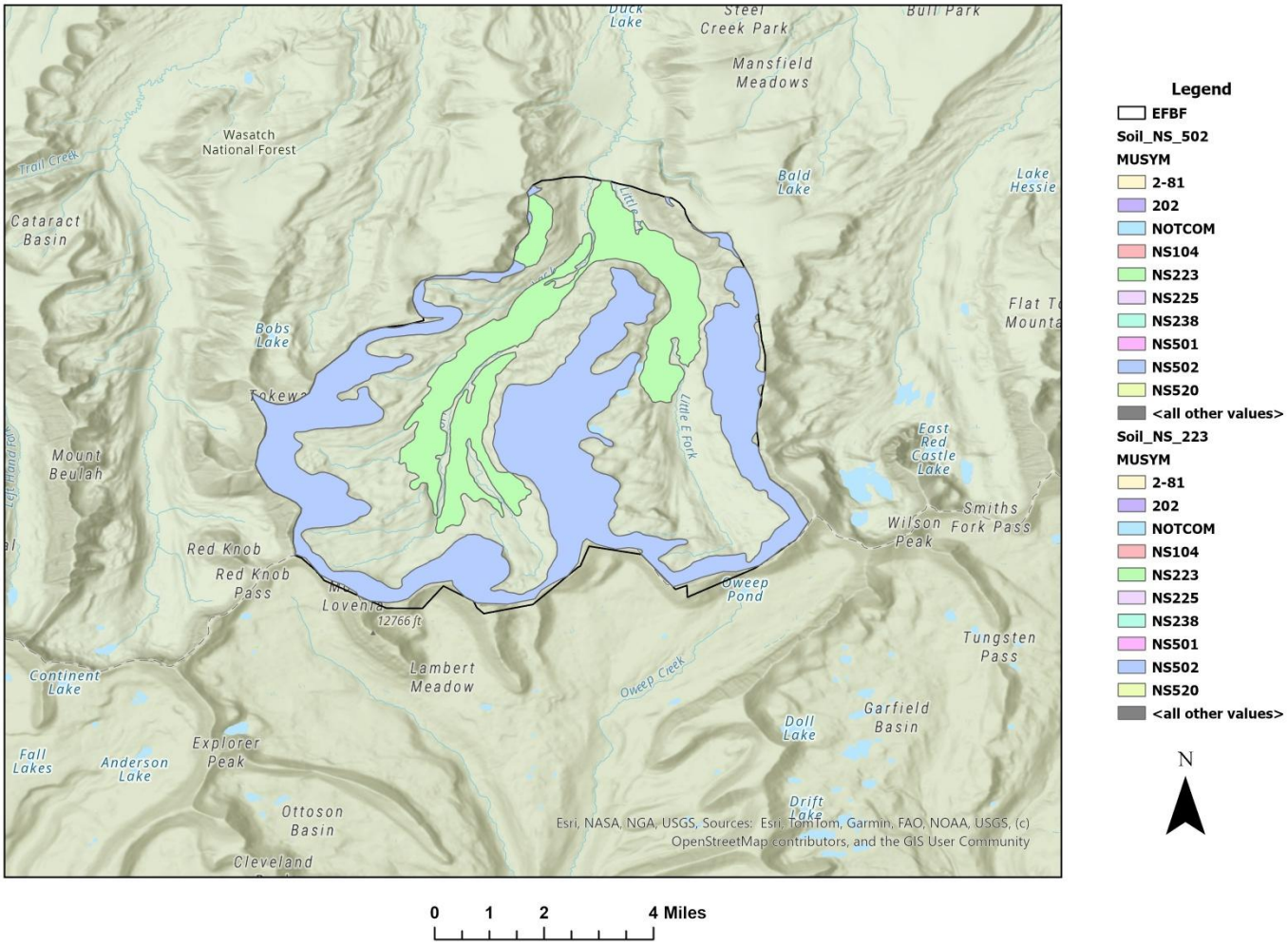
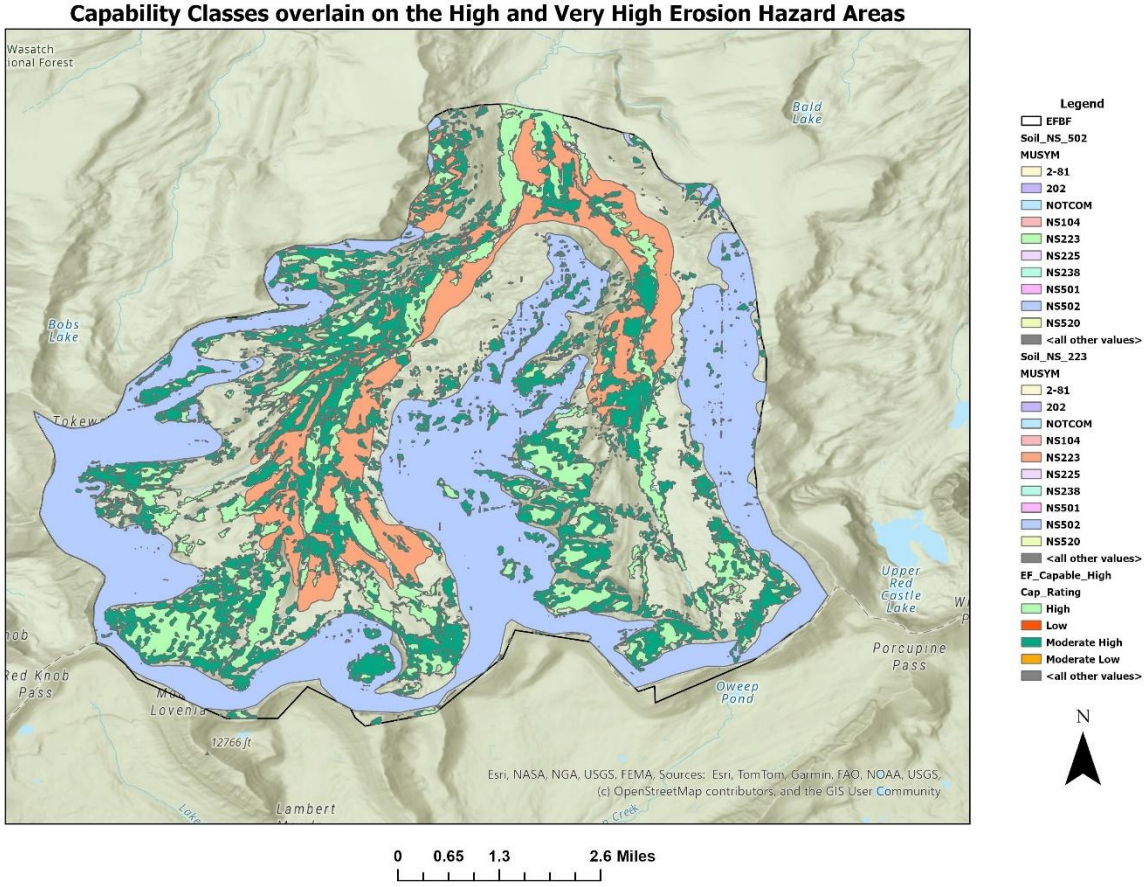


Figure 15

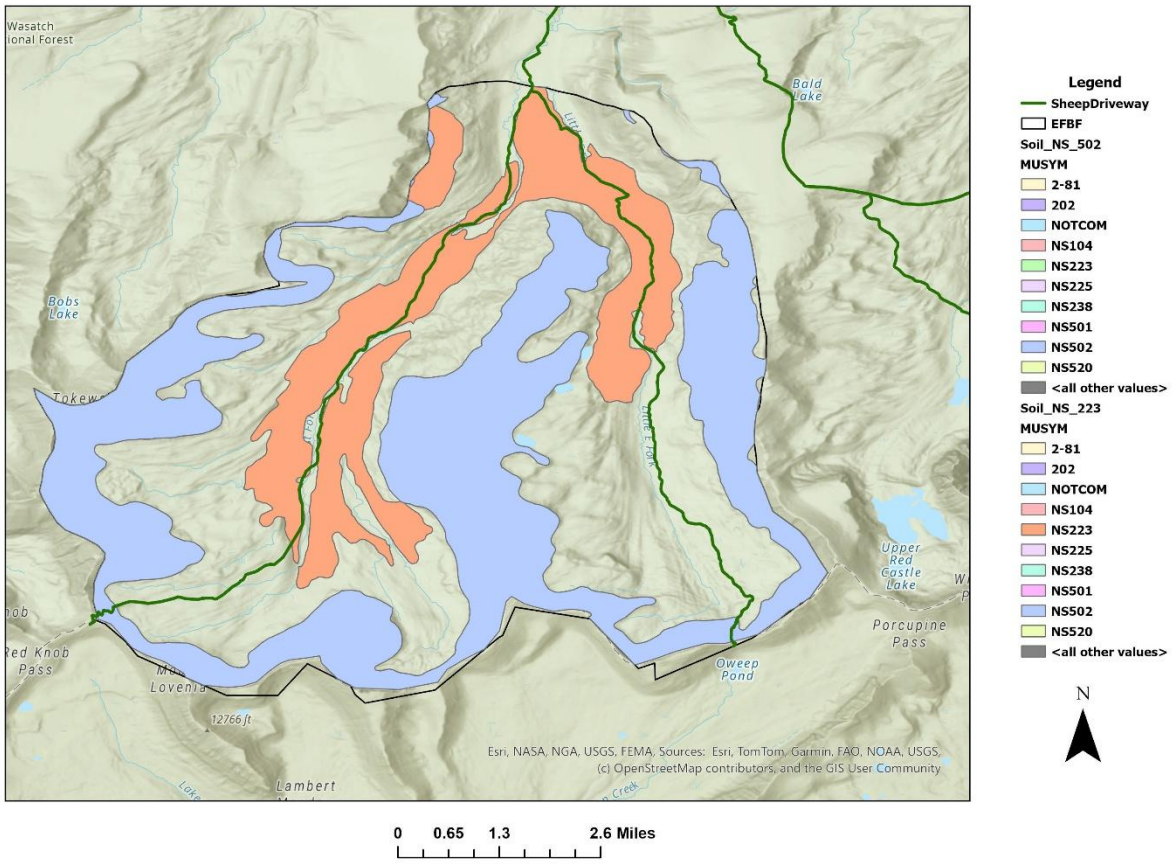
East Fork Blacks Fork Allotment with Forest Service High and Moderately High Capability Classes overlain on the High and Very High Erosion Hazard Areas



If we look at the sheep driveway within the EFBF, it is largely passing through areas of NS223 high erosion hazard soil. (Figure 16). When overlain on the Forest Service capability map, there are added sections of the driveway also on those what the Forest Service has chosen to characterize as low capability areas. In the end, the EFBF and the other allotments have almost no suitable lands when you consider the wilderness values, the erodible soils, steep slopes and other resource values.

Figure 16

East Fork Blacks Fork Allotment, Sheep Driveway and High Erosion Hazard Areas



Both Range Reports have concluded that nearly 100% of the land is capable of being grazed by domestic sheep by avoiding the strict guidelines specified in the Regional Protocol and failing to take soil erosion into account while continuing to graze and trail domestic sheep over these steep slopes. It also means that the intensive on ground data collection and mapping of the 1960s is thrown out the window along with the 2003 WCNF RFP analysis which showed only 16 and 21% of the land capable for the WCNF portion of the project area. This means that the range staff have reinvented the intent of the capability criterion to ensure that all lands are capable regardless of the risk or ecological damage.

NFMA capability and sustainability provisions are clearly violated as shown by our analysis. The Region has capability criteria that include slope (<45%), distance to water (<1 mile), with areas of soils that are not unstable or highly erodible. The Range Specialists included areas up to 60% slope, > 1 mile from water, and did not exclude any areas with unstable or highly erodible soils. The Forest Service capability analysis avoided using the clear definition of lands that are not capable, instead it chose to define all lands as capable by using the term

"low capability". Adhering to the Regional Protocol and analyzing the allotments capability is critical to maintaining ecosystem productivity and sustainability.

Our analysis shows that grazing and trailing tens of thousands of domestic sheep in these allotments exceeds the tolerable soil losses shown in Table 6 of the Soil Specialists report. This exceedance is shown in our calculations above, as demonstrated as long ago as Mont Lewis in 1970, Padgett and Condrat in 1994, Carter 2006, and in the evidence provided by retired Ashley NF Soil Scientist, Darlene Voerner. In addition, our published analysis (Exhibit 1 of Attachment 1) illustrates the lack of capability of these allotments and their being stocked at an order of magnitude greater than an actual quantitative range analysis shows. Using the East Fork Blacks Fork as an example, we compared the Range Specialists' Reports capable areas to that which would have been determined if the Forest Service had it's specialists chosen to include the soil erosion factor in their analysis. When we did that, the total capable acres became 11.9%. Many of these acres are isolated patches that require trailing and grazing across the non-capable areas to reach them, creating damage as they move.

The Forest Service FEIS and Soils Specialist Report references the 1992 WCNF Soil Survey which contains Soil Erosion Categories such as high or very high erosion hazard but failed to use this "Best Available Scientific Information" as claimed in the DROD:17. The Forest Service and their Specialists have known this, and with intention, continued grazing and trailing tens of thousands of sheep across this sensitive land with the disastrous consequences we have documented. This is a violation of NFMA and the intent of the Forest Plans. Not only is it a failure to take an actual "hard look", but it is ecologically unsustainable.

6. Degradation of Wilderness Values

The DROD:48 notes that the Wilderness Act section 4(d)(4)(2) *"the grazing of livestock, where established prior to September 3, 1964, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture."* It then provides guidelines from FSM 2323.22 Exhibit 1 that include this statement: *"Any adjustments in the numbers of livestock permitted to graze in wilderness areas should be made as a result of revisions in the normal grazing and land management planning and policy setting process, giving consideration to legal mandates, range condition, and the protection of the range resource from deterioration."*

The DROD:49 notes that the High Uintas Wilderness Area was established in 1984, and the Utah Wilderness Act reiterated the allowance for domestic livestock grazing if in place at the time the Act. Then, referring to the FEIS, it admits that Alternative 2 creates impacts on the wilderness attributes of untrammeled, natural, undeveloped, opportunities for solitude or primitive or unconfined recreation. But it explains those away because the wilderness area was created with domestic sheep grazing in place. As we demonstrate here, the Wilderness is severely degraded

by the trailing and grazing of thousands of domestic sheep in non-capable lands and lands that should be determined not suitable under NFMA. A summary of our past comments follows.

DEIS Comments:13-17

- The High Uintas Wilderness is the most heavily grazed Wilderness and suggests this is why the likely best bighorn sheep habitat in the Wilderness Preservation System has struggling populations.
- The DEIS fails to state grazing in Wilderness is a nonconforming use that harms wilderness character and biases the NEPA analysis.
- This ignores that wilderness must be administered that leaves it *"unimpaired for future use and enjoyment…protected…preservation of wilderness character.. "*
- The wilderness definition includes that it is *"untrammeled by man…retaining its primeval character...is affected primarily by the forces of nature".*
- Grazing livestock in wilderness is an exception where it is allowed to continue if in place prior to September 3, 1964, but must be regulated.
- The DEIS leads the reader to conclude the proposed action would not harm Wilderness but fails to recognize agency policy to *"close the gap"* between the attainable level of purity and that which currently exists.
- The DEIS biases the NEPA analysis by incorporating condition classes described in an earlier plan, therefore an analysis of No Grazing is not needed.
- Those seeking a true primitive recreation experience would likely be most harmed by the presence of domestic sheep, while reliance on trail registers can be misleading.
- Cites the misapplication of Landres et al 2008 and Keeping It Wild that downplays the essence of Wilderness and how KIW2 has been used to justify trammeling actions in wilderness.
- Critiques DEIS characterization of naturalness that presumes domestic sheep impacts are transient while ignoring the forage consumed, watershed degradation, and disease organisms left in feces.
- Predator control was not mentioned yet the FSM emphasizes the critical role they play in maintaining integrity of natural ecosystems while the area is within lynx habitat, a recent wolverine sighting was made, while bears and coyotes are not mentioned.
- Sheep driveways are sacrifice zones lacking plant diversity and severely eroded.
- The DEIS recognizes there has been no grazing since 1977 on the Fall Creek allotment, while the High Uintas Wilderness was designated in 1984 and the DEIS does not detail impacts from grazing this allotment.

Summary of Evidence of Domestic Sheep Impacts on Wilderness

- **Mont Lewis 1970 Analysis** Attachment 4 was summarized in our comments on the DEIS (28-30).

- Deep soil occurs in boulder fields and talus while slopes below seeps and snowdrifts have plants that occupy most of the soil similar to the boulder fields and talus
- Alpine soils are *"weak"* while shale derived soils are unstable with high erosion hazard with rapid erosion where ground cover is lacking. Any grazing use that damages plant cover may have serious consequences.
- Frost action breaks down soil stability, which is accelerated by grazing of sheep, while trampling by sheep increased the size of sod breaks.
- Wet meadows and bog communities are too wet for sheep grazing while dry meadows are a favorite of grazing animals and have been heavily damaged. These dry meadows occur at the foot of slopes.
- Drier sites in conifer community are in poor condition due to heavy grazing.
- Range condition site analysis on areas with little or no past grazing use had ground cover approaching 100%.
- Wet meadows are not considered suitable.
- Suitable and non-suitable areas are intermixed on most of the alpine area and damage to non-suitable areas must be considered.
- Grazing on slopes above lakes was observed to increase sedimentation.

In the 2006 report by Dr. Carter numerous sites were surveyed showing the denuding of steep slopes and sensitive soils. (Attachment 5). Figure 17 illustrates the result of grazing sheep on steep slopes which have deep soils and near complete ground cover. The left photo below was taken in East Fork Blacks Fork and shows steep slopes with a high amount of bare soil, but with residual deep-rooted vegetation illustrating that the soil can support a high percent ground cover if not grazed. The right photo shows the slope leading into Lake Fork Basin from Red Knob Pass along the sheep trail, but the entire slope, not just the trail, is denuded by grazing sheep with only residual deep rooted thistles present. Figure 18 shows similar areas in EFBF and Middle Fork Beaver Creek (MFBF) with vegetated slopes that have either escaped sheep grazing or in the case of MFBF with decades of no sheep grazing.

Below the figures is a chart taken from the 2006 report showing the bare soil observed at numerous locations compared to that in the Middle Fork Beaver Creek and Burnt Fork allotments that have not been grazed for decades. (Figure 19). These were taken from the grazed West Fork Blacks Fork, East Fork Blacks Fork, and Ottoson allotments and the ungrazed Burnt Fork, and Middle Fork Beaver Creek allotments. The grazed uplands have significant bare soil, while the ungrazed uplands have nearly 100% soil cover. For the complete analysis, data, photographs and more detailed discussion, see Attachment 5 and the Coalition comments on the DEIS (28-75). (Attachment 2).



Figure 17. Photos of steep slopes trampled and grazed by domestic sheep with residual vegetation indicating potential for complete vegetation cover of the soil

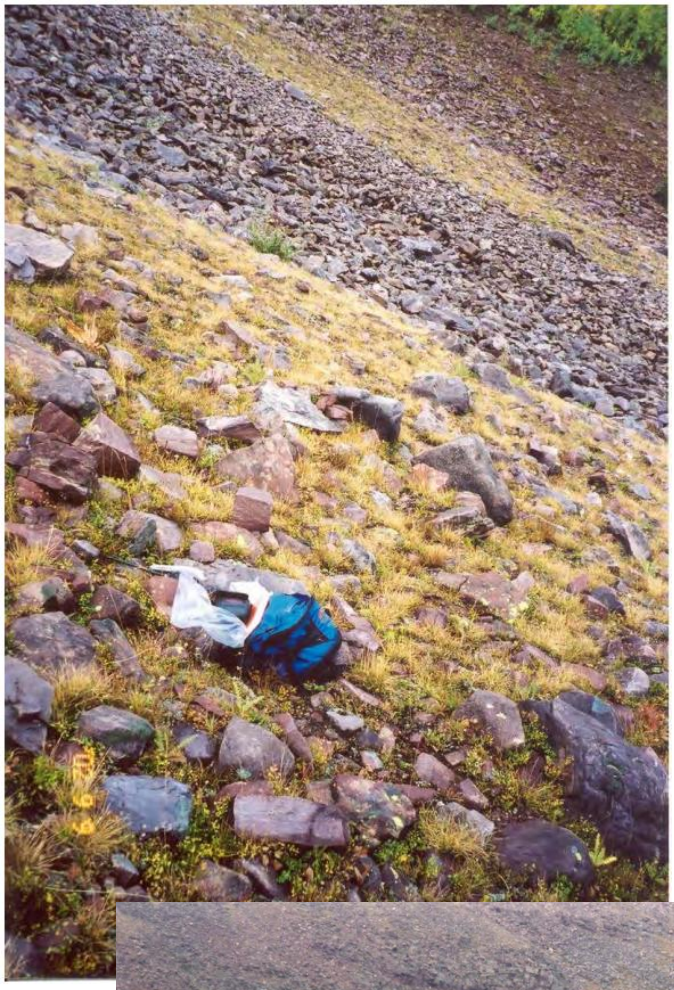




Figure 18. Left from EFBF showing slope that has soil stabilizing the talus slope and is vegetated. Below a photo in the long ungrazed Middle Fork Beaver Creek showing alluvial areas and slopes where soil occurs are vegetated. In areas of active rockfall and talus movement, soils have not developed to support vegetation of any extent.

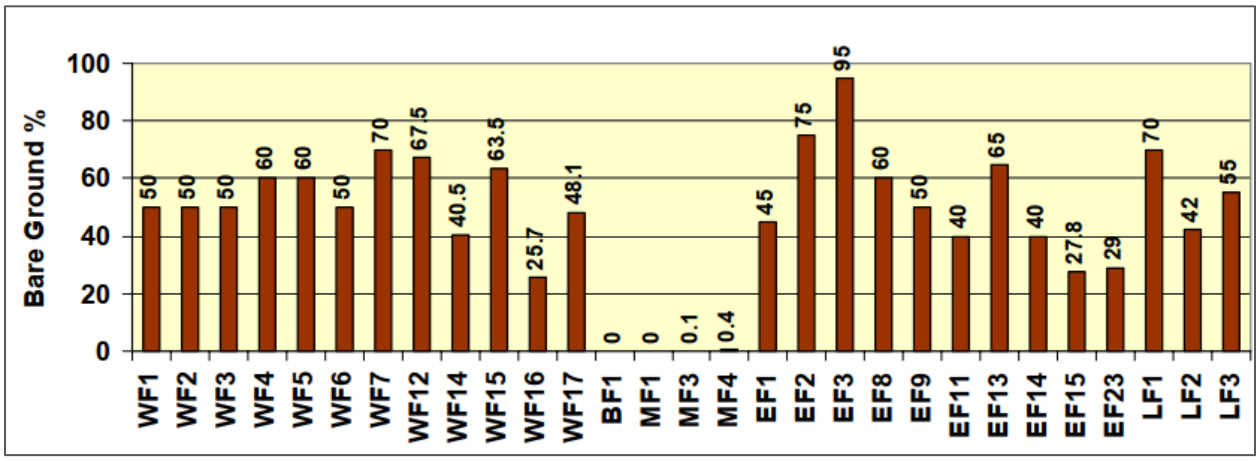


Figure 19 . Comparison of ground cover at the grazed West Fork Blacks Fork, East Fork Blacks Fork, and Ottoson allotments with that in the ungrazed upland locations with that in ungrazed Burnt Fork and Middle Fork Beaver Creek allotments.

As the Lewis report (Attachment 4) illustrated, sheep grazing on slopes above lakes can accelerate sedimentation into the lake. Here a graphic illustration from the West Fork Blacks Fork Lake EJOD shows this as deltas have formed in the lake from the bare soil created by sheep grazing and trampling. There are other examples from our 2006 Report. (Attachment 5). Other examples are included.

A study of Lake EJOD using sediment cores found increased nutrient and sediment loading in the past century, coincident with the period livestock have grazed here. This is a departure from rates of deposition going back 5300 years.[26]



Figure 20. Lake EJOD suffering accelerated sedimentation

[26] Munroe, J.S., Klem, C.M. and Bigl, M.F. (2013) A Lacustrine Sedimentary Record of Holocene Periglacial Activity from the Uinta Mountains, Utah, U.S.A. Quaternary Research, 79, 101-109. https://doi.org/10.1016/j.yqres.2012.12.006

Those Coalition comments on the DEIS also illustrated the denuding of forested habitat on shale derived soils, alpine turf broken up, a report by retired Ashley NF soils scientist showing the late snow and reduced growing season, broken turf and exposed soil, the return of ground covering lichens in a location in which grazing was discontinued, soil loss of several inches, vegetation pedestaled by soil loss. A review of the Forest Service monitoring and photos provided in response to our 2019 FOIA (link to data) illustrated the extent of non-capable areas like wet meadows and steep slopes, and the short growing season. The Forest Service photos also revealed the damage to grazed uplands adjacent to wet areas where gophers are blamed for bare soil.In the long rested Fall Creek allotment they showed the recovery of trailing areas, meadows and streambanks, lack of gopher activity, and ground cover nearly complete.

The DEIS comments also looked at the Bald Mountain study and included photos of the sheep manure in water running off into streams and lakes, reported on the Bald Mountain study (St. Clair et al 2007) that showed the sites with more snow and accessible to sheep had total ground cover of about 50%, while the rocky sites with less snow and less sheep access had total ground cover ranging from about 50% to near 100% and an average of about 75%. Bare ground was much higher in the meadow locations than in the rockier locations.

In those DEIS comments we also reviewed the Forest Service Monitoring site data provided in the 2019 FOIA response. This showed a heavy bias towards monitoring in less sensitive areas. These were dominated by locations that were wet sites and were in valley bottoms and areas of low slope gradient. We don't believe the NEPA "hard look" requirement means to look only in place that are not impacted because they are not preferred by sheep.

- **Report on Sheep Driveway Conditions by Padgett and Flood**[27] (Attachment 6). Wayne Padgett was the Forest Ecologist and Paul Flood was the Forest Soil Scientist. Their report which compared driveway sites to a late seral (undisturbed) site concluded:
    - *Ground cover, species composition, and depth of topsoil differ greatly on some portions of the sheep driveway when compared to the late seral site. Topsoil depth on the late seral site averaged over 11 inches while on the sheep driveway it was less than 2 inches.*
    - *Bare soil on the late seral site was approximately 0.5 percent, along the sheep driveway it ranged from 6.5 to 52.5 percent. When percentage rock and pavement are added to those figures, there is approximately 7 percent for the late seral site and bare soil ranged from nearly 24 percent to over 86 percent along the sheep driveway.*
    - *Existing national and regional standards that limit soil erosion and the loss of long-term soil site productivity are being exceeded along most portions of the driveway; these same standards are being exceeded in many of the pastures as well.*

[27] Padgett, W. and Flood, P. 1993. Sheep Driveway Resource Conditions. Wasatch Cache NF November 4, 1993.

- *Alpine communities that represent near climax conditions in the Uinta Mountains (occurring on sites similar to those we sampled along the sheep driveway) are characterized by nearly 100 percent ground cover.*
- *On unimpacted and low impact sites such as this area, cryptobiotic lichens are commonly present on the rock surface down to where vegetation and/or litter covers the rock. Most rocks on this site had this appearance. On driveway sites, these lichens were often totally absent. Where present in minimal amounts, they often occurred at an elevated position several inches above the ground surface level.*

- **Alpine Plant Community Classification**[28] (Brown 2006). In our comments on the SDEIS (p25) (Attachment 1) we commented on the Brown report and its potential for incorporating degraded conditions as a baseline by his collecting data in allotments that are being grazed by livestock and are degraded. We analyzed the data provided in that report for the sheep allotments. (Table 2). Throughout the SDEIS, utilization is indicated to be low to moderate and has been measured for more than 60 years (SDEIS p141) yet no tabulation or description of this data is provided and related to current or reference conditions. Neither are trend data provided as most monitoring appears to be opportunistic, not systematic. The Forest Service Handbook emphasizes the use of reference areas and the need to use monitoring of those to determine progress towards DFCs. *"Monitoring can then tie to these reference areas as a means of determining progress toward meeting the desired conditions."* (FSH 2209.13).

Table 2. Ground Cover Characteristics in Brown (2006)

Community ID (Brown 2006)	No of Sites	Exposed Soil Min %	Exposed Soil Max %	Exposed Soil Median %	Exposed Soil Mean %
Dry	20	0	20	3	5
Ivesia and Barren	15	2	84	26	37
Low and Dwarf Shrub	4	4	10	5	6
Meadow	32	0	45	3	6
Mesic Carex	11	1	40	4	11
Snowbed	36	0	65	20	23
Wet	10	0	5	0	1

[28] Brown, G. D. 2006. An Alpine Plant Community Classification for the Uinta Mountains, Utah. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region. 140 p. https://app.box.com/s/vt5obbo9tt2cd6ucesai9xjx046pu71y

This table illustrates several important points.

- The minimum amount of exposed soil in all communities is near zero. This comports with Lewis (1970) which indicated potential ground cover is near 100% and with our report[29] comparing grazed and long term rested allotments in the Uinta Mountains. (Attachment 5).
- The maximum exposed soil in wet communities of 5% and average of 1% comports with the acknowledgement by the Range Specialists such as Sheryl Goodrich that sheep avoid wet plant communities therefore these are not capable.
- The maximum exposed soil in all other communities ranged up to 84%, which shows most sites are degraded from potential.

- **Analysis of Forest Service Monitoring Data** (Attachment 7). In response to our 2019 FOIA request, we obtained file folders (03-Studies) that contained monitoring data and photos for the Driveway, the Ashley NF allotments and the Uinta Wasatch Cache NF allotments. Due to time constraints, we reviewed those files only for the Ashley NF in our detailed comments on the DEIS:40-61 showing many issues with interpretations. Major points include:

    - There were 1565 study sites in file (07092019ANFStudyPlotCoordinates) but only **69 reported ground cover in the last 20 years and none reported utilization data.**
    - Overview photos show basins dominated by wet habitats which sheep do not prefer, surrounded by forested and rocky slopes and a few dry areas they will graze.
    - Snowbanks or snow beds are present through most of the grazing period in areas being trailed and grazed. This impairs production due to plant growth barely starting before being grazed.
    - Ottoson allotment examples of sheep grazing in upland adjacent to wet areas they avoid, accelerated runoff scouring channels and breaking up turf.
    - Ottoson Little Basin snow bed showing barren slopes adjacent to wet meadow area while the notes state that the *"growing season is so short for plants to colonize much of the site"*. But no mention of the fact that sheep prefer the uplands to the wet areas and will be on those slopes grazing any growth and trampling the wet soils on the slope.

[29] Carter, J. 2006. Watershed Conditions Uinta Wilderness. Western Watersheds Project. https://app.box.com/s/944957604b8618539585

- Ottoson Little Basin *"discontinuous sod community"* not due to sheep but no other cause given except to claim that the adjacent wet area wasn't broken up. Lewis (1970) called this alpine turf in very poor condition due to heavy sheep grazing.
- Ottoson wet meadow where the Range staff stated, *"Sheep are very reluctant to use wet meadows"* yet this is ignored when adjacent uplands are denuded. This is evident in the Ottoson *"Pocket gopher eskers indicate a site highly selected by gophers"*, but it is adjacent to a stream and wet meadow, so sheep also prefer this area and trample and graze it, yet pocket gophers are the cause of bare soil.
- Oweep sheep trail photo of a head cut with a note admitting that sheep *"likely contributes to the cutting if not the cause of the cut"*.
- Fall Creek allotment photos showed complete ground cover, trails healing, dry moraines adjacent to wetlands healing with plant cover complete across the moraine. See FOIA folder at https://app.box.com/s/ykhjo7ebhbog2za7sdz9ou5kyhvvixdh for photos and descriptions by the Forest Service showing the conditions in Fall Creek after nearly five decades of no livestock grazing and compare to the grazed allotments and driveway descriptions and analysis we have provided here. The contrast is clear. Wilderness and ecological values are returning in Fall Creek and continue to be degraded where domestic sheep are grazed.
- Fall Creek allotment trampled stream banks are healing with complete cover, dry meadow with Deschampsia and Danthonia with 99% ground cover, headcuts healing, a snow bed site is shown with near complete cover of lichens and vegetation. Gopher activity barely noticeable or absent in most descriptions.
- Below is copied from the DEIS:59 comments (Attachment 2).

Painter Basin 2003 (p304 12-022 to 12-052. Note with photo states, *"This shows the vivid contrast in vegetation cover on the near side of the stream in quartzitic materials and the relative sparse cover on the far side of the stream where shale materials are abundant. Had livestock grazing been so intense as to cause the conditions on the far side of the stream, similar conditions could be expected on the near side of the stream. Site specific factors and not the more or less ubiquitous factor of livestock grazing are strongly indicated to be the cause of the sharp contrast between the 2 sides of the stream."* **Here Range Staff fail to note that wet meadow habitat is on the right side. They have admitted sheep avoid these areas, yet here in their zeal to forgive any sheep impacts, they fail to connect the dots to acknowledge the area used by sheep is the less stable shale on the left. Sheep bedding, grazing, trailing, and loss of ground cover all are happening on the left.**



Figure 21. Painter Basin photo from Forest Service files illustrating the barren area on the left where sheep prefer to graze, compated to the wet site on the right they avoid.r

For comparison, we have provided photos and notes below from the Fall Creek folder referenced. (Figure 22 – 24). Some notes from the folder include:

- Folder p102 of meadow with low level of gopher activity, barely visible in photo.
- Folder p118 Steep erodible slope with no evidence of trampling and with vegetation present.
- Folder p168 Juncus parryi site was 90% cover. Gopher activity minimal compared to other Juncus sites in the Uintas. These sites have potential for high ground cover. Potential without gophers 90 - 100%.
- Grandaddy horse allotment note Folder page 7. Pine Island Lake *"Bare ground and accompanying small gully areas exist. It should heal over time if grazing and trampling is discontinued."*

22-7A, Phinney Lake, Duchesne Ranger District, Ashley National Forest
A. Huber 5 August 2009



View 1. Forward view of the transect. The transect is 140' long and is permanently marked with steel pins. Ground cover was measured at 100%. *Danthonia intermedia* is a common graminoid at the site.

Figure 22. Showing complete ground cover in Fall Creek allotment ungrazed by domestic sheep for nearly 50 years.

22-7D, Phinney Southwest, Duchesne Ranger District, Ashley National Forest
A. Huber 5 August 2009



View 1. View up the drainage.

Figure 23. Fall Creek healing erosion feature

22-7G, Fall Creek Meadow, Duchesne Ranger District, Ashley National Forest
A. Huber 5 August 2009



Belt 1. The belt runs out at 41°. Ground cover was measured at 99%.

Figure 24. Fall Creek meadow with near complete ground cover after almost five decades of rest from domestic sheep.

- **Analysis of Driveway data** (Attachment 7).

We received a file from our 2019 FOIA request that contained driveway data. There were 78 unique locations in the database. There were no locations provided for that data. We submitted a FOIA in August of this year for location data, but the file received contained location data only for 36 sites which were along the driveway in the Red Castle, Hessie Lake and Henry's Fork, and Gilbert Peak allotments. There were no points for the driveway in the East Fork Black's Fork allotment. There are points along the East Fork Black's Fork portion of the driveway, but those are not identified with the same identifiers as in the 2019 data. So, we have analyzed the portion for which we have the data. Notes from the FEIS are provided below

  - FEIS:175 *"Trailing outside of the East Fork Sheep Driveway does occur on each individual allotment by the sheep permitted there."*

- FEIS:194 *"The map in Figure 31 illustrates the current trailing routes used by seven bands of sheep (i.e., three from the Ashley NF and four from the UWCNF) from the point they enter the National Forest at the Wyoming-Utah State line to their permitted allotments, and it also illustrates the monitoring sites along the sheep driveway. The length of the trail system is roughly 52 miles or approximately 945 acres based on an average width of 50 yards".*
- FEIS:196 *"Photos, data and field notes from Cache Hill, East Fork-Smiths Fork and Hessie Lake show increased soil disturbance, reduced ground cover, and some active gullies. Each of these highly impacted areas is estimated at about 0.5 miles in length and widths range from 30 to 300 feet. Based on an average width of 150 feet, approximately 27 acres of the driveway were calculated to be in unsatisfactory condition, or less than 3 percent of the driveway."*
- FEIS:196 claims ground cover is meeting or moving towards standards.

We mapped the driveway and the 36 points for which location data were provided. The minimum distance from the driveway to the monitoring point was 5 feet, the average was 530 feet, and the maximum was 1,868 feet. The bare soil ranged from zero or full soil cover in wetland and riparian areas to 90% of bare soil in one upland location. A review of the photos in the Driveway file showed a much larger area of damage than 150 feet. We have provided a review of many of the sites in Attachment 7. See, for example, the very first site (08-03A) in that Attachment showing Big Meadow and claiming only 15% bare soil. (Figure 25). The Meadow is much, much larger than 150 feet and the photo of the ground surface shows about half of the plot is bare soil. In our prior comments we evaluated a plot using Sample Point and it showed a much higher bare soil level than the Forest Service range staff can see. In fact, a similar site (08-04A) was stated to have 44% bare soil. (Attachment 7). In Figure 26, we show that same site (08-03A) in 1998 with near complete ground cover and high diversity, yet the FEIS claims conditions are improving, the photos show otherwise.



Figure 25. Big Meadow Site 8-03A Claiming 15% bare soil against the evident nearly half of the plot being bare soil in the photos.



Figure 26. Site 8-03A taken in 1998 showing a diverse ground cover with little bare soil. Compare to the 2013 photo above with high bare soil and little diversity.

Attachment 7 is self-explanatory with its use of Forest Service monitoring photos and points made. Some of these include:

- Meadows being monitored are very large compared to the claimed 150-foot width, so the driveway damage is grossly underestimated. (Sites 8-03A, 8-04, 8-09A, 8-09B, 8-09C, 8-21E, for example).
- Gophers are given as the cause for reduced soil cover in many cases.
- No accounting for drought v wet years in evaluations. For example, site 08-09B shows an improvement from 64% ground cover in 2004 to 98% in 2013. According to the Drought Monitor, 2004 was in extreme drought in July while in 2013, it was moderate. In addition, the photos appear to be taken before and after grazing.
- Steep, forested slopes with bare soil that is displaced by trampling leading to rills and gullies. (See sites 08-26A and 08-26B)
- Stream banks are scoured. (See site 98-32D). Lodgepole pine in the middle of the stream showing channel widening. Others included in the Attachment.
- Wet meadows show little use, while adjacent uplands are trampled and have bare soil. (See site 08-32C2)
- Snow beds blamed for reduced soil cover while ignoring widespread damage and reduced soil cover in areas not within the snow bed itself. (Site 8-33 for example)

- Summarized the 1993 Sheep Driveway Report which showed major soil loss with off driveway soil 11" depth and driveway soil 2" deep. It noted bare soil on a late seral site was 0.5% and, on the driveway, ranged from 6.5 to 52.5%. Reported lichens present on rocks to the soil surface off the driveway and elevated several inches above the soil surface on the driveway. This indicates major soil loss on the driveway. Note plants were pedestaled on the driveway, again indicated soil loss.
- Illustrated Red Knob Pass bias by only looking at the narrow mesic strip of vegetation while ignoring the highly erodible slopes that are lacking vegetation and upon which sheep trail and graze.
- Flat Top Mountain slope with bare soil along the driveway over a wide area. (See site 19-09).
- Driveway entering Hessie Lake drainage with large gully. (See sites 19-10, 19-11).
- Shows snow persisting until near the end of the grazing period and that it suppresses establishment and growth of plants. Yet, sheep are driven and grazed through these areas. (See site 19-32A).
- Snow bed in an off-driveway location shown with vegetation covering the soil. (See site 19-32D).
- In upper Henry's Fork near Gunsight Pass, slopes are shown that illustrate vegetation growing in areas not directly in the path of rockfall. (See sites 20-05 and 20-05B).
- Reviewed Annual Operating Instructions noting that there are only two permittees grazing these allotments with one permittee JRB LLC having all but one allotment. Shows no pastures rested and trailing patterns around edges of basin along slopes.

Regardless of claims in the FEIS, these points illustrate major degradation of soils, plant communities, watersheds and Wilderness. For example, if you calculate the area of the driveway that is impacted based on the distances to the monitoring sites, it is quite astonishing.

- Mean distance to points = 530 feet for the 52-mile driveway = 6,681 acres
- Maximum distance to point = 1,868 feet = 23,548 acres

These areas are massive compared to the 27 acres the FEIS claims and they validate the observations and measurements we have made over decades of surveying sheep damage in the Uinta Wilderness.

- **Bighorn sheep loss due to forage competition with domestic sheep.**

The 10,300 ewe/lamb pairs grazing these 10 allotments will consume approximately 301 pounds of forage per month per pair. (Attachment 1 Exhibit 1). This results in forage consumption of 6,200,600 pounds for the two-month grazing season. According to Holechek et al (2004)[30], the daily forage consumption of a bighorn sheep is 3.6 lb/day. At this rate, the 6,200,600 lbs of forage consumed by domestic sheep during the summer grazing season would support 1,722,388 bighorn sheep days, or in the 60-day grazing season, it would support 28,706 bighorn sheep. Of course, the domestic sheep are consuming forage that other wildlife species such as elk could use, so the forage use would be spread across a number of species. However, this provides an example of the sheer magnitude of wildlife species displacement by domestic sheep. It is a loss in wildlife and wilderness values.

- **Domestic sheep fecal pollution of recreational waters.**

These same 10,300 ewe/lamb pairs consuming over 6,000,000 pounds of forage would then defecate a huge amount (thousands of tons) of E. coli-containing manure across the landscape during the summer. This waste contains E.coli and other harmful bacteria, including those that can affect wildlife such as bighorn sheep. However, as we have noted in our past comments, these domestic sheep are grazing across these watersheds, even to the highest ridges and spreading that waste across the landscape. The FEIS does not mention E.coli. The FEIS notes that some streams are impaired, others meeting beneficial uses, but these monitoring stations are not located within the allotments where recreationists obtain their water from streams and lakes. These same streams and lakes are directly impacted when domestic sheep trail across, or drink from them and from runoff from sheep waste spread across the allotments.

In our comments on the DEIS (Attachment 2 pp62 – 66), we detailed the deposition of sheep manure in melt water on Bald Mountain. Here's the account, *"I spent the long weekend in the Uintas, my husband and I climbed to the top of Bald Mountain in the Red Castle allotment. There was so much sheep sh.. we couldn't put our packs down. In most places the ground was so saturated the melt was creating overland flow, so the feces was in standing water that was running off into the creeks. We hiked all the way back down without water, because gross. I trust my filter but that was just disgusting."*

Many years ago, Dr. Carter and a friend were backpacking in the same area. His friend drank water running off these ridges and contracted giardia. Dr. Carter did not drink the water and did not contract giardia. From a recreation and human health standpoint alone, this water pollution issue should be sufficient to terminate sheep grazing in the Uinta Wilderness.

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[30] Holechek. Op.cit. Table 8.11.

The photos depict Bald Mountain with snowpack melt water running off with sheep manure in the water, polluting everything downstream. The photos show the condition left at the end of the season last year with little residual vegetation in the areas where melt is ongoing. In the years Dr. Carter backpacked these valleys, slopes, peaks and ridges, they were laden with sheep manure as evidence they had been grazing and trailing in non-capable areas.

A report by the Institute of Environmental Science and Research Limited concluded that *"sheep and lambs excrete considerable less faeces per day than dairy cattle (Sheep 1-2 kg; Cattle 20 kg approx.), but their faeces containing significantly more E. coli per gram- adult sheep 1.67 x 107, dairy cattle 8.2 x 104 per gram)."*[31] *"During rainfall or irrigation generated overland flow could result in considerable contamination of the waterways."*

Modeling research in New Zealand reviewed the role of domestic sheep in E.coli generation. *"Previous research has identified that, at equivalent stocking rates, sheep will deposit approximately 100 times more E. coli onto a pasture than cows due to the high concentrations of E. coli in sheep faeces (Moriarty et al. 2015; Monaghan et al. 2021). However, Muirhead (2023) showed that at equivalent stocking rates the E. coli runoff concentrations from sheep grazed pasture was on average only four times higher than the cow grazed pasture. Furthermore, when the sheep stocking rate was increased four-fold, the average E. coli runoff concentrations increased six-fold (Muirhead 2023). This demonstrates that efforts to model E. coli runoff from grazed pastures cannot simply be based on the E. coli loading rate directly onto the land. It was hypothesized that these observed differences may be driven by the relative surface area of the pasture covered by the sheep and cow faecal pats (Muirhead and Monaghan 2012; Muirhead2023)."* [32] See also Muirhead (2023).[33]

If we use the range of 1 – 2 kg/day rate of fecal deposition by the sheep, the range of deposition per day is 45,320 – 90,640 lbs/day, or 2,719,200 to 5,438,400 lbs/season. This is a health risk to people and wildlife and a degradation of wilderness values.

7. Sensitive plants

The DROD:41 summarizes impacts to three sensitive plant species.

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[31] Moriarty, E. and Gilpin, B. undated. Sheep as a Potential Source of Faecal Pollution in Southland Waterways Institute of Environmental Science and Research Limited

[32] Muirhead, R. W. (2024). Modelling E. coli runoff concentrations from sheep and cow grazed pastures in New Zealand: challenges and future research needs. New Zealand Journal of Agricultural Research, 68(7), 1707–1722. https://doi.org/10.1080/00288233.2024.2414779

[33] Muirhead RW. Escherichia coli runoff from sheep and dairy cow grazed pasture: A plot scale simulation. J Environ Qual. 2023 Mar;52(2):287-295. doi: 10.1002/jeq2.20448. Epub 2023 Feb 8. PMID: 36645734.

- Rockcress draba: *"No impact. Documented and expected in alpine tundra communities in the project area. However, this plant is protected from livestock grazing due to steep rocky slopes, distance from preferred grazing areas, and other topographical obstacles."*
- Utah Ivesia: *"No impact. Not documented in project area but habitat could support this species. Areas where this plant would grow are protected from livestock grazing due to steep rocky slopes, distance from preferred grazing areas and other topographical obstacles."*
- Arctic poppy: *"No impact. Not documented in project area but habitat could support this species. Areas where this plant would grow are protected from livestock grazing due to steep rocky slopes, distance from preferred grazing areas and other topographical obstacles."*

The 2018 BA/BE listed Draba apiculate (beavertip draba) [DRGL6]and Papaver radicatum (rooted poppy). These are listed in the Alpine Plants Classification Appendix A as Papaver uintaense (Uinta poppy) [PAUI]and Draba globosa (beavertip draba)

It is interesting that the Forest Service claims these plants are protected by steep slopes, distance from preferred grazing areas and other topographic obstacles when the AOIs show pastures and trailing in these areas, when there is a major sheep driveway scaling steep slopes grazing the tops of Flat Top Mtn, Bald Mtn, Gilbert Peak and also show contouring around in these steep areas.

The Alpine Plants Classification (Brown 2006) found this:

Rockcress draba (DRGL6): listed as Draba globosa (beavertip draba) found in study plot A35-34E which is the Salix arctica community and study plot W21-12S listed as Dryas octopetala/Carex rupestris community. This was found east of the project area.

Utah Ivesia (IVUT): *"Another Ivesia species (Ivesia utahensis) was found in a barren shale snowbed. Because of its relationship with Juncus drummondii, Sibbaldia procumbens and Antennaria alpina it was classified with the Juncus drummondii snowbed community (study plot W17-31I3)."* This was found in the West Fork Blacks Fork Allotment at Lake EJOD.

Arctic poppy (PAUI): *"Finer material that "creeps" down slope supports additional plants such as Crepis nana, Senecio fremontii, Chaenactis alpina, Epilobium latifolium, Papaver radicatum, Cerastium beeringianum and Artemisia michauxiana. These plants are often restricted to these environmental conditions and are considered indicator species for talus creep communities. "* The plant was found in study plot (A11-4E) The photo on page 58 of the Alpine Plants Classification shows this habitat as talus with soil and 48% slope. These sensitive and erodible slopes are trailed and grazed as sheep either move across ridges or graze adjacent areas in the high elevation pastures. This was found in the Tungsten allotment near the sheep driveway.

Brown has nearly 300 sites and these three plants were found in only 3 locations. Only one was found in the project allotments. It appears that the habitats are damaged to the point the

plants are being eliminated, otherwise they would have been found. This is again an NFMA viability issue.

Sincerely,



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ATTACHMENT 1

August 28, 2023

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To The Forest Service:

Gallatin Wildlife Association, Western Watersheds Project, Wild Earth Guardians, Wilderness Watch, and Yellowstone to Uintas Connection are providing these comments on the SDEIS. We have previously submitted scoping comments and comments in response to the Draft Environmental Impact Statement (DEIS) for the High Uintas Wilderness Domestic Sheep Analysis Project which was released June 25, 2019. We understand from the June 2023 cover letter for the SDEIS that, you will "still be considering and incorporating them in the preparation of the final EIS." Therefore, we are not repeating those comments here, but are updating and supplementing them in response to the SDEIS.

Gallatin Wildlife Association has submitted separate comments (August 15, 2023) on the SDEIS addressing bighorn sheep, climate change and cumulative effects, insufficient alternatives, and habitat conditions. Sage Steppe Wild also submitted separate comments (August 9, 2023) on policy issues, including compliance with NFMA, NEPA, Forest Service Manual and Handbook, Forest Plans, and others. We are incorporating the comments by both organizations herein by reference.

We begin by outlining the major points from our prior comments, followed by discussion updating our prior analysis of grazing impacts, bighorn sheep, Canada lynx, wilderness, and policy issues. Links are provided to references.[1]

Summary of Past Comments

1. Scoping comments submitted by Yellowstone to Uintas Connection dated June 27, 2014.
    a. Described our history of observations and data describing degraded conditions in the project allotments and adjacent sheep allotments.
    b. Provided a report documenting these conditions and comparing ungrazed and grazed allotments.
    c. Pointed out degradation of wilderness values.
    d. Described sheep bedding impacts and the need to document these.
    e. Referenced Mont Lewis' 1970 report documenting sensitivity of these alpine systems to grazing on steep slopes and erodible soils and the need for site specific suitability determinations, determination of plant community production, available forage, and current rates of forage consumption.
    f. Provided a report "Updating the AUM".
    g. Requested that soil scientists' reports and documentation from the West Fork Black's Fork EIS be included in the analysis as sheep alternately trail in and out of both West Fork and East Fork Black's Fork allotments.
    h. Opposed renewing permits.

2. Scoping comments submitted by Western Watersheds Project, Wilderness Watch and Yellowstone to Uintas Connection dated July 13, 2014.
    a. Provided comparison between grazed and ungrazed allotments showing recovery in the ungrazed allotments and continued degradation in the grazed allotments.
    b. Challenged the idea that gophers and tie hacking were causes for degraded conditions.
    c. Pointed out the damage from trailing and grazing sheep on steep slopes and passes.
    d. Asked for comparisons between current grazed and ungrazed areas with historical monitoring data such as the 1960's analyses.
    e. Asked for a determination of the historical range of bighorn sheep and pointed out the suitability of the entire wilderness to be bighorn habitat.
    f. Asked for an equivalency calculation for the forage consumption of domestic sheep in these allotments to the numbers of other animals that could be supported without domestic sheep.
    g. Asked that the West Fork Black's Fork allotment also be analyzed due to the trailing and cumulative impacts in common with the East Fork Blacks Fork.
    h. Pointed out the watershed and erosion effects which are evident in current grazed areas compared to the recovery in long term ungrazed areas.

[1] Reports and publications referenced in our past comments are found at: https://app.box.com/s/60hra81c2mqdxc6mjnlh

i. Asked that the impacts on predators and carnivores be analyzed due to loss of their prey base (competition for forage with domestic sheep), and the effects of trapping and killing by herders, wildlife services, and DWR.
j. Provided a review and some data on gopher ecology and the effects of forage removal and trampling on visible gopher activity showing in the absence of livestock, visible gopher activity was low.
k. Provided data and a chart showing the percent bare ground in grazed and ungrazed locations showing potential is nearly 100% ground cover while in grazed locations it was about 50% bare ground.
l. Asked for analysis of disease vectors (pathogens) related to domestic sheep grazing these watersheds and the potential risk to recreational users.
m. Asked for cumulative effects analysis to include the Regionally Significant Wildlife Corridor and other projects such as timber and salvage projects.
n. In conjunction with that cumulative effects analysis, to analyze the effects of habitat fragmentation on Canada lynx habitat and linkage and loss of prey base from competition with livestock.
o. Asked for updated analysis of goshawk capable and suitable habitat and the effects of projects such as the timber harvests and roads on distribution and population of goshawks.
p. Pointed out the conflict between bighorn and domestic sheep, the Payette decision, the 11/25/2008 Forest Service Chief instruction to Regional Foresters to provide "effective separation" between the two.
q. Asked for updated capability and suitability analysis for domestic sheep.

3. Comments by Yellowstone to Uintas Connection on "An Alpine Community Classification for the Uinta Mountains, Utah" dated February 18, 2015.
    a. Expressed concern over the use of areas that are being grazed by livestock as reference areas and thereby accepting degraded conditions as a baseline or reference for the potential state of the communities.
    b. Areas with reduced ground cover were described as "pristine" or "undisturbed".
    c. The report was biased in hardly mentioning livestock or sheep, while gophers were a dominant theme indicating that the author and advisors from the Forest Service "can identify gopher activity (while ignoring gopher ecology) but cannot recognize sites that are grazed by domestic sheep or impacts from domestic sheep grazing."
    d. Requested the document be withdrawn and revised by incorporating more detailed analysis which was outlined.

4. Scoping Comments submitted by Gallatin Wildlife Association dated December 21, 2015.
    a. These comments raised the question of reanalysis of the sensitive species list for the Region.
    b. Requested an analysis of the history of NEPA and permit renewal for the allotments and allotment plans.

c. Requested an analysis of the history of bighorn sheep in and near the project area, population estimates, management interventions, and costs.
d. Requested analysis of the seven allotments closed in 2003 and the response of bighorn sheep and vegetation to these closures.
e. Requested a summary of bighorn herds, which are considered sustainable, viable at population or genetic level, and defines genetically effective as influenced by natural selection rather than human intervention.
f. Consider limitations on existing bighorn herds or the ability for new populations to be established on historic or suitable habitats within or near the allotments.
g. Note where these National Forests are now providing habitat for viable populations of bighorn sheep as required by NFMA.
h. Analyze disease issues and address how the presence of domestic sheep affects the suitability of bighorn habitat in the Uinta Mountains and map the historic and suitable habitat in the area.
i. Cites Forest Service rules to limit bighorn sheep contact with domestic sheep and requests copies of the herder reports needed to keep accurate records of grazing use and dates, stocking numbers, bighorn sheep sightings, and animal losses.
j. Asked if closing these allotments to domestic sheep would make the habitat suitable for bighorns and allow them to establish?
k. Asks for suitable bighorn habitat to be mapped within 14 miles of the allotments.
l. Expresses concern over connectivity for bighorn sheep, fences as barriers and requests a map of any fencing within the allotments.
m. Asks for all locations and activities to remove, control, or kill wild native carnivores and the involvement of Wildlife Services or the State of Utah.

5. Scoping Comments submitted by a coalition (Gallatin Wildlife Association, Western Watersheds Project, Wild Earth Guardians, Wilderness Watch, Yellowstone to Uintas Connection and others dated December 30, 2015.
    a. We incorporated earlier comments identified in the letter.
    b. Re-emphasized the negative impacts of the action on bighorn sheep, wilderness, TES species and habitats, effects of sheep grazing on watershed function and soil cover.
    c. Expressed the need to compare native plant biodiversity, pollinators, increaser species between long-term livestock exclusion areas and currently grazed areas.
    d. Global warming effects on high elevation vegetation, bighorn sheep.
    e. Need to analyze the impact of forage competition from domestic sheep with native grazers, including numbers equivalent and displacement from preferred habitats.
    f. Include West Fork Black's Fork allotment in the analysis due to its presence in bighorn habitat, its use for trailing to and from the Ashley NF and also trailing into the East Fork Black's Fork.
    g. Analysis of trail register comments is needed.
    h. Analysis of predator/carnivore losses due to conflicts with domestic sheep, requiring predator friendly management and a means of tracking mortality.

i. Cumulative impacts of other projects, road densities, noise, and incursions into roadless areas and other human activities on the Uinta Mountains and the Regionally Significant Wildlife Corridor.

6. Scoping comments submitted by Gallatin Wildlife Association dated March 11, 2016.
    a. Calculated that 25,700 domestic sheep would be grazing the 10 allotments while only 136 bighorns are present. Viability allowed for domestic sheep but not for bighorns.
    b. Do not support the proposed action.
    c. Reviewed bighorn population history in which the former population in the west was 1.5 to 2 million bighorns and have declined by 98% noting that in Utah they were nearly extirpated.
    d. Because of declining bighorn numbers, in 2009 the Forest Service designated them a sensitive species for the Intermountain Region. That designation carries with it the responsibility to protect and enhance habitat to prevent listing under the ESA. Domestic sheep presence is in direct conflict with these responsibilities.
    e. Bighorn populations in the Uinta Mountains have been largely extirpated and the numbers at 136 are the only population on Forest Service lands that exceeded the minimum viable population of 125 animals.
    f. Describe the extent of the High Uintas Wilderness that includes UDWR mapping of significant amount as bighorn habitat.
    g. Notes that most of the bighorn herds are targeted for augmentation. Concerned that presence of domestic sheep and trailing is a serious threat to viability and suitability of bighorn sheep and their habitat.
    h. Requested mapping of domestic sheep allotments and trailing routes and overlap with bighorn herds, identify the amount of bighorn habitat encompassed by domestic sheep allotments and within 9 miles of those allotments.
    i. The presence of domestic sheep within these bounds, based on the best available science, will adversely impact the suitability of bighorn habitat and viability of bighorn populations.
    j. Alternatives predetermined the outcome by not closing these allotments and citing the UWCNF Forest Plan identifying allotments for closure to expand bighorn habitat yet leaving closure to the discretion of the permittees.
    k. Requested ROC model mapping and analysis validating the Minimum Viable Population of 125 or more animals, provided review of MVP indicating much greater numbers are needed.
    l. Reviewed attempts to restore bighorns to the Uinta Mountains and reasons for failures. The grazing of domestic sheep on these ten allotments and the West Fork Black's Fork significantly limits the USFS ability to provide enough interconnected habitat to ensure long term viability.
    m. Note that the South Slope has no bighorn sheep and none of the individual herds on the north slope meet the MVP number.
    n. Reviewed Forest Service goals, standards, guidelines, and sensitive species management direction.

o. Described history of cumulative effects leading to demise of bighorn sheep in Utah, including habitat degradation and competition with livestock for forage and space, human disturbance, and stress citing DWR (2013). Requested analysis of suitable habitat on both Forests to determine if it is sufficient to maintain minimum viable populations.
p. Reviewed bighorn/domestic sheep science on competition and disease. Cited Ninth Circuit ruling that disease transmission from domestic sheep poses a sufficient risk to bighorn sheep viability to merit separation of the bighorns from domestic animals.
q. Cited research supporting interconnected populations and genetic bottlenecks of isolated populations.
r. Support allotment retirement to achieve viable, interconnected herds of bighorns in the Uinta Mountains.

7. Letter from Yellowstone to Uintas Connection to the Region 4 Deputy Director and Regional Range Management Staff Officer dated October 5, 2016.
    a. Reported on a prior meeting with Co-project leads for the UWCNF and ANF to discuss our collection of vegetation data and how that data would be used in an analysis of stocking rates.
    b. Included West Fork Black's Fork allotment in the presentation.
    c. Pointed out how the capable lands determined by the Forest Service are patchy and in some allotments are minimal and that their analysis did not consider soil erosion hazard.
    d. Pointed out our surveys in the early 2000's showing the uplands and slopes had extensive bare soil affecting hydrology and destroying fish habitats.
    e. Restated the Regional capability criteria provided to us by former Regional Forester and how these evolved from the R4 Range Analysis Handbook from the 1960's.
    f. Cited Mont Lewis report (1970) in which he called for grazing capacity to be based only on suitable range (now called capable). His suitable range excluded slopes >20%, soils with high or moderately high erosion index, and areas where ground cover could not be maintained under grazing use. We noted the Forest Service capable lands included large areas of wet meadows which Lewis had indicated are not preferred by sheep, so they concentrate on the drier adjacent upland areas.
    g. Referenced our prior meeting with the Co-project leads, we pointed out the failure of the current effort to validate stocking rates due to the lack of quantitative data.
    h. Pointed out the inadequate forage to support the sheep resulting in the current degradation.
    i. Symptomatic of this we documented the accelerated filling of Lake EJOD from denuded adjacent uplands grazed by sheep and cited a paper in which the author found that the watershed disturbance was detectable in the lake sediments.
    j. We then proposed some modified capability criteria to reflect Mont Lewis' recommendations.

8. PowerPoint presentation to Forest Supervisors for the ANF and UWCNF, Range Staff and Forest Ecologist on July 26, 2018. This was followed by a formal report in September, 2018.
    a. Examples of degraded conditions resulting in bare soichannelseep slopes, ridges and passes, alpine basins heavily grazed, braided stream channels, active head cuts, (compared to those healing in ungrazed watersheds), scoured stream banks, accelerated sediment deposition in lakes were provided.
    b. Comparison of soil cover in grazed and ungrazed uplands showing near 100% soil cover in ungrazed areas while those continuing to be grazed averaged approximately 50%.
    c. Cited suitability, utilization recommendations from Mont Lewis' 1970 report.
    d. Provided current data on forage consumption by domestic sheep and 30% recommended utilization rate.
    e. Reported results of our forage production sampling that showed 294 lb/acre average with wetland samples included, 211 lb/acre without. Presented Forest Service 1960's data showing average of 240 lb/acre.
    f. Presented Region 4 grazing capability criteria.
    g. Presented our forage production map and model and that for Forest Service 1960's data.
    h. Presented our grazing capability model and analysis showing few capable acres in the ten allotments.
    i. Analyzed the current Forest Service capable acreage.
    j. Calculated stocking rates for a series of scenarios showing that current stocking rates are greatly over capacity.

9. Comments submitted on the DEIS by Western Watersheds Project dated August 2, 2019.
    a. Incorporated comments provided by others by reference.
    b. Cited Forest Service handbook and manual guidance on recovery of sensitive species and FSH 2209.13 grazing permit administration Chapter 90 Rangeland Management.
    c. Desired Conditions are designed to continue degraded conditions below the level needed for proper biological and physical function. Examples of Forest Plan desired conditions provided which do not implement wilderness management requirements, instead are designed to benefit, and enable livestock grazing.
    d. Wilderness guidance from the FSM was cited, "Maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces."
    e. Also, among others, "Where there are alternatives among management decisions, wilderness values shall dominate over all other considerations except where limited by the Wilderness Act, subsequent legislation, or regulations."
    f. "Provide an environment where the forces of natural selection and survival rather than human actions determine which and what numbers of wildlife species will exist."
    g. Pointed out how the DEIS failed to comply with these, and other related requirements related to wilderness. In particular, noting that the DEIS failed to

assess impacts from domestic sheep grazing against the higher resource protection needed for wilderness areas.

h. Then cited the lack of consideration of predacious animals and birds and their benefits to the ecosystem.
i. Other citations from Departmental Regulations and the FSM providing requirements to provide habitats to maintain viable populations throughout their geographic range on NFS system lands, avoid impacts to species with viability concerns, avoid actions leading to ESA listing, and develop management practices to accomplish this.
j. Other cited provisions of the FSM require recovery strategies, quantifiable objectives, and management strategies.
k. Provisions of the Ashley NF Plan are cited such as reestablishing native species classified as sensitive, threatened, or endangered, by 1988 place all allotments under management designed to protect the wilderness resource, manage livestock within present capacity of the allotment, complete aquatic inventories of all streams, allow activities that will not adversely affect sensitive or T and E species.
l. Cited the High Uintas Wilderness Amendment requirement that, "The ability of soils to support naturally occurring vegetation communities is not significantly impaired by human activities.", and the need to collect data to show that permitted sheep grazing is not impairing vegetation communities.
m. The DEIS acknowledges that problems exist and that sites in harsh climatic conditions take time to heal while the WCNF Forest Plan requires improving habitat conditions. Yet, permitting domestic sheep in bighorn habitat prevents this from being achieved.
n. The Forest Plan requirements for wilderness include that natural ecological processes are dominant, and habitat needs of species at risk are protected.
o. Other Forest Plan requirements regarding pollinators, maintaining tall forb communities, and monitoring elements were discussed. Citing guideline G24 on protecting pollinators by not allowing activities that negatively affect them occurring during the flowering period. The DEIS does not recognize the effect of livestock grazing on this removal of flowering plants.
p. Reviews the Bighorn Conservation Assessment and its focus on eliminating potential for contact between bighorns and domestic sheep. In particular citing research that "Areas that have been grazed by domestic sheep may not be suitable areas for wild sheep for up to four years after grazing has been discontinued".
q. Cites RMRS-GTR-209 and a court ruling stating that, "Scientific research supports a finding that when bighorn sheep intermingle with domestic sheep, large numbers of bighorn sheep die… there is no way to avoid the incompatibility other than to keep the domestics and the bighorns separate." Where management objectives include maintenance or enhancement of bighorn sheep, spatial or temporal separation must be created.
r. The comments also pointed out the need to update the capability of the area to provide forage for livestock, ground truth the capability determination and complete

a suitability analysis that considers conflicts of use and resource damage resulting from livestock grazing. The DEIS was lacking in the needed analysis.

s. NEPA and the defining of a project purpose and need can be manipulated into being narrowly defined, thus limiting reasonable alternatives as is the case with the DEIS.
t. States that the DEIS analysis for most species does not contain population data trends or habitat conditions. Using CRCT as an example, the DEIS notes they are in decline but will "persist" and that increased sedimentation, trampling etc. will not increase this trend toward federal listing. This is a violation of the "hard look" under NEPA and the viability mandate of NFMA.

10. Comments submitted on DEIS by a coalition (Gallatin Wildlife Association, Western Watersheds Project, Wild Earth Guardians, Wilderness Watch, Yellowstone to Uintas Connection and others dated August 5, 2019. Major topics and related points are outlined below.
    a. The relationship of domestic sheep grazing in the Uintas to climate change.
        i. Expect an analysis of the cumulative effects of Forest Management in these Forests on climate to include other activities in addition to domestic sheep grazing just in the ten allotments.
        ii. Reviewed livestock industry contributions to GHGs, effects on stored carbon in soils and vegetation, motorized vehicle emissions, protection of forests for carbon storage.
        iii. Discussed the Forest Service Roadmap to address climate change and the need to provide connectivity, restore habitats, sequester carbon.
        iv. Discussed the National Fish, Wildlife and Plants Climate Adaptation Strategy that stresses conservation of habitats and reduction of non-climate stressors such as habitat degradation by livestock.
    b. Bighorn sheep risk due to contact with domestic sheep.
        i. Addressed the project and risks to bighorn sheep and Forest Service obligations to conserve sensitive species along with the agency philosophy that risks on other land ownerships exist, therefore the Forest Service need not mitigate the risk.
        ii. Pointed out flaws in the analysis of the cyclic nature of bighorns in the Uinta's which the BE attempted to assert as natural in spite of die-offs and that they remain below carrying capacity.
        iii. Explained that DWR augmenting bighorn herds is not legitimate in order to waive its obligations on sensitive species.
        iv. Pointed out the inconsistencies with both Forest Plans and NFMA regarding viability of sensitive species and continued presence of domestic sheep.
        v. Pointed out flaws in the Biological Evaluation such as the State's MVP not being valid, the Region 4 presenting differing values for MVP, disease likely causing losses and population numbers below the MVP.
        vi. The cumulative effects area is too limited.
        vii. The project risk assessment sets a prior impact date of 3 years, but bighorn population impacts can last more than ten years from exposure to pathogens.

viii. There is no guarantee the permits will undergo NEPA at the end of the ten-year term and the timeline for determining future effects should reflect that.
ix. An updated grazing capability and suitability assessment is needed to account for TES habitats and incompatibilities with domestic sheep.

c. Wilderness qualities.
i. The High Uintas Wilderness is the most heavily grazed Wilderness and suggests this is why the likely best bighorn sheep habitat in the Wilderness Preservation System has struggling populations.
ii. The DEIS fails to state grazing in Wilderness is a nonconforming use that harms wilderness character and biases the NEPA analysis.
iii. This ignores that wilderness must be administered that leaves it "unimpaired for future use and enjoyment..protected…preservation of wilderness character.. "
iv. The wilderness definition includes that it is "untrammeled by man…retaining its primeval character...is affected primarily by the forces of nature".
v. Grazing livestock in wilderness is an exception where it is allowed to continue if in place prior to September 3, 1964, but must be regulated.
vi. The DEIS leads the reader to conclude the proposed action would not harm Wilderness but fails to recognize agency policy to "close the gap" between the attainable level of purity and that which currently exists.
vii. The DEIS biases the NEPA analysis by incorporating condition classes described in an earlier plan, therefore an analysis of No Grazing is not needed.
viii. Those seeking a true primitive recreation experience would likely be most harmed by the presence of domestic sheep, while reliance on trail registers can be misleading.
ix. Cites the misapplication of Landres et al 2008 and Keeping It Wild that downplays the essence of Wilderness and how KIW2 has been used to justify trammeling actions in wilderness.
x. Critiques DEIS characterization of naturalness that presumes domestic sheep impacts are transient while ignoring the forage consumed, watershed degradation, and disease organisms left in feces.
xi. Predator control was not mentioned yet the FSM emphasizes the critical role they play in maintaining integrity of natural ecosystems while the area is within lynx habitat, a recent wolverine sighting was made, while bears and coyotes are not mentioned.
xii. Sheep driveways are sacrifice zones lacking plant diversity and severely eroded.
xiii. The DEIS recognizes there has been no grazing since 1977 on the Fall Creek allotment, while the High Uintas Wilderness was designated in 1984 and the DEIS does not detail impacts from grazing this allotment.

d. Domestic sheep grazing and lynx habitat.
    i. Lynx is threatened but there is no designated critical habitat in Utah although there are vast expanses of habitat where lynx were historically present.
    ii. The reintroduction of lynx in Colorado led to forays into Utah and the Uinta Mountains while to the north in Wyoming there are naturally occurring populations.
    iii. The Uinta Mountains are part of a regionally significant wildlife corridor connecting to the Greater Yellowstone ecoregion through SE Idaho.
    iv. The highest concentration of lynx locations from the Colorado reintroductions is in the Uinta Mountains.
    v. Habitat modeling has identified the Uinta Mountains as core lynx habitat and part of this Regionally Significant Wildlife Corridor, so why are there no lynx in the Uinta Mountains?
    vi. The most obvious and most probable reason is that "following an initial extirpation due to trapping, hunting, poisoning, logging and livestock grazing, natural recolonization of the Uinta Mountains by Canada lynx is prevented by ongoing anthropogenic disturbances. One major continuous disturbance to consider is the domestic sheep trailing and grazing in the Uinta Mountains that has gone on every year for over 100 years."
    vii. Forest Service hypotheses to explain absence of lynx lack consideration of impacts of domestic sheep grazing, neither of their two hypotheses is plausible and cannot support the Alternative 2 conclusion that "is not likely to adversely affect Canada lynx".
    viii. Because lynx surveys since 1999 have not found lynx presence, the FS concludes there was never a resident population in the Uinta Mountains and therefore the Uinta Mountains are not good habitat.
    ix. The lack of lynx could be due to human uses of the forest.
    x. The 10 verified records of lynx occurrence in the Uinta Mountains in the 20th century underestimate the record. There are a total of 37 records including reliable records.
    xi. The question is how many records would be needed to establish that there was a resident population in the 20th century? No one knows, but the premise that there was never a resident population begs the question by presupposing there never was a resident population.
    xii. The premise that cyclic highs in lynx populations supports the hypothesis that lynx in the Uinta Mountains were transient rather than part of a resident population also begs the question since only 4 of the verified records correlate with those cyclic highs.
    xiii. The comments analyzed the snowshoe hare situation using the West Fork Blacks Fork example from the 2006 FEIS in which the Forest Service found 42% of the allotment to be lynx habitat, while this DEIS then states there are only 574 acres of lynx habitat in LAU34.

xiv. By downplaying the amount of lynx habitat, the DEIS is able to discount sheep grazing and trailing effects on lynx habitat by defining less than 2,000 acres of lynx habitat in the project area.
xv. Case law supports consideration of biological corridors and their functionality, thus the corridors within the analysis area and linkages need to be examined as part of the larger corridor system between ecosystems.
xvi. Cited RFP G18, "In lynx analysis units design all management activities to maintain, restore, or protect desired lynx and lynx prey habitats including foraging, denning and movement."

e. Grazing impacts on the Uinta Wilderness ecosystem. These comments are more broadly summarized due to the level of detail contained therein.
   i. These comments included the input from a retired Ashley NF soil scientist.
   ii. It is noted that the DEIS fails to admit any damage or impacts on soils, vegetation, streams, or watersheds by grazing tens of thousands of domestic sheep on this sensitive, steep, and erodible landscape.
   iii. Pocket gophers are blamed for reduced soil cover in spite of evidence we submitted.
   iv. The DEIS discounts damage to sensitive and erodible areas by claiming sheep have equal access to those with low ground cover as well as high ground cover, while failing to acknowledge the areas with high ground cover can include wet meadows which sheep do not prefer.
   v. The Forest Service limits its monitoring to these less sensitive areas and then claims that conditions are satisfactory.
   vi. We pointed out the cumulative impacts of sheep bedding, salting, watering, trailing and camps over the century of use has led to sheep accessing and damaging the entire project area as opposed to the small area described in the DEIS.
   vii. The monitoring studies and conclusions found in records we obtained by FOIA present a picture of an ecosystem without significant impacts, yet the 1970 report by Mont Lewis who was a Range Conservationist on the Ashley NF described the lack of suitability of these alpine areas for grazing and illustrated the grazing impacts.
   viii. Lewis' photographs and descriptions also pointed out the erosion caused by sheep grazing on steep slopes and increasing sedimentation of the lakes and severe erosion caused on the red shale type from grazing.
   ix. Lewis' photographs illustrated alpine turf in poor condition from a history of heavy use.
   x. Mont Lewis provided recommendations for grazing capacity and suitability determination.
   xi. We provided photos illustrating the conditions on steep slopes resulting from grazing and trailing sheep, resulting in accelerated erosion and loss of soil stabilizing vegetation.

xii. Darlene Voerner's (ANF soil scientist, retired) analysis included photographs of broken turf from sheep grazing leading to increasing soil loss, loss of soil covering lichens, barren areas created by this loss of the shallow soil cover, pedestaled vegetation, and the need for a detailed Level 2 soil survey.

xiii. We pointed out flaws in the data received in our FOIA in that there was no utilization data which means utilization standards are meaningless. Our analysis of 1,565 study sites in the Ashley NF found that only 69 reported ground cover from line intercept or ocular estimates in the past 20 years.

xiv. We provided photos from the FOIA files illustrating the minimal capable acres, the proximity of steep slopes and the drier upland sites which are preferred to the valleys with their forest cover, wetland, and willow areas.

xv. Those photos also illustrated the late snowpack and growth barely starting before sheep enter in their thousands to graze and trample these sensitive soils in such a stressed environment with harsh growing conditions.

xvi. Photos from the long ungrazed Fall Creek allotment showed meadows lush and green with 100% ground cover, trails and headcuts vegetated and recovering, wet meadow with adjacent uplands fully vegetated, absence of streambank scouring, and areas of streambank trampling recovering, also snow beds with full cover of lichen and other plants covering the soil.

xvii. An illustration of the preference of sheep from the FOIA files is in Ottoson where sheep are seen grazing and occupying the drier uplands adjacent to the stream and wetland area. Another photo of Ottoson showed severe erosion that is not healing, bare grazed slopes adjacent to wetland area, and broken turf.

xviii. An Ottoson wet meadow photograph with a notation by Sheryl Goodrich that "Sheep are very reluctant to use these areas."

xix. The Rorripa Snowbed photo with the statement that "Snow release date was prior to August 29 this year." These areas remain snow covered until late in the season yet are grazed and trampled so there is no chance of recovery. This photo showed large bare soil with no evidence of gophers, indicating it is not gophers creating the bare soil.

xx. An Ottoson gopher activity photo showing gopher activity in uplands adjacent to a wet meadow, but this is also a site that would be selected by sheep which would concentrate in the upland to avoid the wet meadow.

xxi. An Oweep sheep trail with a headcut and the Range staff admitting sheep trailing contributes to the headcut.

xxii. A photo in Painter Basin showing denuded uplands adjacent to a wetland area with the statement, "Had livestock grazing been so intense as to cause the conditions on the far side of the stream, similar conditions could be expected on the near side of the stream." Here the Forest Service makes the comparison with a wetland that according to their own statements would be avoided by sheep. Yet it is used to claim that the bare uplands are not degraded by sheep in the very areas they typically would graze.

xxiii. Sample Point analysis of a Forest Service monitoring photo showed that a ground cover data sheet reporting 2% bare soil was actually 40%.

xxiv. We cited a lichen study that illustrated the disruption of lichen communities and ground cover by sheep grazing.

xxv. A report of a visit to Bald Mountain stated, “"I spent the long weekend in the Uintas, my husband and I climbed to the top of Bald Mountain in the Red Castle allotment. There was so much sheep sh.. we couldn't put our packs down. In most places the ground was so saturated the melt was creating overland flow, so the feces was in standing water that was running off into the creeks. We hiked all the way back down without water, because gross. I trust my filter but that was just disgusting." This ridgetop location was heavily grazed by sheep and the ground littered with feces.

xxvi. We presented our analysis of Forest Service monitoring locations. Many monitoring points had no location data. We found that 75% of the monitoring sites were in “capable” areas that did not include consideration of a number of factors such as soil erosion hazard, forested cover, forage production and does not represent the complete set of criteria that should determine capability.

xxvii. The analysis showed the majority of sites were in areas of <10% slope indicating the more sensitive erodible or steep slopes were monitored less with wet and willow dominated sites dominating those monitored. These are the less preferred sites.

xxviii. We presented maps of the Forest Service monitoring sites showing their concentration in valleys and also a map of the range capability for cattle and sheep as determined by the Forest Service showing the very minimal areas capable for sheep.

xxix. We concluded the comments noting the heavy bias of the Forest Service monitoring and the lack of acknowledgement of domestic sheep impacts, that recovery is happening in the Fall Creek allotment, which is ungrazed, and there is no comparison of grazed and ungrazed areas.

Purpose and Need

The SDEIS (p5) describes the Purpose and Need for this project.

> The primary purpose of this project is to comply with the November 7, 2013 settlement agreement resolving Western Watersheds Project et al. v. United States Forest Service, Case No. 10-cv-612 ELJ-REB. In conjunction with the primary purpose, the other main purpose of this project is to provide forage for permitted domestic livestock grazing in a manner that maintains or moves conditions toward achieving Forest Plan objectives and desired conditions.

This is a purpose and need that is clearly defined to perpetuate the status quo, i.e. a "decision already made" which is counter to the intent of NEPA for a fact-based objective analysis. Prioritizing wilderness qualities, watershed health, protecting soils, sustaining native plant communities, and meeting the needs of fish and wildlife are omitted as a priority, that includes threatened, endangered, and sensitive species.

As outlined at the beginning of these comments, we have provided a great deal of input on all aspects of this project over ten years. We can find nothing that sincerely addresses this input and can only conclude that this SDEIS, its alternatives, and its upcoming decision document are merely "justifying a decision already made." (NEPA 1502.2). The courts have held that in defining a very narrow purpose and need, the agencies run afoul of NEPA.[2] (See Sage Steppe Wild comments on the SDEIS for more discussion on agency obligations in selecting alternatives.)

> The "purpose" of a project is a slippery concept, susceptible of no hard-and-fast definition. One obvious way for an agency to slip past the strictures of NEPA is to contrive a purpose so slender as to define competing "reasonable alternatives" out of consideration (and even out of existence). The federal courts cannot condone an agency's frustration of Congressional will. If the agency constricts the definition of the project's purpose and thereby excludes what truly are reasonable alternatives, the EIS cannot fulfill its role. Nor can the agency satisfy the Act. 42 U.S.C. § 4332(2)(E).[3]

The SDEIS (p24) notes that the determination of alternatives for analysis was made by "resource specialists from both Forests, and some of the cooperating agencies that represented agriculture and some that had jurisdictional authority over wildlife… ." This does not mention the input from interested publics and amounts to an internal livestock-centric group of interests. We note that the MOU for Management of bighorn sheep on NFS lands in Utah is a joint agreement among the Forest Service, Utah Dept of Agriculture and Utah Division of Wildlife Resources.[4] The Forest Service Handbook FSH 2209.10 Chapter 10 describes public involvement. It is supposed to:

- "Involve the permittee and interested publics in management of the range allotment." (Par. 11.3).

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[2] See Sage Steppe Wild "Comments on the High Uintas Sheep DEIS" for a full description of policy requirements and flaws in the analysis for the DEIS/SDEIS.
https://app.box.com/s/la5v8o0mtj4ynnl4wia3vsqbw1dt66i1

[3] Simmons v. U.S. Army Corps of Engineers, 120 F.3d 664, 666 (10th Cir. 1997).
https://caselaw.findlaw.com/court/us-7th-circuit/1089603.html

[4] Memorandum of Understanding for the Management of bighorn sheep on National Forest System (NFS) lands in the State of Utah. 2019. FS Agreement Number: 19-MU-1 1046000-028.
https://wildlife.utah.gov/pdf/bg/plans/bighorn_uinta_mountains.pdf

- "Obtain ID team, interested publics, and permittee assistance in securing the necessary inventory and monitoring information and establish criteria for determining allowable use levels." (Par. 12.2).
- "The interdisciplinary (ID) team, the permittee, and interested publics should assist in the rangeland inventory and analysis and in the preparation of environmental documents." (Par. 13).

Citing congressional intent "to allow livestock grazing on suitable lands" and the desirability of providing forage for permitted domestic livestock, the SDEIS (p6) also recognizes this is a discretionary action by the Forest Service. These points of providing forage for livestock and doing so on suitable lands is key to our opposition to this project.
Suitable lands must also be "capable" according to the criteria defined by the Forest Service and the forage on those capable lands must be sufficient to provide for wildlife and livestock while leaving sufficient residual vegetation to protect watersheds and sustain the plant communities. The SDEIS (p10) cites the UWCNF RFP by stating, "Manage livestock grazing levels and operations on suitable lands for sustainable forage use within properly functioning conditions."

The question then becomes is there sufficient capable and suitable lands and forage to support domestic livestock while also meeting the needs of wildlife and watershed function? The SDEIS has not answered that question.

Domestic sheep grazing

Capacity and Stocking Rate: While the SDEIS mentions capable acres within the allotments, it doesn't map those and analyze the relationship between individual blocks of capable lands and describe the trailing and grazing taking place on the non-capable lands. We have reported significant degradation of areas within the allotments including uplands, slopes, stream banks and trails. The lack of a current evaluation of forage availability, forage demand, and setting a stocking rate based on forage available on capable areas leads to this damage.

In 2016, we conducted a survey for available forage in the project area using locations in allotments that were not grazed prior to field sampling.[5] The goal was to determine forage production and stocking rates for the allotments using the full suite of Forest Service capability criteria. This was needed due to the failure of the Forest Service to determine current forage production and incorporate all of its capability criteria into the determination of capable acres for domestic sheep grazing. This results in the Forest Service overstating the capable acreage and stocking rate for the allotments. This full analysis was presented to the UWCNF and Ashley

[5] Vasquez, E., Carter, J., and Jones, A. 2018. A Forage Capacity and Stocking Rate Determination for the High Uintas Wilderness Domestic Sheep Analysis.
https://app.box.com/s/2c8dgun6na1v71zlew9oczpzq3nb27mo

NFs in a meeting in July, 2018 and in report form in September, 2018. It has also been published in a journal.[6] That article is included as Exhibit 1 to these comments.

The locations surveyed for forage production were representative of the six major soil types in the project area within the UWCNF. These were mapped, and image analysis performed to derive a predicted forage production layer. In addition, USFS forage production data from the 1960's was digitized and analyzed to produce a forage production dataset which could also be mapped. A canopy density dataset was generated in order to exclude densely forested areas in accordance with Forest Service capability criteria. We then applied a model of the Forest Service capability criteria, our forage production data, canopy cover density, slope, and removed wetland areas and water bodies to determine capable acreage. Both our 2016 and the Forest Service's 1960's datasets could be applied. Table 1 shows that the mean production is about the same today as it was in the 1960s.

Table 1. Key Statistics for Forage Production (lb/acre)

Time Period	Median	Mean	Maximum
1960's	206	240	615
2016	166	294/211*	1431**

*If wetland samples are excluded, the mean forage production becomes 211 lb/acre.
**Includes wetland samples

The current Forest Service regional criteria for determining capable acres are:[7]

- Areas with less than 45 percent slope for domestic sheep, 30% for cattle.
- Areas producing or having the potential to produce an average of 200 lbs or more of forage/acre on an air-dry basis over the planning period.
- Areas without dense timber, rock, or other physical barriers.
- Areas with naturally resilient soils (not unstable or highly erodible soils).
- Ground cover greater than 60%.
- Areas within one mile of water or where the ability to provide water exists.

In the 2003 WCNF RFP only the slope, forage criteria (based in extrapolation from vegetation map) and distance to water were used. We obtained GIS files from the Forest Service representing capable acreage in the Forest Plans for the UWCNF and ANF. These were used to map capable acreage using the three criteria that did not exclude dense timber or wetlands and did not collect forage production data. The capable acres using the Forest Service abbreviated

[6] Carter, J., Vasquez, E. and Jones, A. (2020) Spatial Analysis of Livestock Grazing and Forest Service Management in the High Uintas Wilderness, Utah. Journal of Geographic Information System, 12, 45-69. https://doi.org/10.4236/jgis.2020.122003

[7] U.S. Department of Agriculture (USDA) (1998) Rangeland Capability and Suitability Determinations for Forest Plan Revisions R-4 Revised 2/20/98. Region 4 Forest Service, Ogden, UT. See also FEIS for the 2003 WCNF RFP Appendix B-9.

determination within the ten allotments was 53,399 acres, or 35.7% of the 160,410-acre project area. See Figure 1.

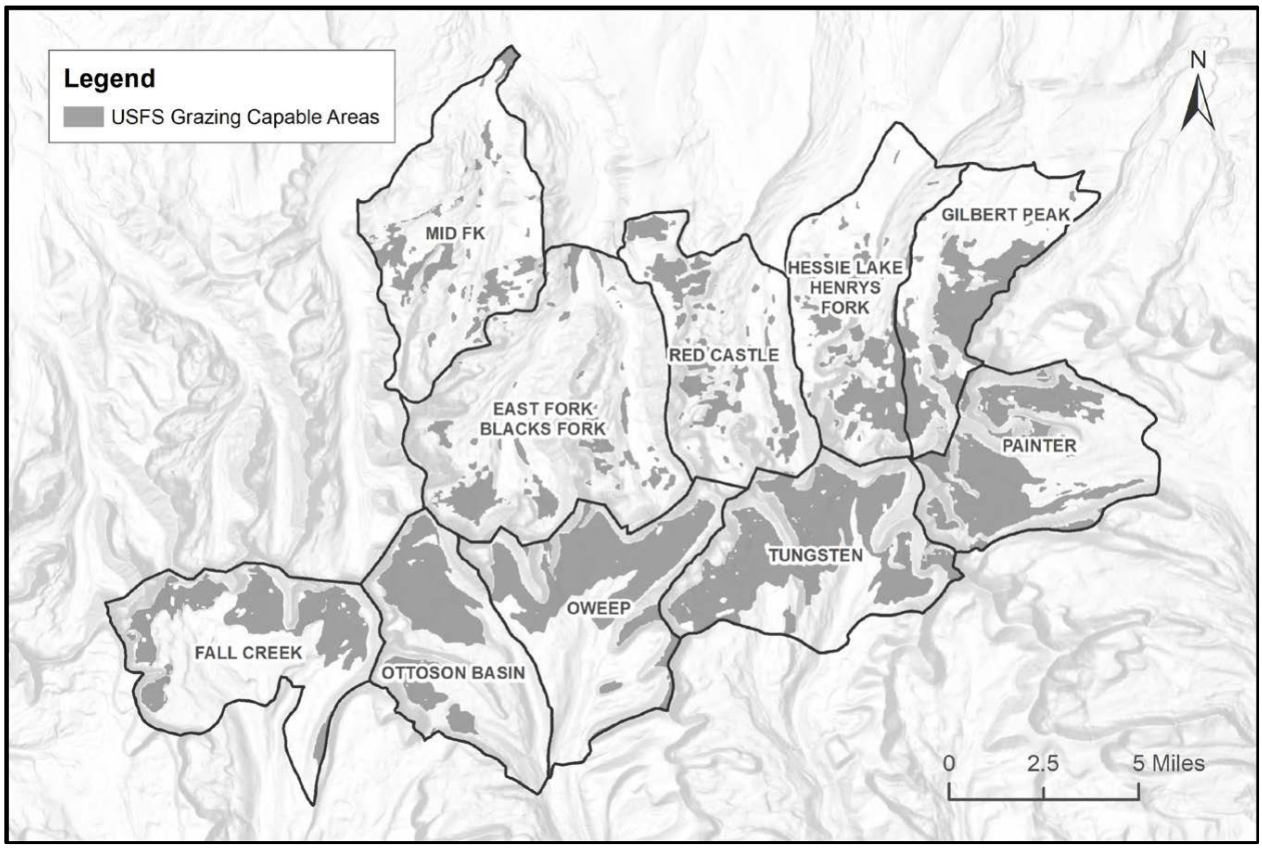


Figure 1. Ashley and Wasatch-Cache National Forest determination of capable acres = 57,399 acres, or 35.7 percent of total acres.

We calculated the capable acres using our forage determination and modeled forest canopy cover, while excluding wetlands and water bodies (The Forest Service has acknowledged that domestic sheep avoid grazing in these wet areas). Here we present the summary for two cases. In Case 1, we calculated the acreage of lands meeting the current regional criteria of ≤45% slope, 2016 forage production ≥ 200 lb/acre, and excluded areas of dense timber, water bodies and wetlands. In Case 2, since the most recent Forest Service forage production data was collected in the 1960s, we digitized the 1960's forage production data which was then used to determine acres with forage production ≥ 200 lbs/acre. This, along with slope ≤ 45%, while excluding dense timber, water bodies and wetlands were used to determine capable acres. Figures 2 and 3 illustrate the extent of capable acreage for these two cases.

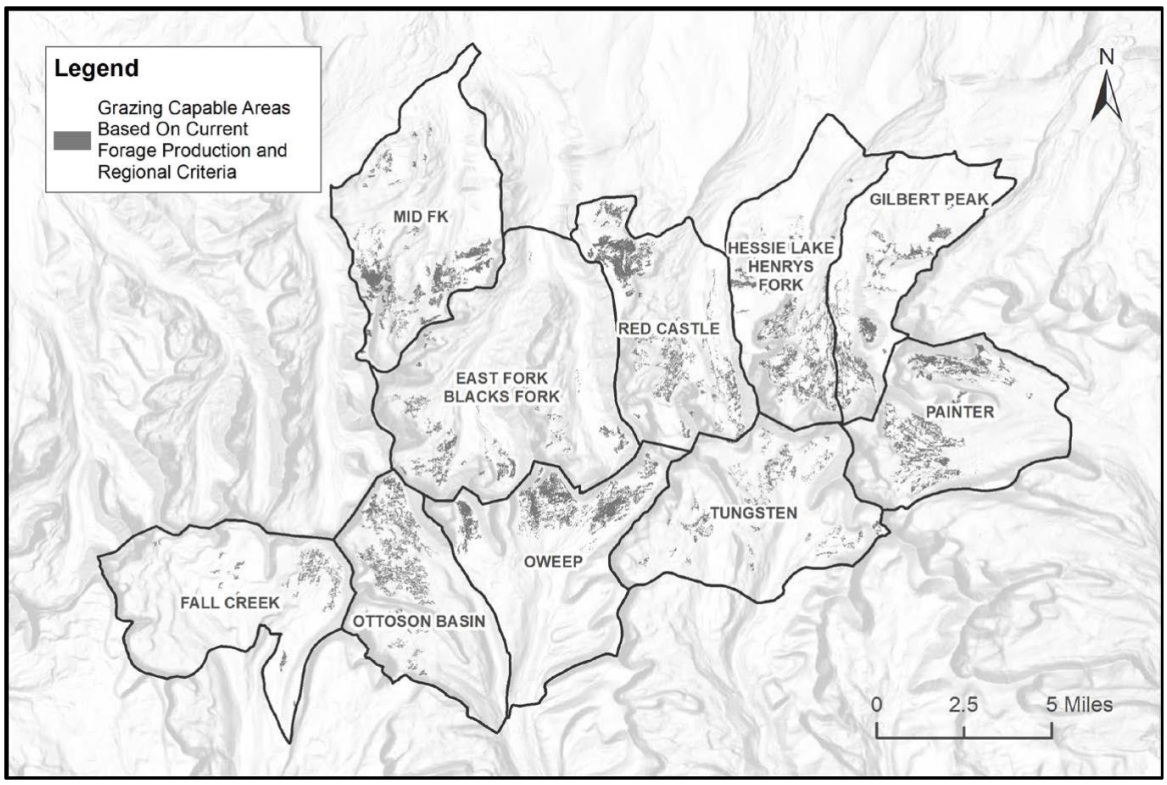


Figure 2. Capable acres determined from regional capability criteria and current forage production = 9685 acres, or 6.0 percent of total acres.

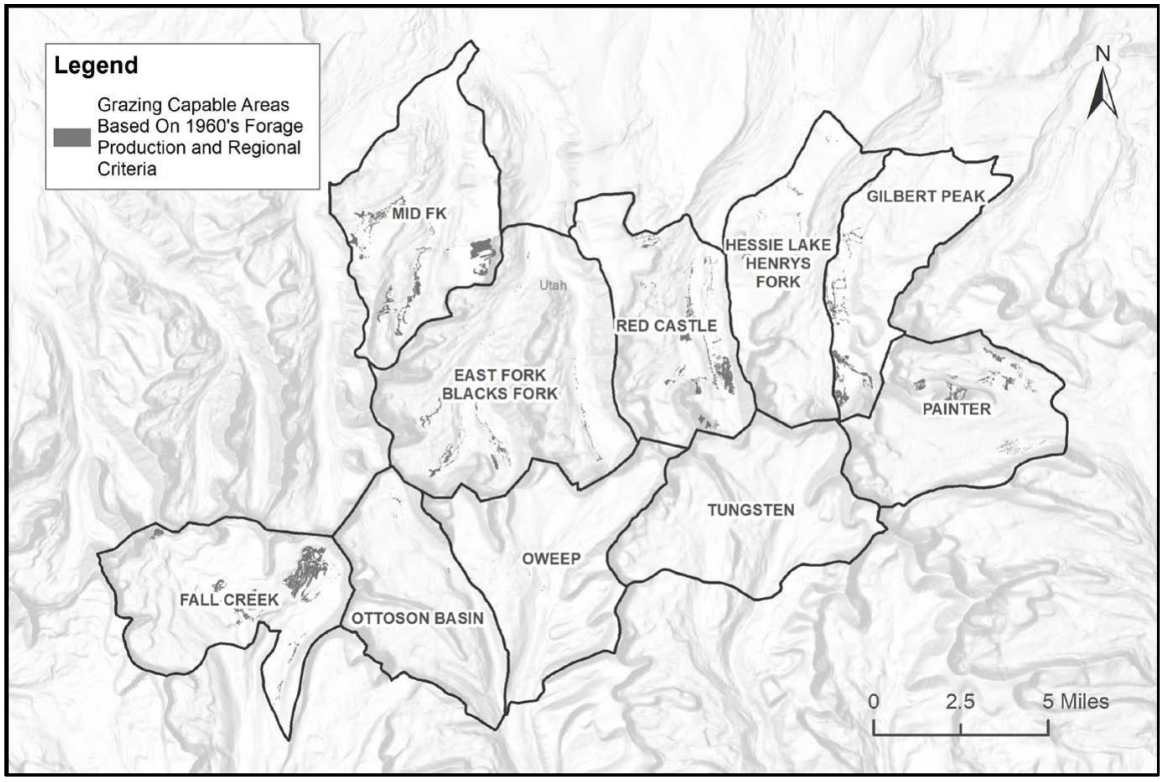


Figure 3. Capable acres determined from regional capability criteria and 1960's forage production = 2,887 acres or 1.8 percent of total acres.

This analysis determined there are only 9,685 capable acres for Case 1, or 6% of the project area and 2,887 acres for Case 2, or 1.8% of the project area. Clearly, an accurate determination of capability shows the lack of a full analysis by the Forest Service overstates the actual capable acres by factors of 6 and 20. (Table 2).

Table 2. Capable Acres by Allotment

Allotment	Case 1	Case 2
East Fork Blacks Fork	613	263
Fall Creek	319	734
Gilbert Peak	846	355
Hessie Lake Henry's Fork	1103	56
Middle Fork	1197	634
Ottoson Basin	1099	14
Oweep	1346	4
Painter	1186	317
Red Castle	1449	510
Tungsten	527	0
Total	9685	2889
Percent of Total Area (160,410 acres)	**6.0**	**1.8**

The total forage demand for the currently permitted 12,850 ewe/lamb pairs grazing these ten allotments based on their time in the allotments and a forage demand of 301 pounds per month per pair is 8,062,641 pounds. In Case 1, using the 2016 mean forage production of 294 lb/acre and 9685 capable acres gives total forage production of 2,847,390 pounds. Applying a 30% utilization rate to this amount gives 854,217 pounds available. This is 10.6% of the current demand by domestic sheep. In Case 2, using the 1960's mean forage production values on the 2887 capable acres is 848,778 pounds. Applying a 30% utilization rate to this amount gives 254,633 pounds available. This is 3.2% of the demand. The implication of this for current stocking rates is clear. In Case 1, a 90% reduction would be needed to balance domestic sheep use by the current permitted numbers to the available forage. In Case 2, a 97% reduction would be needed to balance domestic sheep use by the current permitted numbers with the available forage. The extra forage needed must come from grazing and trailing sheep throughout the non-capable areas on steep slopes, erodible soils, and sensitive alpine meadows resulting in the degraded conditions we have reported.

We have read the climate analysis for this project. It does not go far enough in accounting for climate effects and greenhouse gas emissions. The FEIS for the WCNF RFP (p3-351) gives the 10-year average AUMs permitted on the Forest. The total for cattle is 41,507 AUMs and for sheep it is 30,711 or overall, 72,218 AUMs. The climate analysis presents figures from INFRA for numbers grazed for each forest, but there are no total emissions generated on a Forest-wide basis. The ANF Forest Plan (pII-9) states the total AUMs is 75,000. While the Forests' climate analysis estimates the weight and forage consumption of the sheep grazing these allotments, they may be low based on observations of the sheep in the allotments. The Forest Service

should request auction/sale records from the permittees to determine a more accurate representation of today's sheep weights as well as the numbers of lambs per ewe. The effects analysis (cumulative effects) should be couched in terms of the total emissions from the actions on the Forests, including logging, prescribed burns, livestock grazing and should include past, present, and foreseeable projects. A recent paper demonstrated the social carbon cost of public lands grazing. It was estimated to be $1.1 – 2.4 billion.[8]

It is also important to recognize that the capable areas are separated and patchy. This means that sheep are grazed, trailed, and bedded in non-capable areas which are more sensitive to disturbance. In addition, the capable areas would still need to be refined using the Regional Criteria for suitability. One of those factors which can result in the land not being suitable is in key wildlife habitats such as for bighorn sheep (See Sage Steppe Wild comments on the SDEIS).

Closing Allotments: The SDEIS did not analyze an alternative to reduce the number or size of allotments. It did not analyze reducing stocking rates to balance forage demand with available forage. Instead, it proposes to continue the status quo which will perpetuate the damage. It also did not consider closing the Fall Creek allotment which has not been grazed since 1977 (SDEIS p26). Given that the High Uintas Wilderness was designated in 1984, the SDEIS should propose closing this allotment since grazing was not occurring at the time of Wilderness designation. We note that there is no current AOI for the allotment. The SDEIS (p8) also cites a provision from the Ashley NF Plan that states, "Sheep allotments that remain unutilized for a period of 5 years may be considered for conversion to another class of stock or closed (IV-32)." The Fall Creek allotment meets this criterion many times over.

Bighorn sheep suitable habitat occurs throughout the 10 project allotments in addition to adjacent allotments. (Figure 4). The WAFWA 9-mile buffer[9] applied to the westernmost observations of bighorn sheep (data obtained from the Forest Service) show possible exposure of bighorn sheep that would extend into Painter Basin, Gilbert Peak, Hessie Lake/Henry's Fork, Red Castle, Tungsten, East Fork Black's Fork, and Oweep allotments. (Figure 5). The BE Figure 3 shows the likelihood of bighorn sheep forays into these same allotments and beyond.[10] The WCNF RFP ROD[11] (p19) references closing seven allotments to expand the area for bighorn sheep habitat if permits are waived. The WCNF RFP FEIS (p3-178) listed these: Gilbert Peak, Henry's Fork – Hessie Lake, Red Castle, East Fork Black's Fork, West Fork Black's Fork, East Fork Bear River, and Stillwater. These should be closed to protect the current distribution of

[8] Kauffman, J.B., Beschta, R.L., Lacy, P.M., and Liverman, M. 2023. Forum: Climate, Ecological, and Social Costs of Livestock Grazing on Western Public Lands. https://link.springer.com/article/10.1007/s00267-023-01853-6

[9] Wild Sheep Working Group. 2012. Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat. Western Association of Fish and Wildlife Agencies. https://wafwa.org/wpdm-package/recommendations-for-domestic-sheep-and-goat-management-in-wild-sheep-habitat-2/

[10] Christensen, B. 2023. Terrestrial Wildlife Biological Evaluation for the High Uintas Wilderness Domestic Sheep Analysis.

[11] USDA. 2003. Record of Decision Revised Forest Plan Wasatch-Cache National Forest.

bighorn sheep and to provide for expansion of bighorn sheep into other suitable areas, all domestic sheep grazing should be terminated in the High Uintas Wilderness.

The SDEIS (p175) claims that separation of bighorn sheep and domestic sheep is maintained in the open allotments by stating, "bighorn sheep generally use the ridge tops and steep slopes for foraging, whereas domestic sheep generally use the valley bottoms. Thus, foraging competition between domestic sheep and the Uintas BHS is likely relatively limited." The problem with this theory is it does not reflect reality. We commented on the presence of heavy domestic sheep droppings on Bald Mountain, the denuded conditions on Red Knob and Dr. Carter has hiked many of the long ridges in the project area, finding that domestic sheep have heavily grazed and trampled the ridges. In addition, they are trailed back and forth between the ANF and UWCNF across the ridges.

These additional allotments should be included in the analysis. For example, we have mentioned the West Fork Black's Fork allotment in past comments. Historically, sheep have been trailed through the WFBF allotment to the south slope on the ANF.[12] This would likely be the Ottoson allotment. From the WFBF DEIS (Chapter 3, p19) " Sheep Trailing – A sheep herd is permitted to trail across the allotment in the early summer as it travels to an allotment on the Ashley National Forest; this same herd trails across the allotment again in the fall as they travel home from the Ashley National Forest." The current AOI for the Ottoson allotment shows trailing through the East Fork Black's Fork allotment. However, during the time we were addressing the WFBF, we recall being told by the Forest Service that sheep trailed up through the WFBF over Red Knob into the Ashley NF and that these herds would then return through the EFBF. So, the history of trailing through these allotments and by which herds needs to be disclosed to ensure that all connections are addressed and analyzed.

The Ashley NF Plan states, "Manage Bear Top Mountain in giving preference to Rocky Mountain bighorn sheep." (pIV-29). "Resource management activities will be allowed if they will not adversely affect any T and E or sensitive species." (pIV-30). "Authorize the introduction of bighorn sheep in the Bear Mountain vicinity following determination that any significant adverse environmental effects can be avoided or mitigated." (pA-38). Many comments in the FEIS for the ANF Forest Plan urged reintroduction of bighorns, consolidation of sheep allotments, closure of Fall Creek and Chepeta allotments, reintroduction into places such as Lake Fork, Rock Creek, Grandaddy Basin, Yellowstone and Uinta River drainages, and others. Many areas were described as suitable for bighorns. Here, the ANF describes its intent to provide bighorn sheep habitat.[13]

[12] Wasatch Cache National Forest. 2006. Draft Environmental Impact Statement West Fork Black's Fork Grazing Allotment.

[13] USDA. 1986. Final Environmental Impact Statement for the Ashley National Forest Land and Resource Management Plan.

Figure 4. Project Allotments, Adjacent Sheep Allotments and DWR Modeled Suitable Habitat

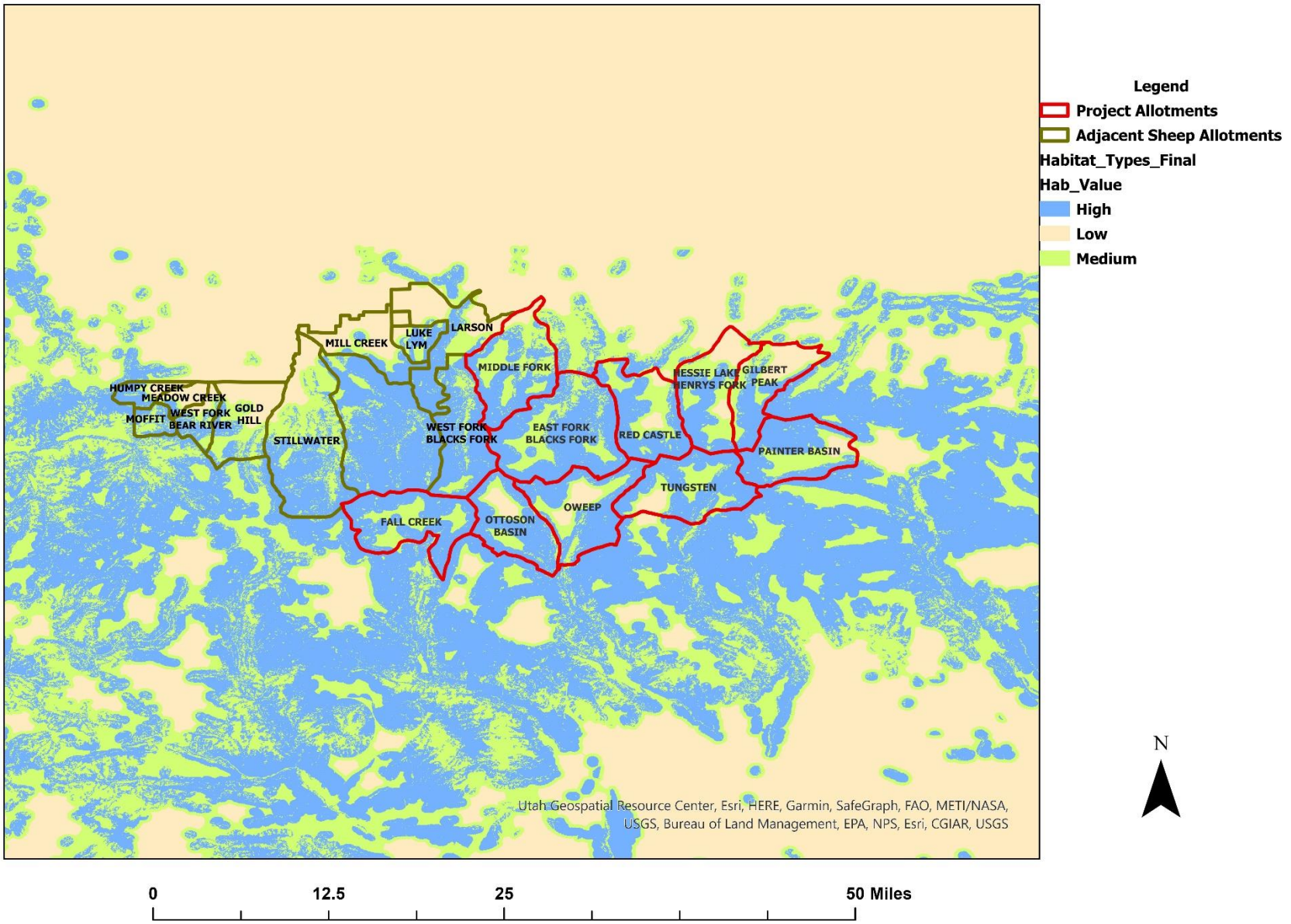
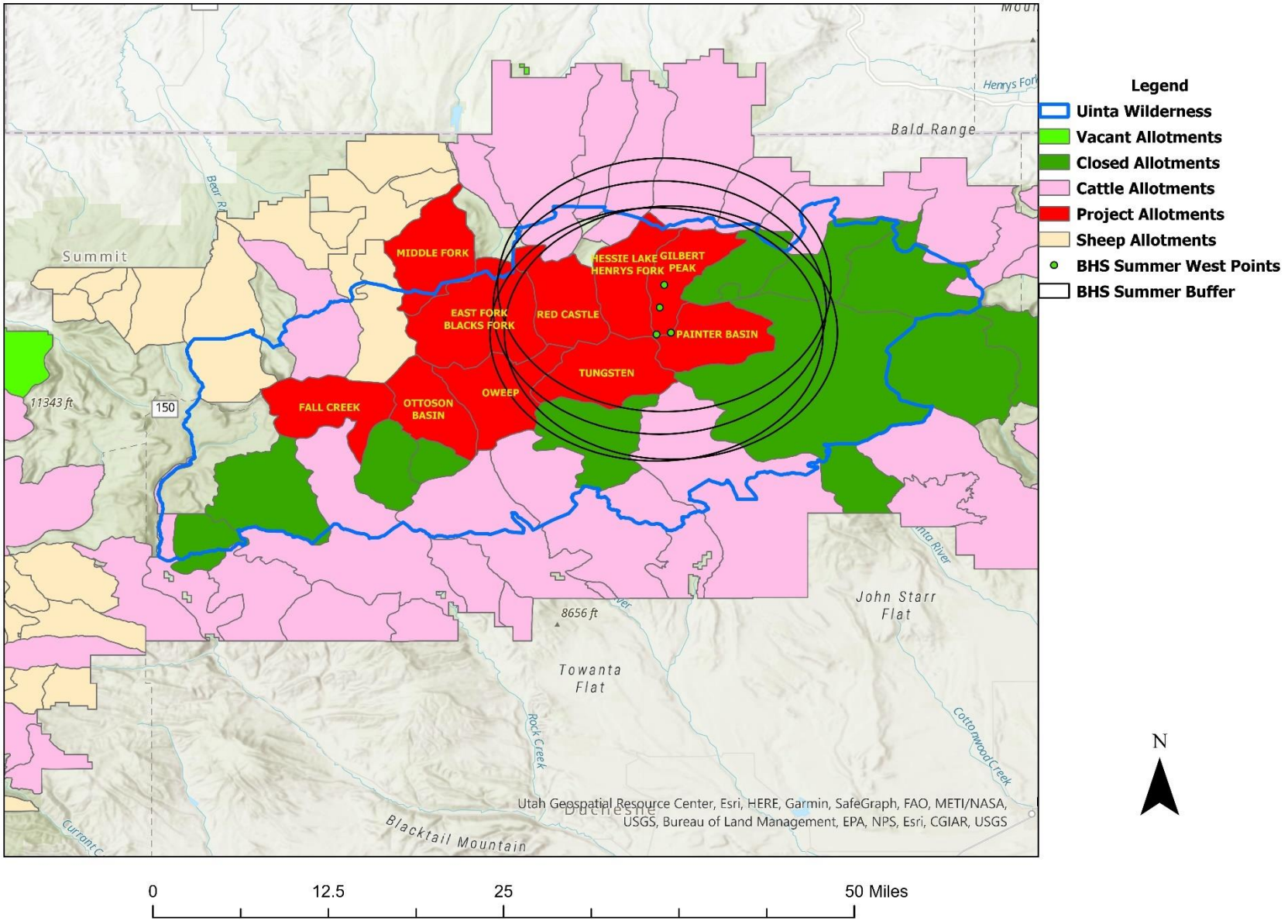


Figure 5. **Bighorn Sheep Summer Observations**
Westmost Points Buffered 9 Miles



The SDEIS (p45) Range Vegetation section provides descriptions and photo examples of plant community types and cites the Brown (2006) description of these plant communities.[14] We have commented on the Brown report and its potential for incorporating degraded conditions as a baseline by his collecting data in allotments that are being grazed by livestock and are degraded. We analyzed the data provided in that report for the sheep allotments. (Table 3). Throughout the SDEIS, utilization is indicated to be low to moderate and has been measured for more than 60 years (SEIS p141) yet no tabulation or description of this data is provided and related to current or reference conditions. Neither are trend data provided as most monitoring appears to be opportunistic, not systematic. The Forest Service Handbook emphasizes the use of reference areas and the need to use monitoring of those to determine progress towards DFCs. "Monitoring can then tie to these reference areas as a means of determining progress toward meeting the desired conditions." (FSH 2209.13).

Table 3. Ground Cover Characteristics in Sheep Allotments

Community ID (Brown 2006)	No of Sites	Exposed Soil Min %	Exposed Soil Max %	Exposed Soil Median %	Exposed Soil Mean %
Dry	20	0	20	3	5
Ivesia and Barren	15	2	84	26	37
Low and Dwarf Shrub	4	4	10	5	6
Meadow	32	0	45	3	6
Mesic Carex	11	1	40	4	11
Snowbed	36	0	65	20	23
Wet	10	0	5	0	1

This table illustrates several important points.

- The minimum amount of exposed soil in all communities is near zero. This comports with Lewis (1970) which indicated potential ground cover is near 100% and also with our report[15] comparing grazed and long term rested allotments in the Uinta Mountains.
- The maximum exposed soil in wet communities of 5% and average of 1% comports with the acknowledgement by the Range Specialists such as Sheryl Goodrich that sheep avoid wet plant communities therefore these are not capable.
- The maximum exposed soil in all other communities ranged up to 84%.

[14] Brown, G. D. 2006. An Alpine Plant Community Classification for the Uinta Mountains, Utah. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region. 140 p. https://app.box.com/s/vt5obbo9tt2cd6ucesai9xjx046pu71y

[15] Carter, J. 2006. Watershed Conditions Uinta Wilderness. Western Watersheds Project. https://app.box.com/s/944957604b8618539585

This data indicates that severely degraded conditions of high amounts of exposed soil exist across these allotments. This argues against the supposition that conditions are "satisfactory" which the SDEIS (52) defines as "Meeting desired conditions or trending towards desired conditions." Yet we have not seen a quantitative measure or reporting of exactly how those conditions are met. Our review of historical monitoring data and reports revealed a minimum amount of data that could be used to make these determinations. This was addressed in our comments dated August 5, 2019 which emphasized the bias in the Forest Service monitoring.

Canada Lynx

The SDEIS (Table 23) concludes for Canada lynx that they are "Considered dispersers and no evidence of lynx reproducing in Utah. Track surveys 1999-2017 did not find hard evidence of lynx in the Uinta Mountains. Project would not change vegetation layers or remove snowshoe hare habitat. May affect, not likely to adversely affect." In our prior comments, we addressed the supposition that there are not now, or never was a resident population of lynx in the Uinta Mountains. We also addressed the location of the Uinta Mountains in the Forest Service's Regionally Significant Wildlife Corridor[16] connecting the Yellowstone ecosystem and Northern Rockies to the Uinta Mountains and Southern Rockies, in particular the Colorado population. Since those comments we have reviewed the history and regulatory status of lynx for comments on the Species Status Assessment being conducted by the US Fish and Wildlife Service. Those are included in Exhibit 2 of these comments. Important points from those comments follow.

A review of the regulatory history and science involved in the ESA listing for Canada lynx and subsequent land management on National Forests reveals that much of the science is misinterpreted to favor human activities that degrade and fragment lynx habitat, while absence of evidence due to lack of studies is used to claim these activities either have little effect, or in the case of timber manipulations, can even be beneficial.

This "unoccupied" status results from failing to find current evidence of lynx long after habitats have been fragmented by mines, high road density, an explosion in motorized recreation, timber projects and including habitat alteration by livestock grazing.

The use of "verified" records to determine occupancy or historical populations ignores reliable reports of lynx indicating that rather than 10 records there are up to 37 records/observations in the Uinta Mountains if "reliable" records are included. In the Uinta Mountains there are also records of lynx on the North Slope reported by a former Forest Service employee, Harold Wadley, who worked in the Uinta Mountains in 1957 and 1958. Traveling by snowshoe, he used dogs to track and tree lynx. His records show he treed 20 Canada lynx in those two years,

[16] Map shows the north-south linkage between large landscapes connecting forests from the northern Rocky Mountains in Canada to the southern Rocky Mountains of the United States referenced in the Wasatch-Cache Revised Forest Plan page 4-70, 4-120, and 4-143.

and he estimated there were 15 Canada lynx on the north slope of the Uinta Mountains between the West Fork of the Bear River and the Little East Fork of the Black Fork River.

The FSM 2670.31 provides guidance for T&E species. (1) *"Place top priority on conservation and recovery of endangered, threatened, and proposed species and their habitats."* (2) *"Establish, through the Forest planning process, objectives for habitat management and/or recovery of populations."* (4) *"Avoid all adverse impacts on threatened and endangered species and their habitats, except when it is possible to compensate adverse effects totally through alternatives identified in a biological opinion."* (6) *"Identify and prescribe measures to prevent adverse modification or destruction of critical habitat and other habitats essential for the conservation of endangered, threatened, and proposed species. Protect individual organisms or populations from harm or harassment as appropriate."*

The Forest Service and other agencies are not analyzing and characterizing the habitat structures and current degraded state of potential lynx habitat in lynx linkage and peripheral areas. Note that the regionally significant wildlife corridor is a lynx linkage to the UWCNF and ANF in the Uinta Mountains where the landscape has been divided into numerous LAUs. Those LAUs are not analyzed in terms of habitat characteristics, structural alterations, degradation, and threats. The NRLMD states, "When National Forests are designing management actions in unoccupied mapped lynx habitat they should consider the lynx direction, especially the direction regarding linkage habitat." However, the same NRLMD states that the objectives, standards, and guidelines "do not apply to linkage areas."

Our comments for the SSA also used the example of habitat degradation of this regional corridor from mining and livestock grazing. Even though this corridor was mapped by the Forest Service and included in the WCNF RFP, the habitat, its fragmentation and degradation are never analyzed.

Regulatory inadequacy was the reason for listing lynx as threatened. Our analysis shows that there has been a gradual diminution of consideration or analysis of the factors negatively affecting lynx which renders so-called protections in the Northern Rockies Lynx Management Direction[17] and Forest Plans nearly meaningless, and where livestock grazing is addressed, there is nothing to hold agencies accountable for habitat degradation.

For example, the interagency Conservation Agreement[18] indicated that "The Science Report, prepared by an international team of experts in lynx biology and ecology, is a compendium and interpretation of current scientific knowledge about the Canada lynx, its primary prey and habitat relationships. This document serves as an important scientific reference for the various lynx activities of the cooperating Federal Agencies." The CA went on to discuss the Canada

[18] USDA Forest Service and USDOI Fish and Wildlife Service. 2006. Canada Lynx Conservation Agreement. USFS Agreement #OO-MU-11015600-0 13.
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5160661.pdf

Lynx Conservation Assessment and Strategy.[19] "The LCAS builds upon this scientific base and identifies the risks to the species that may occur as a result of federal land management." The LCAS then identified risks to the species, including:

1. Timber harvest and pre-commercial thinning that reduce denning or foraging habitat or convert habitat to less desirable tree species.
2. Fire exclusion changing the vegetation mosaic maintained by natural disturbance processes.
3. Grazing by livestock that reduces forage for prey.
4. Roads and winter recreation trails that facilitate access to historical lynx habitat by competitors.
5. Incidental trapping and shooting.
6. Predation.
7. Being hit by vehicles.
8. Obstructions to movement such as highways and private land developments.

Then comes the Northern Rockies Lynx Management Direction that eliminates consideration of roads, mining, grazing, and over snow travel. In the NRMLD (p3) there is reference to a FWS *"Clarification of Findings"* in a Remand Notice which basically explains away most forest activities as impacting lynx or lynx habitat, i.e. a *"threat"* to lynx. The NRMLD puts it this way:

> *After the LCAS was issued the FWS published a Clarification of Findings in the Federal Register (FEIS, Vol. 1, Appendix P), commonly referred to as the Remand Notice. In the Remand Notice the FWS states, "We found no evidence that some activities, such as forest roads, pose a threat to lynx. Some of the activities suggested, such as mining and grazing, were not specifically addressed [in the Remand Notice] because we have no information to indicate they pose threats to lynx" (p. 40083).*
>
> *Further on in the Remand Notice they state, "Because no evidence has been provided that packed snowtrails facilitate competition to a level that negatively affects lynx, we do not consider packed snowtrails to be a threat to lynx at this time" (p. 40098).*

From an agency perspective, what's not to like? Unlimited recreation, grazing, high road densities, and no obligation to account for the effects? These are all activities that are well known to fragment habitat yet are excluded from any standards or analysis under the current NRLMD. For example, the WCNF RFP FEIS (p20) notes, "Potential impacts from roads and trails include fragmentation of habitat and displacement of wildlife. The amount is a function of the amount of use on the road or trail. The greatest potential for adverse impacts associated

[19] Ruediger et al. 2000. Canada Lynx Conservation Assessment and Strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, MT. 142 pp.
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5199571.pdf

with roads is from construction for timber harvest or oil and gas exploration and development…". We recall that the prior Forest Plan for the WCNF included a 1 mile/sq.mi road density standard which disappeared in the current RFP. The 1986 Ashley NF Plan notes that existing road density, excluding the High Uintas Wilderness was 1.11 miles/sq.mi. We could find no current road density limitations in either Plan. We are requesting that the current and potential status of Canada lynx linkage, peripheral areas, LAUs in the Regionally Significant Wildlife Corridor in the ANF and UWCNF be analyzed. Some guidance for the analysis is found in several publications. This is provided in more detail in Exhibit 2.

A recent paper found that lynx exhibited decreasing use of stand initiation structures up to a minimum availability of 25%.[20] Another found that 50% of lynx habitat must be mature-undisturbed forest for it to be optimal lynx habitat and no more than 15% can be young clear-cuts, i.e. trees <4" dbh.[21] At the home range extent, the study found that "females with larger surviving litter sizes had less fragmented home range, lower moisture variance, young regenerating forest patches with low perimeter-area ratio, and lower percent composition of old regenerating forest than home ranges of females with smaller surviving litter sizes." That same study also noted that "At the southern extent of their range, Canada lynx habitat is historically patchy and is subject to loss and fragmentation by some forest management practices (i.e. regeneration harvests, pre-commercial and commercial thins, prescribed burns), wildfires and insect infestations, and climate change". These results provide a guide to evaluating current forest stand structure, fragmentation by roads, logging and whether connectivity between patches is adequate. Ruggierio et al (1999)[22] also discuss the effects of fragmentation on competition with lynx by other carnivores and the loss of connectivity.

Sophisticated, peer-reviewed modeling identified the Uinta Mountains as core lynx habitat.[23] The study used vegetation cover types, road densities and classified suitable vegetation types based on current science at the time. After all cells that surpassed both the vegetation suitability and road density suitability thresholds were identified, habitat patches were formed using ArcGIS. For the purposes of the model, the analysis considered large enough core patches for lynx to be those that are at least 1,600 km^2, the approximate area of eight

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[20] Holbrook, J. D., J. R. Squires, L. E. Olson, N. J. DeCesare, and R. L. Lawrence. 2017. Understanding and predicting habitat for wildlife conservation: the case of Canada lynx at the range periphery. Ecosphere 8(9): e01939.10.1002/ecs2.1939. https://esajournals.onlinelibrary.wiley.com/doi/10.1002/ecs2.1939

[21] Kosterman, Megan K., "Correlates of Canada Lynx Reproductive Success in Northwestern Montana" (2014). Graduate Student Theses, Dissertations, & Professional Papers. 4363. https://scholarworks.umt.edu/etd/4363

[22] Ruggerio, L.F., Aubry, K.B., Buskirk, S.W., Koehler, G.M., Krebs, C.J., McKelvey, K.S., Squires, J.R. (Eds.), Ecology and Conservation of Lynx in the United States. University of Colorado Press, Boulder, CO. https://www.fs.usda.gov/rm/pubs/rmrs_gtr030.pdf

[23] Bates, W., and Jones. A. 2007. Least-Cost Corridor Analysis for Evaluation of Lynx Habitat Connectivity in the Middle Rockies. Wild Utah Project, Salt Lake City, UT. https://app.box.com/s/52au96m3hpsx3wx7pvophlqbethbg5j2

average home range sizes for male lynx in the American Rockies.

The authors further assumed that areas identified as core patches in their model would: (1) be of sufficient area to support more than two mated pairs of lynx to reside year-round, for multiple years; (2) provide necessary land cover types for denning and hunting; (3) contain necessary prey to support lynx year-round; and (4) sufficient safety from human persecution. The model indicated that there are nine clusters of relatively well-connected blocks of suitable landscapes of sufficient size to be considered core lynx habitat. These habitat concentration areas included the High Uinta Mountains Wilderness (plus adjacent forested lands), a core patch in the Bear River Range, and many core patches near one another in both the west slope of the Colorado Rockies and the greater Yellowstone region." All the habitat factors were then evaluated through a separate analysis to determine the suitability for lynx traveling throughout the study area. This provided a "least-cost" path for lynx traveling between core patches. It is shown in Figure 6.

Colorado Parks and Wildlife engaged in a similar effort to map predicted use areas in Colorado.[24] They used location data from reintroduced lynx fitted with transmitters, filtered those data to remove locations for the first six months to account for habituation, considered elevations above 8,000 feet, and included factors for housing and road density, slope, distance to forest patches and vegetation types. Summer and winter data were used to generate models for both seasons.

Olson et al (2021)[25] used lynx observations in the west, climate, and human induced factors to model lynx habitat. Using lynx GPS and tracking data from Idaho, Wyoming, Montana, Washington, and British Columbia, the study found that lynx habitat is made up of a complex array of environmental conditions, not primarily vegetation type and elevations as currently mapped. They included an index of summer vegetation production, percentage of tree cover, road density and night light intensity as indices of anthropogenic influences. One confounding issue is their assumption of boreal forest soil pH as a factor due to the wetter conditions in boreal forests. However, we know lynx use a variety of forested types in the southern portion of their range and this factor might disqualify habitats unnecessarily. The model provides insight and a basis for more detailed analysis of lynx potential habitat and its fragmentation within the Regionally Significant Wildlife Corridor, including the Uinta Mountains and the linkage to the north. Their resulting map is shown in Figure 7.

[24] Ivan, J., Rice, M., Shenk, T., Theobald, D., and Odell, E. Undated. Predictive Map of Canada Lynx Habitat Use in Colorado. Colorado Parks and Wildlife. Accessed on January 20, 2023. https://cpw.state.co.us/Documents/Research/Mammals/Publications/CPWPredictiveLynxMapReport.pdf

[25] Olson et al. 2021. Improved prediction of Canada lynx distribution through regional model transferability and data efficiency. Ecology and Evolution 11:1667 – 1690. https://www.fs.usda.gov/research/treesearch/63384

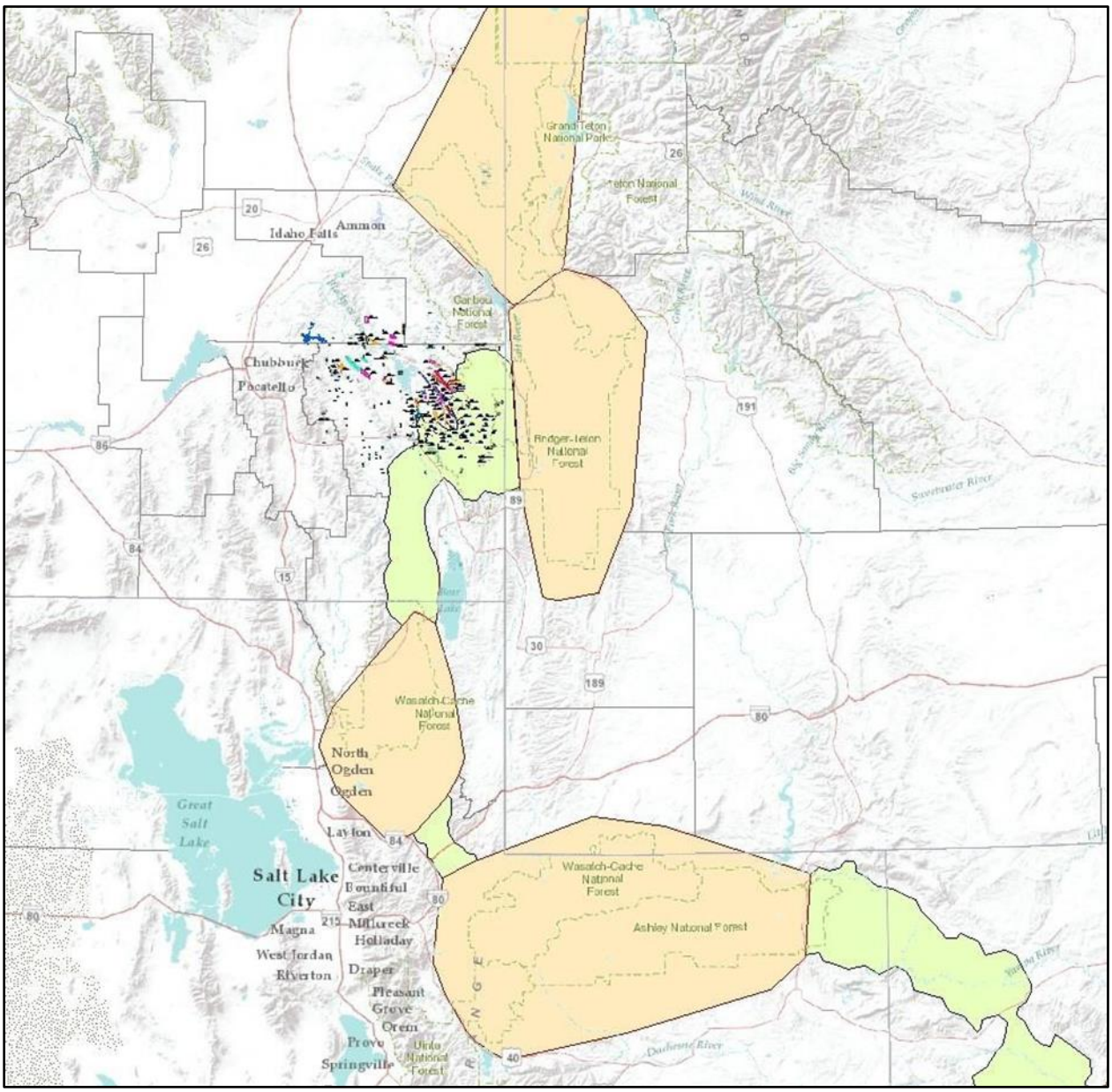


Figure 6. Modeled corridor from Bates and Jones. Orange is depicting a core area for lynx, while yellow are linkages. Mine leases in Idaho shown in various colors blue, red, orange depending on status.

The SDEIS and DEIS have not conducted a lynx population review and habitat analysis of sufficient detail to determine the effect of Alternative 2 on lynx and its prey. In addition, there is a lack of analysis of the current and potential state of habitat from the effects of other projects past and present. For example, consider the various North Slope timber projects and the recent Ashley NF projects that include the South Slope Fuels Reduction, Ashley Range Wide Improvement Project, Ashley NF Aspen Restoration Project, and the Ashley Forest Wide Prescribed Fire projects. That the Ashley NF deems these projects are needed indicates the ANF recognizes the apparently degraded ecological condition across the ANF. This argues against any Forest Service position that conditions in the Ashley NF are either "satisfactory" or meeting DFCs. We provided detailed comments on each of those projects addressing Canada lynx and other wildlife and hereby incorporate our comments by reference.

Recent court cases in Montana revolving around road density and habitats for wildlife have confronted the Forest Service over its flawed analyses that understate the effects of roads by omitting user-created and illegal roads, and by claiming their road closures are effective. Thereby illegal motorized use and impacts on wildlife are unaccounted for.[26] [27] A current article provides photo illustration of the effects of logging roads and the failure of attempted Forest Service closures. A cumulative effects analysis for Canada lynx and other special status species must include consideration of all activities that have, are or will fragment the habitat for these species be accounted for and this would include all roads whether open, closed, temporary, illegal and user created.

[26] Alliance for the Wild Rockies v. Leanne Marten, et al. In US District Court for the District of Montana. CV 21-05-M-DLC. Filed 08/03/23. https://app.box.com/s/89u7tipvoenzln5hmvdobty4d33skk1i

[27] Native Ecosystems Council, Alliance for the Wild Rockies v Keith Lannom. In US District Court for the District of Montana. jCV 21-22-M-DWM. Filed04/04/22. https://app.box.com/s/u2srro4tdzuzlct63fhmjkojpu4c85uh

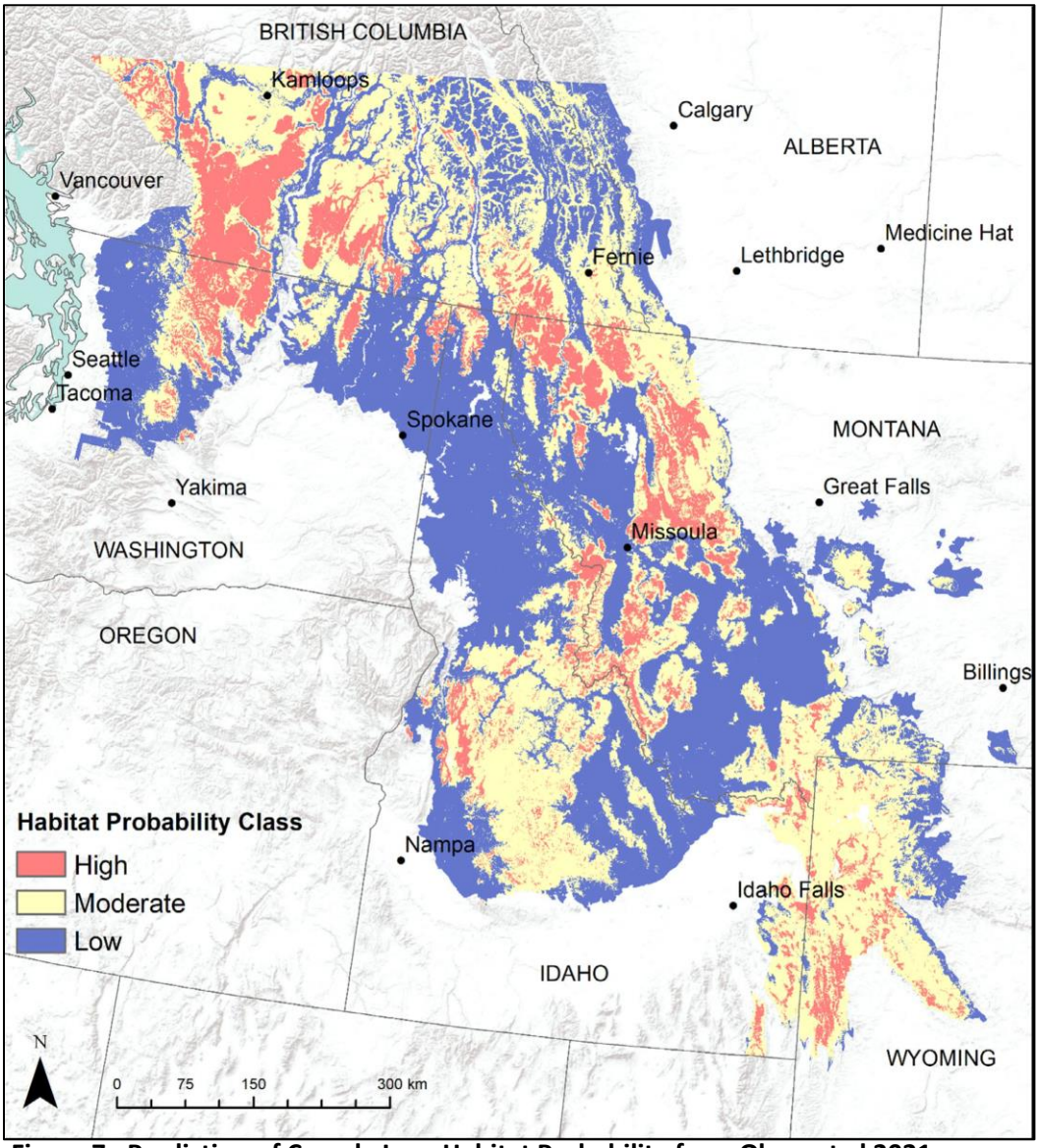


Figure 7. Prediction of Canada Lynx Habitat Probability from Olson et al 2021.

Wilderness

Introduction: Little has changed between the DEIS and the SDEIS. We summarized some key points at the beginning of this comment letter from our past comments. Since the SDEIS analysis is virtually identical to that of the DEIS, we refer you to our earlier comments, which address the flaws in significant detail. However, one issue in particular deserves mention again. The SDEIS repeats the mistake of the DEIS regarding grazing impacts from the proposed action. The SDEIS states that the proposed action "does not create new, additional, or amplified impacts to the wilderness resource." SDEIS at 213. But that statement is false, as the proposed action alternative would permit grazing in the Fall Creek Allotment, where grazing had not occurred and the allotment was in vacant status for many years prior to Wilderness designation and for the 40 years since. Opening the allotment to sheep grazing now would undoubtedly have significant impacts to wildlife and watersheds and to the experience of wilderness visitors. Access to that allotment would likely create the addition of a new stock driveway from the South Slope or from the North Slope within the Wilderness, depending on where the sheep would be coming from (see also SDEIS at 218).

Further, because grazing on the allotment has ceased long before wilderness designation, it would be unlawful to reestablish grazing at this point in time. The fact that grazing had occurred at sometime in the distant past doesn't meet the requirements of the Wilderness Act. If it did, the language in the law limiting where grazing is allowed would be meaningless, since virtually all public lands were grazed at some point in time.

The SDEIS on page 215 recognizes that 90% of the project area is in the Wilderness: about 143,971 acres of the 160,410 acres of the project area. Every single allotment under analysis in the SDEIS contains some acreage within Wilderness, and seven of the ten allotments are entirely within Wilderness. The impacts of thousands of domestic sheep in the Wilderness are significant.

Wilderness Analysis Questions and Concerns: To expound upon our previous comments, we have additional questions and concerns about the adequacy of the analysis in the SDEIS. The SDEIS states as follows:

> The wilderness system considers several factors when classifying an area of wilderness including the degree of being untrammeled, natural, undeveloped, opportunities for visitors to find solitude or primitive unconfined recreation; and other features of scientific or historic values. Grazing within the Wilderness is evaluated on how it impacts those factors (resource indicators).
>
> To address impacts on primitive recreation opportunities due to domestic sheep grazing, the forests estimated the amount of user visitation in the drainage, identified the high recreational use areas,

> determined when the domestic sheep would be using these same areas and evaluated the time of the recreational and grazing overlap (Appendix A – Wilderness/Recreation Resource Report [project record]).

SDEIS at 216. There are at least four problems with these paragraphs.

- As we explained in our earlier comments, the Wilderness impacts from the proposed action are not negligible, and parsing Wilderness out into discrete facets in order to narrow the lens and minimize acknowledgement of the projects effects stems from a misguided misinterpretation of the law. Scientific information has demonstrated that the sheep allotments are heavily overstocked because of fatal flaws in identifying suitable range. Evidence of the continuing deterioration of the grazed allotments has been provided in our previous submissions.

- The analysis completely ignores recreation displacement caused by domestic sheep grazing. Many visitors choose to ignore the areas where sheep graze, which the Forest Service is undoubtedly aware of, so the impacts to recreation aren't merely limited to those who visit the grazed areas, but also to all those who are displaced by the fact the areas are grazed. The analysis downplays the impacts of continued grazing by ignoring the impacts to those who have been displaced by grazing.

- There is an implicit bias in the SDEIS (and DEIS) toward narrowly focusing the analysis on impacts to recreationists. Aside from overemphasizing recreation as compared to other, and arguably more important, wilderness attributes, this narrowness is reflected in the conception that visitors are only affected if they physically observe domestic sheep in the visual sense. But even the most untrained visitor would probably detect signs of livestock grazing beyond encountering the sheep themselves. It would also appear the depauperate nature of the High Uintas Wilderness, in terms of large fauna as compared to other large Wildernesses in the West, is primarily due to the domestic sheep. That is an important negative impact itself, which secondarily has an impact on visitors who wish to see wildlife. At the same time, the SDEIS and DEIS admit there is great uncertainty about impacts to recreationists because assumptions in the SDEIS are based on anecdotal data or statistically incomplete data collected on the visitor registration/survey cards. The question needs to be asked, what percentage of visitors choose to write in the comment section at the end of the trip even if they registered?

- Why isn't the project record on the website? There are several references in the SDEIS, including the one noted above. Important information like this should be on the webpage.

One of the other problems with the SDEIS is its inconsistent redefining of the bighorn range. For example, when comparing the DEIS to the SDEIS, Figure 33 in the SDEIS and Figure 33 in the DEIS are different in that the SDEIS figure provides no buffer for bighorn sheep in the

Wilderness, as per the latest science. In essence, this biased analysis endangers the bighorn sheep that use the Wilderness.

Another failing of the SDEIS pertains to the range of alternatives considered. Nowhere does the analysis consider an option to close allotments when they become vacant. At the very least, this opportunity should be available for a rancher who wishes to waive (donate) an allotment back to the agency. This would have no impact on ranchers.

Wilderness and the 2022 MOU: One of the changes made in the SDEIS was to the 2022 MOU, which certainly seems to be driving the Forest Service's approach to this issue. But MOUs cannot supplant the Forest Service's statutory and regulatory obligations. We have several specific problems and concerns with the agency's reliance on such memoranda, including the following:

- The MOU was established without public input. It is a backroom deal, done before completion of the NEPA analysis, in which the state agency and the Forest Service appear to have privately agreed to prioritize domestic sheep grazing on public lands over the conservation of bighorn sheep (and other native wildlife) by agreeing that actions in pursuit of the latter won't restrict the former. This approach to decision-making betrays unlawful predetermination and undermines the public engagement and transparency goals of statutes such as NEPA.

- It is clear that the goal of the MOU and this SDEIS is to artificially maintain the bighorn sheep herd through continual augmentation from Antelope Island (SDEIS at 179), by killing cougars (SDEIS at 187), and even allowing ranchers to kill bighorns in the Wilderness if they come close to domestic sheep (SDEIS at 179) rather than make the logical decision to close the sheep allotments. The signatories to the MOU, including the Forest Service, agreed to help implement the State's 2018 bighorn plan (SDEIS at 33). Killing cougars is a disgustingly significant part of the 2018 Utah State bighorn plan. The SDEIS ignores the profound negative impacts to Wilderness and non-wilderness lands from this cougar killing pogrom and from the augmentation program (presumably done by helicopter if done in the Wilderness).

- Similarly, the MOU requires the Forest Service "to develop habitat projects" for bighorns to the east of sheep allotments and to "coordinate with UDWR" in efforts to collar and/or capture bighorns. SDEIS at 178. The SDEIS does not analyze the impacts of these efforts on Wilderness, assuming they might be contemplated in Wilderness. Given the proposal to capture bighorn sheep via helicopter in the Wilderness a few years ago, this seems likely to involve collaring and possibly augmentation. Helicopters and habitat manipulation are antithetical to Wilderness.

Summary: The High Uintas have the potential be one of the most outstanding Wildernesses in the entire National Wilderness Preservation System, but the continued and expanded program

of grazing of domestic sheep, under the proposed action, severely hampers the recovery of native wildlife, native predators, and watersheds in the Wilderness, and will continue to significantly degrade the experience of wilderness visitors. In the SDEIS, the Forest Service falls short of its legal obligation to fully, and transparently assess, the environmental impacts of (and the legal problems with) this misguided action.

Bighorn Sheep

The entire premise of the SDEIS analysis of effects to bighorn sheep is based on the assumption that there is no need to address risks emanating from Forest Service-managed lands when there is additional risk present from BLM-managed and private lands. This assumption is both scientifically and legally faulty.

Scientific Flaws: The SDEIS analysis assumes that because there is (1) already *M. ovipneumoniae* (hereinafter *"M.ovi"*) in the High Uintas bighorn herds, and (2) the Forest Service has no control over the high-risk BLM and private land allotments, there is no additional harm from transmission of *M.ovi* from the National Forest allotments. But in fact, there are many strains of *M.ovi,* such that infection with one strain will not prevent future infection by another strain.[28]

In a 2017 study, the authors found that "… introduction of a new genotype (strain) of *M. ovipneumoniae* into a chronically infected bighorn sheep population in the Hells Canyon region of Washington and Oregon was accompanied by adult morbidity (100%) and pneumonia-induced mortality (33%) similar to that reported in epizootics following exposure of naïve bighorn sheep. This suggests an immune mismatch occurred that led to ineffective cross-strain protection."[29] Dr. Thomas Besser, one of the country's foremost experts on bighorn infectious disease research, goes on say about this study that "In this paper we documented introduction of a new *M. ovipneumoniae* strain that triggered a dramatic change in the pattern of disease: all adult ewes developed signs of pneumonia (morbidity) and 30% died (mortality). The lambs again experienced a fatal pneumonia outbreak, primarily triggered by lung infections with the newly introduced *M. ovipneumoniae* strain. The finding of lack of cross-strain immunity has since been repeated elsewhere, confirming that the limited immunity that bighorn sheep may develop to a strain of *M. ovipneumoniae* with which they have been infected for years fails to consistently protect them from genetically novel strains that they may encounter."[30]

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[28] Declaration of Dr. Thomas Besser, ¶ 40, February 26, 2021, filed in *WildEarth Guardians et al. v. Kristin Bail et al*., Case 2:20-cv-00440-RMP (E.Dist. WA). Attached as Exhibit 3.

[29] Cassirer EF, Manlove KR, Plowright RK, Besser TE. 2017. Evidence for strain-specific immunity to pneumonia in bighorn sheep. J Wildlife Mgmt 81(1)133-143. Attached as Exhibit 4.

[30] Declaration of Dr. Thomas Besser, ¶ 29.

Thus, despite claims to the contrary in the SDEIS, the additional risk caused by any Forest Service domestic sheep allotments does indeed increase risk to the High Uintas bighorn herds—regardless of any other risk posed by domestic sheep grazing in BLM and private allotments.

In addition, the SDEIS suggests that sources other than domestic sheep may be at play in transmitting *M.ovi* to bighorn sheep. The science does not support that supposition: "While *M. ovipneumoniae* has recently been reported in species other than sheep and goats (Caprinae), neither its ability to persist in these hosts for long periods of time, nor the ability of these non-Caprinae hosts to transmit the pathogen to bighorn sheep has been demonstrated, and the low carriage prevalence and the low genetic diversity of *M. ovipneumoniae* in non-Caprinae hosts are not consistent with them representing a separate reservoir for bighorn sheep infection."[31] "Domestic goats also pose a definite risk to bighorn sheep due to their *M. ovipneumoniae* reservoir status, although limited current data shows that goat sources tend to cause less severe and less persistent bighorn disease. In contrast, non-Caprinae species have not yet been shown to present any risk of transmitting *M. ovipneumoniae* to bighorn sheep."[32] Moreover, *M.ovi* is extremely common in domestic sheep: the USDA National Animal Health Monitoring Service Sheep 2011 project, a national survey of domestic sheep operations, detected *M.ovi* infections in approximately 90% of domestic sheep operations sampled, including in all operations larger than 500 head involved in the study.[33]

In sum, the science is clear that moderate and high-risk allotments on the two National Forests are seriously problematic for the High Uintas sheep herds irrespective of risks emanating from BLM-managed and private lands. And that risk cannot be downplayed through implications that bighorns might be contracting *M.ovi* from other animals.

Forest Plan Amendment Flaws: The Forest Service has not followed the required procedures under the 2012 NFMA regs. When doing a project specific forest plan amendment, the agency must identify which substantive requirements from their regulations are directly related to the plan direction being removed, and then apply those requirements within the scope and scale of the amendment. *36 CFR § 219.13(b)(5).* The Forest Service identified the substantive requirements directly related to the plan provision being removed in the attachment to the cover letter, but did not include that in the SDEIS itself. Nor did the FS properly apply those substantive requirements within the scope and scale of the amendment because it did not adequately analyze all relevant impacts to show that the plan amendment meets those substantive requirements, as set forth in 36 CFR §§ 219.8, 219.9.

The creative interpretation being attempted here—that the Forest Service does not need to maintain viability if any wildlife population also uses non-Forest Service lands and has threats on those lands—would conceivably apply to virtually all fish and wildlife populations. This

[31] *Id.*, at ¶ 26.
[32] *Id.*
[33] *Id.*, at ¶ 24.

proposed forest plan amendment is an unreasonable interpretation that the Forest Service is only applying to bighorn sheep, and is contrary to prior long-standing interpretation by the agency. The Forest Service has the responsibility to ensure its own actions maintain viability even if other parties cause harm off the forest. By removing the plan provision, the Forest Service could take actions that would impair viability and yet wouldn't be inconsistent with Plan. That is a significant change that was not analyzed and does not meet the substantive requirements for ecological sustainability and diversity of plant and animal communities.

Viability requires enough animals for a self-sustaining population in the long-term, and constant augmentation does not qualify as self-sustaining in any way. Relying on the state to augment herds does not equate to viability.

We also find it interesting that the forest plan amendment was proposed for only the Wasatch-Cache National Forest and not the Ashley National Forest. The Ashley Forest Plan dates to 1986 and is thus subject to NFMA's viability rule. In addition, the Ashley Plan contains a standard to manage fish and wildlife habitat to maintain or improve diversity and productivity.[34] That standard is not addressed in the SDEIS.

MOU Flaws: The Forest Service cannot rely on the MOU between the Forest Service, the BLM, the State of Utah, and the domestic sheep permittees because the MOU was developed in violation of the Federal Advisory Committee Act (FACA), 5 U.S.C. App. II, §§ 2, 9-14. The inclusion of the permittees in the MOU discussions and as parties to the MOU removes any protections that would otherwise apply to intergovernmental communications.

Moreover, the overarching concept of the MOU is that Best Management Practices (BMPs) will adequately protect bighorn from domestic sheep. They won't. The Western Association of Fish and Wildlife Agencies (WAFWA) Guidelines, 2009, specifically state on page 15: "Effectiveness of management practices designed to reduce risk of association are not proven and therefore *should not be solely relied upon to achieve effective separation."*

And even if BMPs were effective at maintaining separation (they aren't), the Forest Service must provide in the SDEIS a scientific analysis of the effectiveness of the BMPs, which they haven't. Perhaps that is because it is not possible to do so. One U.S. District Court has already concluded that, in the absence of scientific analysis, BMPs could not be relied upon to maintain separation.[35]

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[34] USDA Forest Service. 1986. Ashley National Forest land and resource management plan, final environmental impact statement, and record of decision. At IV-32.

[35] *Western Watersheds Project v. Bureau of Land Management*, U.S. District Court for the District of Idaho, Civ. No. 09-0507-E-BLW, Decision and Order, October 14, 2009. https://casetext.com/case/western-watersheds-project-v-bureau-of-land-management-4

There is also the practicality of enacting the BMPs in such rugged and remote terrain. It takes a small herd of herders to watch every sheep at all times, and strays are common. In addition, the delays between infection and disease onset, and between disease onset and death, make it impossible to identify the specific moment of transmission or the specific animals involved in a *M.ovi* transmission event.[36] Therefore, tracing any disease transmission event back to its origin is virtually impossible.

In short, courts have found similar BMPs and MOUs that are not legally enforceable insufficient to protect bighorn sheep, lacking in scientific support, and thus not adequate to meet the Forest Service's legal duties to maintain viable populations of bighorns.

Risk of Contact Analysis Flaws: First, the risk analysis doesn't even mention, let alone take into account, stray domestic sheep. It is very common for strays to stay behind for days or even weeks after the primary domestic sheep herds are moved off the allotments. In one recent analysis on the Gunnison BLM District in Colorado, Colorado Parks & Wildlife documented 25 stray domestic sheep occurrences over just a few years. And those constituted only the documented occurrences. Unless the Forest Service is going to consider strays as an important factor in this analysis, we challenge the agency to demonstrate in the record and by searching UDRW records that strays are not an issue in this analysis area.

Second, the Uintas Bighorn Sheep Assessment from May 2021 indicates that the longest summer ram foray was 14.3 miles, while the longest winter ram foray was 5.6 miles. This data does not seem to have made it into the ROC analysis. Instead, the risk assessment somehow determined that the Hessie's Lake/Henry's Fork and Tungsten allotments are rated moderate and low risk even though bighorns are documented coming right up to the eastern edge of these two allotments.

We ran the bighorn location data using WAFWA's suggested 9-mile buffer from the western-most documented bighorns, and that map (Figure 5) indicates substantial overlap with most of the allotments under analysis here.

Keep in mind that our map uses a 9-mile buffer, not the 14.3-mile buffer that UDRW's own data indicates. The maps in the SDEIS at Figures 33 & 34 support our contention that the risk assessment artificially reduces the risk for all the but 2 eastern allotments. Based on those two maps, at a minimum we should be discussing closure of 5 allotments: Gilbert Peak, Painter Basin, Hessie Lake/Henry's Fork, Tungsten, and Red Castle. Anything else is inconsistent with the analysis in the SDEIS.

Third, the Wild Sheep Working Group has advised that results of the Risk of Contact Tool may be interpreted as follows: "Given the potential severity of die-off resulting from interspecies contact, we recommend management scenarios that allow for disease free intervals of at least 50

[36] Declaration of Dr. Thomas Besser, ¶ 34.

years. If we assume a moderate probability of contact with an allotment resulting in an interspecies contact that will result in a disease transmission outbreak event (0.25), then we would need to see a rate of contact of less than 0.08 contacts per year (or less than 0.8 contacts per decade)." (WSWG 2012).[37] In addition, the ROC Tool *as applied and approved by the court* in the years of litigation over the Payette National Forest decision to curtail domestic sheep grazing provides more support for using the WSWG rate of contact. In the Payette analysis, the ROC Tool was also run using the same rate of contact (that is, 0.25, or 1 in 4) indicating an average outbreak period of 50 years.

Instead, the analysis determines that a cumulative contact rate of 0.304—or almost 4 times higher than the WSWG recommended contact rate—is adequate to maintain these herds. (And again, we question these ROC numbers since strays were not considered and the SDEIS maps are inconsistent with the risk ratings.) The SDEIS conclusions rely on arbitrary contact rates of "high," "medium," and "low" that have no basis in the scientific literature. And even if one accepted these arbitrary labels, there is no attempt at justifying why only the "high" risk allotments are being considered for closure when one "medium" risk allotment demonstrates a contact rate of .106 (Hessie Lake/Henry's Fork), which is well above the 0.08 recommended by WSWG.

The 0.304 contact rate equates to one bighorn contact with an allotment approximately every 3.3 years. Compare this to the WSWG recommendation that management should allow for disease free intervals of at least 50 years. Viability be damned, this is clearly a plan to maintain constantly diseased bighorn herds through augmentation.

Fourth, the failure to use 80,000 bighorn location data points is suspicious. We do not comprehend how a collar can be placed on a bighorn without noting the sex of the animal, yet even if that is true those data points should've been tagged as female rather than deleted from the analysis.

Herd Analysis Flaws: The SDEIS only looks at risk at the meta-population scale by combining all herds into one, but the record indicates there is one herd that is most at risk: Hoop Lake. There is no map of individual herd locations but the SDEIS discusses 5 herds, and one that is closest to the allotments. That would be the herd with overlap with 2 allotments and very close to 2 more, which means it is at so highest risk of disease. The SDEIS does not discuss what the impact to meta-population would be from loss of that one herd in terms of reduction of geographic distribution and loss of genetic diversity. In addition, there is no viability analysis at the herd level, just at the overall meta-population level.

[37] See also Lyons et al. 2016. Final Report: Application of the Bighorn Sheep Risk of Contact Model on the Okanogan-Wenatchee National Forest. Washington Conservation Science Institute. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd512632.pdf

All the impacted bighorn herds are very small. Even though the meta-population has about 150 animals, each herd only has about 20-30. Hoop Lake, at highest risk, has only about 20. And assuming the Hoop Lake herd is on the western end of the CHHR closest to the Forest Service allotments, it is not close to BLM land or private land. Thus, the Forest Service allotments are the greatest risk to that herd and are likely the cause of its continuing disease issues. Maintaining low numbers of animals for long time puts herd at risk of inbreeding or loss during stochastic events. All herds have experienced recurring disease which keeps them small and prevents full recovery, yet as discussed above, a new strain of *M.ovi* could wipe out any of these herds.

The meta-population approach minimizes the impacts to the Hoop Lake herd in particular. That herd has had a stagnant growth rate and low numbers of animals for a decade because disease is likely suppressing growth. The Forest Service allotments are the main risk to this herd and closing those allotments would significantly reduce the risk, but this is not analyzed in the SDEIS.

Range of Alternatives Flaws: A third alternative that would address more of the risk to bighorn from Forest Service domestic sheep allotments was dropped using the same justification as appears throughout the SDEIS: why bother protecting bighorns on the National Forest when there is high risk from nearby BLM-managed and private lands. As noted above, the Forest Service has a legal duty to maintain viability of bighorns *on National Forests*. What happens outside of the National Forest boundary does not relieve the Forest Service of their duty. And science is clear that any risk to bighorns is cumulative, not redundant. The third alternative should be considered, and even then it is highly questionable whether it goes far enough to reduce risk to bighorns. Thus, we advocate for an analysis of two additional alternatives: the third alternative discussed at SDEIS pp. 181-2, plus an additional alternative that would encompass all allotments within the 9-mile WAFWA buffer.

Significant New Information: The bighorn sheep location data relied up on this analysis indicates that the 2009 NEPA analysis of the East Fork/Blacks Fork allotment should be reopened. It is clear from our map, above, that there is substantial overlap with the allotment when applying WAFWA's standard 9-mile buffer. This new information requires that either that 2009 NEPA be reopened, or that the allotment is considered in this analysis. In addition, there has been substantial new science on bighorn/domestic sheep disease transmission since 2009, as we have discussed above and is detailed in Dr. Besser's attached declaration.

Sincerely,



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EXHIBIT 1

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Spatial Analysis of Livestock Grazing and Forest Service Management in the High Uintas Wilderness, Utah

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Abstract

This case study addresses the Forest Service reauthorization for grazing of domestic sheep in Utah's High Uintas Wilderness, USA. It provides an approach using spatial analysis and aerial imagery to evaluate the lands capable of being grazed based on Forest Service criteria and field surveys. The resulting model and analysis demonstrated that the Forest Service has not applied its own criteria. This has led to the Forest Service overestimating the amount of land and numbers of sheep that can be supported in the study area. Past field studies show this has resulted in environmental damage by grazing sheep. Our analysis concludes that the numbers of domestic sheep should be greatly reduced to protect these lands and wilderness values. Limitations of the study include the lack of a suitably detailed soil survey to determine erosion susceptibility, a lack of ground cover data, a lack of Forest Service data for the level of grazing use, or utilization, and the lack of a Forest Service quantitative measurement of vegetation production in each plant community and soil type. In the end, our use of aerial imagery, GIS determinations of areas of steep slopes and dense forests, and our measurement of vegetation production in the dominant soil types showed most of the land is not capable for grazing domestic sheep even in the absence of this other data.

Keywords

Livestock, Capacity, Wilderness, Spatial Analysis, Remote Sensing

1. Introduction

In 2014, the Ashley National Forest (ANF) and the Uinta-Wasatch-Cache National Forest (UWCNF) in Utah initiated a scoping process for the High Uintas

Wilderness Domestic Sheep Analysis, followed by a Draft Environmental Impact Statement in 2019 [1] [2]. The purpose of the project is to reauthorize grazing of 12,850 ewe/lamb pairs of domestic sheep on ten grazing allotments totaling 160,410 acres within the High Uintas Wilderness which lies in NE Utah's Uinta Mountain Range.

Due to the importance of these watersheds, their associated water supplies for the public, wilderness qualities, and concerns for the effects of this proposal on these values as well as native fish and wildlife, the authors engaged in a study and Geographic Information System (GIS) analysis to inform the Forest Service environmental analysis. The goal of the study was to evaluate the capacity of the allotments to support domestic sheep grazing using Forest Service criteria, field data collection and image analysis combined in a GIS analysis. Using such a technique offers a means of reducing or eliminating many of the negative impacts of livestock grazing by balancing livestock use with available capacity and avoiding placing livestock in sensitive areas such as steep slopes, unstable or highly erodible soils. This can lead to healthier watersheds, reduction of soil erosion, restoration of fish and wildlife habitat and their associated populations across not only wilderness areas, but all livestock-grazed public and private lands.

1.1. Livestock Grazing Extent, Effects and the Need for a Systematic Approach to Management

There are approximately 3.4 billion ha worldwide that are grazed by livestock, with 73% estimated to be suffering soil degradation [3]. In the western USA, livestock are permitted to graze on over 103 million acres within the National Forest System and 168 million acres of public lands managed by the Bureau of Land Management [4], including 13 million acres of designated wilderness [5]. These BLM and Forest Service managed lands suffer degradation with over 50% in poor or fair condition [6].

Regionally important rivers such as the Bear, Green and Colorado are supplied water from the High Uintas Wilderness area watersheds and provide water to regional populations for agriculture, municipal and industrial use, power and recreation [7]. These rivers and their watersheds are also important to native fish such as Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*) and Bonneville Cutthroat trout (*Oncorhynchus clarki utah*). Wildlife, including bighorn sheep (*Ovis canadensis*), Rocky Mountain elk (*Cervus canadensis nelsoni*) and many other mammals and birds also depend on these watersheds [2]. The High Uintas Wilderness is a core area for Canada lynx (*Lynx canadensis*) [8] and historically significant numbers occurred here [9]. It is part of a Regionally Significant Wildlife Corridor (Corridor) connecting the Greater Yellowstone Ecosystem and Northern Rockies to the Uinta Mountains and Southern Rockies. This Corridor is recognized by the Forest Service as well as regional conservation organizations [10] [11] [12]. It is important to maintain habitat integrity and productivity in these watersheds for these purposes, so overstocking of li-

vestock or grazing livestock in areas susceptible to accelerated erosion and degradation must be avoided.

A meta-analysis of the effects of cattle grazing on arid ecosystems in western North America found reductions in rodent species diversity and richness; vegetation diversity; shrub, forb and grass cover; total vegetation cover and biomass; seedling survival; biological crust cover; and litter cover and biomass while soil bulk density increased, soil erosion increased, and infiltration rates decreased in grazed areas when compared to ungrazed areas [13]. A comprehensive review of ecosystem effects of livestock grazing in western North America found that livestock grazing reduces levels of biodiversity, leads to decreased population densities for a wide variety of taxa, disrupts ecosystem functions, including nutrient cycling and succession, changes community organization, and changes the physical characteristics of both terrestrial and aquatic habitats [4]. A similar review of livestock effects to streams and riparian ecosystems determined that livestock grazing negatively affects water quality and seasonal quantity, stream channel morphology, hydrology, riparian zone soils, instream and streambank vegetation, and aquatic and riparian wildlife. No positive environmental effects of grazing were found in this comprehensive survey of the literature [14].

Field surveys by the Forest Service in the 1960s in the High Uintas Wilderness documented erosion damage on highly erodible soils and steep slopes which had developed gullies, and which was exacerbated by sheep grazing and trampling [15]. Mont Lewis, a Forest Service range conservationist working in the Uinta Mountains in the 1960s, documented accelerated erosion, alpine turf in poor condition, and lakes being filled with sediment from grazing sheep in areas that were sensitive to erosion damage [16].

A recent study using sediment cores from Lake EJOD in a grazing allotment in the High Uintas Wilderness found increased nutrient and sediment loading in the past century, coincident with the period livestock have grazed here. This is a departure from rates of deposition going back 5300 years [17] (**Figure 1**). Lewis (1970) noted that these non-suitable areas (today these are called non-capable) should not be grazed [16]. Many of the soils were determined to have a very high erosion hazard. Surveys in the late 1990s and early 2000s showed grazed uplands had suffered loss of plant cover with upland grazed areas having bare soil averaging over 50% while areas that had not been grazed for decades had almost no bare soil. Streams were damaged from high runoff events creating bank scouring (**Figure 2**) and steep slopes were being grazed and trampled [18] (**Figure 3**). Surveys by soil scientists working for the Ashley National Forest in the 1980s described severe erosion and loss of soil cover and biological crusts [19]. In recent decades Forest Service monitoring has been sporadic and focused in areas of low erosion hazard in more level terrain such as valleys, wet or mesic meadows, and riparian areas, finding conditions to be satisfactory [2] [15].

This evidence of degradation as a result of grazing livestock at levels exceeding capacity and in areas of high susceptibility to erosion is what the straightforward



Figure 1. Lake EJOD, High Uintas Wilderness, deposits of sediment entering the lake from its grazed watershed [18].



Figure 2. Stream bank scouring, High Uintas Wilderness [18].

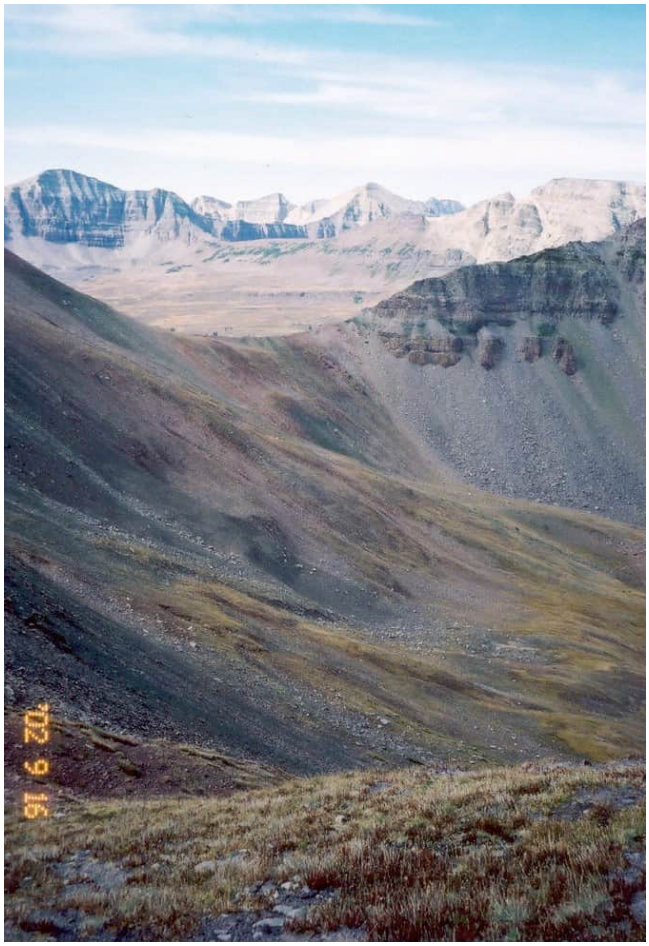


Figure 3. High Uintas Wilderness steep slopes grazed by domestic sheep [18].

use of GIS analysis techniques we provide here, combined with systematic data collection to fill data gaps, could reverse.

1.2. Grazing in Wilderness

In 1964, Congress passed the Wilderness Act and defined wilderness: "A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain". Wilderness is "land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions...." In addition, wilderness should be "affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable" (16 U.S.C. § 1131(c)). The law provided statutory protections for wilderness areas and established the National Wilderness Preservation System. The Act, among other things, mandated that wilderness areas be administered in a manner that will leave them "unimpaired for future use and enjoyment as wilderness" and provide for "the protection of these areas" and "the preservation of their wilderness character" (16 U.S.C. § 1131(a)).

The provision allowing livestock grazing in the Wilderness Act is an exception to the general premise of the Act, which directs agencies to manage wilderness areas to preserve their wilderness character and natural conditions. "Within wilderness areas in the national forests designated by this Act...the grazing of livestock, where established prior to September 3, 1964, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture" (16 U.S.C. § 1133(d)). Thus, livestock grazing which existed in wilderness areas when the Wilderness Act was enacted, has continued. Livestock grazing is an exception to normal wilderness protections. We have pointed out the various impacts on the land which show the degradation of ecosystem and natural values, which would also be inconsistent with the intent of the Wilderness Act.

2. Methods

2.1. Study Area

The study area is the ten grazing allotments at issue and their watersheds that occur in the ANF and UWCNF within the High Uintas Wilderness (**Figure 4**). Allotment boundaries align with watershed divides in most cases. The study area occurs in the Middle Rocky Mountain Physiographic Province [20]. Elevations range from about 8000 feet to 13,528 feet above sea level at the summit of Kings Peak. The land consists of steep canyons, U-shaped glaciated basins and river valleys, alpine tundra, lakes, streams and wetlands, mountain peaks, and large open meadows (**Figure 5**). Forested areas consist of sagebrush (Artemesia spp.), quaking aspen (*Populus tremuloides*), lodgepole pine (*Pinus contorta*), Douglas fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea engelmannii*) [12] [21].

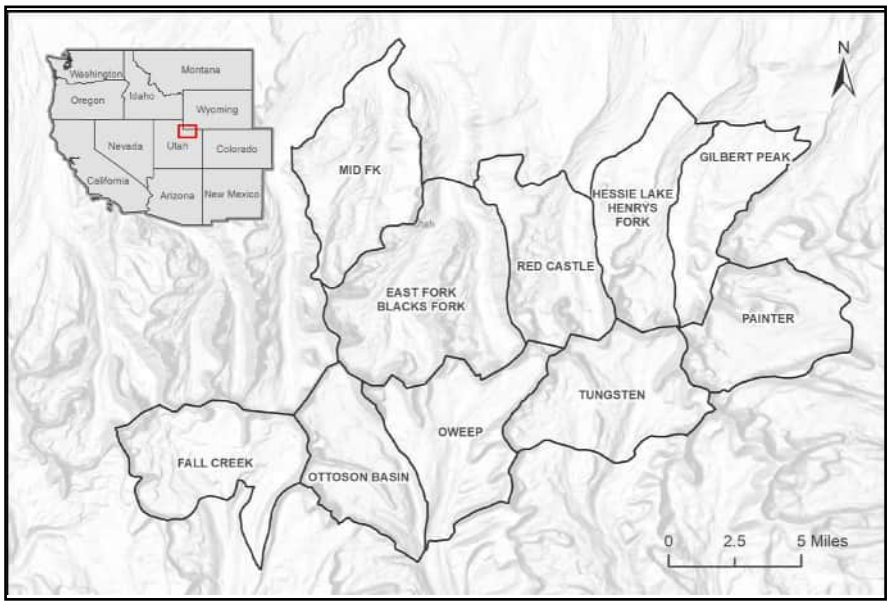


Figure 4. Study location and map of allotments.



Figure 5. Forest Service photo showing topography, dense forested areas, mixed wetland and upland areas and adjacent steep slopes [15].

The ten grazing allotments cover a total of 160,410 acres and have a near summer-long grazing season [2]. At this high elevation, the grazing season occupies most of the snow-free period with some areas retaining snow into August [15] (**Table 1**). The Forest Service describes the climate for this alpine area as having annual precipitation between 33 and 50 inches per year with most occurring in the form of snow [16]. Summer thunderstorms are also an important factor [20].

2.2. Forest Service Capability Criteria

The concept of "capability" for livestock grazing is a core concept directed at limiting soil erosion and degradation of grazing allotment watersheds and plant communities. It does so by factoring out areas of steeper slopes, highly erodible soils, and barren areas, in order to reduce risk of soil erosion and degradation of plant communities which leads to loss of productivity. It also is used to determine stocking rates based on forage consumption rates of livestock and allocates an appropriate proportion of the available, preferred or desirable forage species on the capable acres to livestock so that stocking rates are sustainable and reduce the risk of degradation [22]. The capable lands and stocking rates on the High Uintas Wilderness allotments have not been updated to reflect more recent guidance from the Region 4 Forest Service that oversees the ANF and UWCNF that manage these ten grazing allotments.

The current USFS regional criteria (Criteria) for range capability were described in a 1998 memorandum by the Forest Service [23]. These were:

1) Areas with less than 45 percent slope for domestic sheep, 30% for cattle.

2) Areas producing or having the potential to produce an average of 200 lbs. or more of forage/acre on an air-dry basis over the planning period.

Table 1. Numbers of permitted sheep and length of grazing season.

Allotment	Permitted Ewe/Lamb Pairs	Season	Allotment Acres
East Fork Blacks Fork	1350	7/6 - 9/10	25,440
Fall Creek	1100	7/1 - 9/30	16,612
Gilbert Peak	1400	7/11 - 9/10	11,896
Hessie Lake Henry's Fork	1400	7/11 - 9/10	14,539
Middle Fork Black's Fork	1200	7/11 - 9/10	16,855
Ottoson Basin	1300	7/15 - 9/10	12,620
Oweep	1400	7/15 - 9/10	16,686
Painter	1200	7/12 - 9/6	14,756
Red Castle	1300	7/6 - 9/10	14,857
Tungsten	1200	7/12 - 9/6	16,149
Totals	12,850		160,410

3) Areas without dense timber, rock, or other physical barriers.

4) Areas with naturally resilient soils (not unstable or highly erodible soils).

5) Ground cover greater than 60%.

6) Areas within one mile of water or where the ability to provide water exists.

In its 2003 Forest Plan Revision, the WCNF used only Criteria 1, 2 and 6 [20]. It evaluated the slope of the land using a digital elevation model to determine where the lands of less than or equal to 45 percent slope were located. Lacking current forage production data, the WCNF used a vegetation layer as a surrogate for forage production. While forage production had been determined in the 1960s and was their most recent data, it was not used. The Final Environmental Impact Statement for the Wasatch-Cache Revised Forest Plan [20] described it thusly: "The vegetation layer was used as a surrogate for minimum forage production. In general, coniferous-forested vegetation types (spruce, fir, pine, Douglas-fir), oak, and barren areas were said to not produce the minimum 200 lbs/acre of forage. All other types were included as potential forage-producing types." The Forest Plan for the ANF was produced in 1986 prior to the publication of these recent Regional criteria. According to the ANF, the capability analysis done in the 1960s was used in the Forest Plan [24]. It does not incorporate the current Criteria. Neither Plan relied on current forage production data.

2.3. Grazing Capability Model

Due to the lack of a dataset for ground cover and sufficiently detailed soil surveys, our model did not exclude highly erodible soils and areas with ground cover less than 60% (criteria 4 and 5). It is of note, however, that excluding slopes greater than 45 percent by the very nature of soil erosion/slope relationships defined in the Universal Soil Loss Equation [25] would inherently exclude many areas of unstable soils or soils with high erosion hazard. Criterion 6, distance to water, was evaluated and was not a limiting factor as all areas meeting

slope, forage production and lack of dense timber criteria 1, 2 and 3 were within one mile of water. Small, isolated capable areas were removed from the final map as these are inaccessible (within dense forest) or surrounded by non-capable areas that are impractical to graze without placing the non-capable areas at risk. In sum, the model determined capable acres based on land less than one mile from water, less than or equal to 45 percent slope, producing 200 lb/acre or more of forage (based on actual forage surveys, described below), and lacking dense timber.

The model used ESRI's ArcGIS 10.5.1 [26] and ModelBuilder [27] as the modeling environment. As the main output, we obtained a dataset in polygon format that described the landscape according to the areas capable of supporting domestic sheep grazing. Water bodies were excluded. Wetlands are not grazed by sheep, so were excluded in the model [16]. **Figure 6** illustrates the steps implemented for the sheep grazing capability model by a stepwise removal of acreage > 45% slope, areas with forage production < 200 lb/acre, and areas with dense forest canopy. The resulting areas which meet Forest Service capability criteria were further reduced by removing isolated areas of land meeting capability criteria due to the need to use non-capable areas for access. Then water bodies and wetlands, areas which are not grazed or are not preferred by domestic sheep, were removed. This provided a final acreage of land which the model determined is capable of being grazed without risk of excessive damage. We would qualify this by saying this depends on having stocking rates that are within the forage capacity of the areas grazed. Datasets used or generated in model development are listed in **Table 2**. We requested and received GIS data from the Forest Service [28] and their historic monitoring data [15] in order to perform the analysis.

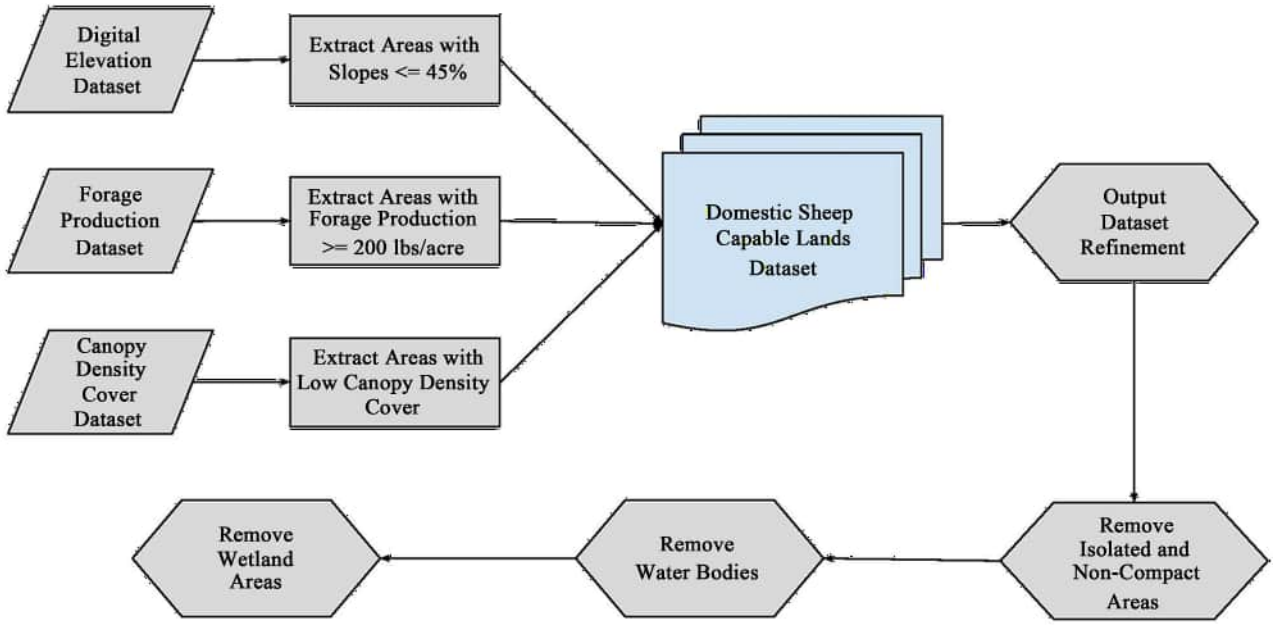


Figure 6. Flowchart of the domestic sheep grazing capability model.

Table 2. GIS datasets.

Dataset Name	Format Type	Version	Resolution	Source
NED Digital Elevation Model	Raster	2013	10 meters	US Geological Survey [29]
Slope	Raster	2018	10 meters	Derived from NED Digital Elevation Model
NAIP Digital Ortho Photo Images	Raster	2016	1 meter	USDA National Agriculture Imagery Program [30]
Canopy Density Cover	Raster	2018	1 meter	Wild Utah Project
National Wetlands Inventory	Polygon		Version 2.0, 2016	US Fish and Wildlife Service [31]
Predicted Forage Production	Raster	2018	10 meters	Wild Utah Project
Forage Production Maps	Digitized PDFs	1960-1967	1:17,000	US Forest Service [32]
Digitized Forage Production	Polygon	1960	1:17000	Digitized by Wild Utah Project
Grazing Allotments and Pastures Boundaries	Polygon	2016	1:24,000	US Forest Service [33]
NHD Water Bodies	Polygon	Version 1.07	1:24,000	US Geological Survey [34]
Grazing Capability (Forest Plan Revision)	Polygon	2001	1:24,000	US Forest Service [35] [36]
Forage Production Survey Sites	Point	2016	N/A	Wild Utah Project
Soils	Polygon	2011, 2016	1:24,000	US Forest Service [37] [38]

2.4. Development of Model Parameter Inputs

Slope: Criterion 1 as interpreted in the WCNF Revised Forest Plan [20] defines areas with slope ≤ 45% as capable for domestic sheep grazing. Determination of such areas was made using the Slope Analysis tool within the ESRI ArcGIS software [26]. As the chief input dataset, the NED Digital Elevation Model was used to derive the slope raster file [29] (**Table 2**). In a follow-up process, the output slope raster was filtered in order to generate a raster dataset containing areas with slopes ≤ 45%.

Forage Production: To refine the vegetation production estimate used by the Forest Service, we obtained field data for actual forage production. In order to get a representative sample of available forage in the project area, our team relied on areas that were not grazed by livestock prior to field sampling which occurred in August, 2016. Using soil map files [37] [38] and soil descriptions [39] obtained from the Forest Service, we determined that seven soil types were most common in the UWCNF portion of the project area which was not grazed prior to sampling. These occurred in the ungrazed areas and could be sampled to de-

termine forage production. Of these soil map units, the Rubble and Rock Outcrop type covers 17,219 acres or almost 22% of the UWCNF study area, and is largely barren high county, so would not be expected to contain enough forage to factor into a grazing capacity analysis. Therefore, this soil type was not sampled and was assigned a value of zero for forage. The six remaining soil types were then visited by field teams in August, 2016 to collect forage production samples. Sites were inspected for signs of current sheep use such as droppings, tracks, bedding areas, and visible grazing use, in order to exclude these from the forage capacity samples if they were determined to have been grazed that season.

Sample site locations for collecting forage data were determined from locations of Forest Service monitoring sites and complemented with random locations generated with GIS to ensure coverage of all soil types. The number of locations was distributed equally among the soil types. Thirty-six locations were sampled across the 6 common soil types. At each pre-determined location within each soil type, plot clippings were collected along a transect heading due north [40]. To collect plot clippings, 24 × 24-inch sample frames were placed at 25', 50', 75' and 100' along each 100' transect. All herbaceous species in each sample plot were clipped to one inch above the ground, placed in Ziploc bags and brought back to camp, where they were kept open to air out until transported to the lab where they were air dried and weighed on an electronic balance. The amount of air-dry forage per acre was then calculated.

The forage production samples were then correlated with the aerial ortho-photos of the study area. Figure 7 illustrates the process of correlation and

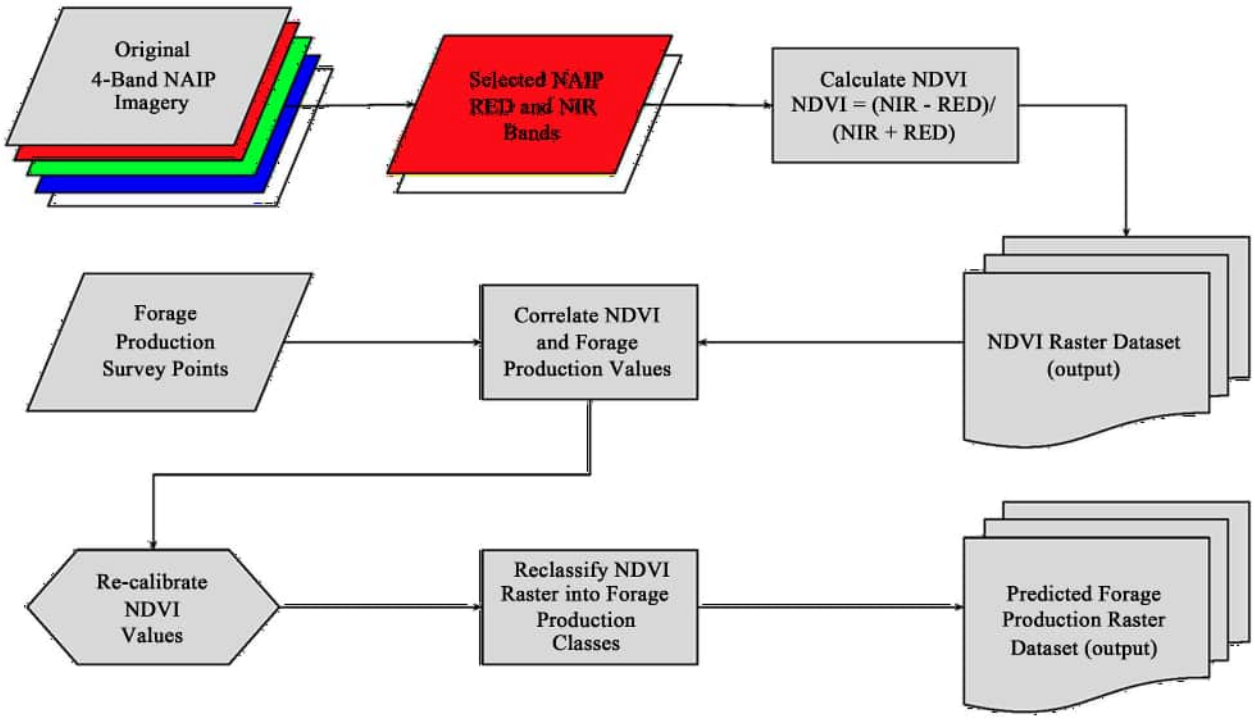


Figure 7. Image analysis process for the estimation of NDVI values, correlation of NDVI with forage production survey points, and image classification to derive a predicted forage production raster dataset.

NAIP image classification that was applied to derive a predicted forage production raster layer, using the Image Analysis tools within ESRI ArcGIS [20]. In the first step, we utilized NAIP imagery from August, 2016 to estimate Normalized Difference Vegetation Index (NDVI) values across the study area [30] (**Figure 8**). NDVI is estimated based on a ratio between the red and near-infrared (NIR) optical bands embedded in the NAIP imagery. The equation for NDVI is presented as NDVI = (NIR − RED)/(NIR + RED). This mathematical operation was completed by using the Raster Calculator in ArcGIS which generated a raster file. In the next step, the forage production survey points were used to correlate those values to the NDVI values from the previous step (**Figure 9**). These two datasets were correlated to each other by using the pixel values in the NDVI raster dataset and the forage production values determined at each survey location. By using the data correlation, we were able to re-calibrate the NDVI values to forage production values and confidently conduct a raster classification into different forage production classes based on the differential raster values of those vegetation classes (**Figure 10**).

Dense Timber: Areas of dense timber are considered not capable in the Forest Service Criteria because livestock generally avoid grazing in areas of thick conifer cover, either due to lack of forage or access limitations. In the model, areas with high and medium canopy density were excluded from capable areas since those canopy density categories are associated with areas with dense timber, a large number of fallen trees, and areas with restricted access to livestock. In order to achieve a reliable dataset that would describe areas of dense timber throughout the study area, we revisited the NDVI raster dataset from the previous

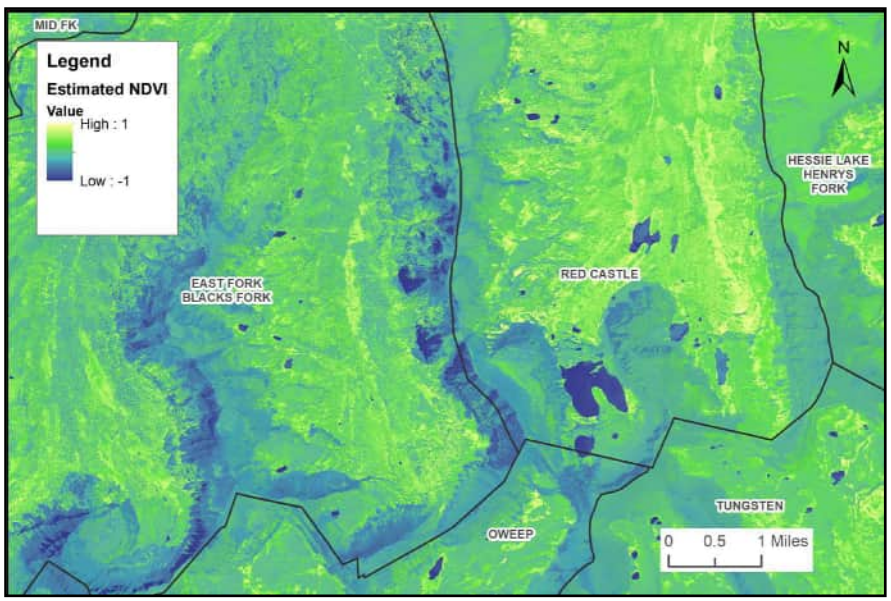


Figure 8. NDVI raster obtained from image analysis operation by estimation of a ratio between the green and near-infrared bands in NAIP ortho photo images [30]. (Areas shown in blue represent water bodies and areas shown in various shades of green represent vegetation in various NDVI values).

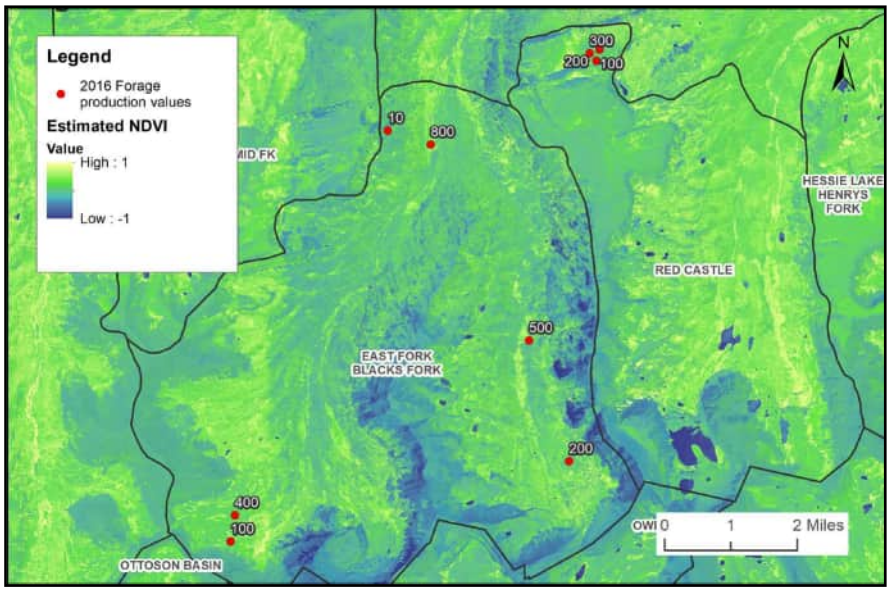


Figure 9. NDVI raster and forage production values estimated from the survey conducted in 2016.

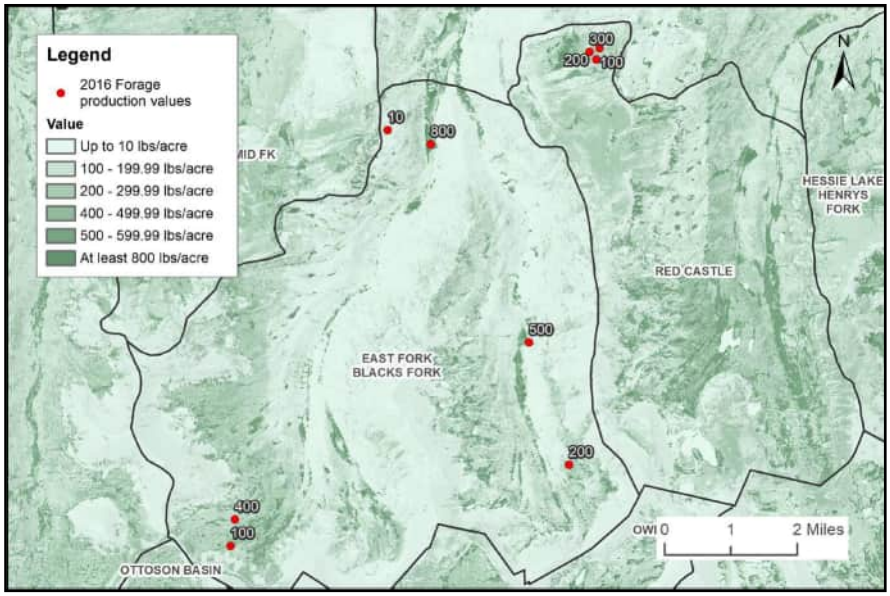


Figure 10. Predicted forage production raster from image classification of forage production data.

process and adjusted the raster classification process by targeting the different levels of forest canopy density. The resulting dataset describes the study area in terms of canopy density levels (*i.e.* high to low). Figure 11 illustrates the data transformation process to obtain the canopy density cover dataset. Figure 12 shows the resulting forest canopy density raster dataset.

Comparisons Using Model Outputs: Once these model outputs were derived, we made two comparisons to the Forest Service determination of capable lands. In Case 1, we calculated the acreage of lands meeting current Criteria of ≤45% slope, 2016 forage production ≥ 200 lb/acre, and excluded areas of dense timber,

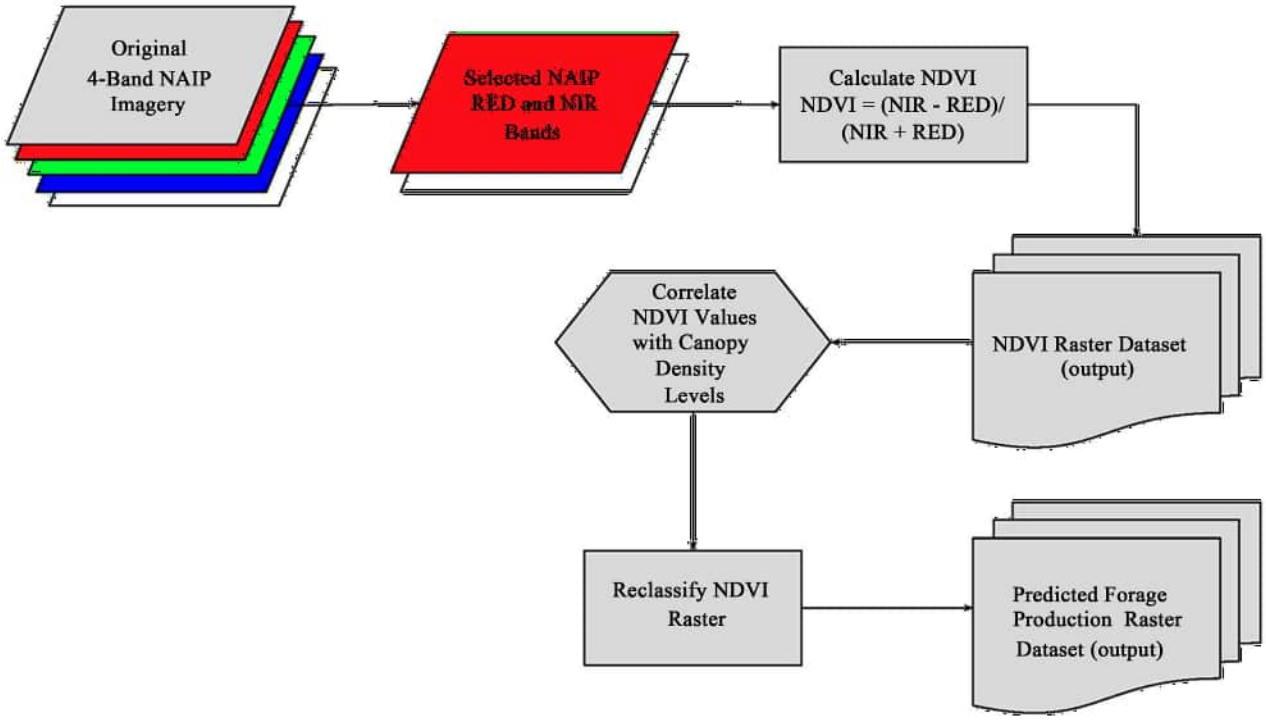


Figure 11. The data transformation process to obtain the canopy density cover dataset.

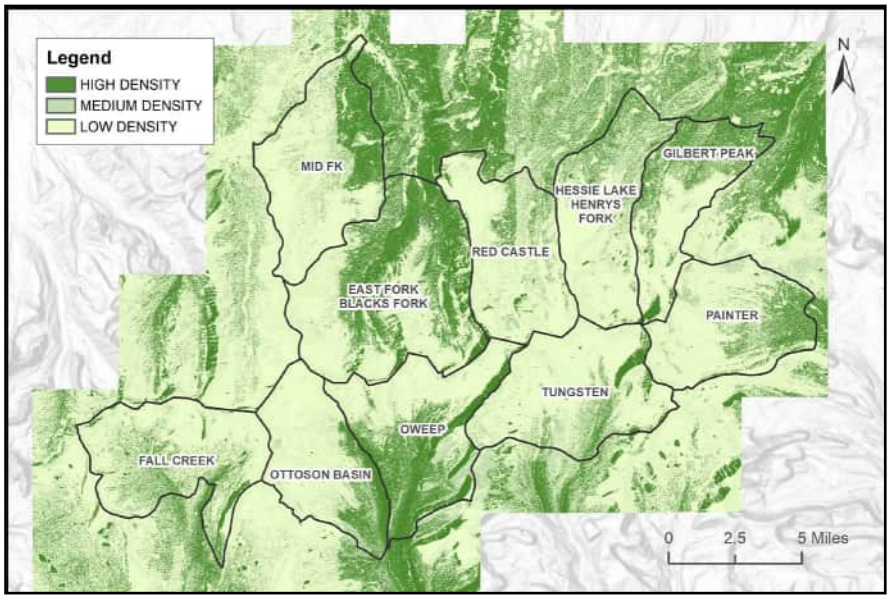


Figure 12. Canopy density raster dataset using NDVI values from NAIP imagery and the resulting classification into density categories.

water bodies and wetlands. In Case 2, since the most recent Forest Service forage production data was that collected in the 1960s, we digitized the 1960's forage production data which was then used to determine acres with forage production ≥ 200 lbs/acre [32] (**Table 2**). This, along with slope ≤ 45% and excluding areas of dense timber, water bodies and wetlands were used to determine capable acres.

2.5. Stocking Rate Determination

Forage Consumption: A forage consumption rate for sheep was provided in the USFS Region 4 Range Analysis Handbook showing forage consumption for a 125 lb ewe to be 4.1 lb/day air dry weight while an 80 - 90 lb lamb would consume 2.9 lb/day [22]. Since permits allow two lambs per ewe, we used 9.9 lb/day (301 lb/month) as a forage consumption rate for each ewe/lamb pair applied to the permitted numbers for each allotment. According to government statistics, in 2017, the average live weight of sheep and lambs for slaughter was 132 pounds [41]. This indicates our estimated forage consumption rate for a ewe and two lambs could be an underestimate if full permitted numbers of ewes and lambs are being grazed.

Utilization: Recommended utilization rates are 20% for alpine ranges grazed during the growing season or in poor condition, while for ranges in good condition and grazed during the dormant season 30% is recommended [42]. Lewis (1970) recommended 30% utilization for all areas except wetlands [16]. He recommended 40% in wetlands, while acknowledging these are not preferred by sheep, are not suitable for grazing and that the drier uplands nearby will be preferred. For this analysis we used a 30% utilization rate even though past work has shown these alpine and subalpine upland areas to be in poor condition with depleted ground cover, gully erosion, stream bank scouring and heavy grazing in non-capable areas such as uplands and steep slopes, indicating that they are most often in poor condition [16] [18] [19].

3. Results and Discussion

3.1. Current Forage Production and Comparison to 1960's Data

The 1960's forage production data excluded non-forage species in grazing capacity determinations [15] [16] [22]. **Table 3** summarizes key statistics from the 1960's determinations and our 2016 forage production data set.

The median sample weight was less in 2016 than in the 1960s while the mean was greater in 2016. This is logical since the 2016 data included all herbaceous species whether forage or non-forage, while the 1960s' data did not include non-forage species. The 2016 maximum values were samples from wetlands. The highest non-wetland sample was near the 1960's maximum.

3.2. Comparison of Capable Acres

Table 4 summarizes the capable acres determined for the ten allotments applying the current Criteria. These are contrasted with those determined by the ANF and WCNF in their Forest Plans. The Forest Service determination of capable

Table 3. Key statistics for forage production (lb/acre).

Time Period	Median	Mean	Maximum
1960s	206	240	615
2016	166	294	1431

lands was represented in the GIS data they provided [35] [36]. Their determination was that 35.7% of the land area was capable (**Table 4** and **Figure 13**). They did not exclude areas of dense timber or wetlands and did not collect forage production data, while relying on assumed production from their vegetation layer. Case 1 resulted in only 6% of the total allotment area being capable (**Figure 14**). Case 2 resulted in only 1.8% of the total allotment area being capable (**Figure 15**). The Forest Service determination of capable lands overestimates the actual amount by nearly 6 times based on applying their current Criteria and our 2016 forage production data (Case 1) and nearly 20 times when the 1960's

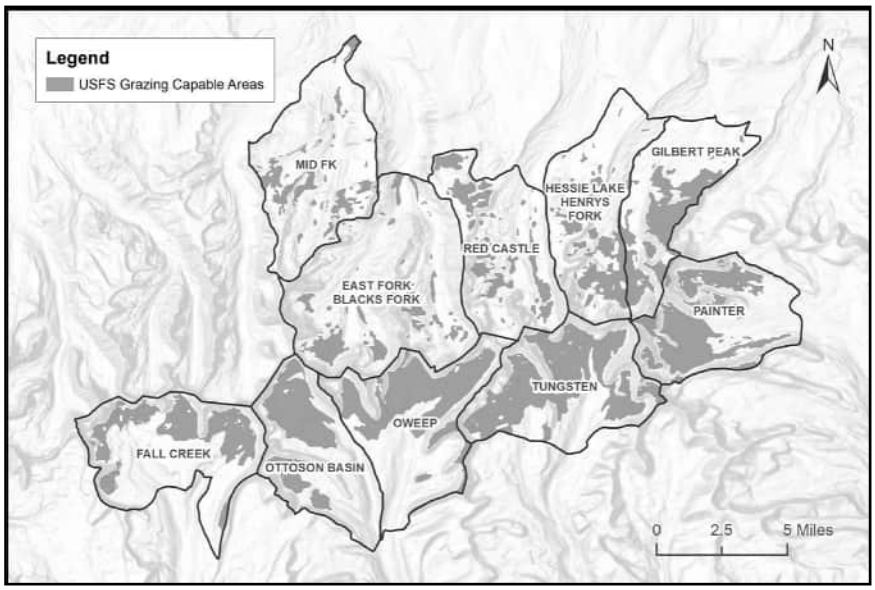


Figure 13. Ashley and Wasatch-Cache National Forest determination of capable acres = 57,399 acres, or 35.7 percent of total acres.

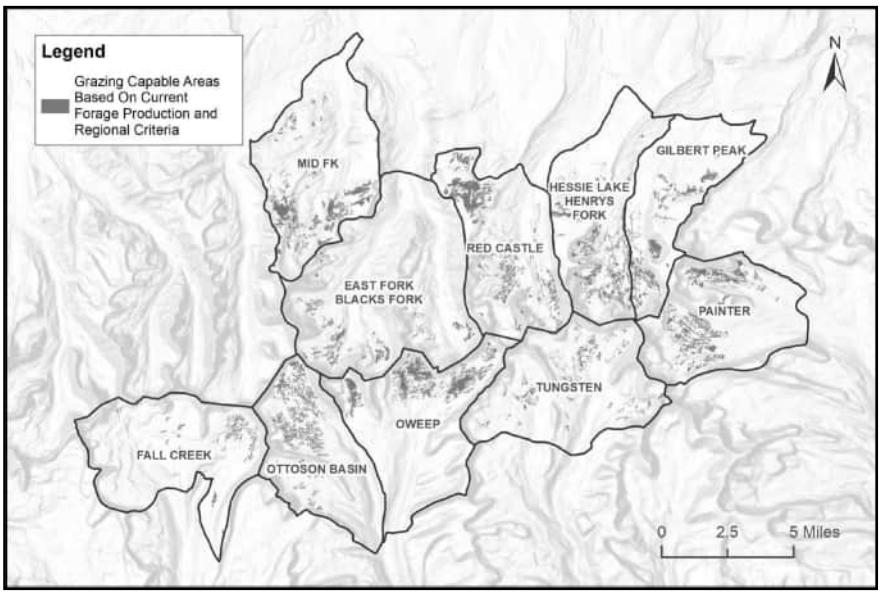


Figure 14. Capable acres determined from regional capability criteria and current forage production = 9685 acres, or 6.0 percent of total acres.

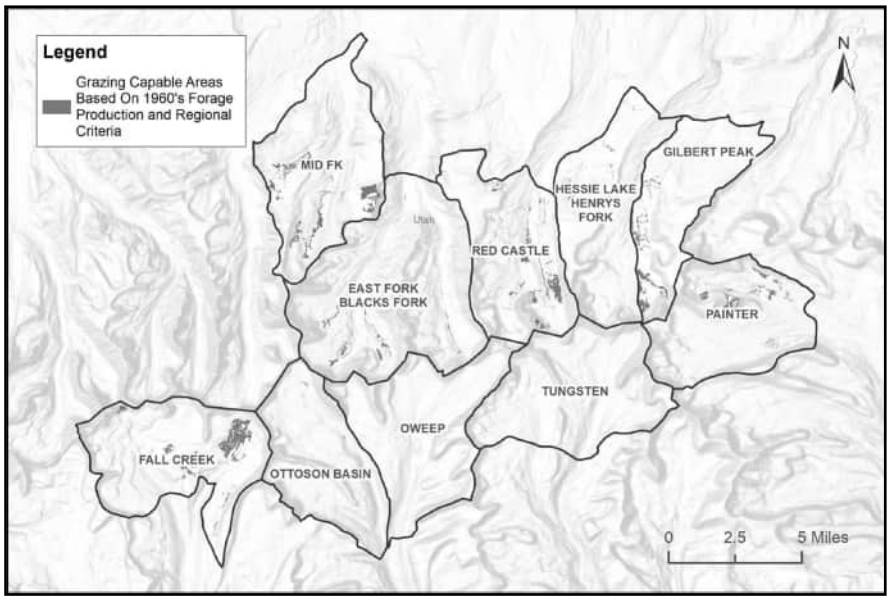


Figure 15. Capable acres determined from regional capability criteria and 1960's forage production = 2.887 acres or 1.8 percent of total acres.

Table 4. Summary of capable acres.

Total Allotment Acres	Forest Service Capable Acres	Total Capable Acres Current Forage: Case 1	Total Capable Acres 1960s Forage: Case 2
160,410	57,399	9685	2887
Percent of Total	35.7%	6.0%	1.8%

forage production data were applied (Case 2). If sufficiently detailed soil survey information and ground cover data were available, more areas would likely be found not capable as indicated by past surveys [16] [18] [19]. However, even in the absence of these data, our model demonstrates that the allotments lack land capable for grazing domestic sheep.

3.3. Evaluation of Forage Demand, Available Forage and Stocking Rates

The total forage demand for the currently permitted 12,850 ewe/lamb pairs grazing these ten allotments based on their time in the allotments and a forage demand of 301 pounds per month per pair is 8,062,641 pounds (**Table 5**). In Case 1, using the 2016 mean forage production of 294 lb/acre and 9685 capable acres gives total forage production of 2,847,390 pounds. Applying a 30% utilization rate to this amount gives 854,217 pounds available. This is 10.6% of the current demand. In Case 2, using the 2016 mean forage production values on the 2887 capable acres is 848,778 pounds. Applying a 30% utilization rate to this amount gives 254,633 pounds available. This is 3.2% of the demand. The implication of this to current stocking rates is clear. In Case 1, a 90% reduction would be needed to balance domestic sheep use by the current permitted numbers to

Table 5. Forage demand compared to available forage.

Total Forage Demand for 12,850 ewe/Lamb Pairs for the Current Grazing Period	8,062,641 lbs.
Case 1: Available Forage on 9685 Capable Acres	854,217 lbs. or 10.6% of Total Demand
Case 2: Available Forage on 2887 Capable Acres	254,633 lbs. or 3.2% of Total Demand

the available forage. In Case 2, a 97% reduction would be needed to balance domestic sheep use by the current permitted numbers to the available forage.

Where does the additional forage to support these 12,850 ewe/lamb pairs of permitted sheep come from? The domestic sheep are grazed and trailed throughout the non-capable areas on steep slopes and highly erodible soils and in the sensitive alpine meadows, where sheep consume whatever small amounts of edible plants they can find. This management has caused and continues to cause accelerated erosion, high flood forces during runoff events, changes in plant communities, and erosion of streambanks [16] [18] [19].

3.4. Impact on Wilderness Values

Cole and Landres (1996) delineated the threats to wilderness ecosystems to include: 1) recreation; 2) livestock grazing; 3) fire management; 4) invasive species; 5) diversion and impoundment of water; 6) atmospheric pollutants; and 7) management of adjacent lands [43]. Here we are considering only the livestock grazing effects, which they delineate as trampling, grazing, defecation, death of plants, compaction and destabilization of soils, redistribution of nutrients, changes in geomorphology, gully formation, and lowering of water tables, reduced water quality and impacts on wildlife populations. They considered the most significant effect at the species level is the indirect effects on wildlife. They point out that many of these wilderness areas are located at high elevations or in the desert, are naturally stressed and not resilient.

We have described the ecological degradation of plant and soil communities occurring in the High Uintas Wilderness due to grazing in non-capable areas. In addition, the current large-scale removal of vegetation by domestic sheep grazing in the High Uintas Wilderness reduces food and cover for native wildlife that depend on herbaceous plants. Snowshoe hares (*Lepus americanus*) are a principle food source for Canada lynx (*Lynx canadensis*), a Threatened species. Grazing by domestic sheep may be playing a role in the current absence of lynx from the High Uinta Wilderness [44]. Bighorn sheep populations today are a small fraction of historical numbers, with a loss of over 98 percent of historic numbers [45]. Domestic sheep compete with native bighorn sheep for food, space and water. They are also asymptomatic carriers of diseases such as pneumonia that result in sick and dead bighorn sheep if the two come into contact with one another [46].

The ANF and UWCNF have monitored many locations in these ten grazing allotments and, in recent years, have not identified impacts of domestic sheep

grazing. For example, the Forest Service notes that "over 99% of the studies show ground cover is in satisfactory condition" and plant communities are dominated by plants of high value for watershed protection [2]. We reviewed the data files, photographs and data sheets provided by the Forest Service [15] and analyzed the Forest Service monitoring locations [28] to determine why they failed to find the problems documented by earlier Forest Service range and soil scientists and one of our own authors which documented severe erosion, active gully progression or headcutting, streambank scouring, and lack of ground cover in the drier uplands and on steeper slopes [16] [18] [19] (**Figure 16** and **Figure 17**). When long term ungrazed areas were compared to areas that continue to be grazed by domestic sheep, ground cover was high in the ungrazed areas, gully erosion and headcuts were healing, and streambanks were healthy and not eroding [18]. Lewis (1970) showed definitive improvements in plant community composition with improved vigor in an area where sheep had been excluded for 11 years leading to a change in condition assessment from fair to good [16].

Using GIS, we compared the Forest Service monitoring locations to percent slope and found that 59% of monitoring locations were in areas < 10% slope, and 83% in areas < 20% slope. This indicated that Forest Service monitoring was focused in areas that are less likely to be unstable and are less sensitive to sheep grazing impacts. Few sites were monitored in areas > 40% slope which would be on the slopes more subject to erosion and instability. Eighty three percent of locations were in riparian areas, alpine wet and dry meadows and willow complexes which are the less sensitive areas and many that are least preferred by sheep and which also correspond to more level terrain. Forest Service ground cover data is rarely collected. If casual observations noted in their files as well as on data sheets are all counted, only 10.8% of the monitoring sites since 2000 noted a ground cover estimate. The satisfactory conditions the Forest Service noted in their Draft Environmental Impact Statement appear to logically follow, given these measures were taken in the areas less sensitive to domestic sheep impacts [2].



Figure 16. Upland adjacent to riparian area showing bare soils and trailing damage [18].



Figure 17. Result of sheep grazing on steep slopes leaving loose, erodible soil and sparse plant cover [18].

Cole and Landres (1996) [43] note: "We can, however, attempt to identify those places where grazing is most inappropriate and develop grazing management objectives and guidelines that are more compatible with the goals of wilderness than the goal of maximizing sustainable animal production (the most common goal outside wilderness)". Wilderness is "land retaining its *primeval character and influence*, without permanent improvements or human habitation, which is protected and managed so as to *preserve its natural conditions*…." In addition, wilderness should be "*affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable*. By these definitions alone, domestic sheep grazing is incompatible with the Wilderness Act. The degradation documented in the Uinta Wilderness over the decades is clearly not compatible with the Wilderness Act's intent.

4. Conclusions

The GIS analysis we have conducted for the High Uintas Wilderness Domestic Sheep grazing reauthorization indicates that only a small fraction of these allotments are capable of supporting domestic sheep grazing. The capable acres identified in our forage capacity model for this mountain range are scattered, small areas disconnected from each other to a large extent and require sheep to be trailed between them. Historically, nearly every acre sheep can access has been grazed across the Uinta mountains, regardless of slope, ground cover, elevation, soil erosion hazard and vegetation condition. Previous monitoring has identified that large-scale erosion is occurring in the High Uintas Wilderness due to this practice of trailing and grazing domestic sheep in non-capable areas.

This analytical process using GIS provides a framework for evaluation of other grazed lands and an evaluation of the costs and benefits of livestock grazing versus other values such as wildlife, native plant communities and water supplies. It shows that current and proposed Forest Service management is based on lack of compliance with its own Regional Capability Criteria, inadequate monitoring and insufficient analysis. Limitations of the study include the lack of a suitably detailed soil survey to determine erosion susceptibility, a lack of ground cover data, a lack of Forest Service data for the level of grazing use, or utilization, and the lack of a Forest Service quantitative measurement of vegetation production in each plant community and soil type. In spite of these limitations, the use of slope, forest cover and forage production as derived in our study reduced field work necessary to do this evaluation and showed that these were the dominant factors needing to be addressed.

Forest Service management can address the problems in the High Uintas Wilderness by applying the analytical process we have provided and adjusting stocking rates and grazing periods based on the capable acres, current forage production and forage consumption rates, while applying a sustainable utilization rate. Sheep should be managed to remain within the capable areas and away from steep slopes. Monitoring should include trend in ground cover and utilization. It should be standardized, quantitative and performed annually. It should include capable and non-capable areas with a focus on those areas most preferred by domestic sheep such as the dry meadows and uplands in the valleys, uplands at the margins of wet areas and slopes at the valley margins. Sufficiently detailed soil surveys should be carried out for future evaluations. Only then will the Forest Service approach conditions where domestic sheep grazing in this wilderness may be sustainable and recovery of past degradation can begin.

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Dr. Carter has spent decades surveying and exploring the High Uintas Wilderness both at his own expense and while in the 2001-2010 time period he was an employee of Western Watersheds Project (WWP), also a 501c3 organization. Since retiring from WWP 2010, he has donated his time and expenses to this work. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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EXHIBIT 2

Vegetation Analysis of Grazed and Ungrazed Alpine Hairgrass Meadows[1]

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Highlight

Alpine hairgrass meadows in Colorado and Wyoming were examined for plant species differences related to sheep grazing history. Nine alpine areas were studied and three of these had not been grazed by domestic sheep for many years. Frequency values for eight plants were found to be useful in determining whether or not hairgrass meadows have been predominantly grazed over the years by domestic sheep. No additional information was obtained by including species cover data for classification purposes.

The first information on alpine vegetation of the southern Rocky Mountains came from botanical explorations made in the early 1800's. Only new or rare plants to the area were listed and few detailed accounts were given of the vegetation as a whole (Cox, 1933). Griggs (1956) agreed with Weaver and Clements (1938) in their conclusion that alpine communities are little understood, and ascribed the limited work in alpine areas to the complex nature of tundra communities. The heterogeneity found in alpine species groupings is such that some botanists have concluded that there is no sense at all to tundra vegetation. Polunin (1948) said the more he learned about alpine vegetation as a whole, the less he felt inclined to generalize about it.

A greater portion of alpine tundra of the southern Rocky Mountain Region was categorized as alpine grassland than any other community type by both Cox (1933) and Weaver and Clements (1938). This categorization is an important factor in grassland management since management principles are often based on the predominant vegetation type. Included in six grassland types described by Cox (1933) are three associations which contain tufted hairgrass (*Deschampsia caespitosa*) in abundance. These are: snowflush association, alpine-moor association, and wet-meadow association. In the alpine-moor association, hairgrass is said to form a transition from wet areas to upper slopes of the dry alpine meadows. Hairgrass was considered the dominant in wet-meadow associations and as an important species in the other two associations.

Tufted hairgrass is a well-known montane species but has received little specific attention in alpine tundra studies. The species is distributed throughout alpine regions of the world and include the Alps, Pyrenees, and the Himalayas. A favorable habitat for tufted hairgrass is indicated by sub-

[1]Appreciation is extended to the National Science Foundation (GB-11335) for partial support of this study. Received July 21, 1971.

stantial snow cover or by snow melt water influence. Additionally, late-lying snowbanks are known to offer protection against grazing. Hairgrass meadows are also recognized as being the best developed of true grass meadows in alpine tundra (Marr, 1961). Lawrence (1915) observed that hairgrass requires permanent ground moisture and relatively cool to cold climates in order to survive. Cooper (1908) described hairgrass as being a secondary species in his classification of dry grassland tundra meadows. Hohn (1908) on the other hand, included hairgrass as being more important in swamps of the aspen zone.

Tufted hairgrass has been observed to be the most important forage species occurring on alpine sheep ranges (U.S. Forest Service, 1956). Its importance is recognized because of its ecological range, abundance, amount of herbage produced, and use by domestic sheep. Moist to wet sites in alpine hairgrass meadows have been observed to produce 0.7 tons of air-dry plant material per acre, with at least 85% of this consisting of plants which were palatable to domestic sheep. In contrast, turf-sites which are well drained and located on ridge tops are known to produce about 0.4 tons per acre of air-dry material with approximately 65% palatable for sheep (U.S. Forest Service, 1956). The importance of tufted hairgrass as a component of other vegetation types of the alpine tundra has also been noted by several researchers.

A study was made of alpine tufted hairgrass meadows in the southern Rocky Mountain Region to determine if plant composition differed in historically grazed areas as compared to that of ungrazed areas. Some studies of a local nature have been conducted in alpine hairgrass meadows and to date no comparisons of any characteristic of phytosociological structure have been made for geographically separated areas. Furthermore, no reports have been made comparing alpine hairgrass meadows which have not been grazed for many years to those grazed by domestic livestock.

Methods and Procedures

Nine areas were selected from alpine regions located in southern Wyoming and throughout Colorado (Fig. 1). Criteria for selection of an area for study included: accessibility, geographic relationship to other areas in the study, past use by domestic sheep, and timberline relationships. All study areas were located well above timberline and included a geographical representation of the southern Rocky Mountain Region. A stand size 7 × 10 meters was selected as a macro-plot representing hairgrass meadow vegetation. Each stand was sampled by placing 50 quadrats (10 × 10 cm) at random within. Presence for all species encountered in quadrats was noted and frequency computed. Density of hairgrass only was recorded for all 50 quadrats in each stand. Cover values were visually estimated for each species that occurred in every fifth quadrat. Thus, a total of 10 samples for species cover values were obtained for each stand. Data

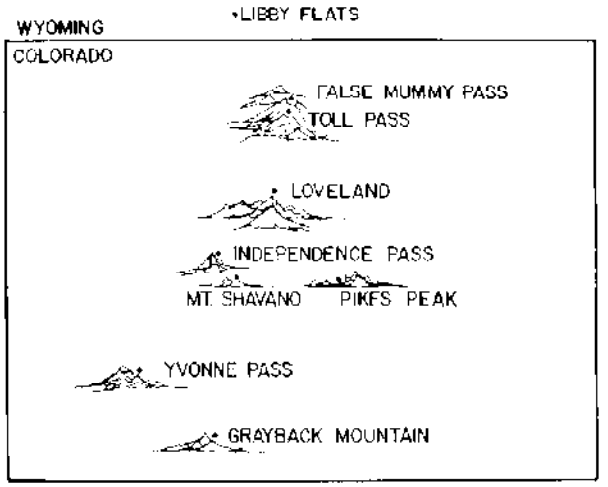


FIG. 1. Location of study areas containing alpine hairgrass meadows.

were obtained from three ungrazed areas having a total of 28 stands. These areas were False Mummy, Trail Ridge Road, and Pikes Peak. Grazing by domestic sheep has not been permitted for many years in the three areas and hopefully, an indication of hairgrass meadow vegetation differences due to continuous grazing can be assessed.

Cover data for species were available only for the two latter areas. The remaining six areas had a long history of use by domestic sheep and were represented by 49 stands. Generally grazed meadows were easily accessible and free of snow during the season of use by sheep. Relative soil moisture levels were determined for all stands, and included the following: very wet, wet, mesic, and dry mesic. A total of 77 stands were sampled with the number of stands within areas ranging from 6 to 12.

Bonham and Ward (1970) reported that 20 species were found consistently throughout alpine hairgrass stands. These species were selected for use in this study. Multivariate analysis of variance in combination with step-wise discriminant analysis was performed on frequency and cover data in order to determine the set of species giving the largest significant difference between group means. This procedure was also used to evaluate the power of species occurrence to discriminate between grazed and ungrazed areas.

Results and Discussion

The abundance of hairgrass in alpine meadows was found to vary both within and between grazed and ungrazed areas. Density of hairgrass ranged from 18 plants/m² to 48 plants/m², in grazed and ungrazed areas respectively. However, at least 40 plants/m² were observed for one meadow in a grazed area while the greatest range in hairgrass density occurred in ungrazed areas. The range of hairgrass frequency, on a meadow basis, was from 10 to 100% occurrence in ungrazed areas while that of grazed areas ranged from 18 to 98%. The overall percentage frequency of hairgrass for areas ranged from 49 to 85%. The lower frequency values occurred in southern sample areas while the higher values occurred in northern areas (Fig. 1).

Table 1. Important species and their frequency (%) of occurrence in grazed and ungrazed alpine hairgrass meadows. Only eight species were significantly ordered.

Species	Frequency		Importance level as discriminator	Discriminant coefficient
	Ungrazed	Grazed		
Phleum alpinum	0	17	1	−0.126
Potentilla diversifolia	1	30	2	−0.115
Polygonum bistortoides	44	30	3	0.167
Poa alpina	0	11	4	−0.156
Caltha leptosepala	28	6	5	0.131
Geum rossii	60	38	6	0.130
Senecio dimorphyllus	9	14	7	0.058
Oreoxis alpina	1	12	8	0.011
Achillea lanulosa	2	22		
Androsace septentrionalis	3	11		
Arenaria obtusiloba	14	10		
Artemisia norvegica	38	18		
Erigeron simplex	20	24		
Festuca ovina	28	24		
Leavisia pygmaea	4	12		
Ranunculus adoneus	12	6		
Sibbaldia procumbens	16	38		
Taraxacum ceratophorum	0	8		
Trifolium parryi	32	18		

Alpine hairgrass meadows are known to be associated with heavy snow accumulation (Marr, 1961). It was evident from this study that late lying snowbanks prevented grazing of some meadows even in areas used by sheep. Thus, responses of vegetation to long-term grazing exposure have been confounded with snowmelt. However, it was generally noted that snow receded earlier in the southern part of the study region and subsequently hairgrass meadows were opened to grazing earlier. Correspondingly, more species of palatable forbs occurred in these hairgrass meadows, which gave a higher species diversity for grazed compared to ungrazed areas. Important forbs and their distribution in grazed and ungrazed meadows are listed in Table 1. Western yarrow (*Achillea lanulosa*) was the most widely distributed species throughout grazed areas and was a common species in several of these hairgrass meadows. In contrast, marsh-marigold (*Caltha leptosepala*) was observed to be common in ungrazed regions and occurred sparingly in a few meadows of grazed areas.

The importance of alpine avens (*Geum rossii*) as a component of ungrazed areas is evident from this study. Smith and Alley (1966) observed that alpine avens was an important member of several alpine vegetation types, and often dominated specific types. Furthermore, this species was recognized in their study as being unpalatable to sheep and other grazing animals. In contrast, Strasia et al. (1970) found that alpine avens made up 10% of sheep diets consistently throughout the summer on alpine ranges. In the present study, alpine avens occurred abundantly in hairgrass meadows of ungrazed areas and was found to dominate in meadows with mesic to wet habitats regardless of grazing history.

The common grasses occurring in alpine areas, for example Patterson bluegrass (*Poa pattersoni*), alpine bluegrass (*Poa alpina*), alpine timothy (*Phleum alpinum*), and sheep fescue (*Festuca ovina*) are more abundant in the drier habitats of alpine tundra. It was noted that these important grass species never occurred with hairgrass when density of the latter species exceeded 40 plants/m^2. Since it was suggested by Holway and Ward (1968) that hairgrass density is influenced by snow accumulation in alpine areas of Colorado, a covariance analyses was conducted on the data with hairgrass density as the covariate. No significant effect of the occurrence of other species with respect to hairgrass density was observed in this study.

Multivariate analysis of variance using all species, indicated that a significant difference existed in species mean occurrences for grazed versus ungrazed areas ($P < .01$). Step-wise discriminant analysis was then performed on the variance-convariance matrix for species listed in Table 1. This procedure yields coefficients for each species which are then used to classify the species group into grazed or ungrazed meadows. Eight species were found to be important discriminators for detecting significant differences in grazed versus ungrazed meadows. Alpine timothy was determined to be the most important discriminator for detection of ungrazed hairgrass meadows. It was obvious that two criteria were important: (1) the variance of the occurrence for the species and, (2) the absence of alpine timothy in ungrazed hairgrass stands. This species used alone as an indication of grazing history, correctly classified all ungrazed meadows, but misclassified 43% of the grazed meadows. Research on the management of alpine sheep ranges has indicated that alpine timothy is second only to hairgrass in importance according to its range, abundance, amount of herbage produced, and use by sheep (U.S. Forest Service, 1956) while bluegrass species were listed third. Neither alpine timothy nor bluegrass species occurred in hairgrass meadows of ungrazed regions.

Cinquefoil (*Potentilla diversifolia*) in addition to alpine timothy, increased classification accuracy to 70%. The former species was also more abundant in grazed areas than in ungrazed areas. The power to discriminate between grazed and ungrazed conditions concomitantly was reached only by using all eight species in order of their importance as indicated in Table 1.

The species coefficients give relative contrasts of the eight species and their importance as predictors of grazing relations in hairgrass meadows (Table 1). Approximately equal amounts of these species imply the existence of an intermediate stage between grazed and ungrazed conditions, historically. Two of the three species with positive coefficients were included by Strasia et al. (1970) as being important in diets of sheep. Furthermore, these two species, alpine avens and American bistort (*Polygonum bistortoides*) occur more abundantly in ungrazed hairgrass meadows.

Only three of the eight discriminator species occurred more frequently in ungrazed areas. Although alpine avens is an important species in ungrazed areas, its value as an indicator species was lowered by the fact that it occurred as the most frequent species in one of the grazed areas, Mt. Shavano. Snow accumulation on hairgrass meadows in this area however, indicated little or no grazing of these meadows early in the season.

Alpine timothy and alpine oreoxis (*Oreoxis alpina*) did not occur in meadows with hairgrass densities greater than 25 plants/m^2, while marsh marigold did not occur when hairgrass densities were less than 12 plants/m^2. The remaining five indicator species occurred at all levels of hairgrass densities encountered.

Only five species were found to have cover values greater than one percent in ungrazed areas compared to only three species having in excess of one percent cover for grazed areas. The analysis of cover data using these procedures indicated that only three species were significant in distinguishing grazed areas from those ungrazed. Two of the three species were important both for cover and frequency of occurrences. American bistort was the most important discriminator using cover data. Previous studies have indicated that this forb is preferred early in the grazing season and make up a significant proportion of the diet of sheep (Strasia et al., 1970). The second most important species was found to be sandwort (*Arenaria obtusiloba*), followed by marsh-marigold.

It is obvious from this study that the absence of other major grass species in hairgrass stands is ecologically significant and indicates that grazing history has affected the species composition of alpine hairgrass meadows. Furthermore, important forbs such as American bistort, which are eaten by sheep during the early part of the season were much more abundant in ungrazed areas. Additionally, forbs having low palatability such as western yarrow, were observed to be more abundant in grazed hairgrass meadows than in ungrazed hairgrass meadows. Forbs are preferred by sheep early in the season and those that are not preferred by sheep can be predicted from this study. Forbs classified as not used by sheep include: cinquefoil and western yarrow. In contrast, marsh-marigold, alpine buttercup (*Ranunculus adoneus*) and alpine sage (*Artemisia norvegica*) are forbs which have not been reported as important in sheep diets, yet this study suggested that they might be (Table 1). Further studies need to be carried out in order to determine more fully the relationship of species composition and abundance in hairgrass meadows with regard to the grazing affects of domestic sheep.

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EXHIBIT 3



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The Influence of Grazing and Other Environmental Factors on Lichen Community Structure along an Alpine Tundra Ridge in the Uinta Mountains, Utah, U.S.A.

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The Influence of Grazing and Other Environmental Factors on Lichen Community Structure along an Alpine Tundra Ridge in the Uinta Mountains, Utah, U.S.A.

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Abstract

This study examined the influence of snowmelt, vascular plants, grazing, substrates, and soil characteristics on the distribution of lichen communities along an alpine tundra ridge in the Uinta Mountains of Utah. Percent cover of lichens, rocks, snow, and vascular plants were estimated at 18 study sites along an altitudinal transect. Vascular plant cover and species diversity were greatest at the lower elevation sites, and differences in plant communities were related to differences in rock cover and grazing. Lichens showed a similar trend, with rock cover, grazing, vascular plants, and timing of snowmelt all defining community structure. We hypothesize that domestic sheep have dispersed fragments of two lichen species from western Wyoming to grazed sites along the study transect. Generally, terricolous and epiphytic lichens differed between the lower and upper sites in species composition and growth-form distribution. Distribution of lichen growth forms was positively correlated with increasing rock cover. Late snowmelt areas were also distinguished by a defined group of lichens.

Introduction

There has been very limited research on the distribution and structure of tundra lichen communities. Creveld (1981) organized an extensive list of lichen species into 382 relévés and then arranged the relévés into vegetation types according to the Braun-Blanquet method of vegetation analysis. More recently Türk and Gärtner (2001) published a review paper examining biological soil crust communities in the subalpine and alpine habitats of the European Alps, including some information about lichens. Phytosociological studies of lichen communities in Greenland have also been published (Daniëls, 1982; Hansen, 1978), along with a more recent review paper concerning lichen-rich soil crusts (Hansen, 2001).

Knowledge about alpine lichens in the Western United States is limited and generally floristic in nature. Anderson (1964) published a comprehensive survey of the lichen genus *Lecidea* in Rocky Mountain National Park, Colorado; many of his collections were from true alpine tundra sites. Egan (1969) described the alpine lichen flora of Mount Audubon, Colorado, and later expanded his research to include three additional sites in New Mexico (Egan, 1971). Komárková (1979) published the results of an extensive phytosociological survey of the alpine zones of the Indian Peaks area of the Colorado Rocky Mountains, which included a comprehensive list of the lichen species. Flock (1976, 1978) evaluated the effects of snow cover and soil moisture on the distribution of lichens and bryophytes on Niwot Ridge in central Colorado. The only previous study dealing specifically with alpine lichens in Utah is a floristic survey of eight alpine tundra sites in central and eastern Utah that resulted in a list of 14 macrolichens (Imshaug, 1957).

More recently, research in alpine tundra zones in the Olympic Mountains of Washington has focused on the structural and functional attributes of lichen communities (Glew, 1997; Gold et al., 2001). Glew (1997) researched the effects of specific types of vascular plant communities on lichen community structure and observed that the structure of the epiphytic lichen community was directly related to the structure and composition of the vascular plant community. Glew (1997) also reported that specific types of vascular plant communities (e.g., krummholz and late snow) tended to support less diverse lichen communities, a phenomenon related to, either directly or indirectly, specific abiotic conditions (e.g., soil moisture, limited light, late-lying snow). Gold et al. (2001) examined several functional parameters of different kinds of alpine soil crust communities including a crust dominated by a thick layer of fruticose lichens. Compared to other sites in their study, soils at the lichen dominated site had the highest organic matter content, soil moisture, and concentrations of soil nitrogen and phosphorous. Although these studies have contributed significantly to our understanding of alpine tundra lichen communities in the Western United States, there is still a need for research that characterizes biotic and abiotic influences on the structure of alpine lichen communities.

Many of the alpine tundra areas of the Western United States having been extensively grazed since the mid to late 1800s (Marr, 1964); however, there have only been a limited number of studies investigating the impact of grazing, herding, and bedding of domestic animals on alpine tundra habitats (Johnson, 1962; Lewis, 1970; Paulsen, 1960; Smith and Johnson, 1965; Strasia et al., 1970; Thilenius, 1979). Data from these studies document the effects of domestic grazers on vascular plant vegetation, but lack any specific reference to lichens. In most cases, grazing-related damage to the vascular plant community was minimal except in bedding or watering areas or along driving trails (Thilenius, 1979). One study suggested that light to moderate grazing by sheep may even increase vascular plant cover (Strasia et al., 1970). It was also noted that grazing precipitated changes in the overall composition of the vascular plant community, with certain species increasing in abundance while others decreased slightly (Strasia et al., 1970). Similar reports are available for Arctic tundra areas where both

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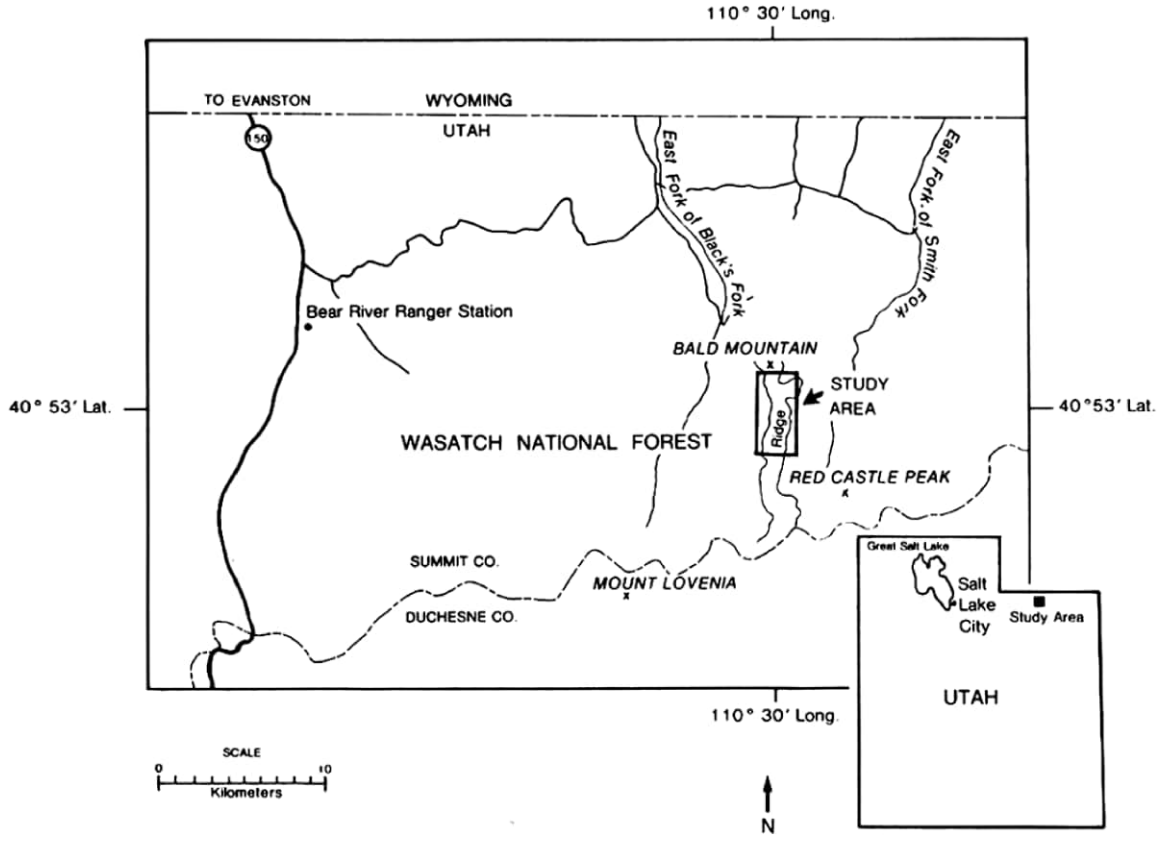


FIGURE 1. Map of study area in reference to the Wasatch National Forest and Bald Mountain. Inset shows location of study area in reference to the state of Utah.

domestic reindeer and wild caribou are the major grazers (Moser et al., 1979; Olofsson, 2006; Pegau, 1969, 1970; Polezhaev, 1980; Skuncke, 1969). These studies and others (Andreev, 1975; Utkin, 1974) show conclusively that when grazing animals are herded extensively, there are significant changes in both the lichen and vascular plant communities; specifically, the total lichen cover was reduced, some sensitive species were completely eliminated, and there was a proliferation of grass species (Olofsson, 2006; Polezhaev, 1980).

Several studies have examined the effects of trampling by humans, particularly along trails, on tundra landscapes (Bell and Bliss, 1973; Grabherr, 1982; Willard and Marr, 1970, 1971). These studies generally showed that tundra habitats are extremely sensitive to the effects of persistent trampling by human beings. Recovery of tundra landscapes following damage related to human activity was also shown to be extremely slow (Willard and Marr, 1971). Lichens, especially fruticose species, were noted to be particularly sensitive to human-related perturbations. Conversely, crustose and squamulose species on soil and rock substrates were generally less sensitive to human-related impacts (Willard and Marr, 1971).

The overall intent of our research was to obtain both quantitative and qualitative data for biotic and abiotic factors potentially influencing lichen community structure along an altitudinal gradient in the alpine tundra of the Uinta Mountains. We hypothesize that domesticated grazers (sheep) and vascular plant communities measurably influence the composition of alpine lichen communities. We further predict that abiotic factors such as soil chemistry, habitat rockiness, and snowmelt patterns also shape lichen community structure. This initial data set will be particularly crucial in light of the sensitivity of many lichens to various kinds of human-related perturbation compounded by the inherent vulnerability and slow recovery rates indicative of alpine tundra habitats.

Materials and Methods

SITE DESCRIPTION

The Uinta Mountains are located in northeastern Utah and northwestern Colorado. The north-south axis of the range averages between 48 and 65 km wide, whereas the east-west axis is approximately 240 km long. This study was conducted along an alpine tundra ridge that extends south of Bald Mountain and ranges from 3508 to 3938 m a.s.l. (Fig. 1). A transect, 4.5 km in length, consisting of 18 sites, was established along the ridge in 1983 (Fig. 2). The study transect was separated by vegetation type into three sections. The lower meadow sites (1–9) ranged between 3500 and 3600 m a.s.l. Sites 10–18 represented a gradient of increasing elevation from 3630 to 3880 m a.s.l. Sites 1–6, starting at the lower south-facing slope of Bald Mountain, consisted of an open alpine meadow dominated by *Carex rupestris* and *Geum rossii*. Sites 7–9 were located in a broken hummock area with *Carex rupestris*, *Geum rossii*, several *Salix* species, and some *Picea engelmannii*. Sites 10–18 were exposed, windswept, rocky areas with notably lower vascular plant cover. The upper sites were also dominated by *Carex rupestris* and *Geum rossii*, along with *Festuca ovina* and *Selaginella densa* as important subdominants.

FIELD METHODS

Lichen community structure was evaluated along gradients in elevation, vascular plant community composition and structure,

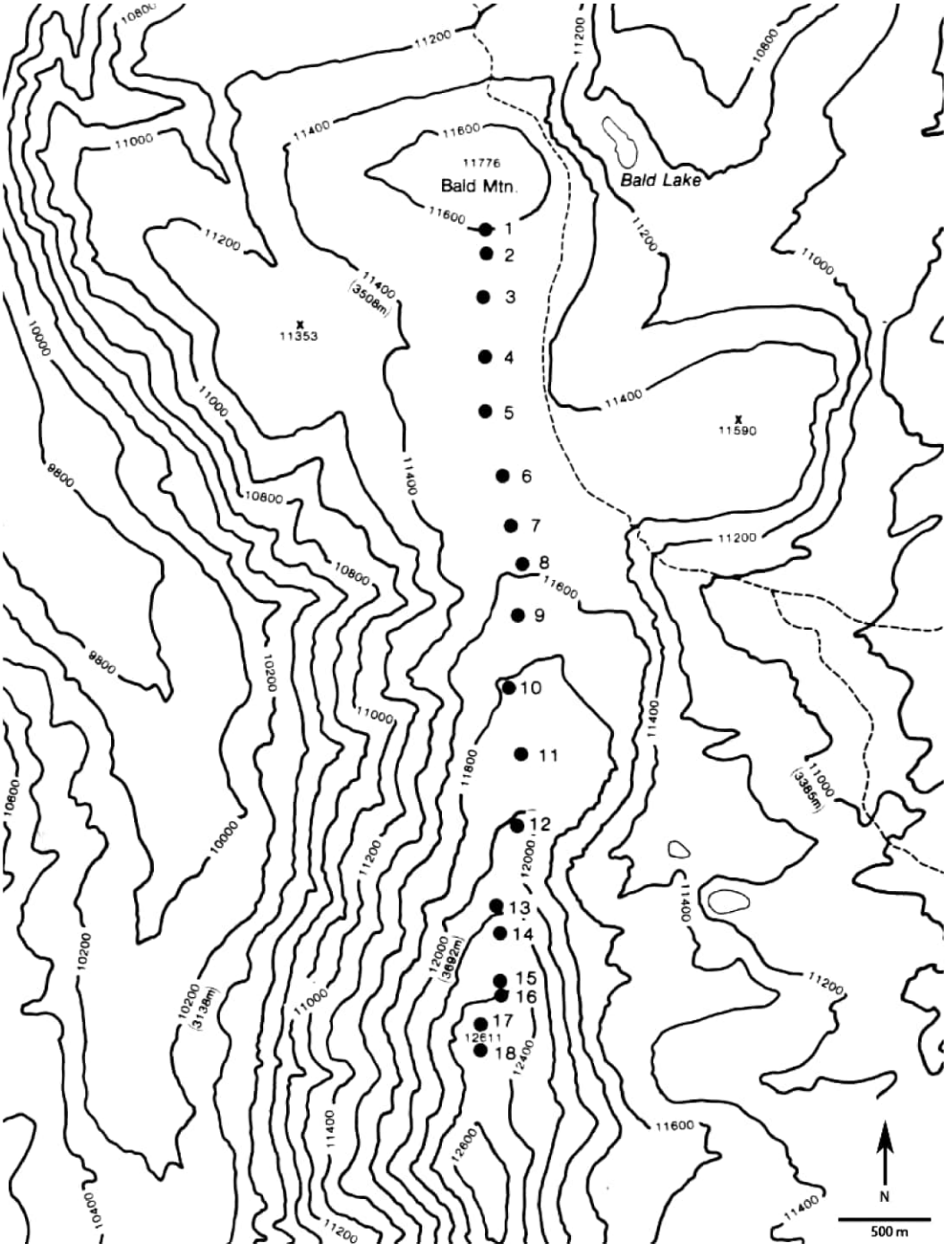


FIGURE 2. Detailed map of the study transect showing meadow sites (1–6), hummock sites (7–9), and rocky ridge sites (10–18). Talus slopes that provide barriers to grazing sheep are located between sites 9 and 10, as well as at sites 14 and 16. Contour interval is 200 m.

rockiness, snowmelt, various soil parameters, and grazing impact. The major vegetation types and physical features of the ridge were identified during the summer of 1982 after thorough examination of aerial photographs followed by detailed on-site investigations. A total of 18 distinctive areas were identified along the length of the ridge.

Following documentation of basic vascular plant community types and physical features along the study transect, permanently marked 10 × 10 m macroplots were established at each site. A random numbers table was used to locate ten 1 m^2 quadrats within each macroplot. A 0.25 m^2 square quadrat was then used to visually estimate percentage cover of lichens, vascular plant species, and rocks (large rocks with any dimension >10 cm in diameter and small rocks with all dimensions <10 cm in diameter) in one randomly identified quadrant of each square meter. Substrate notations were also made for all lichen species. General grazing effects by sheep were qualitatively estimated at each site on the basis of observed herding, grazing, and bedding patterns, a review of historical grazing allotments, and discussions with land managers and local sheep herders. Finally, snowmelt patterns along the study transect were documented using aerial photography. Photographs of the study transect were used to determine whether a site was snow free by the last week of May, June, July, or August of 1983; these data were then used to specifically evaluate lichen species distribution patterns as related to late snowmelt areas.

During the summers of 1980–1983 lichens and vascular plants were collected from each of the 18 transect sites. In addition, two surface (5 cm) soil samples were collected from each transect site for chemical and physical analysis of soil properties.

LABORATORY METHODS

Lichen and vascular plant specimens were processed in the laboratory, and voucher specimens were prepared. Secondary chemistry of lichens was determined using standard chemical spot tests (Huneck and Yoshimura, 1996; Orange et al., 2001). Thin-layer chromatography techniques (Culberson and Kristinsson, 1970; Culberson et al., 1981) were also used as needed to clarify lichen secondary chemistry for select species groups.

For species-level identifications, thin sections of lichen fruiting structures were prepared to determine ascospore size, shape, and color; number of spores per ascus; as well as the dimensions and characteristics of the various hymenial tissues. Voucher specimens of both lichens and vascular plants have been deposited in the Brigham Young University Herbarium.

A Utah Flora (Welsh et al., 2003) was used as the taxonomic authority for all vascular plant species. Lichen taxonomy was based on "A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada" (Esslinger, 1997).

All soil samples were analyzed for macronutrient concentrations and compositional properties using standard soil analysis procedures (Page, 1982). Calcium, magnesium, and potassium were extracted using a 1 N ammonium acetate solution. Phosphorus was extracted using a 0.2 N acetic acid solution, and total nitrogen was determined using standard Kjeldahl methods. Concentrations of nutrient elements were determined using atomic absorption techniques. Organic matter content was determined by wet oxidation using potassium dichromate (Page, 1982). Soil pH was measured using a saturated soil paste and a pH meter. The hydrometer method was used to determine soil particle size distribution and abundance (Page, 1982).

STATISTICAL METHODS

Transect sites were ordinated with respect to soil chemistry variables using the Multivariate Statistical Package (MVSP) statistical software. Centered, standardized Principal Components Analysis (PCA) was run with nine soil parameters for 17 sites (site 16 had no soil). Sites were clustered based on lichen species data. An unweighted pair-group method (UPGMA) was used to agglomeratively and heirarchically build the cluster based on Ruzicka's Similarity Coefficient (Ruzicka, 1958). Sites were additionally ordinated in MSVP with Canonical Correspondence Analysis (CCA), using lichen species data and soil chemistry data as species and environmental data files, respectively. Lichens occurring in at least 3 of the 18 sites were included in this analysis. Rare species were down-weighted. Niche overlap values for lichen species were determined following the method of Colwell and Futuyma (1971) and clustered following an UPGMA algorithm. Important Species Indices (ISI) were calculated for vascular plants and lichens using the methods of Warner and Harper (1972). Student's *t*-test for two independent samples was used to compare average percent lichen cover between the lower, grazed, meadow sites and the upper, ungrazed, rocky sites.

Results

ENVIRONMENTAL VARIATION AT THE SITE

The general pattern of snowmelt along the transect is likely consistent from year to year. In May only a few areas, none within the plots, were snow free. By the end of June, a number of areas in the higher elevation sites were snow free, whereas, the lower meadow sites were still under snow (Fig. 3). We attribute this pattern to the higher sites being windswept, while the lower sites are areas of snowdrift and accumulation. By the end of July, snow cover was patchy, but notably still present at site 9, and adjacent to sites 13 and 17. All sites were snow free by the end of August.

The higher elevation sites had significantly more large rock cover than the lower sites (Fig. 4). Sites 11–18 were especially rocky and included a talus slope site that had 100% rock cover (site 16). Among the lower meadow sites, site 1, located on the lower, southern slope of Bald Mountain, also had greater rock cover (Fig. 4). Decreasing vascular plant cover was associated with increasing rockiness in the upper portion of the transect (Fig. 4).

Based on physical characteristics, sites were divided into three groups: (1) meadows; (2) hummocks; and (3) rocky. Principal Components Analysis of nine soil variables (percent clay was eliminated as it was constrained by percent sand and silt) showed separation of some exceptional sites (17 and 15), but the remainder of the sites were not clearly separated based on groups or elevation (Fig. 5). Some of the meadow sites had higher silt concentrations (sites 3–6), but neither principal component axis separated these sites from the others.

The vascular plant community in the lower meadow sites was dominated by *Carex rupestris*, *Geum rossii*, *Festuca ovina*, and *Artemisia scopulorum*. The frequency of *Salix cascadensis* generally increased with increasing elevation. Another significant change in the vascular plant community, with increasing elevation, was the occurrence and increasing abundance of the cryptogam, *Selaginella densa* (Fig. 4). This low-growing vascular plant typically serves as an important substrate for a large number of lichen epiphytes. Other dominant vascular plants in the upper sites included *Draba cana*, *Paronychia pulvinata*, and *Lychnis apetala*.

Transect sites 1–5 had been continually grazed and often used as a bedding area for sheep since at least 1916, while sites 6–9 had only been lightly grazed, and sites10–18 had been essentially ungrazed (Zobell, personal communication). Furthermore, there is a talus slope that effectively separates sites 1–9 from sites 10–18. This talus area acts as a natural barrier to sheep movement, and only occasionally do sheep stray from the herd into the upper elevation sites above the talus slope (Redden, personal communication).

LICHEN SPECIES DISTRIBUTION PATTERNS

A total of 65 lichen species in 38 genera were identified from the study transect (Table 1). Dominant species included (in order of decreasing ISI—Important Species Indices) *Lecidea atrobrunnea* (ISI = 1.09), *Aspicilia calcarea* (0.90), *Umbilicaria virginis* (0.89), *Sporastatia testudinea* (0.88), *Lecanora thomsonii* (0.86), *Rhizocarpon geographicum* (0.39), *Lecidea auriculata* (0.35), *Xanthoria elegans* (0.26), and *Allocetraria madriporiformis* (0.26). There was a clear and marked increase in the abundance of lichens at the rockier sites, which were also higher in elevation and ungrazed (Fig. 6). Most of the lichens were crustose in growth form (37 species), with several foliose lichens (17 species). Fruticose (6 species) and squamulose (5 species) growth forms were much less

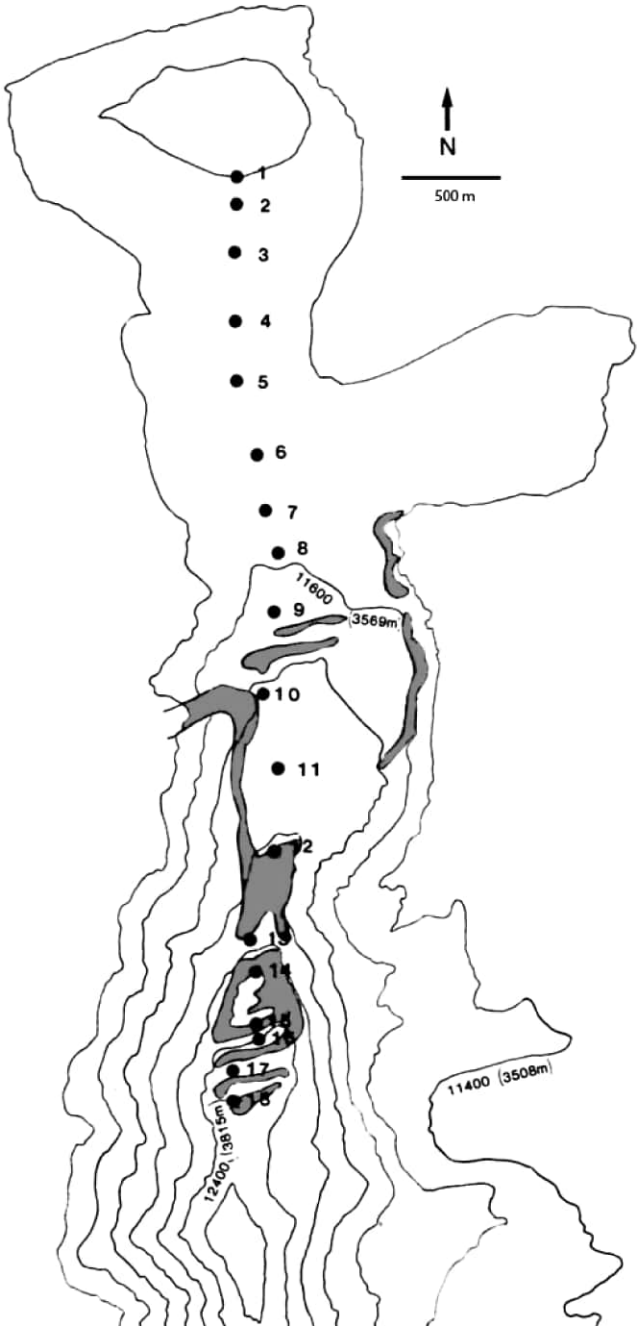


FIGURE 3. Transect map showing snow melt patterns as of the end of June 1983. Shaded areas represent snow-free locations. Contour interval is 200 m.

represented. Crustose lichens also had higher percent cover across all sites than all other growth forms combined, and showed a particularly marked increase in the upper, rocky sites (mean percent cover 14%). Foliose-umbilicate lichen species were restricted to the upper area.

Both the CCA analysis and cluster dendrogram of the study sites revealed two main clusters (lower sites, and higher sites plus site 8) and did not support separation of the lichen community into three distinct sub-communities as we saw with the vascular plants, but rather into two different communities separated by the talus slope between sites 9 and 10. The two analyses showed nearly identical topologies, with the same similar sites clustering together in both analyses. We show the CCA biplot (Fig. 7) because it shows the relationship of soil parameters. The relationship of soil parameters is highly similar to that in the soil chemistry PCA (Fig. 5); however, the sites separate more cleanly because of the addition of lichen species data. In the remainder of the analysis we will discuss the distinct communities in the context of the two areas (rocky upper sites, lower meadow sites). Total lichen cover was significantly ($t = 5.52$, $p < 0.0001$) higher in the upper, rocky sites (mean = 19.6%) than in the lower, meadow sites (mean = 6.0%).

The lichen cluster dendrogram, based on niche overlap measurements, revealed several lichen species associations (Fig. 8). We assigned these to categories based on characterizations of the sites given above. In the rocky upper sites there was a sharp contrast between those species that were terricolous and saxicolous. Another group was primarily associated with the meadow sites. Broad-ranging species occurred across the entire transect, while rare species were too rare to determine clear patterns of distribution. A few species appeared to be associated with late snowmelt (e.g., site 9). Many species were markedly more abundant in the rocky upper sites, including *Allocetraria madreporiformis*, *Aspicilia calcarea*, *Dimelaena oreina*, *Lecanora thomsonii*, *Lecidea atrobrunnea*, *Lecidea tessellata*, *Rhizocarpon geographicum*, *Sporastatia testudinea*, *Umbilicaria virginis*, *Xanthoparmelia cumberlandia*, and *Xanthoria elegans*. Not surprisingly, all but one of these taxa (*A. madreporiformis*) was saxicolous, and most were crustose (Table 1).

The grazed sites (1–5) had distinctly different groups of lichen species. Most of the terricolous lichens in this area were crustose or squamulose, with only one fruticose species (*Aspicilia hispida*) and three foliose species (*Cladonia* sp. 3, *Xanthoparmelia chlorochroa*, and *Peltigera rufescens*). The ungrazed/lightly grazed sites (with the exception of the late snowmelt site 9 and talus slope sites 14 and 16) had two fruticose, terricolous species: *Allocetraria madreporiformis* and *Cetraria aculeata*; and three foliose, terricolous species: *Cetraria ericitorum*, *Physconia muscigena*, and *Vulpicida tilesii*. Grazing activity was directly related to the lower elevation occurrence of the two vagrant species (*Aspicilia hispida* and *Xanthoparmelia chlorochora*), both of which were absent from the upper sites.

Epiphytic lichens were also less common at the grazed sites, but this is apparently related to the availability of suitable plant substrates. In particular, *Selaginella densa*, a common vascular plant substrate for epiphytic lichens in alpine tundra habitats, was consistently present in ungrazed or lightly grazed plots (Fig. 4), but absent in the lower sites. Only two epiphytic/humicolous lichens (*Caloplaca tiroliensis*, *Candelariella aurella*) were collected from the lower sites, whereas a total of nine epiphytic/humicolous lichens were collected from the upper sites.

Discussion

Data from this project demonstrated that lichen community distribution and structure are directly influenced by several factors, including domestic sheep grazing, degree of rockiness, nature of the vascular plant community, and snowmelt patterns. Grazing activity had a double impact on lichen community structure at the lower transect sites by ''adding'' new species while eliminating species sensitive to trampling. In contrast, soil data did not contribute to our understanding of lichen community distribution or structure.

The vagrant (unattached) lichen species *Aspicilia hispida* and *Xanthoparmelia chlorochroa*, found only at the heavily grazed and sheep bedding sites (1–5), are common components of short grass steppe and grazed shrub lands between 1500 and 2300 m in the

TABLE 1

Substrates on which lichens were found growing in this study included soil (S), pebbles and small rocks (P), large rocks (LR), and plants (E). Growth forms included crustose (Cr), fruticose (Fr), foliose (Fo), foliose with umbilicate attachment (Fo-um), and squamulose (Sq). The Important Species Indices (ISI) are calculated as frequency times mean percent cover. Mean percent cover for combined lower sites (1–9) and combined upper sites (10–18) is reported; a dash indicates that a species was not detected along that portion of the transect.

Species	Substrate	Growth form	ISI	Sites 1–9	Sites 10–18
Acarospora smaragdula	P, LR	Cr	0.03	0.18	<0.01
Acarospora sp.	P, LR	Cr	0.01	—	0.04
Allocetraria madreporiformis	S	Fr	0.26	0.19	0.87
Arthronia glebosa	S	Cr	0.01	0.05	—
Aspicilia calcarea	LR, P	Cr	0.90	0.47	1.42
Aspicilia hispida	S	Fr	0.02	0.12	—
Aspicilia sp.	LR, P	Cr	0.19	0.18	0.39
Brodoa oroarctica	LR	Fo	<0.01	—	<0.01
Caloplaca arenaria	P	Cr	0.02	0.09	—
Caloplaca epithallina	E	Cr	<0.01	—	0.04
Caloplaca jungermanniae	E	Cr	<0.01	<0.01	—
Caloplaca tiroliensis	E	Cr	0.02	<0.01	0.07
Calvitimela armeniaca	LR	Cr	0.02	—	0.12
Candelariella aurella	E	Cr	0.02	0.01	0.07
Candelariella rosulans	LR, P	Cr	0.15	0.17	0.17
Catapyrenium cinereum	S	Sq	0.09	0.22	0.06
Cetraria aculeata	S	Fr	0.05	0.09	0.22
Cetraria ericetorum	S	Fr	<0.01	<0.01	—
Cladonia sp. 1	S	Fo	0.11	0.41	0.01
Cladonia sp. 2	S, E	Fo	0.05	0.18	0.21
Cladonia sp. 3	S	Fo	0.11	0.81	—
Dimelaena oreina	LR	Cr	0.19	—	0.97
Evernia divaricata	S	Fr	0.01	—	0.09
Fulgensia bracteata	S	Cr	0.03	0.03	0.06
Lecanora argopholis	LR	Cr	0.01	0.12	—
Lecanora bicincta	LR	Cr	0.01	—	0.12
Lecanora epibryon	E	Cr	<0.01	0.01	<0.01
Lecanora hagenii	E	Cr	<0.01	—	<0.01
Lecanora marginata	LR	Cr	0.01	—	0.06
Lecanora polytropa	LR, P	Cr	0.08	0.20	0.05
Lecanora rupicola	LR	Cr	0.01	—	0.04
Lecanora thomsonii	LR	Cr	0.86	<0.01	2.89
Lecidea atrobrunnea	LR, P	Cr	1.09	0.78	2.44
Lecidea auriculata	LR, P	Cr	0.35	0.24	0.46
Lecidea tessellata	LR, P	Cr	0.18	0.07	0.49
Lecidea sp. 1	S	Cr	<0.01	<0.01	<0.01
Lecidea sp. 2	E	Cr	0.01	0.01	0.11
Lepraria vouauxii	S	Cr	<0.01	0.07	—
Megaspora verrucosa	E	Cr	<0.01	—	0.01
Melanelia tominii	LR	Fo	<0.01	—	0.02
Mycobilimbia berengeriana	S	Cr	<0.01	<0.01	—
Ochrolechia upsaliensis	E	Cr	0.02	0.10	0.06
Peltigera rufescens	S	Fo	0.02	0.13	<0.01
Phaeorrhiza nimbosa	S	Sq	<0.01	—	<0.01
Physcia sp.	LR	Fo	<0.01	<0.01	<0.01
Physconia muscigena	S	Fo	0.07	0.16	0.13
Placidium squamulosum	S	Sq	<0.01	<0.01	—
Protoparmelia badia	LR	Cr	<0.01	0.04	<0.01
Psora decipiens	S	Sq	<0.01	0.02	0.01
Psora luridella	S	Sq	<0.01	0.05	—
Pseudephebe minuscula	LR, P	Fr	0.01	—	0.13
Rhizocarpon disporum	LR, P	Cr	0.12	0.27	0.09
Rhizocarpon geographicum	LR, P	Cr	0.39	0.16	1.02
Rhizoplaca chrysoleuca	LR	Fo-um	<0.01	—	0.03
Rhizoplaca melanophthalma	LR, P	Fo-um	0.08	0.10	0.09
Solorina bispora	S	Fo	<0.01	—	<0.01
Sporastatia polyspora	P	Cr	<0.01	—	<0.01
Sporastatia testudinea	LR, P	Cr	0.88	<0.01	3.17
Staurothele drumondii	LR, P	Cr	0.02	0.07	0.02
Umbilicaria decussata	LR	Fo-um	<0.01	—	0.05

(continued)

TABLE 1

(continued)

Species	Substrate	Growth form	ISI	Sites 1–9	Sites 10–18
Umbilicaria virginis	LR	Fo-um	0.89	<0.01	2.90
Vulpicida tilesii	S	Fo	<0.01	0.02	0.01
Xanthoparmelia chlorochroa	S	Fo	<0.01	0.02	—
Xanthoparmelia cumberlandia	S, LR, P	Fo	0.15	0.03	0.57
Xanthoria elegans	LR, P	Fo	0.26	0.02	0.53
Mean percent lichen cover				6.01	19.57

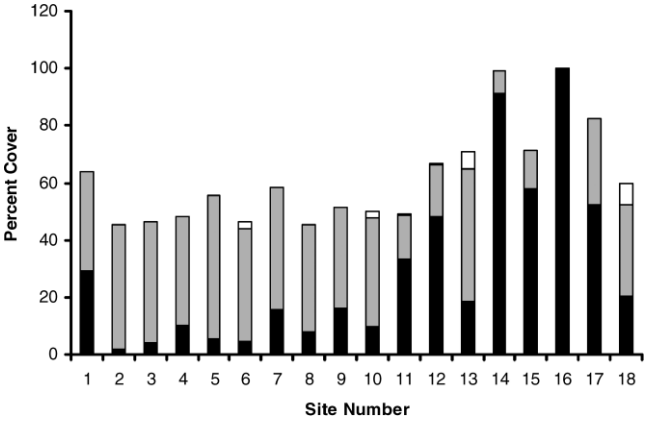


FIGURE 4. Rock cover (black), angiosperm cover (gray), and *Selaginella densa* cover (white) for all 18 sites. Remaining cover was in the categories of bare ground, plant litter, lichens, and mosses. Percent sum cover could exceed 100% in the instances where rocks were overtopped by lichens or angiosperms.

intermountain Western United States (Looman, 1964). Vagrant lichens typically associated with these habitats have been shown to be generally tolerant of grazing impact (MacCracken et al., 1983; Warren and Eldridge, 2001). Examination of the winter grazing sites (western Wyoming) for the Uinta sheep herds showed that both *Xanthoparmelia chlorochroa* and *Aspicilia hispida* were abundant in those locations. We hypothesize that during the grazing history of the Uinta sites unspecialized, small fragments of these two taxa have been transported from the winter range up to the grazed alpine tundra sites on the wool of sheep. In contrast, the more common tundra soil lichens, *Allocetraria madreporiformis*, *Cetraria aculeata*, *Cetraria ericetorum*, *Physconia muscigena*, and *Vulpicida tilesii*, were restricted to the ungrazed and lightly grazed portions of the transect because of their greater sensitivity to grazing (Olofsson, 2006). It has been reported that lichen growth form correlates with susceptibility to grazing impact with fruticose and foliose species generally more susceptible to grazing while crustose and squamulose species, with a much lower vertical profile, are not as impacted (Warren and Eldridge, 2001). The obvious exception to this pattern is the two ''introduced''

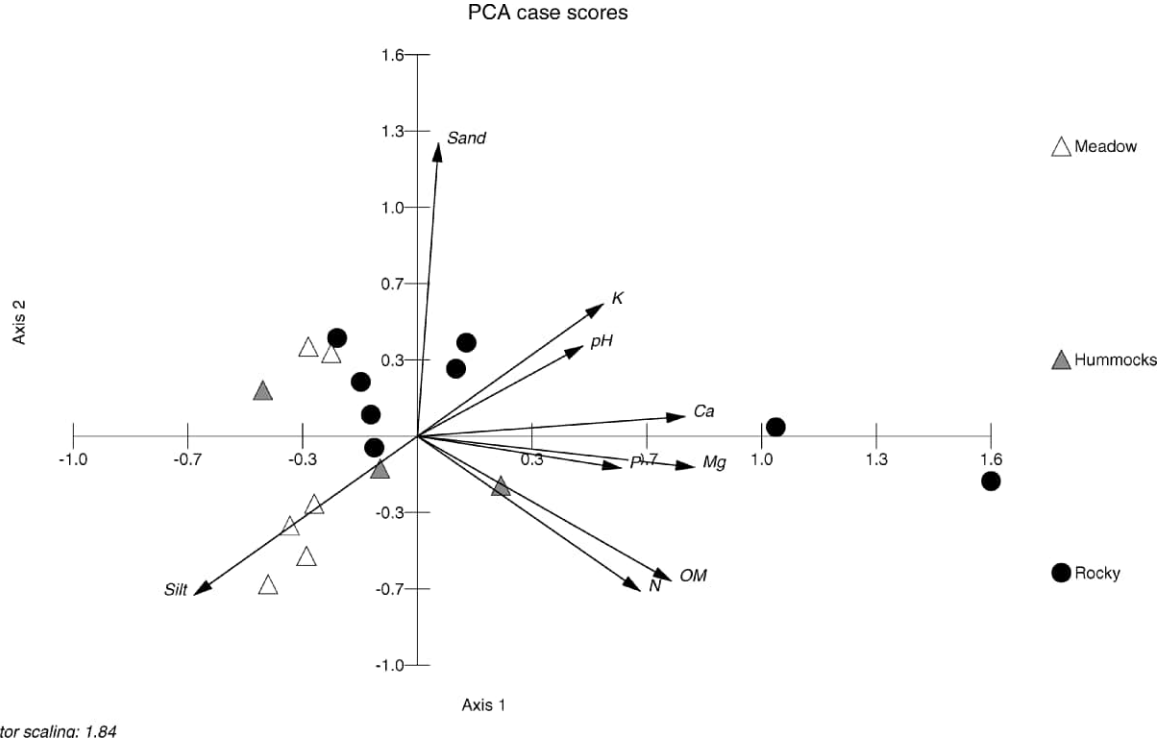


FIGURE 5. Euclidean biplot of centered and standardized Principal Components Analysis (PCA) of soil data. Eigenvalues were 53.2 and 20.0 for the first and second axes, respectively, and thus this figure explains 73.2% of the variability in the data. Meadow sites fall into two groups, the upper group contains sites 1 and 2, the lower group contains sites 3–6. The two outliers in the rocky sites (high positive values on PCA axis 1) are sites 17 and 15 (left to right). Note that the three areas are not separated into discrete groups on either axis.

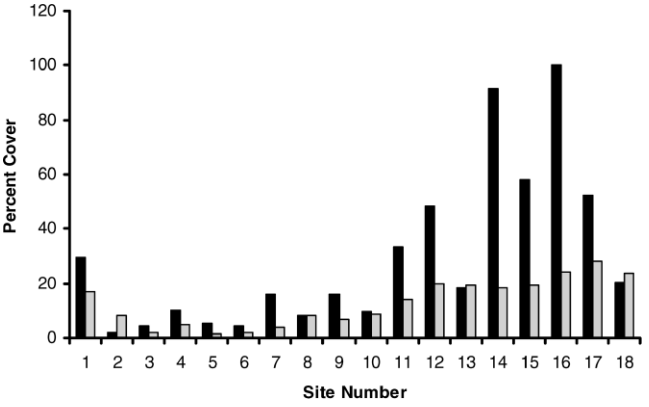


FIGURE 6. Relationship of rock cover (black bars) to lichen cover (gray bars) along the transect.

vagrants—*Xanthoparmelia chlorochroa* (foliose) and *Aspicilia hispida* (fruticose). However, unlike most other fruticose and foliose species, these two taxa are uniquely adapted to domestic grazing activity with sheep effectively fragmenting and dispersing both species (MacCracken et al., 1983). Interestingly, these two species reproduce almost exclusively by unspecialized thallus fragments with sexual reproduction rare to essentially nonexistent. Differences in lichen species and growth form patterns between the lower and upper sites further document the effects of domestic sheep on lichen communities. The potential sensitivity of the vascular plant *Selaginella densa* to grazing impact may also help to explain differences in lichen community structure between the upper and lower transect sites.

Observed differences in the number of epiphytic lichens between the lower and upper sites (2 and 9 species, respectively) appear to be directly related to the distribution of the low-growing vascular cryptogam *Selaginella densa*. This plant, which commonly supports a diverse group of epiphytic lichens, was absent from the lower elevation sites (1–5) but sporadically abundant at sites 6–19 (Fig. 4), thus accounting for the significant difference in the diversity of epiphytic lichens between the lower and upper sites. In alpine habitats, *Selaginella densa* typically occurs with other low-growing vascular plants on rocky ledges with thin soils (Welsh et al., 2003)—conditions uncharacteristic of the lower elevation sites.

Increasing lichen cover was also related to increasing rockiness with decreasing vascular plant cover and increasing elevation along the transect (Fig. 4). This pattern of increasing rockiness, especially larger rocks, was also associated with increasing lichen species diversity. Rocks are common lichen substrates, often supporting a diversity of species and growth forms. Specifically, higher percent cover and diversity of crustose and foliose-umbilicate species at the upper elevation sites were correlated with the increasing availability of rock surface area. The lichen cluster dendrogram, based on niche overlap measurements, further documented this pattern (Fig. 8), with species from the upper rocky sites clustering together (Group I) and the lower elevation meadow species grouping separately (Group II).

The lichen cluster dendrogram also showed a distinct cluster of late snowmelt lichen species (Group IV). Specifically, three species, *Psora decipiens*, *Rhizocarpon disporum*, and *Cladonia* sp., were consistently associated with late snow sites—a species pattern observed by the authors at other late-snow areas in the Western United States. Group III included a group of ubiquitous, broad-ranging species that occurred across the entire study transect. In contrast, Group V contained a group of rare species with very narrow distribution.

The similarity of the lichen community at site 1 (south-facing slope of Bald Mountain) to the upper elevation communities was generally related to the number of larger rocks at that site, which in turn supported a more diverse group of lichen species. Furthermore, higher lichen cover (16.7%) and similar growth-form distributions (more crustose species) also reflected the rockiness at that site in general and the abundance of larger rocks in particular (Fig. 6). However, the relatively smaller number of epiphytic lichens, and a soil community dominated by crustose and squamulose species suggested grazing impact and thus a closer fit with the rest of the lower elevation, grazed sites.

This research contributes to our understanding of how both biotic and abiotic factors influence lichen community distribution

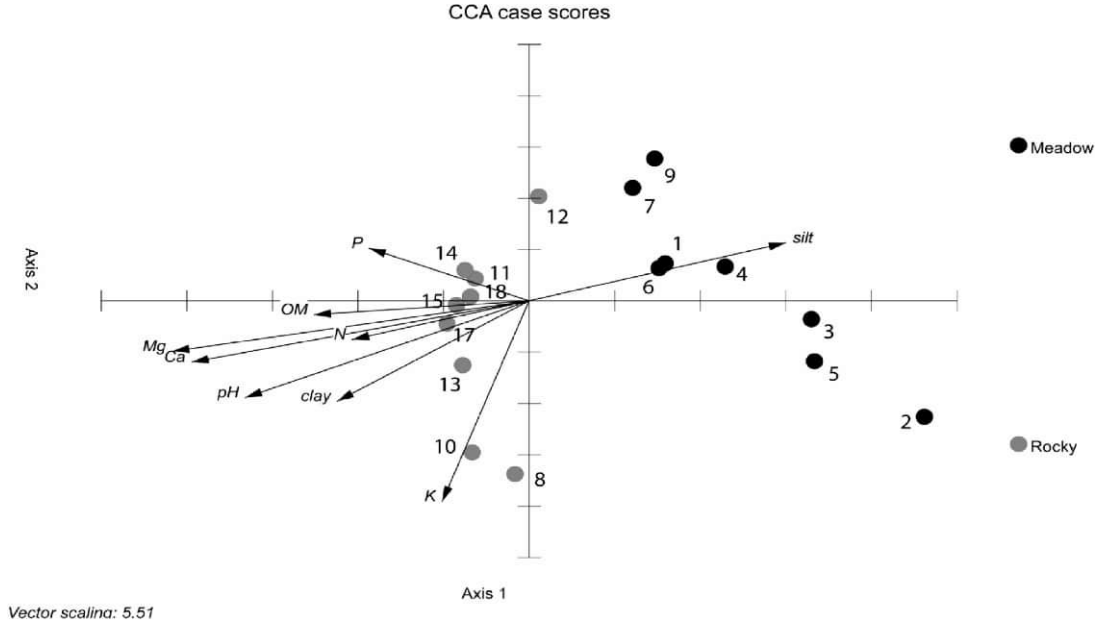


FIGURE 7. Canonical Correspondence Analysis (CCA) of lichen species data. The percentage of variation in the data explained by axis 1 and axis 2 was 26.4% and 12.3%, respectively.

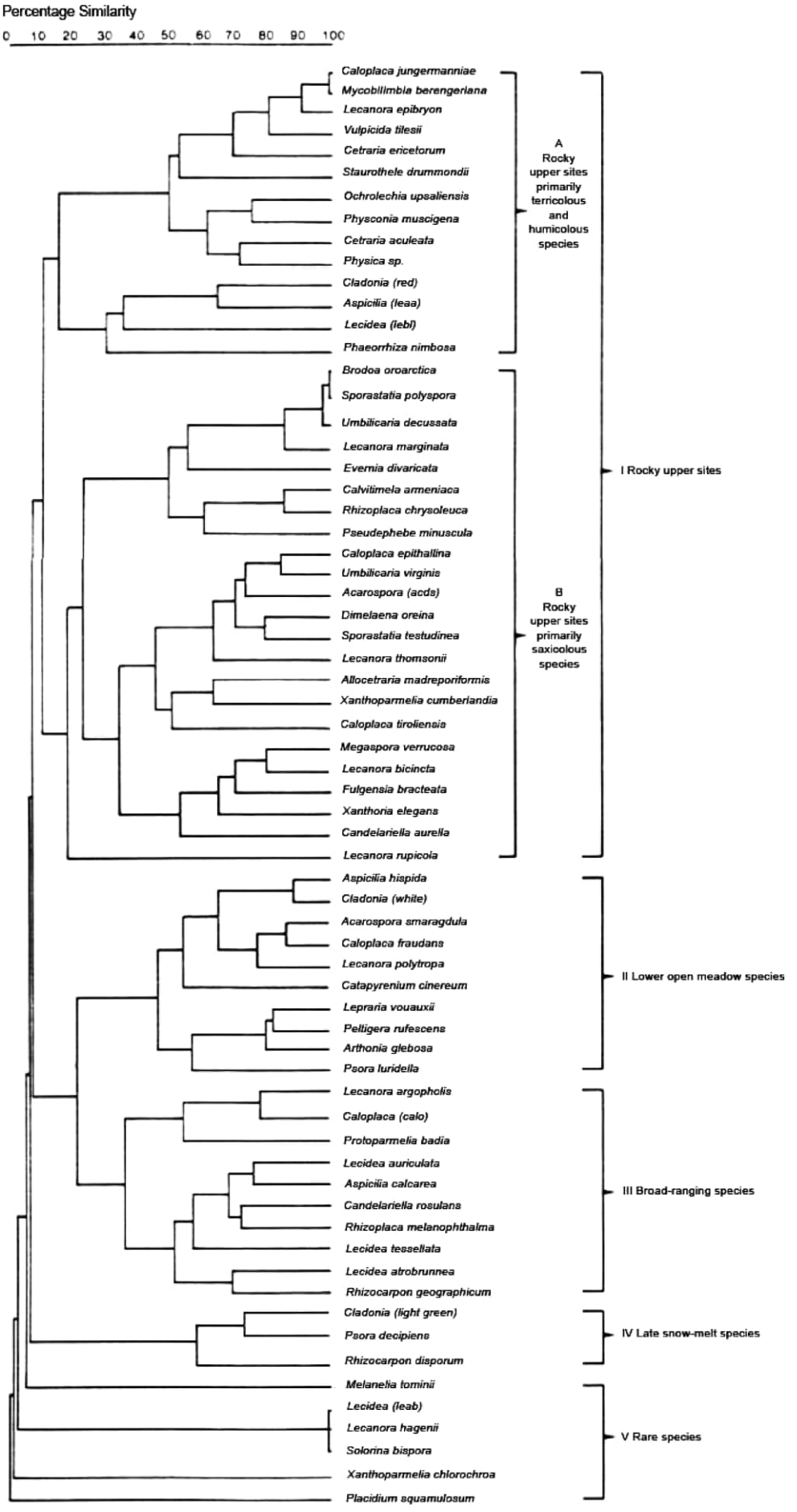


FIGURE 8. Cluster dendrogram of lichen species based on niche overlap values.

and structure in alpine tundra habitats. This information will prove particularly useful as we seek to restore and reclaim fragile, alpine tundra sites that have been historically impacted by human-related activity, such as grazing. Furthermore, these data will provide critical insights into the potential role of alpine tundra lichens as sensitive, early indicators of grazing impact on tundra ecosystems.

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Monitoring Domestic Sheep Energy Requirements and Habitat Selection on Summer Mountain Range Using Low-Cost GPS Collar Technology

Elizabeth M. Baum

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Science

Todd F. Robinson Chair
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Department of Plant and Wildlife Sciences

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ABSTRACT

Monitoring Domestic Sheep Energy Requirements and Habitat Selection on Summer Mountain Range Using Low-Cost GPS Collar Technology

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With the advent of global position system (GPS) collar technology, we have developed a much greater understanding of the temporal and spatial distribution of livestock and their associated grazing patterns. While significant research using GPS collars has been reported for cattle, little research is available describing collar use in understanding the behavior of domestic sheep. The purpose of our research was to evaluate the energy requirements of sheep with the use of GPS collars. To accomplish this, we adapted a low-cost i-gotU GPS tracking device that is typically designed for cattle and modified it to fit sheep. Each collar was programmed to record sheep movements within four grazing habitat types during different times of the year. Habitat typesincluded spring pasture (SP), spring low hill habitat (SH), summer mountain habitat (MH) and winter desert habitat (DH). We divided our research into two studies: 1) to track and compare energy expenditure of domestic sheep between four habitats using collars for recording sheep movements, and 2) to model summer mountain selection by sheep using the collar derived coordinate positions and environemtal variabls in an RSF model process. We hypothesized that there would more energy expended while out on desert habitat in comparison to other range habitats and sheep would select for sites on summer mountain habitat that were close to water, gentle in terrain, and higher in elevation. We used sheep energy equations to determine the energy requirement. Collar derived coordinates were used to measure the horizontal distance traveled on flat terrain or verticle distances both upslope and downhil across variable terrain. Our results found that total distance traveled was not different between SP, SH and MH at 6.7, 7.1 and 6.9 km/d, respectively, however, total movement was different ($P<0.05$) on DH at 10.5 km/d. Sheep movement was greater ($P<0.05$) on slopes (altitude change in 3m between waypoints) versus flat terrain (movement between waypoints >20m). For example, sheep spent 65% of movement on slope and 39% on flat movement for SH, 86% of movement was spent on slope and 16% on flat terrain for MH, and 89% of movement was spent on slope and 11% movement was on flat for DH. Total energy required between the four habitats was different ($P<0.05$) at 5.9, 8.6, 7.1 and 13.9 Mcal ME/d for SP, SH, MH and DH respectively. While on summer MH sheep avoided slopes and rugged terrain, but selected for sites close to water, northern facing aspects and areas higher in elevation. We found that sheep expend the most energy on DH and sheep on MH will select for gentle terrain, areas close to water, northern facing slopes, higher elevation and avoid slopes. With this insight, sheep managers can better meet energy requirements needs and understand habitat utilization of their flocks.

Keywords: Sheep, grazing habitat, habitat selection, GPS, energy

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CHAPTER 1

Monitoring the Energy Requirements of Sheep on Four Different Rangeland Habitats Using Low-Cost GPS Tracking Collars

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ABSTRACT

The movement and energy use of livestock, in particular sheep, can be used to better understand forage requirements, maintain healthy sheep herds, and promote ecological sustainability. GPS collars have been developed to monitor livestock movement, grazing patterns, and animal behavior across heterogeneous landscapes. Our research objectives are to effectively characterize the temporal and spatial movement, energy use, and distribution of sheep in relation to habitat type. To achieve this objective, we used a low-cost GPS tracking collar to record sheep movements and energy use while rotating between four different range habitat types. As sheep were moved between four different grazing habitats (spring pasture, SP; spring low hill habitat, SH; summer mountain habitat, MH and winter desert habitat, DH), environmental factors, distance traveled, vegetation intake, and stage of reproduction were used in energy equations to determine energy expenditure of sheep while out on each different range habitats. GPS derived coordinate locations were used to determine the distance traveled by sheep on flat surfaces or up and down hilly terrain. Total distance traveled was not different between SP, SH and MH at 6.7, 7.1 and 6.9 km/d respectively, but they were different ($P<0.05$) from DH at 10.5 km/d. Sheep movement was greater on sloped terrain (9 km/d) than on flat surfaces (1.22 km/d; $P<0.05$). Sheep spent 65% of movement on slope and 39% on flat movement for SH, 86% of movement was spent on slope and 16% on flat terrain for MH, and 89% of movement was

spent on slope and 11% movement was on flat for DH. Total energy required between the four habitats was different ($P<0.05$) at 5.9, 8.6, 7.1 and 13.9 Mcal ME/d for SP, SH, MH and DH, respectively. Three iterations of the i-gotU GPS collars were created in efforts to 1) improve issues with the jostling of the GPS unit components within the collar enclosure because of excess animal wear, 2) minimize moisture condensation and dust accumulation, and 3) improve battery life. We found that sheep expended most energy on DH, which was likely due to time spent searching for available forage. We found that the most effective GPS collar configuration had a larger memory, the i-gotU 600, which decreased joslting and improved ability to intake more waypoints and improved sealing, which kept at bay the moisture and dust. Battery life did continue to be an issue and still needs further investigation. This style of collar effectively recorded sheep movements and energy measuremnts by creating a cost-effective collar for sheep producers to utilize in order to better understand the temporal and spatial movements of their flocks. This information can be used in future research and management by informing managers while sheep are out on different range habitats and the amount of time spent on activity (i.e. movement on slope, movement on flat) has the most profound affect on energy expended. As well as grazing sheep out on DH has a tremendous drain on the energy requirements of sheep and may require additional supplements in the last trimester of gestation to assure healthy ewes coming off desert in preparation for lambing.

INTRODUCTION

Domestic sheep (*Ovis aries*) production is considered the oldest organized industry in the world (Aaron and Ely 2014; Chessa et al. 2009). Utilized for their meat, wool, and milk, sheep have long been favored for their multifaceted uses (Aaron and Ely 2014; Chessa et al. 2009).

Research has been conducted on maximizing the production of sheep through an improved understanding of their energy requirements (Cannas et al. 2004; Chessa et al. 2009). These requirements have been found to be significantly influenced by a number of factors including topography, weather, feed quality and reproductive stage (Cannas et al. 2004). These factors can now be taken into account when considering energy requirements with the aid of GPS tracking devices and maintenance equations (Bailey et al. 2017).

Recently, the advent and improvement of GPS tracking technology has been used to track both temporal and spatial grazing distribution and activity patterns of livestock (Anderson et al. 2012; Augustine and Derner 2013a; Bailey et al. 2017; Knight et al. 2018). Anderson et al. (2012) monitored the spatial distribution of free-ranging collared cattle to provide a greater understanding of how to better manage herds. Bailey et al. (2017) used GPS collars to evaluate cattle behavior, distribution patterns, and energy use to validate the possibilities of these findings being used in genetic selection.

Of the 5 million sheep being raised in the United states, 300,000 of those are in the state of Utah, ranking it 5th nationally (Utah Wool Growers Association 2017). Located in the Intermountain West of the United States, Utah's land is 80% rangeland that is too dry, rocky and mountainous for raising farm crops. Even in areas where cultivation is unsuitable, sheep can utilize plant biomass and convert that energy into profitable commodities (i.e. wool, milk, meat; Aaron and Ely 2014). These conditions favor a traditional system of rotating herds through different range habitats throughout the year due to the variation in climate, vegetation availability and terrain (Holechek 1983). While research has been published describing the energy requirements of sheep, the literature lacks information on the range of ewe energy expenditure as

they transition between different production stages and range (habitat) types (i.e. gestation and lactation; ecological sites).

There are three major contributors to energy expenditure in livestock: maintenance, environment, and stage of production (Cannas et al. 2004). A portion of maintenance is defined as activity spent on resting, locomotion (flat or sloped terrain) and grazing (Lachica et al. 1997). With the recent affordability of GPS tracking devices and the advances in tracking and distribution, GPS trackers are becoming more accessible to the public (Allan et al. 2013; Augustine and Derner 2013a; Karl and Sprinkle 2019). Therefore, maintenance can be closely monitored with the aid of GPS collars as it tracks the movements of livestock across a heterogenous landscape.

The second major contributor to energy expenditure is climatic conditions (i.e. wind, snow, rain) that negatively affect the homeostasis of sheep. These conditions play a major role in how metabolizable energy is used (NRC 2007). Even though the sheep are equipped with wool, wind and rain can greatly reduce the thermal regulation that wool provides for the animal (Cannas et al. 2004; Cottle and Pacheco 2017). The combined effects of cold temperatures, wind, and precipitation can increase the maintenance requirements up to three times (Cannas et al. 2004). Thus, thermal stress caused by extreme temperatures, wind and rain, negatively affects the profitability of sheep production due to increased maintenance requirements resulting in a reduction in total body weight gain and a decrease in the efficiency of feed utilization (Pluske et al. 2010).

The various reproductive stages a ewe undergoes throughout the year greatly impacts energy expenditure (ASI 1996). Early gestation takes place after breeding in the fall. As winter sets in, they enter mid to late gestation. Ranchers will then remove sheep from the desert range to begin

the lambing season. After ewes have lambed, they are placed in paddocks to allow for lamb and ewe to bond before being released out on range habitat to prevent ewes from losing lambs amongst the entire herd of ewes and lambs. During this time, ewes are beginning the early stages of lactation. After bonding time is allowed, ewes are placed out on spring lambing pastures. From the lambing pasture, ewes and lambs are moved initially to the spring low hills range for short-term grazing and then to the summer range where they remain throughout the summer. From gestation to lactation, each stage requires different amounts of energy in order to maintain homeostasis (ASI 1996; Cannas et al. 2004). For example, gestation requires greater amounts of energy towards the end of the gestational period, when the majority of foetal growth occurs in the final 60 days (Paganoni and Roberts 2018). As well as the energy requirements of lactating ewes is much higher than those of gestating ewes (Cannas et al. 2004). It becomes evident that in order to determine energy requirements of sheep, understanding the different stages of life and different habitats energy demands a ewe experiences throughout a year cycle, is imperative.

The purpose of our study was to characterize the movement of sheep and determine their energy requirements as they transition between different life stages and range habitats. To accomplish this, we equipped sheep with a GPS tracking device to monitor their movements and detect energy expenditure. We predicted their energy requirements would be different between the range habitats.

MATERIALS AND METHODS

GPS collars

The GPS collars were developed by modifying and adapting cattle collars described by Knight et al. (2018) to fit sheep. The collars were constructed using an enclosure (#BT2310 Polycase, Avon, OH, USA) attached to a 1" x 27" nylon dog collar using 73mm wide black Gorilla tape (Gorilla Glue, Inc, Cincinnati, OH, USA). An i-gotU GT-600 GPS unit (Mobile Action Technologies, New Taipei City, Taiwan) was modified by removing the back of the unit, leaving the electronic board in its case, and removing the internal battery at the battery terminals. The leads from a JST PH 2-pin 200mm male header cable (#3814 Adafruit, New York, NY, USA) were fed through a 0.5mm hole in the end of the enclosure and soldered to the leads from the GPS unit. The back of the GPS unit was then reattached. A 6600 mAh 3.7V lithium-ion battery pack (#353 Adafruit, New York, NY, USA) that has a JST PH 200mm 2-pin female header attaches to the GPS unit leads (see Fig. 1.3). The batteries were charged using a Sabrent 60 W 10 port charger (#HB-BU10, Sabrent, Los Angeles, CA, USA). The battery pack was also attached to the collar using Gorilla tape. With the GPS unit and battery attached, both were wrapped twice using 44mm duct tape (Shuretape Technologies, Avon, OH, USA; Fig. 1.2).

The GPS unit was programmed to collect waypoints every 5 minutes. At the end of the collection period the collars were removed from the ewes and the GPS unit removed from the enclosure. The data was downloaded using @Trip software (Mobile Action Technologies, New Taipei City, Taiwan) then exported as a csv file. The data file was inspected and waypoints that were out of the grazing perimeter were removed along with movement values greater than 72 m/minute (Agostinho et al. 2012). As an example of waypoint numbers, most data files had approximately 27,327 GPS waypoints recorded from each collar.

Sheep flock

A commercial sheep flock consisting of Rambouillet crossbreed white-face ewes (600 ewes; 4.2±0.9 years of age) was used as the basis for this study. Collars were attached to the ewes prior to the flock being moved to individual grazing habitat and then removed when the sampling period was complete. Sheep flocks were moved sequentionally through the four different grazing habitats which included spring pasture (SP), spring low hills (SH), summer mountain habitat (MH), and winter desert habitat (DH).

Spring pasture

Two weeks post-lambing the ewes and lambs were moved from the lambing pens through three pastures (SP) from mid- April to the end of May 2020 near Fountain Green, Utah, USA. The first pasture (39.67°, -111.643° N, 39.615°, -111.641° E), consisted of 15 acres at an elevation of 1,779 m (Fig. 1.3). The second pasture (39.666°, -111.674° N, 39.662°, -111.660° E) consisted of 61 acres at an elevation of 1,920 m (Fig. 1.3). The third pasture (39.666°, -111.661° N, 39.651°, -111.646°) was 80 acres at 1,880 m elevation (Fig. 1.3). The vegetation was similar between pastures and consisted predominantly of alfalfa (*Medicago sativa*), Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Pascopyrum smithii*), and bluebunch wheatgrass (*Pseudoroegneria spicata*). The climate was characterized by cool summer temperatures (20°C mean air temperature) and cold winters (-4°C mean air temperature) with an annual precipitation of 38 cm. Average annual temperature ranged from 15 to 20°C during the summer and -5 to -3°C during the Winter (PRISM 2004).

Spring low hills

From the early spring pasture, the sheep were moved to a 3,000-acre private allotment on spring low hills habitat (SH) for June 2020 (39.705°, -111.590° N, 39.686°, -111.559° E; Fig.1.4). Elevation ranged from 2,150 to 2,506 m with hilly terrain. Ungulates on the property

that could potentially compete with sheep included elk *(Cervus canadensis)* and mule deer *(Odocoileus hemionus)*. Vegetation included bluebunch wheatgrass, Indian ricegrass (*Achnatherum hymenoides*), antelope bitterbrush (*Purshia tridentata*), Wyoming big sagebrush (*Atremisia tridentata ssp wyomingensis*), Utah juniper (*Juniperus osteosperma),* and two-needle pinyon (*Pinus edulis).* The climate was characterized by cool summer temperature (15°C mean air temperature) and cold winter temperature (-4°C mean air temperature) with annual precipitation of 53 cm. Average annual temperature ranged from 13 to 18°C during the summer and -4 to -2°C during the winter (PRISM 2004).

Summer mountain habitat

From July to September 2020 the sheep were moved to mountain habitat (MH) near Scofield Reservoir (39.91°, -111.16° N, 39.88°, -111.12° E; Utah County, UT, USA) on 2,500 acres (Fig. 1.5). Elevation ranged from 2,191 to 2,550m with open meadows climbing to mountain ridges. Ungulates on the property that could potentially compete with sheep included elk and mule deer. Vegetation included quaking aspen *(Populus tremuloides),* subalpine fir *(Abies lasiocarpa),* gambel oak *(Quercus gambelii),* Wyoming big sagebrush, Utah serviceberry *(Amelanchier utahensis*), bluebunch wheatgrass*,* timothy grass *(Phleum pratense)* and broom snakeweed *(Gutierrezia sarothrae)* found in the open meadows. The climate was characterized by cool summer temperatures (15°C mean air temperature) and cold winters (-5°C mean air temperature) with annual precipitation of 50 cm. Average annual temperature ranged from 43 to 70°C during the summer and -11 to 1°C during the winter (PRISM 2004).

Winter desert habitat

From late December to late February 2020-2021, the sheep were grazing on BLM winter desert habitat (DH) located in the western desert of Utah (39.62°, -113.41° N, 39.45°, -113.33°

E) covering approximately 35,000 acres (Fig. 1.5). Elevation ranged from 1,400 to 1,700 m with open hilly terrain. Vegetation included, Indian ricegrass, squirreltail *(Elymus elymoides),* bud sagebrush *(Picrothamnus desertorum)*, shadscale saltbush *(Atriplex confertifolia)*, broom snakeweed, winterfat *(Krascheninnikovia lanata),* black sagebrush *(Artemisia nova),* and Utah juniper dotting the landscape. The climate was characterized by warm summers (24°C mean air temperature) and cold winters (-1°C mean air temperature). Average annual temperature ranged from 19 to 24°C during the summer and -1 to 1°C during the winter with annual precipitation of 22 cm (PRISM 2004).

Energy determination

The energy requirement of the sheep was calculated based on the environmental factors, habitat type, and lifestage. A weather station (Davis 6152C) was placed on each of the habitats to provide temperature, wind, and rain environmental measurements in order to calculate cold stress factors. Energy requirement was determined using equations from NRC (2007), Cannas et al. (2004) and Tedeschi and Fox (2020a and 2020b).

Equation 1

$$ME_m = ([SBW^{0.75} * a1 * S * a2 * \exp(-0.03 * AGE)] + (0.09 * MEI * k_m) + ACT + NE_{msc} + UREA) / k_m$$

Where,

SBW = shrunk body weight (96% of body weight (FBW; kg))

$a1 = 0.062$ Mcal $* NE_m / kg^{0.75}$

S = multiplier for gender; 1 for ewes and wethers, 1.15 for rams

a2 = effects of previous months temperature; 1 + 0.09 * (20 – (previous month temperature))

AGE = years 1 to 6

MEI = ME intake; Mcal/d

k_m = efficiency constant; 0.644

Equation 2

ACT = activity; (0.00062 * FBW * flat distance (km) + 0.00669 * FBW * slope distance (km)

Equation 3

NE_{msc} = cold stress, SA * (LCT – Current Temp) * k_m / IN

SA = 0.09 * $SBW^{0.75}$

LCT = 39 + E * EI – IN * HE / SA

HE = MEI – (RE + NEpr + NElr)

IN = TI (1 – 0.3 * (1 – exp(-1.5 * rf / WD)) * EI

EI = [(1.759 - 0.0707 * wind (km/hr) + 0.6095 * wool (cm)) * MUD * hide] * 0.239.

Urea = cost of excreting N as urea; [(g ruminal N balance – g recycled N + g excess N from MP)

* 0.0073] * k_m

Equation 4

NE_{preg} = 36.9644 * exp[-11.465 * exp(-0.00643 * t) – 0.00643 – t] * (LBW/4)

Where,

LBW = birth weight of lambs combined

$ME_{preg} = NE_{preg} / 0.13$

Equation 5

$Ne_l = [(251.73 + 89.64 * MF + 37.85 * (MP / 0.95) * 0.001 * MY] / k_m$

Where,

MF = milk fat %

MP = milk protein %

MY = milk yield kg/d

Vegetation sampling

Vegetation samples were taken at every site to determine nutrient content. 100m transects were randomly placed throughout the habitat sites. A 1-square meter hoop was placed every 10 meters along the transect, alternating sides, and all vegetation within the hoop was clipped and placed into paper bags, stored in a freezer until all samples were collected. The number of transects per site was determined by area of habitat and vegetation type present. All vegetation samples were taken out of freezer and separated by site and type (i.e., forb, grass, shrub) and sent to DairyOne forage laboratory for a wet chemistry nutrient analysis for dry matter (DM), crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), and metabolizable energy (ME) content analysis (DairyOne Forage Laboratory, Ithaca, NY, USA).

Data analysis

Latitude and longitude data were converted to UTM coordinates. UTM coordinates were then used to calculate distance traveled (m) between waypoints. GPS altitude differences were used to determine slope movement. Slope movement was counted as any increase or decrease of 3 m or more. The distance traveled on flat surfaces compared to slopd terrain was used to calculate activity (ACT; see equation 2). Energy requirement was determined for each ewe using the information collected. For each habitat, total energy required was calculated as the sum of NE_m, NE_{preg} and NE_l. Each habitat energy requirement was the addition of these three NE amounts depending on the life stage of the ewes while on each habitat; SP NEm + Nel, SH NEm + Nel, MH NEm + Nel and DH NEm + NEpreg.

Statistical analysis was conducted with the proc Mixed module in SAS (2002). Fixed main effects included habitat and day, while animal was random to account for repeated measures. Least square means for habitat were determined to be significant at $P<0.05$. Habitat main effect comparisons were analyzed and expressed as least square means.

RESULTS

Collar Data Collection

Collars placed on ewes on the SP and SH habitats resulted in two of the 6 collars not collecting data, one did not record any data and the other recorded 6 days. The units where data was downloaded ranged from 30 to 49 days of GPS waypoints. Average time difference between the waypoints was 5.0±2.7 minutes. Five of the six units deployed on the SH provided data. One

unit did not collect waypoints. Twenty-seven to sixty-seven days of waypoints were collected from the five collars. Average time difference for waypoints for SH was 9.3±6.8 minutes. Because the percentage of collars deployed to provide data was less than desirable for SP, SH and MH, ten collars were deployed on the DH, of which, data was downloaded from nine collars. The tenth collar did collect waypoints, but the battery power ran out on day 3. Waypoints were collected between thirty-seven and fifty-nine days. The average time difference between waypoints for DH was 8.7±4.5 minutes.

Forage Measurements

Habitat forage samples are presented in Table 1.1. Forage types from each site were combined to provide grass, forbs and browse values. SP habitat contained majority of grasses such as Kentucky bluegrass mixed with few forbs. SH habitat was located on uncultivated higher hilly country containing bluebunch wheatgrass, Indian ricegrass, antelope bitterbrush and Wyoming big sagebrush MH contained stands of mix forested fir trees, maples, and aspen stands, with meadows of slender wheatgrass (*Elymus trachycaulus*), saline wildrye, timothy grass, broom snakeweed, and mountain sagebrush. DH vegetation included, Indian ricegrass, squirreltail, bud sagebrush, shadscale saltbush broom snakeweed, winterfat, and black sagebrush. Percent of each forage type consumed came from Taylor Jr (1994) for each habitat. The total ME consumed was based on the percentage of forage type multiplied by the ME of each type.

Movement, Distribution, and Energy Use

GPS files were downloaded were waypoints were divided into 24-hr periods. Latitude and longitude values were converted to Universal Transverse Mercator (UTM). Distance traveled between waypoints was determined using the UTM. The total movement was calculated and divided into slope or flat movement totals based on altimiter values. For each day, the Mcal ME

was determined using values found in Table 1.2. The total ME was calculated with the addition of net energy of gestation (NE_{gest})and net energy of lactation (NE_l) to maintenance (NE_m). Weight and flock average age were provided by the owner of the flock. Environmental values were collected from the weather station that was placed at each habitat site. Milk values are table values from the NRC (2007).

Spring pasture (SP) sheep movement collected by the GPS collars is presented in Table 1.3. Since SP was flat, slope movement was not determined. There were differences ($P<0.05$) between the three SP pastures for total movement and ME. Between the three pastures, there were differences ($P<0.05$), where the 15-acre (P1) was 4.85 km, the 61-acre (P2) was 7.09 km and the 80-acre was 12.02 km (P3; Table 1.3). Maintenance Mcal/d was different ($P<0.05$) at 5.09, 5.23 and 5.54 for P1, P2 and P3 respectively. Adding NE_l to NE_m total ME was different ($P<0.05$) at 5.77, 5.90 and 6.22 Mcal/d.

Comparing the four habitats, DH total movement was different ($P<0.05$) from the other three, with no other difference noted among the other habitat sites. Personal observation by the herder, and corroborated by the data, the first four days the sheep were on DH, they moved more (between 2.5 and 3 km) than the rest of the time on the habitat. Slope movement was different ($P<0.05$) across the four habitats with SP at 0.0 because the habitat was flat (Table 1.4). Flat movement was highest at 6.7 km/d ($P<0.05$) on SP compared to 2.8 km/d for SH and both different from MH and DH at 1.1 and 1.2 km/d, respectively. Percent of movement up and down slopes was different ($P<0.05$) across all treatments, ranging from 0.0 for SP to 88.7% for DH. Flat percent was inverse to slope %.

The ACT value ranged from 0.27 to 4.5 Mcal ME/d with all habitats being different ($P<0.05$; Table 1.3). Metabolizable energy was different ($P<0.05$) between the treatments, ranging from

5.2 for SP to 13.6 Mcal ME/d for DH. Adding gestation or lactation NE increased ($P<0.05$) the total ME/d requirement for SP at 5.9 and DH at 13.9 Mcal ME/d, SH was 8.6 and MH at 7.1 Mcal ME/d.

DISCUSSION

We found the amount of time sheep spent moving across rangelands took a large toll on the amount of energy expended between each range habitat. While there has been research observing the activity and movement patterns of sheep, little research exists documenting differences in activity patterns across multiple diverse rangeland habitats during different seasons (Clapperton 1964a; Squires 1974; Warren and Mysterud 1991). Squires (1974), documented sheep distribution in Australia where temperatures ranged from 32-38°C, sheep averaged 14 to 18 km/d on hot summer range habitat. We found our sheep moved between 7 to 11 km/d on summer habitat where temperatures were not so servere. This could be due to the fact sheep in Australia spent more time walking to water sources to stay hydrated. SP had relatively flat ground with 0% of movement spent on slopes, there was an increase in movement as sheep were transferred to increasingly larger pastures (Fig. 1.3). We concluded the increase in movement was correlated to increase in size of pasture. This has also been observed in a study by Clapperton (1964b) where sheep kept in larger pastures moved greater distances than sheep in smaller pastures. P3 showed the greatest amount of movement (12.02 km) and was also the largest pasture. We also observed this on DH where the greatest total movement between range habitats took place on the largest allotment (35,000 acres). Though the pastures were similar in forage make-up, P3 biomass was less in comparison to P1 and P2, therefore possibly causing sheep to continusouly moving for

forage consumption. These factors all could have contributed to the greatest movement occurring on P3 before they were taken up to SH. The total ACT of SP (0.27) accounted for only 5% of the total metabolizable energy expended. We attribute this to the easy terrain and readily available grasses and forbs. Sheep on the SP therefore did not need to as much time searching for forage and terrain allowed for easy movement.

SH, MH, and DH contained minimal movement on flat but majority of movement on slopes. Lachica et al. (1997) found net energy cost of slope movement is higher than for movement on flat terrain due to energy expended to work against gravity. This is congruent with our findings that all habitats that contained higher percentages of slope movement, required more energy to be expended (Table 1.4). A study conducted on mountain winter range in New Mexico found that sheep utilized slopes less than 45°, and slopes 50-75° decreased the utilization further (McDaniel and Tiedeman 1981). This is important to note that sheep will utilize slopes less when slope steepness increases. Though SH and MH had slopped terrain and steeper mountain sides when compared to the topography of DH, metabolizable energy was less on SH and MH in comparison to that of DH due to more slope movement taking place on DH. During mid to late summer while sheep were on SH and MH, forage was abundant and readily available, therefore sheep spent less time moving in search of food. Whereas sheep on DH, when snow was present, had to spend more time foraging to meet energy requirements needs and therefore possible utilizing unfavorable terrain in search of forage to meet energy requirement intake moving 10.5 km/d.

We found that movement on slope profoundly affected the amount of energy expended between range habitats. McDaniel and Tiedeman (1981) also showed sheep utilized sites located on tops of ridges. A similar observation was made in a study by Bowns (1971) who observed

range sheep in Northern Utah preferred to utilize higher elevation sites for safer bedding grounds and sought valley bottoms to graze during the day. In the forests of Norway, Warren and Mysterud (1991) reported sheep moving uphill at night for resting and predator protection. We found sheep utilized slopes on all habitats that contained hilly terrain. As slope movement increased, the total metabolizable energy also increased (Table 1.4). SP contained 0 % slope movement and required only 5.9 Mcal/d in comparison to SH, MH, which showed no difference in total movement from SP, but did show a difference in increased slope movement which resulted in higher metabolizable energy expended in both habitats (Table 1.4). This was also observed in our results as the energy expended on slopes was the greatest on DH and resulted in highest total metabolizable energy being expended on DH (13.87 Mcal/d). The difference between the readily available grass on SP to the sparce DH vegetation resulted in the sheep moving approximately 4 km/d more. The increase in movement on DH was movement up and down hilly terrain. The Mcal ME associated with DH slope movement accounts for 88.4% of the ACT ME, with ACT NE accounting for 33% of total ME required per day. Whereas the ACT for SP accounted for 5% of total daily ME required. Comparing the four habitats and knowing the impact slope movement has on energy requirement, SP would have the lower requirement even though the ewe's lactation requirement was included. Spring low hill and MH, on a percentage, have more inclines requiring the sheep to move up and down the terrain even with more readily available forage present. This in comparison to sheep on DH spending more time in search of vegetation across hilly terrain and therefore expended more energy.

From previous research we were able to adapt existing GPS units used in cattle research to create a low-cost GPS tracker for sheep movement. instead of cattle. Augustine and Derner (2013b) studied grazing patterns in cattle by combining Lotek 3300LR GPS collars with activity

sensors that recorded up and down and side-to-side movements of the head, to classify if the animal is grazing versus, traveling, bedding, or resting. They found rather than simply quantifying the distribution of cattle, they were able to examine foraging distribution. From this we can see the potential GPS collars have in improving understanding of animal behavior. Knight et al. (2018) created a low-cost alternative to the Lotek 3300 GPS tracking collar using the i-gotU GT-120 GPS tracking collar and compared the performances of both. He discovered there was no difference for slope, location, and distance to water, but distance traveled was lower for Knight collars than for Lotek collars. Karl and Sprinkle (2019) developed a "commercial off-the-shelf (COTS) electronic components," low-cost GPS unit and compared it to the Knight collar for accuracy. Both studies proved it possible to manufacture low-cost GPS tracking devices that best facilitate tracking more domestic animals in a herd for short durations of time. By adapting the Knight et al. (2018) i-gotU configuration to sheep we were able to track the movements of sheep across diverse landscapes to understand their energy expenditure between ranges.

CONCLUSION AND MANAGEMENT IMPLICATION

With the use of GPS trackers, our predictions were confirmed that sheep grazing the four different habitats did affect energy requirement of the sheep. Energy requirement was greatly affected by the amount of time spent moving on hilly and sloped terrain. Activity had the greatest impact on total energy requirement between habitats. When compared to the other four habitats, SH, MH and DH had movement on slope resulting in higher amounts of Mcals/d. The total movement traveled was the greatest on DH, due to the lack of readily accessible and

palatable forage on the DH. Sheep consequenctly spent greater amounts of energy searching for food which possibly caused them to utilize more sloped terrain.

Due to the tremendous drain on energy requirements of the ewe while grazing on winter desert habitat in Utah, we advise additional supplements be given to sheep in their last trimester of gestation to assure healthy ewes coming off the desert and preparing for lambing and lactation. Energy supplementation is most useful under conditions of drought or heavy snow (Holechek and Herbel 1986). Due to the recent drought in the western United States, rangelands are struggling to provide enough forage for flocks and as a result, less animals have been allowed to graze. With challenging forage conditions, ewes are also challenged with energy demands imposed by the growing lamb in utero. Producers are highly advised to supplement ewes diet with grain during the last 4 weeks of gestation (ASI 1996). By offering energy supplments on DH before lambing, milk production can be maximized as well as heavier lambs born resulting in higher prices during fall lamb sale (ASI 1996).

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FIGURES

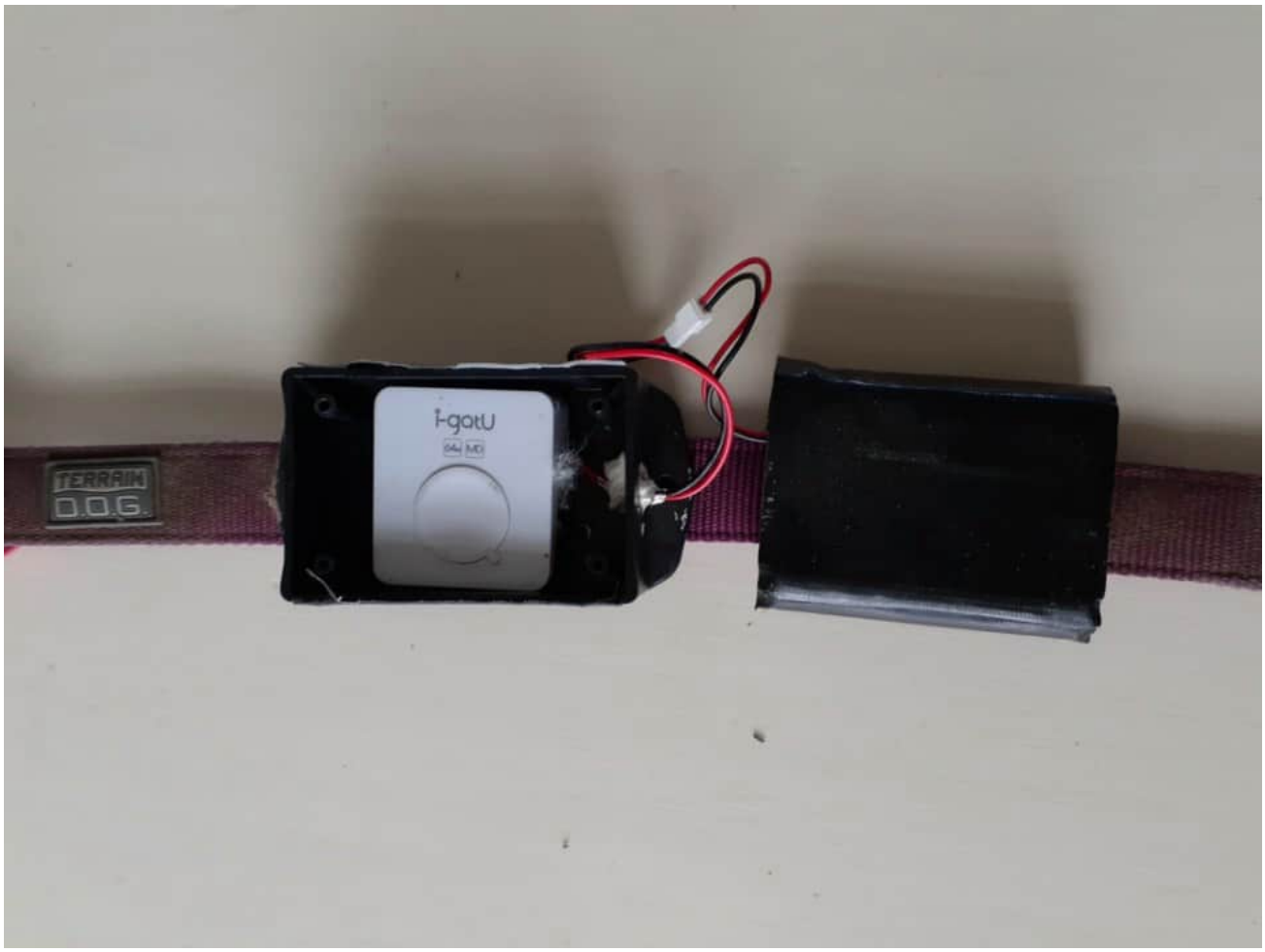
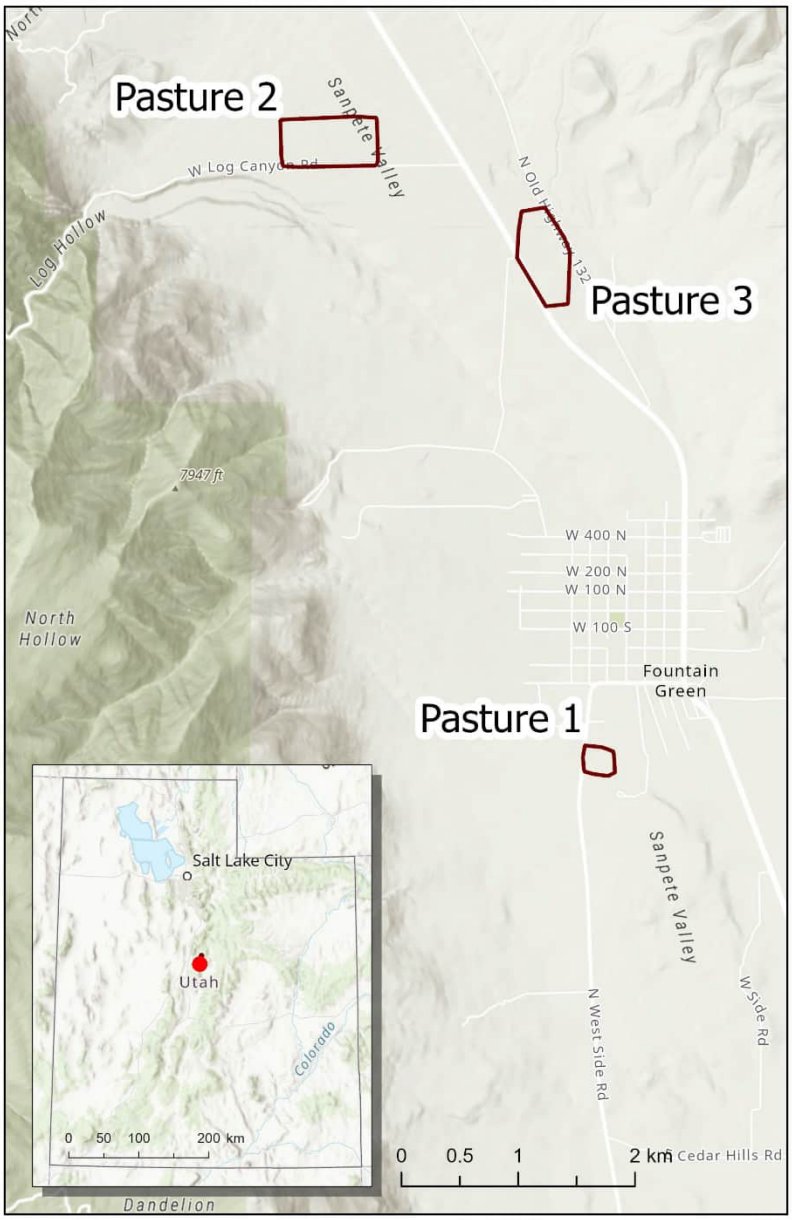


Figure 1.1 Constructed collars with i-gotU GT-600 powered by a 6600 mAh lithium battery



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Figure 1.2 Spring pastures. First pasture (P1) (39.617°, -111.643° N, 39.615°, -111.641° E), second pasture (P2) (39.666°, -111.674° N, 39.662°, -111.660° E), third pasture (P3) (39.666°, -111.661° N, 39.651°, -111.646°). Pastures surround Fountain Green, UT. Cultivated land covered mostly with Kentucky bluegrass and alfalfa.

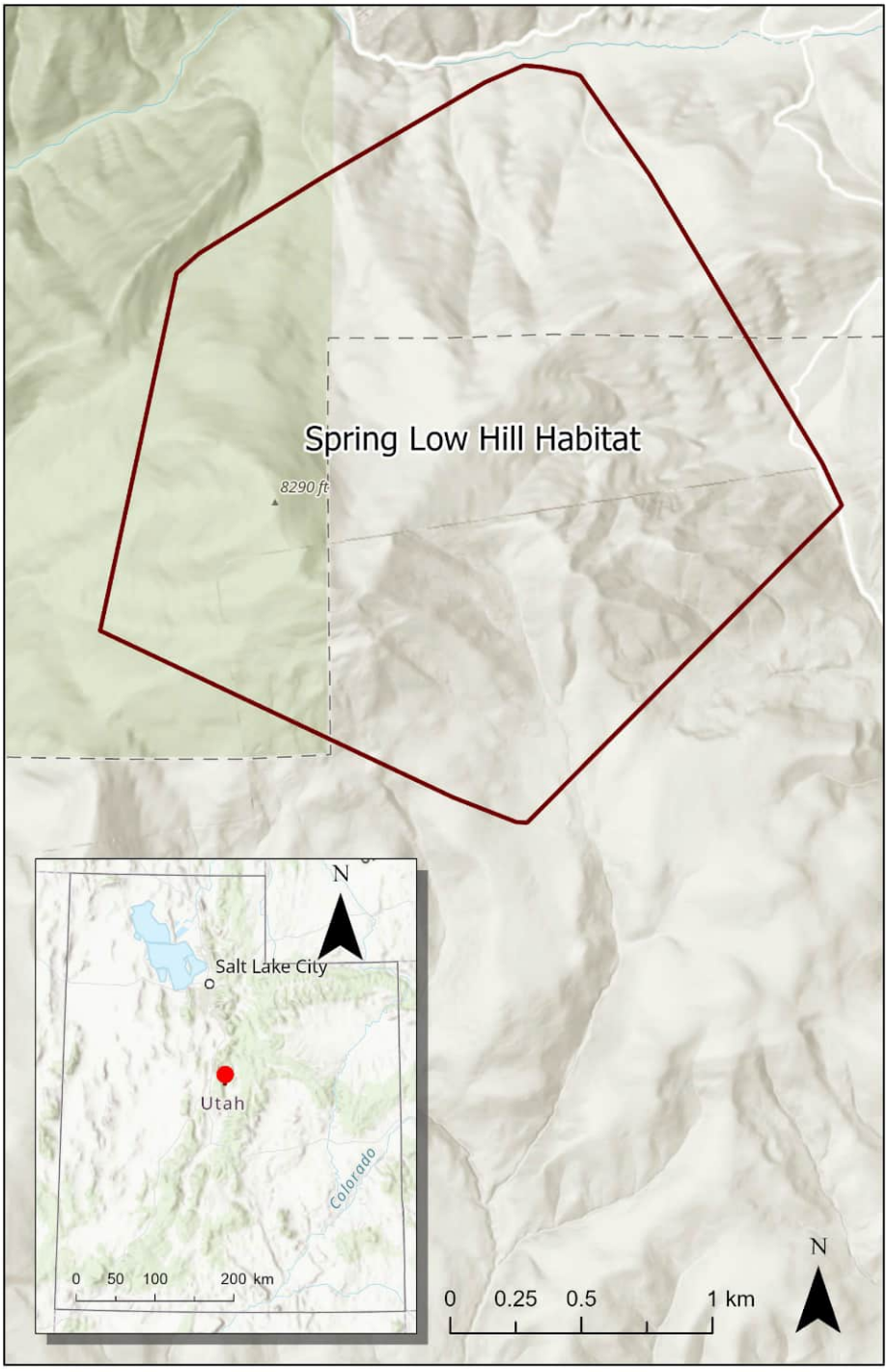


Figure 1.3 Spring low hill pastures (SH) (39.705°, -111.590° N, 39.686°, -111.559° E) located Northeast of Fountain Green, UT. Vegtation includes: scrub oak, Utah juniper, mountain big sagebrush, and indian rice grass.

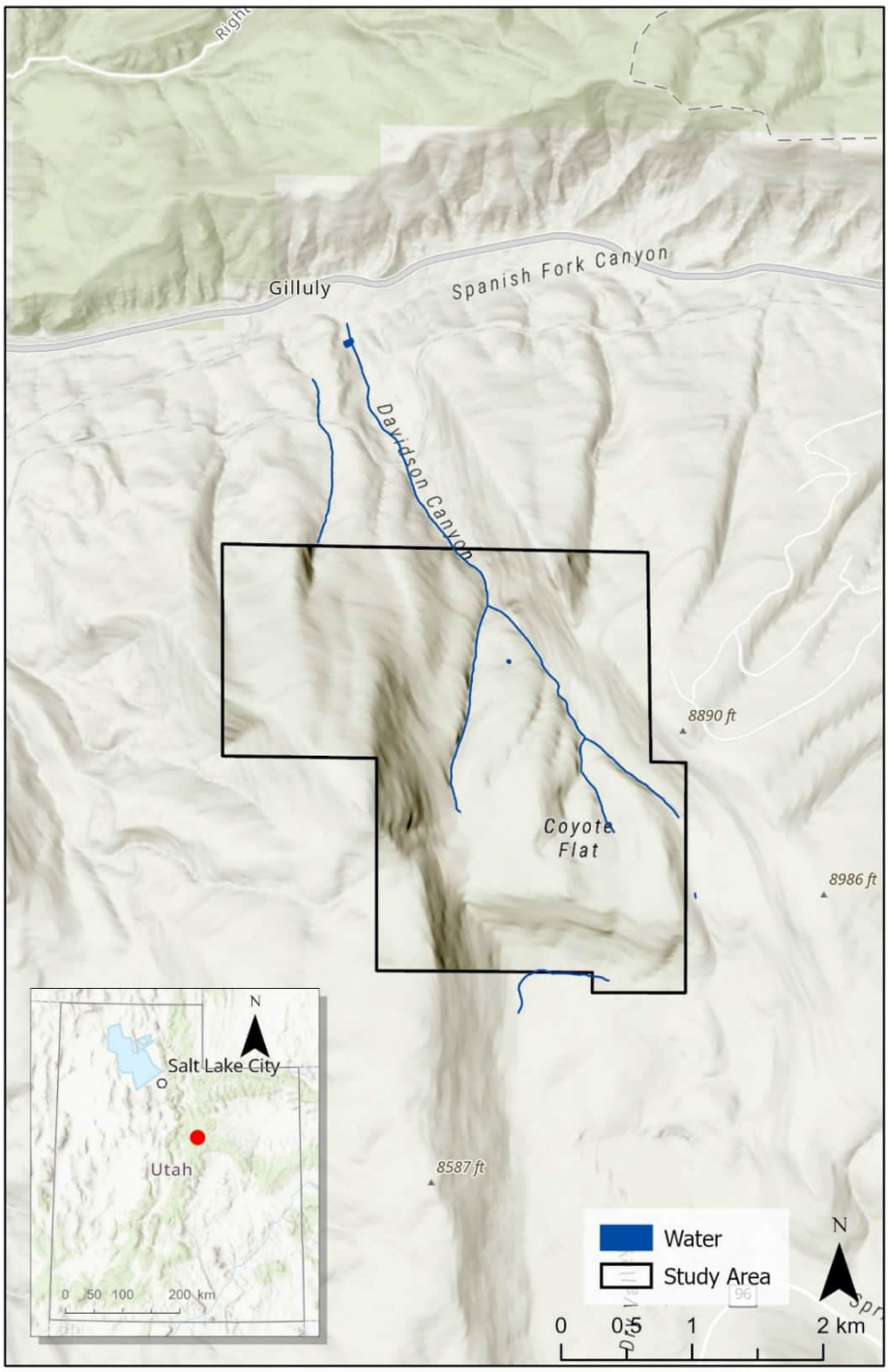


Figure 1.4 Mountain summer range (39.91°, -111.16° N, 39.88°, -111.12° E) located North of Scofield reservoir. Vegetation includes: mountain big sagebrush, aspen, gambel oak, broom snake weed, and Indian rice grass.

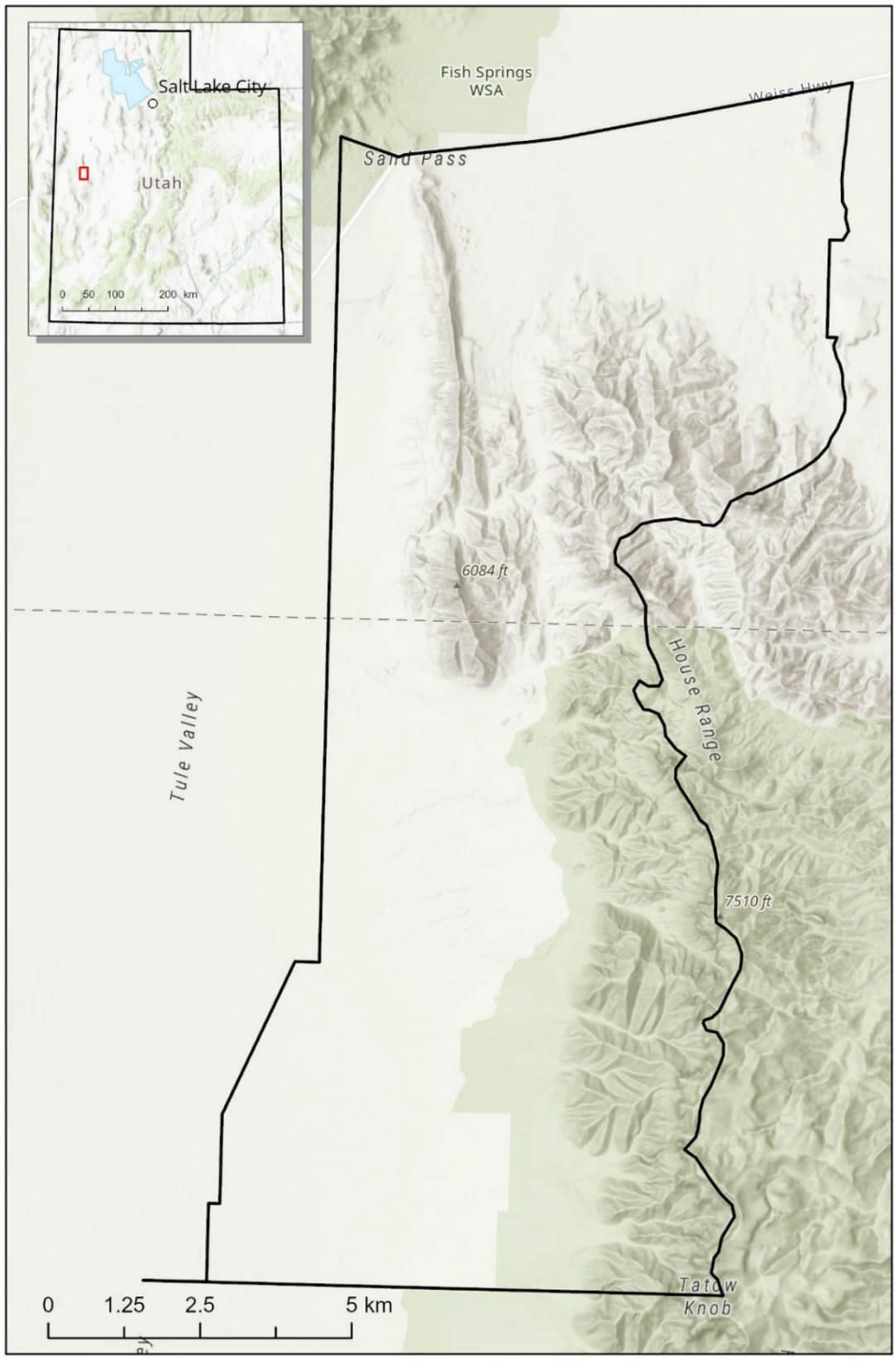


Figure 1.5 Winter Desert Range (39.62°, -113.41° N, 39.45°, -113.33° E) located in on BLM land in the West deserts of Utah. Vegetation includes: shadscale saltbush, bud sagebrush, black sagebrush, winterfat, indian ricegrass and Utah juniper.

TABLES

Table 1.1 Forage analysis of feeds on each grazing habitat

	DM, %	CP, %	NDF, %	ADF, %	NFC, %	ME, Mcal/kg
Spring pasture, SP						
Grass	47.1	12.5	51.1	36.1	26.7	2.42
Forbs	47.9	24.0	27.1	20.1	38.4	2.68
Spring low hills, SH						
Grass	45.9	9.0	55.6	31.9	25.7	2.32
Forbs	39.3	11.3	46.9	36.7	21.4	2.23
Browse	68.3	9.9	36.9	28.5	42.7	2.33
Mountain, MH						
Grass	83.9	6.5	66.1	42.8	18.2	1.99
Forbs	73.5	9.6	32.5	25.7	47.5	2.39
Browse	69.8	9.9	32.3	25.2	47.4	2.40
Winter desert, DH						
Grass	87.1	5.4	75.0	50.1	10.5	1.88
Forbs	84.6	5.6	64.2	52.1	20.9	2.00
Browse	64.0	8.5	50.3	41.8	30.8	2.15

Table 1.2 Input values for energy equations

	Grazing Habitat[a]			
	SP	SH	MH	DH
Weight, kg	66	66	69	70
Age, years	4.2	4.2	4.2	4.2
ADG, g/d	40	40	40	40
Previous Temp	6	12	16	4
Current Temp	12	16	13 (9.9)	-0.6
Rain, mm	0	2	0	0.25
Wind, km/h	8.0	3.1	3.3	5.9
Wool Depth, mm	12	14	20	51
Milk yield, l/d	1.7	0.75	0.25	0.0
Milk fat, %	2.85	2.85	2.85	0.0
Milk protein, %	2.53	2.53	2.53	0.0

[a]Sp = spring pasture, SH = spring low hill habitat, MH = mountain habitat, DH = winter desert habitat.

Table 1.3 Movement and energy requirements of ewes on spring lambing pastures (SP) of different sizes.

	Pasture[a]			
	P1	P2	P3	SEM
Total movement, km	4.85[e]	7.09[f]	12.02[g]	0.22
ACT, ME Mcal/d[b]	0.20[e]	0.28[f]	0.49[g]	0.01
NE_m, Mcal/d[c]	5.09[e]	5.23[f]	5.54[g]	0.01
Total ME, Mcal/d[d]	5.77[e]	5.90[f]	6.22[g]	0.01

[a]Pasture P1 = 15 acres, P2 = 61 acres, P3 = 80 acres.
[b]ACT= distances traveled on slopes and flat surfaces.
[c]$NE_m = ([SBW^{0.75} * a1 * S * a2 * \exp(-0.03 * AGE)] + (0.09 * MEI * k_m) + ACT + NE_{msc} + UREA) / k_m$
[d]Total ME = $NE_m + NE_l$.
[efg]Rows values with differing superscripts differ at $P<0.05$.

Table 1.4 Energy requirements needed for each grazing habitat.

	Grazing Habitat[a]				
	SP	SH	MH	DH	SEM
Total movement, km	6.66^{f}	7.09^{f}	6.89^{f}	10.52^{g}	0.19
Slope movement, km	0.00^{f}	4.46^{g}	5.91^{h}	9.30^{i}	0.14
Flat movement, km	6.66^{h}	2.82^{g}	1.12^{f}	1.22^{f}	0.14
Slope %[b]	0.0^{f}	64.7^{g}	85.6^{h}	88.7^{i}	0.92
Flat %[b]	100^{i}	38.7^{h}	16.3^{g}	11.3^{f}	1.07
ACT, ME Mcal/d[c]	0.27^{f}	2.06^{g}	2.76^{f}	4.49^{i}	0.07
NE_m, Mcal/d[d]	5.20^{f}	7.91^{h}	6.92^{g}	13.55^{i}	0.11
Total ME, Mcal/d[e]	5.88^{f}	8.59^{h}	7.08^{g}	13.87^{i}	0.11

[a]Sp = spring pasture, SH = spring low hill habitat, MH = mountain habitat, DH = winter desert habitat.

[b]Percent of total movement on slope or flat terrain.

[c]ACT= distances traveled on slopes and flat surfaces

[d]$NE_m = ([SBW^{0.75} * a1 * S * a2 * \exp(-0.03 * AGE)] + (0.09 * MEI * k_m) + ACT + NE_{msc} + UREA) / k_m$

[e]Total ME = $NE_m + NE_{preg} + NE_l$.

[fghi]Rows values with differing superscripts differ at $P<0.05$.

CHAPTER 2

Resource Selection of Domestic Sheep on Mountainous Summer Pasture

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ABSTRACT

Past research has documented livestock grazing patterns and dynamics across pastoral landscapes. We used domestic sheep locations derived from coorniate positions obtained from GPS collars to study sheep habitat selection on summer mountain habitat North of Scofield Reservoir Utah, USA. Data was collection between the months of July to September, 2020. We developed a resource selection function (RSF) model to determine the influence of slope, distance to water, aspect, ruggedness, elevation, and vegetation types on sheep habitat selection while grazing on summer mountain habitat. We found sheep selected for sites closer to water, with more gentle terrain, higher in elevation and north-facing slopes. Vegetation types were less reliable due to the lack of species composition information and the possibility of sheep being herded to avoid areas of overuse. Although it is often assumed that sheep utilize slopes more than their heavier and larger cattle counterparts, they overall tended to avoid steep slopes compared to all other predictor variables. While remaining in relatively close proximity to water, seeking high elevation sites with gentle terrain and on north-facing slopes, this information regarding sheep summer grazing selection can be used to improve livestock management practices including flock management that increasessheep foraging patterns and energy effeciciency.

INTRODUCTION

Effective livestock management requires an understanding of the temporal and spatial distribution of livestock on pastoral landscapes (Liao et al. 2018). Factors that affect the distribution of livestock include both abiotic factors (i.e. slope, ruggedness, elevation, aspect, distance to water) and biotic factors (i.e. vegetation types; Bailey et al. 1996; Cook 1966; Senft et al. 1987; Squires 1974; Warren and Mysterud 1991). The selection for or against these factors can determine the temporal and spatial distribution of livestock across a heterogenous landscape. By understanding habitat selection by livestock, managers can better meet the resource needs and energy requirements of their animals.

Several studies have identified general relationships between domestic sheep (*Ovis aries*) foraging patterns and habitat characteristics (i.e. ruggedness of terrain, steepness of slope, availability of water). For instance, grazing can be influenced by both distance of vegetation from water and steepness of slope (Bailey et al. 1996; Senft et al. 1987; Squires 1974). Squires (1974) found that the highest grazing use and foraging patterns of Merino in Australia were less than 0.8km from water. Beyond this distance individual plants that remained ungrazed were significantly higher (Squires 1974). The distribution of livestock, in particular cattle, is limited by the steepness of the slope and unevenness of the terrain (Cook 1966; Mueggler 1965; Patton 1971). McDaniel and Tiedeman (1981) found sheep on mountain winter range in New Mexico, utilized slopes less than 45%, but utilization was reduced by 50-75% on steeper slopes. They discovered sheep normally utilize sites located on tops of ridges and tops of upper slopes before descending to the valley floor. Bowns (1971) found that an unherded flock of range sheep in

Northern Utah, USA preferred to bed on higher elevation terrain at night and sought valley bottoms to graze during the day. This behavior is congruent with moving and resting behavior of sheep in the coniferous forests of Norway where Warren and Mysterud (1991) reported sheep moving uphill at night for resting and sleeping on higher ground where they gain protection from predators. Abiotic factors such as slope, elevation, and distance to water have a major impact on the distribution and habitat selection of sheep.

Biotic factors, including the availability and quality of forage have been shown to affect sheep grazing distribution patterns (Bailey et al. 1996; Senft et al. 1987). Sheep are intermediate feeders which suggests they have a high capacity to adjust their feeding habits to meet forage availability to meet their energy and nutrient intake requirements (Holechek 1984). In the Intermountain West, sheep are considered the best adapted of all ungulate species at meeting their requirement needs due to their foraging adaptability, by utilizing the available forage resources (i.e. grasses, forbs, shrubs) and plant communities they come in contact with (Holechek 1984). In a recent study conducted on two separate range ewe herds in Wyoming, Scasta et al. (2020) found that sheep grazing on different allotments at different elevations, experienced shifts in diet selection and forage preference. A herd grazing at 1829-2438 m had a diet made up of 51% grass and 31% forbs while the other herd grazing at 2438-3048 m had a diet made up of 42% forbs, 14% shrubs and 13% grasses. Similar studies have also indicated that sheep diets are more varied than that of cattle, and when nonspecific diet is available, sheep will sustain a mixed diet of forbs, grasses, and shrubs (Grant et al. 1985; Parsons et al. 1994). It is reasonable to conclude that the diet of sheep is as variable as the heterogenous landscapes where they graze.

The use of geospatial tools has been valuable in quantifying the use and movement of animals across heterogenous landscapes. The development of geographic information systems (GIS) and GPS collars technology has been important in quantifying the resource selection of the greater sage-grouse *(Centrocercus urosphasianus)*, where Baxter et al. (2017), using geographic information system (GIS) and resource selection mechanism, revealed habitat preferences that allowed for better management of this species. Resource selection was used along with birth-site selection of American bison *(Bison bison)* to predict in greater accuracy of areas most likely to be the best habitat for birthing sites (Kaze et al. 2016). While resource selection has been commonly used in wildlife research, little has been done with using this method to analysis the habitat selection in domestic livestock.

Domestic sheep herds in the intermountain west have been utilizing rangelands since 1847, with approximately 300,000 sheep grazing Utah rangelands today (Utah Wool Growers Association 2017). Utah's landscape consists of 80% rangeland making it unsuitable for farming but ideal for raising domestic livestock. In the Intermountain West, sheep are commonly rotated through different rangeland habitats within a year cycle. GPS locations from GPS collars on range ewes grazing on summer mountain habitat to identify use areas, we analyzed environmental features within the habitat at multiple spatial scales and measured the influence of slope, aspect, ruggedness, distance to water, and vegetation types in relation to use sites of the sheep. We then used model-averaged coefficients to produce a GIS model of habitat selection for sheep on the mountain summer habitat. The purpose of our research is to identify the biotic and abiotic variables selected by sheep in a quantifiable way, in hopes of providing fundamental information for sheep managers to effectively improve livestock management. We hypothesize that sheep will select and show preference for high elevation, gentle terrain and close to water.

MATERIALS AND METHODS

Study Area

Our study was conducted on private land north of Scofield Reservoir (39.91° -111.16° N, 39.88°, -111.12° E) in Utah County, Utah, on 2,500 acres (Fig. 2.1). Elevation ranged from 2,191 to 2,550m and included a variety of terrain from gentle sloping meadows to steeper forested hillsides. Ungulates on the summer grazing allotment that could potentially compete with sheep included elk *(Cervus canadensis)* and mule deer *(Odocoileus hemionus)*. Vegetation included quaking aspen *(Populus tremuloides),* subalpine fir *(Abies lasiocarpa),* Gambel oak *(Quercus gambelii),* mountain big sagebrush *(Artemisia tridentata subsp. vaseyana),* Utah serviceberry *(Amelanchier utahensis*), bluebunch wheatgrass *(Pseudoroegneria spicata),* timothy grass *(Phleum pratense)* and broom snakeweed *(Gutierrezia sarothrae)*. The climate was characterized by cool summer temperatures (15°C mean air temperature) and cold winters (-5°C mean air temperature) with annual precipitation of 50 cm. Average annual temperature ranged from 43 to 70°C during the summer and -11 to 1°C during the winter (PRISM 2004). Human related activity was minimal except for the full-time sheep herder.

Sheep GPS Tracking

During the summer of July to September 2020, we placed six global positioning system (GPS) collars on six ewes from a herd of 600 adult Rambouillet crossbreed white-face ewes (71±1.2 kg; 4.2±0.9 years old; 1.65 lambs/ewe). The GPS collars were modified from Knight et

al. (2018) as follows: An enclosure (#BT2310 Polycase, Avon, OH, USA) was attached to a 1" x 27" nylon dog collar using 73mm wide black Gorilla tape (Gorilla Glue, Inc, Cincinnati, OH, USA). An i-gotU GT-600 GPS tracker (Mobile Action Technologies, New Taipei City, Taiwan) was modified by removing the internal battery and attaching a JST PH 2-pin 200mm male header cable. A 6600 mAh 3.7V lithium-ion battery pack (#353 Adafruit, New York, NY, USA) that has a JST PH 200mm 2-pin female header attaches to the GPS tracker. The battery pack was also attached to the collar using the Gorilla tape. The GPS tracker was housed in the enclosure and sealed with silicone. With the GPS unit and battery attached, both were wrapped twice using 44mm duct tape (Shuretape Technologies, Avon, OH, USA; Fig. 1.3).

The GPS tracker was programmed to collect waypoints every 5 minutes. At the end of the collection period the collars were removed from the ewes. The data was downloaded using @Trip software (Mobile Action Technologies, New Taipei City, Taiwan) then exported as a csv file. The data was inspected and waypoints removed that were out of the grazing perimeter. In total 27,327 GPS coordinate points from all each collar were recorded.

Predictor Variables

Following the method used by Johnson (1980), a second order selection was used to conduct the resource selection function (RSF) by deliniating our study area and comparing the home range of the sheep to the total grazingland available within study area as defined by the property fencing was used. We obtained environmental data, (i.e. elevation, water location) from the Utah Automated Geographic Reference Center (AGRC 2021). ArcGIS to was used to generate slope, aspect, and ruggedness from elevation data (ESRI 2021). All environmental data was in raster format with a 10m spatial resolution. We binned aspect into seven different directions including: north, northeast, northwest, south, southeast, southwest, and west. Vegetation data was collected

from landfire raster dataset (LANDFIRE 2016) and using the Society of American Foresters-Society for Range Management (SAF-SRM) cover type we grouped vegetation into 20 different groups based on dominant vegetation type. The raster layer for streams was taken from the Utah Automated Geographic Reference Center (AGRC 2021). A point feature was used to designate where the man-made pond was located within the allotment. No anthropogenic features were included in this study (i.e. distance to roads, power lines), because there were very few and unlike wildlife, domesticated animals, are less affected by human related features and activity. Using the ArcGIS Extract MultiValues to Points tool in the Spatial Analyst toolbox, we extracted cell values at locations specified in a point feature class from all rasters and recorded values to the point feature class attribute table (ESRI 2021). The vegetation vector was joined using the Spatial Join tool in the Spatial Analyst toolbox (ESRI 2021).

Resource selection functions and hotspot analysis

The RSF predictions were generated from a logistic regression which utilizes data from use and non-use sites and includes the set of predictor variables previously described to provide pixel or polygon resource unit probability (Boyce et al. 2002; Manly et al. 2007). To model habitat use of sheep on the allotment, we checked for multi-collinearity among the explanatory variables and found no evidence of collinearity between variables. The Create Random Points tool in the Spatial Analyst toolbox was used to generate the same number of random locations as there were use locations (n=20,958) in order to ensure adequate characterization of the study area (ESRI 2021). A 0 was assigned to random locations and 1 to use location sites in the attribute table (Boyce et al. 2002). With the "lme4" package in R, we used a linear mixed-effects logistic regression with a random intercept for individuals (Team 2021). We compared predictor variables at use locations versus random locations within the study area (Bates et al. 2014;

Gillies et al. 2006; Manly et al. 2007; Team 2021). Akaike's Information Criterion (AIC) was used to select the most parsimonious models that best fit the data using the R package 'MuMIn' (Akaike 1973; Team 2021). To create a raster heat map, we converted the 10m DEM to points and ran the Extract Multi Values to Points tool in the Spatial Analyst toolbox to create a sample grid and exported the attribute table with the coordinates and habitat variable measurements to a csv file. We then used the variable coefficients from our selected model and the variable values from the 10m sample grid (n= 110,615) to generate heat map that visually shows in different colors a prediction of utilization at each sample site (Fig. 2.3). A csv file containing the coordinates and prediction for each 10m cell was exported as a csv file and imported as a point layer in ArcGIS Pro using the XY Table to Point tool in the Data Management toolbox. The point layer was then converted to a raster using the Point to Raster tool in the Conversion toolbox.

RESULTS

Resource selection function

A total of 27,327 locations for ewes were collected on the grazing habitat from 5 of the 6 GPS collars from July to September 2020. We evaluated 20 models for habitat-use of the sheep (Table 2.1). The top model had an AIC weight of 0.819 and the delta score between the first and second model was 3.34, indicating that our top model was the best fit for our data. Based on AIC, our global model, which included every coefficient (i.e. vegetation types, aspect directions, slope, elevation, water proximity, and ruggedness), had the best fit data for summer use on Scofield (Table 2.1). Slope was highly significant in the best-fit model ($P<0.001$). The

coefficient value for slope was negative and was estimated for each one degree increase in slope, with the probability of use by sheep declining by -0.9 (Table 2.2, Fig. 2.2). All three of our top models included water proximity as a significant variable ($P<0.001$; Table 2.1). Proximity to water had the second strongest negative beta estimate (-0.15) meaning that as distance from water increased by one meter, utilization of habitat decreased by -0.15 (Table 2.2). The ruggedness coefficient was significant ($P<0.05$) against rugged terrain and showed sheep avoided ruggedness (Table 2.2). Sheep showed preference for higher elevation sites, meaning as elevation increased by 1 meter, sheep utilization increased by 0.03 ($P<0.05$; Table 2.2). The ewes selected for north, northwest, southwest and west facing slopes ($P<0.05$; Table 2.2, Fig. 2.2).

The vegetation analysis compared every type to the intercept in preference selection. We selected the intercept "bristlecone" *(Pinus longaeva)*, due to the high avoidance sheep showed toward the bristlecone vegetation type. Compared to bristlecone pine, the significant (positive values) vegetation types that were selected for were herbaceous, engelmann spruce *(Picea engelmannii)*-subalpine fir, douglas fir *(Pseudotsuga menziesii),* white fir *(Abies concolor)*, aspen, mountain big sagebrush, tall forbs, alpine rangeland, chokecherry-serviceberry-rose, and juniper- *(Juniperus osteosperma)* pinyon *(Pinus edulis)* woodland vegetation types (Table 2.2). The most avoided vegetation type (negative values) was bigtoothed maple because it had the most negative beta estimate of -3.83 ($P<0.05$; Table 2.2). It is important to note that bigtoothed maple covered less than one percent of study area (0.53%; Fig. 2.4). Whereas the most common, mountain big sagebrush, covered 43% of the study area, aspen cover 33% and gambel oak 12% of total study area (Fig. 2.4).

SJ Plot and Hotspot analysis map

An "sjplot" was created in R showing all the predictor value estimates, including significant and non-significant variables at P>0.05 and sorting them in descending order with the highest selected variables on top to the most avoided variables on the bottom (Fig. 2.2; Team 2021). Further right from the neutral line indicates a strong selection for (in blue), while further left indicates a stronger avoidance (in red). The plot visually displays which variables were highly selected for (i.e. vegetation types, aspect types, elevation) to variables that were selected against (i.e. slope, distance from water, vegetation types, ruggedness, aspect types). Herbaceous, white fir, and douglas fir, were the top three vegetation types strongly selected for in comparison to bristlecone pine with small standard errors, all of which showed significance (P<0.05; Table 2.2; Fig. 2.2). The significant aspect variables show sheep using northern, northwestern, southwestern and western facing slopes (Table 2.2; Fig. 2.2). Variables such as ruggedness and elevation shown closer to the neutral line indicate strength of selection of use for elevation and avoidance of use for ruggedness (Table 2.2; Fig. 2.2). While bigtooth maple has a stronger avoidance by the ewes, being further from the neutral line (Fig. 2.2). Slope was highly avoided with a small standard error of 0.01 indicating slopes were avoided by sheep.

The raster heat map displayed hot spot analysis indicating the areas most likely to be used by the ewes in red and the areas most likely to be avoided in green (Fig. 2.3). For example, the steeper areas on the allotment are covered in green indicating a lack of usage by the sheep (Fig.

2.3). Whereas the gentler terrain on the allotment is generally covered in red and orange indicating higher usage sites (Fig 2.3).

DISCUSSION

Central to understanding sheep behavior, is understanding the way sheep utilize their environment (Johnson 1980). By using a resource selection functions (RSF) we were able to statistically analysize and identify the habitat features selected by sheep in order to provide understanding of resource usage by animals across a landscape (Manly et al. 2007). The results of our analysis support our hypothesis that sheep selected for higher elevations, avoided steep slopes, and preferred areas closer in proximity to water. Our model representing habitat use on mountainous summer rangelands found that slope was the most important continuous variable for characterizing sheep use. Slope had the highest negative beta estimate (-0.9, SE 0.01, $P<0.001$; Table 2.2) of all the continuous variables, meaning that, when compared to the other continuous variables, sheep strongly avoided steep slopes on the allotment (Fig. 2.2; Fig. 2.3). Other research has documented that sheep generally utilize steeper slopes more than cattle, and seek higher ground (Bowns 1971; Cook 1966; McDaniel and Tiedeman 1981; Mueggler 1965). Bowns (1971) and Glimp and Swanson (1994) found that sheep are less intimidated by steeper slopes than cattle and tend to prefer upland grazing sites. McDaniel and Tiedeman (1981) found increasing slope steeper than 45% negatively decreased utilization. Compared to other livestock species, sheep utilize steeper slopes more often, being less negatively impacted as slope increases (McDaniel and Tiedeman 1981). It is important to note that sheep were accompanied

by a herder during their time on the summer mountain habitat. We acknowledge that the presence of a herder affects sheep movement across the landscape. While there are times when sheep movement is manipulated by the herder, majority of the time the sheep are left to make habitat selections uninfluenced. The RSF was performed to determine the habitat selection of sheep grazing on summer mountainous range located in central Utah, USA. While the strong selection against steep slopes could be partially attributed to the ewes being herded, sheep tend to take the path of least resistance if presented with one (McDaniel and Tiedeman 1981).

Distance to water is a consistent primary determinant in predicting livestock grazing distribution (Bailey et al. 1996; Senft et al. 1987; Squires 1974). Our model showed as distance from water increased, utilization decreased (beta estimate of -0.16, SE 0.01; $P<0.001$; Table 2.2; Fig. 2.2; Fig. 2.3). Our findings are corroborated by other published research regarding sheep use of habitat (El Aich et al. 1991; James et al. 1999; Squires 1974). Squires (1974) and El Aich et al. (1991) found that as distance from forage to water increased, forage intake decreased. James et al. (1999), observed merino sheep in Australia are normally found within 3 km of a water site. However, McDaniel and Tiedeman (1981) found distance from water did not limit forage intake. They found a similar amount of forage was consumed from 2,000 to 2,400 m from water as from 0 to 500 m from water. This could be a result of additional water sources supplied on the pasture and stock tanks located on the bottoms and tops of the mountain slope. As well as periodic snows that provided additional moisture. Habitat selection is clearly influenced by distance to water for our sheep grazing on the summer mountain habitat.

Sappington et al. (2007) defines rugged terrain as broken, uneven, rocky terrain. We predicted sheep would choose more gentle terrain that included less rugged habitat. Ruggedness had a negative beta estimate (-0.023, SE 0.01; $P<0.02$; Table 2.2, Fig. 2.2; Fig. 2.3), meaning the

sheep on the allotment avoided rugged terrain. Ruggedness was found to be in the best-fit model but was not a significant variable in our second best-fit model that held 14% of the weight. McDaniel and Tiedeman (1981) documented when terrain becomes especially rough, sheep passed through the area leaving available forage untouched. While there is a deficiency in data for sheep utilizing rugged terrain, this behavior could be attributed to accessibility of gentler areas that allow for easier mobility and grazing. The sheep on our summer mountain habitat reflected this behavior and avoided rugged terrain.

Sheep have shown to select for higher elevation habitat where they graze on the tops of ridges, and upper slopes, and move uphill for bedding down at night (Bowns 1971; Glimp and Swanson 1994; McDaniel and Tiedeman 1981; Warren and Mysterud 1991). Even though the selection for higher elevation was not as strong as it was for slope avoidance (beta estimate of 0.04, SE 0.01; $P<0.004$; Table 2.2, Fig. 2.2; Fig. 2.3), this could be attributed to the lack of high elevation flat areas in our allotment for bedding down. Often, if left unmonitored, sheep will bed down in the same locations, on higher elevated ground, and overutilize rangeland vegegtation within the area (Bowns 1971; Warren and Mysterud 1991). The sheep in our study were herded, therefore the likelihood of overutilization of sites decreased, due to herders selecting different bedding locations. It has also been proposed that this uphill movement for higher-lying ground at night is not seen so much as a response to nutritional needs, but rather to provide other advantages, such as predator avoidance and offer safest bedding sites (Warren and Mysterud 1991). From our study and others, there is evidence for sheep to seek for higher ground.

The vegetation types selected for or against in this study were all in comparison to the avoided bristlecone pine vegetation type. The vegetation type sheep selected against was bigtooth maple, but they showed preference for herbaceous, Engelmann spruce-subalpine fir,

douglas fir, white fir, aspen, mountain big sagebrush, tall forbs, alpine rangeland, chokecherry-serviceberry-rose, and juniper-Pinyon pine woodland type. It is important to note that these vegetation types describe the dominant vegetation and exclude several palatable species that could be the true attraction to sheep but are undocumented. A plausible explanation for the vegetation selection could also be attributed to the herder preference and pushing sheep through areas to avoid over utilization of other sites. Another important factor to consider is the percent each vegetation type covers on the study area (Fig. 2.4). Though bigtooth maple was strongly selected against, that could also be due to it covering less than one percent of the study area (0.53%). Therefore, it is not common on the landscape and the chance of sheep encountering this vegetation type is much lower than mountain big sagebrush which covers 43% of the landscape (Fig. 2.4). During the beginning weeks on the mountainous summer range, GPS points showed sheep predominantly grazing on open fields of herbaceous graminoids, forbs, and shrubs before being moved down into forest stands of douglas and white fir stands. Douglas fir *(Pseudotsuga menziesii)* is the third most common forest type in Utah (USU 2004). While sheep showed selection for douglas fir, it could be likely that douglas fir vegetation type was more dominant across our mountain habitat therefore sheep spent more time grazing in it and not necessarily due to selection. Sheep prefer to subsist on graminoids, but can adjust their feeding habits to available forages (i.e. forbs, shrubs; Holechek 1984). Therefore, even though there was selection for and against vegetation types on the allotment, it remains difficult to conclude the significance of our findings due to the variation in percentage of cover between vegetation types, sheep being herded, and a lack of knowledge of other types of vegetation within the dominate vegetation type.

The aspects on our allotment habitat that were variables in the best-fit model were northern, northwest, southwest and west facing slopes (Table 2.2). Aspect plays a critical role in influencing soil quality and vegetation patterns (Farzam and Ejtehadi 2017; Singh 2018; Yang et al. 2020). Differences in aspect can alter vegetation structure and composition by effecting air and soil temperature, moisture content, and evaporation (Farzam and Ejtehadi 2017; Singh 2018). North-facing aspects receive less sunlight and therefore retain moisture more effectively, giving life to thicker and denser vegetation (Farzam and Ejtehadi 2017). Whereas, sunnier south-facing aspect's vegetation is sparse and thin and therefore prone to erosion (Farzam and Ejtehadi 2017; Singh 2018). While the literature is lacking specific examples of sheep selecting for certain aspects, these studies give a possible reason our sheep selected northern aspects over southern aspects. Northern facing slopes provide sheep with better foraging habitat as well as protection from the hot summer sun.

Our results demonstrate sheep habitat selection on summer mountain range. However, additional improvements to this study could allow for further extrapolation of data. Our data is from one flock and the addition of more flocks would provide a more complete data set for habitat selection from other mountainous habitat sites. While we placed collars to represent 10% of the flock, increasing collar sample size to estimate herd movement would increase the validity and accuracy of our findings (Biau et al. 2008). Not only would increasing sample size improve our research but monitoring sheep throughout several years and on different rangelands would provide additional insights to habitat selection. By extending the length of time out on habitats and continuing to monitor sheep as they transferred between locations throughout a year, would allow data to be compared between sites and create a holistic view of sheep habitat selection throughout a regular grazing year. Another noticeable limitation when using RSF is the lack of

existing data layers that also provide accurate information. For example, our vegetation layer describes dominant cover type but provides no further information of total species composition of area. Without a comprehensive knowledge of plant communities, it becomes difficult to draw any meaningful conclusions from this data layer. With improvements made to sample size, length of study and data layers, the study of habitat selection in sheep could be extrapolated for other similar range habitats for the improvement of livestock management.

CONCLUSION

Sheep grazing on our mountainous summer range avoided slopes, and preferred higher elevation, northern aspects, gentle terrain, and remained closer to water. Vegetation selected for and against, lacked reliability to make inferences, due to the GIS layer limitations in knowledge of species composition in areas and sheep being herded. Our results highlight what other studies have recorded in sheep habitat selection (Bowns 1971; El Aich et al. 1991; Holechek 1984; McDaniel and Tiedeman 1981; Squires 1974; Warren and Mysterud 1991). With the use of geospatial technology to generate an RSF for sheep grazing on mountainous summer range, we were able to quantify sheep habitat use in order to improve summer grazing management of sheep. Improvements could come by altering herding strategies to better utilize sheep friendly habitats and avoid those that are not beneficial. Further work using the tools outlined in this research and addressing outlined limitations is needed to look more closely at habitat selection of sheep.

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FIGURES

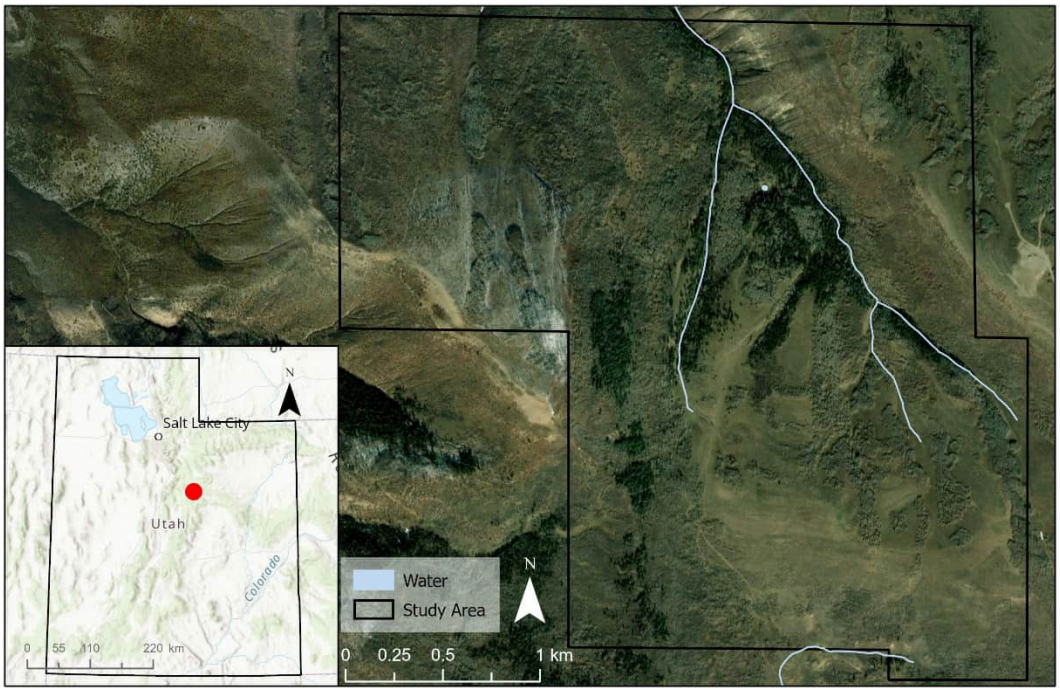


Figure 2.1 Study site location north of Scofield Reservoir, UT. Polygon represnet the mountainous range where sheep grazed from July 2020 to September 2020.

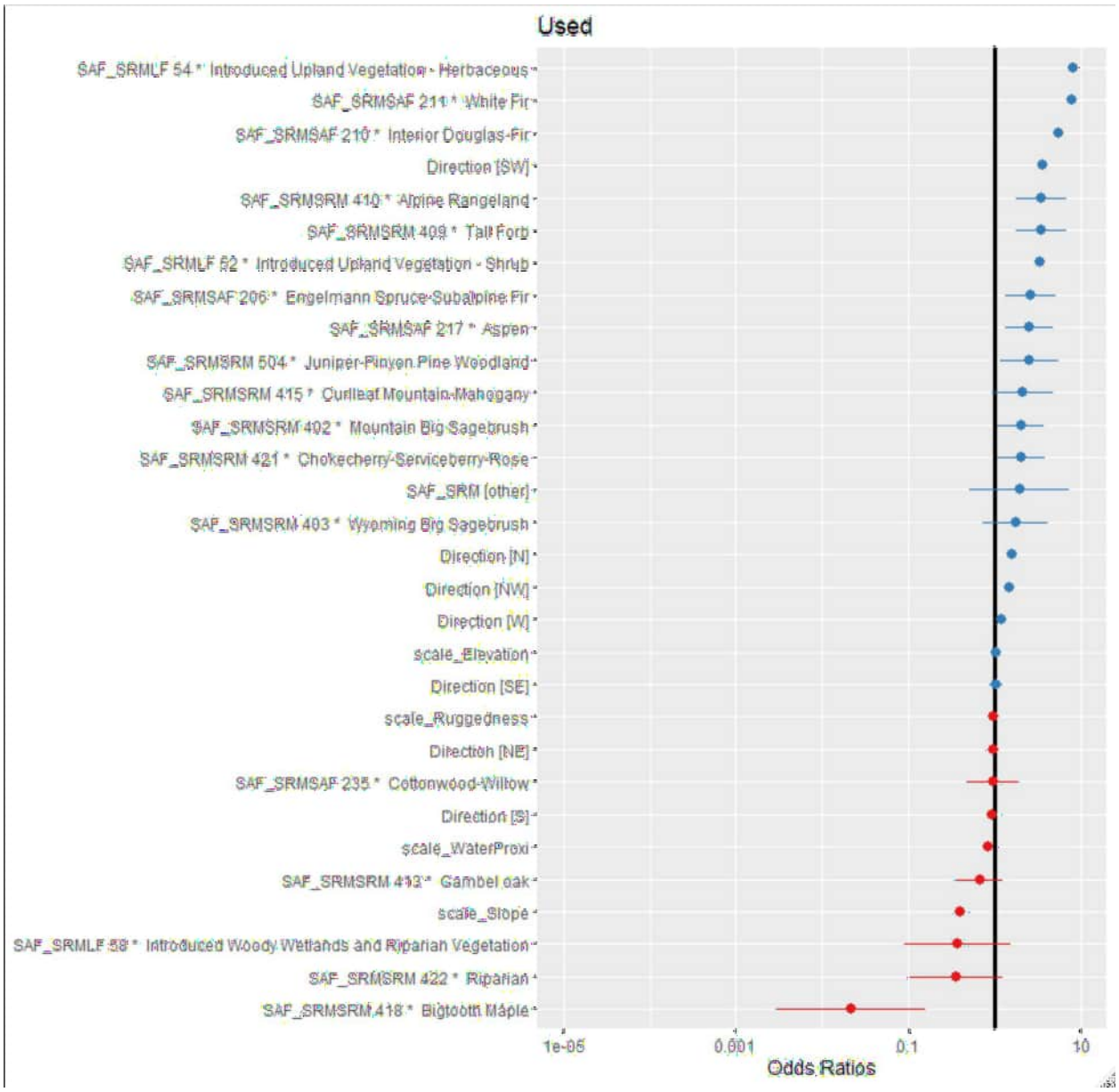


Figure 2.2 "sjplot" showing predictor value estimates with standard error bars in descending order with the highest selection on top in blue to the highest avoidance on the bottom in red. The "neutral" line, that is thicker than the rest indicates no effect. The vegetation types come from forest cover types of the United states and Canada (SAF) and the society for range management (SRM).

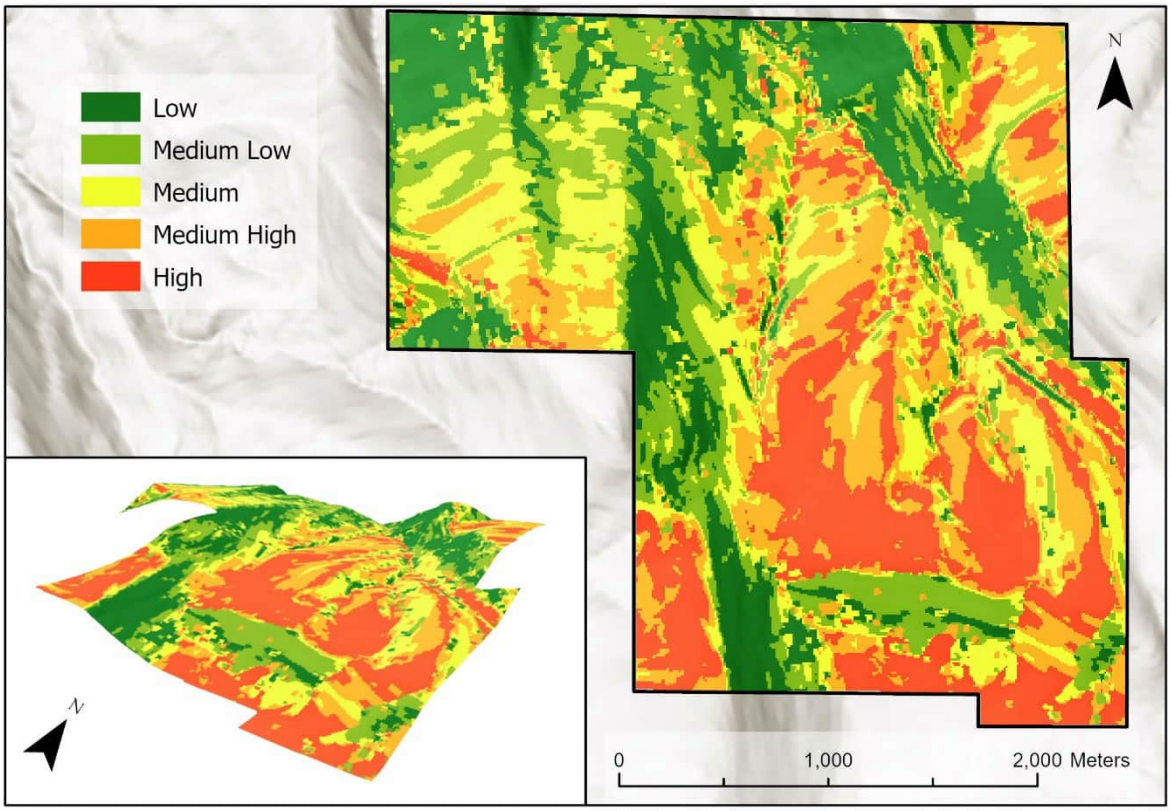


Figure 2.3 Heat map analysis of study area showing the relative probabilities of selection by domestic sheep binned into five categories from low (dark green) to high (red).

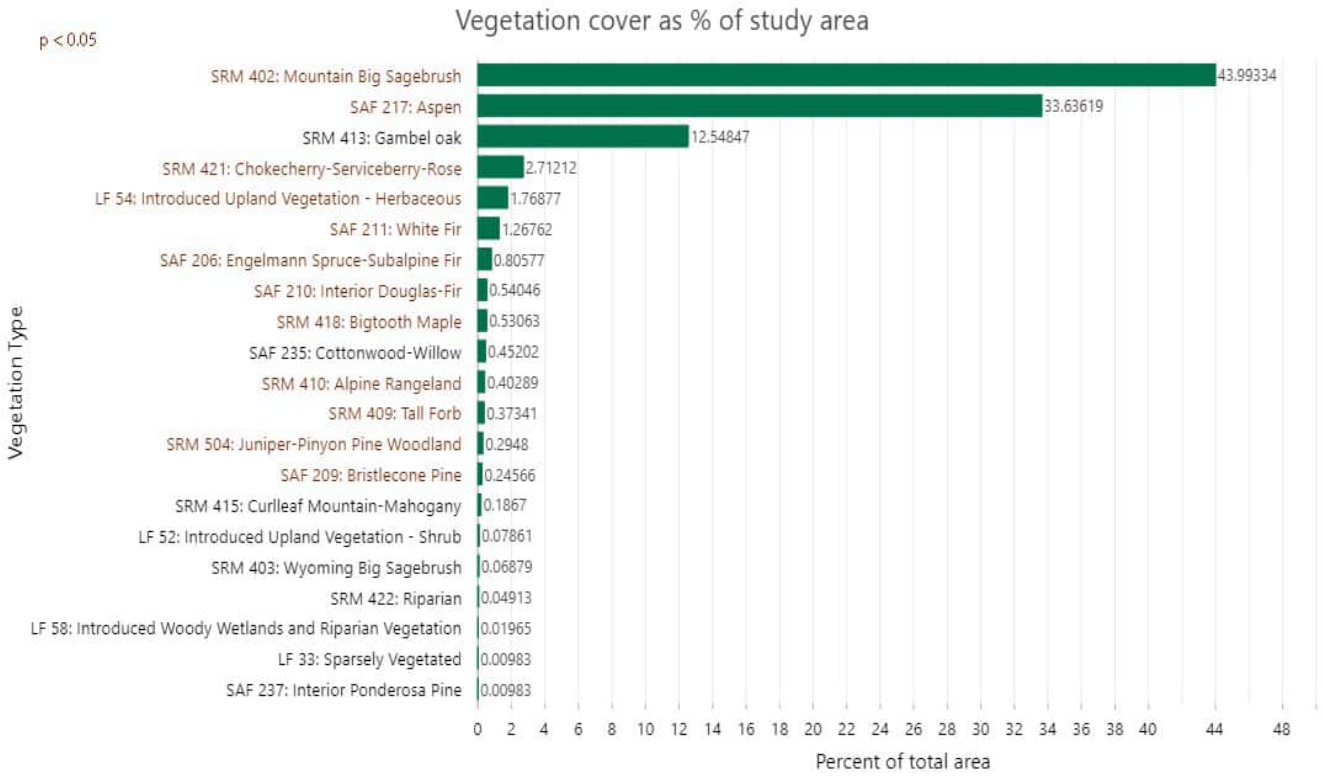


Figure 2.4 Vegetation cover as percentage of study area.

TABLES

Table 2.1 Model selection table showing 20 models, the number of parameters (k), the difference in Akaike's Information Criterion from the top model (ΔAIC), and the model weight for 20 a prioiri models for sheep habitat selection on mountainous summer range.

Model No.	Model Structure	df	AICΔ	Weight
M8	Vegetation+Aspect+Elevation+Ruggedness+Slope+ WaterProxi	32	0.00	0.819
M9	Vegetation+Aspect+Elevation+ Slope+ WaterProxi	31	3.45	0.146
M12	Vegetation+Aspect+Ruggedness+Slope+WaterProxi	31	6.26	0.036
M15	Vegetation+Aspect+Elevation+Ruggedness+Slope	31	174.47	0.00
M10	Vegetation+Elevation+Ruggedness+Slope+WaterProxi	25	1722.60	0.00
M11	Vegetation+Elevation+Slope+WaterProxi	24	1726.25	0.00
M13	Vegetation+Slope+WaterProxi	23	1764.94	0.00
M20	Aspect+Elevation+Slope+WaterProxi	12	2119.79	0.00
M14	Aspect+Elevation+Ruggedness+Slope+WaterProxi	13	2121.44	0.00
M16	Aspect+Eelevation+Ruggedness+WaterProxi	12	2653.03	0.00
M19	Aspect+Elevation+Slope	11	2657.22	0.00
M2	Slope	3	4873.91	0.00
M17	Vegetation+Aspect+Elevation+Ruggedness+WaterProxi	31	5397.86	0.00
M18	Vegetation+Elevation+Ruggedness+WaterProxi	24	7874.49	0.00
M7	Vegetation	21	8345.67	0.00
M3	Aspect	9	10431.73	0.00
M4	Elevation	3	13101.52	0.00
M5	Ruggedness	3	15622.73	0.00
M1	Intercept only model	2	15646.70	0.00
M6	WaterProxi	3	15647.90	0.00

Table 2.2 Model coefficients from best-fit model for habitat selection of sheep grazing on mountainous range located north of Scofield UT, USA.

Significant Coefficients	Beta Estimate	Standard Error	P Value
Topography			
Slope	-0.907542	0.013590	< 0.001
WaterProxi	-0.159241	0.012157	< 0.001
Elevation	0.039046	0.013579	0.004
Ruggedness	-0.022930	0.009817	0.019
Aspect			
Direction N	0.468430	0.045034	< 0.001
Direction NW	0.410669	0.043689	< 0.001
Direction SW	1.264073	0.046279	< 0.001
Direction W	0.172613	0.046250	0.000190
Vegetation Type			
Bristlecone Pine	-1.332760	0.331533	< 0.001
Bigtooth Maple	-3.836484	1.012389	0.000151
Herbaceous	2.089378	0.323017	< 0.001
Englemann Spruce-Subalpine Fir	0.959606	0.342799	0.005121
Interior Douglas-Fir	1.706320	0.348417	< 0.001
White fir	2.049769	0.328012	< 0.001
Aspen	0.926217	0.319575	0.003752
Mountain Big Sagebrush	0.708248	0.319086	0.026445
Tall Forb	1.243699	0.341405	0.000270
Alpine Rangeland	1.257119	0.344002	0.000258
Chokecherry-Serviceberry-Rose	0.696006	0.326403	0.032978
Juniper-Pinyon Pine Woodland	0.924872	0.391449	< 0.001

EXHIBIT 5

January 25, 2023

Jim Zelenak
Adam Zerrenner
Ben Conrad
US Fish and Wildlife Service
Ecological Services, Montana Field Office
585 Shephard Way, Suite 1
Helena, MT 59601.

Re: Canada lynx Species Status Assessment – Comment Submittal

Sent VIA Email to: jim_zelenak@fws.gov; Adam_zerrenner@fws.gov and Ben_conard@fws.gov

Dear Jim, Adam, and Ben:

Yellowstone to Uintas Connection is providing these comments as input to your current species status assessment for Canada lynx. Yellowstone to Uintas Connection is a 501c3 non-profit entity working to restore fish and wildlife habitat including the Regionally Significant Wildlife Corridor connecting the Greater Yellowstone Ecosystem to the Uinta Mountains and Colorado through the application of science, education, and advocacy. We named our organization and the Corridor from the Greater Yellowstone Area that passes through SE Idaho and SW Wyoming into NE Utah, the Yellowstone to Uintas Connection (Y2UConn) in order to bring attention to it across the West.

Y2U has been working to correct habitat fragmentation and degradation in the Y2UConn. Over the decades, we have documented the destruction and degradation of the natural character, water quality, and wildlife habitat integrity of the National Forests and BLM managed lands in this region, including the Y2UConn. Human developments including energy development, mining, livestock grazing, motorized recreation, and logging on public and private land have contributed to an apparent loss of function in this connection for Canada lynx. Our focus has been on restoring this corridor to function as a linkage for Canada lynx and wolverine. We review the literature, analyze and comment on agency actions such as phosphate mining and timber projects which fragment the habitat. Motorized recreation is a massive presence and largely unregulated and uncontrolled.

In recent years, we have been addressing the phosphate mining industry in SE Idaho on lands managed by the Caribou National Forest (CNF) and identified by the CNF as linkage habitat.[1] The phosphate mines typically dig up and destroy thousands of acres for each mine plus ancillary haul roads, powerlines, pipelines, and rail lines. To date, over 20,000 acres of forested habitats that are important to many wildlife species have been lost. Wildlife and habitat studies are minimal with no population data or trend analysis for viability assessments. Monitoring of project impacts on wildlife are scarce to non-existent. The typical outcome for lynx analysis is

[1] Caribou National Forest. 2003. Revised Forest Plan and FEIS. https://www.fs.usda.gov/detail/ctnf/landmanagement/planning/?cid=stelprdb5228906 Accessed January 21, 2023.

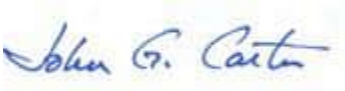
for the project proponents to acknowledge they may occasionally travel through the project or analysis area but will move around the periphery of the disturbance by way of other available habitat. While the project proponents, including the agencies, also acknowledge this area is part of the linkage area designated by the CNF and FWS, the habitat integrity of that area lynx are supposed to be able to access is never analyzed in terms of functionality for lynx. The CNF RFP linkage criteria lack any force or definition related to lynx habitat components, connectivity, or snowshoe hare needs.

What is lacking are adequate regulatory and land use planning criteria that require agencies such as the Forest Service and BLM to fully analyze and correct habitat fragmentation. In the following comments, we provide a summation of this Y2UConn as linkage habitat and an analysis of the failure of data interpretation, regulation and planning criteria to provide habitat and connectivity for lynx.

After years of providing input and analysis, the CNF remains unable or unwilling to fully analyze and implement habitat protection criteria for this linkage area, while consultations with U.S. Fish and Wildlife Service (FWS) are lacking in detail with FWS approving project after project without requiring any systematic and detailed analysis of lynx habitat functionality or connectivity. The 2017 FWS Species Status Assessment (SSA) continues to deflect to Forest Planning as protective of lynx and its habitat without providing any evidence this is the case.[2] While we expect the FWS is familiar with the principal documents relating to protection of lynx habitat, in the following, we briefly outline and comment on these as it is a good reminder of the state of knowledge and absence of effective regulation pertaining to lynx and its protection.

Dr. John Carter, Ecologist, and founder of the Yellowstone to Uintas Connection and Kiesha's Preserve, a wildlife preserve in the Y2UConn in SE Idaho, prepared these comments for input to the current Canada Lynx Species Status Assessment. Dr. Kirk Robinson, founder of the Western Wildlife Conservancy, has worked on this Regional Corridor and carnivore ecology for many years and assisted with input on the logic of lynx occupancy in Colorado and Utah.[3] The comments were reviewed by Dr. Barrie Gilbert, (retired) Utah State University.[4]

Respectfully,



John Carter, PhD Ecology
Yellowstone to Uintas Connection
Kiesha's Preserve
PO Box 363
Paris, Idaho 83261

[2] U.S. Fish and Wildlife Service. 2017. Species Status Assessment for the Canada lynx (Lynx canadensis) Contiguous United States Distinct Population Segment. Version 1.0, October, 2017. Lakewood, Colorado.
[3] Kirk Robinson, J.D., PhD Philosophy. Founder and current Executive Director of Western Wildlife Conservancy. https://westernwildlifeconservancy.org/mission-vision/ Accessed on January 24, 2023.
[4] Barrie K. Gilbert PhD, Department of Wildland Resources, (senior scientist retired), Utah State University, Logan Utah. Dr. Gilbert is a behavioral ecologist and recent author of One of Us: A Biologist's Walk Among Bears.

ABSTRACT

These comments provide a brief review of the regulatory history and science involved in the ESA listing for Canada lynx and subsequent land management on National Forests. The review reveals that much of the science is misinterpreted to favor human activities that degrade and fragment lynx habitat, while absence of evidence due to lack of studies is used to claim these activities either have little effect or in the case of timber manipulations, can even be beneficial. A review of the NRLMD and its application in linkage and peripheral areas as incorporated into Forest planning uses the Caribou NF as an example. The NRLMD provides limited guidance and protection to the Caribou NF as it is deemed "unoccupied" by lynx. This is in spite of evidence that lynx persisted in the area of the CNF over historical times. This "unoccupied" status results from failing to find current evidence of lynx long after habitats have been fragmented by mines, high road density, an explosion in motorized recreation accessing nearly every acre of land, timber projects and including habitat alteration by livestock grazing. The CNF Forest Plan includes recognition of lynx linkage, but the provisions in that plan for linkage habitat lack adequate quantification and standards.

Noting that there is a lack of emphasis on landscape connections between core areas of the DPS, analysis and mapping is provided showing the existence of long recognized regional wildlife corridors. A principal corridor is the Yellowstone to Uintas Connection linking the GYA to the Uinta Mountains and Colorado by passing through SE Idaho from lynx critical habitat in Wyoming. This is the most continuous high elevation, forested corridor making these connections. It also aligns with the CNF linkage to other areas. Protection and restoration of this and other corridors is essential to promote lynx connectivity and sustain meta-populations.

This review shows that regulatory mechanisms are inadequate to protect lynx habitat and connectivity. Monitoring of snowshoe hare habitat and populations as well as lynx presence in these southern areas of the DPS is lacking. While some habitat mapping and modeling has been done, it is not being applied or expanded to identify and describe in sufficient detail the habitats and migration corridors needed for lynx to persist. Land management plans must be updated and amended to provide data-based criteria and quantitative standards to ensure habitat for lynx and snowshoe hare are connected and functional.

REGULATORY ISSUES

The Programmatic Lynx BA. Canada lynx were listed as a Threatened species under the Endangered Species Act (ESA). In December 1999, the Forest Service and Bureau of Land Management completed their "Biological Assessment of The Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada

Lynx" (Programmatic Lynx BA).[5] The Programmatic Lynx BA concluded that the current programmatic land management plans *"may affect, and are likely to adversely affect, the subject population of Canada lynx."* The Lynx BA team recommended amending or revising Forest Plans to incorporate conservation measures that would reduce or eliminate the identified adverse effects on lynx. The Programmatic Lynx BA's determination means that Forest Plan implementation is a *"taking"* of lynx and makes Section 7 formal consultation on the land management plans (LMPs) mandatory, before actions are approved. The Lynx BA *"likely to adversely affect"* conclusion was based on the rationale that land use plans within the Northern Rockies have inadequacies, including:

1. Aggressive fire suppression may limit the availability of foraging habitat.
2. Allow levels of human access via forest roads that may risk incidental trapping, shooting, or access by competing carnivores.
3. Weak in guidance for new or existing recreation developments.
4. Allow mechanized and non-mechanized recreation that may pose a risk, by allowing compacted snow trails and plowed roads that facilitate competitors and predators.
5. Weak direction for maintaining habitat connectivity.
6. Weak in direction for coordinating management activities with adjacent ownerships to assure consistent management of lynx habitat across the landscape.
7. Fail to provide monitoring of lynx, snowshoe hares, and their habitats, making the detection and assessment of adverse effects from other management activities difficult or impossible to attain.
8. Forest management has resulted in a reduction of the area in which natural ecological processes were historically allowed to operate, thereby increasing the area potentially affected by known risk factors to lynx. The Plans have continued this trend. The Plans have also continued the process of fragmenting habitat and reducing its quality and quantity. Consequently, plans may risk adversely affecting lynx by potentially contributing to a reduction in the geographic range of the species.
9. Plan revisions are needed to incorporate conservation measures included in the Canada Lynx Conservation Assessment and Strategy.[6]

The LCAS *"was developed to provide a consistent and effective approach to conserve Canada lynx on federal lands in the conterminous United States. The USDA Forest Service, USDI Bureau of Land Management, and USDI Fish and Wildlife Service initiated the Lynx Conservation Strategy Action Plan in spring of 1998."* The LCAS was published shortly after the Canada lynx was listed as Threatened under the ESA. Risk Factors from the LCAS (2000) include:

[5]USDA Forest Service and DOI Bureau of Land Management.1999. Biological Assessment of the Effects of National Forest Land and Resource Management Plans and Bureau of Land Management Land Use Plans on Canada lynx.

[6]Ruediger et al. 2000. Canada Lynx Conservation Assessment and Strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, MT. 142 pp.

1. Timber harvest and pre-commercial thinning that reduce denning or foraging habitat or convert habitat to less desirable tree species.
2. Fire exclusion changing the vegetation mosaic maintained by natural disturbance processes.
3. Grazing by livestock that reduces forage for prey.
4. Roads and winter recreation trails that facilitate access to historical lynx habitat by competitors.
5. Incidental trapping and shooting.
6. Predation.
7. Being hit by vehicles.
8. Obstructions to movement such as highways and private land developments.

All of these factors continue to operate within the National Forests and BLM lands within and surrounding the Y2UConn. They are not effectively addressed while degradation and fragmentation of habitat continues. Monitoring of these activities is minimal to non-existent.

Northern Rockies Lynx Management Direction. We reviewed the Northern Rockies Lynx Management Direction (NRLMD).[7] This direction *"applies to mapped lynx habitat on National Forest System land presently occupied by lynx, as defined by the Amended Lynx Conservation Agreement (CA)[8] between the Forest Service and FWS…When National Forests are designing management actions in unoccupied mapped lynx habitat they should consider the lynx direction, especially the direction regarding linkage habitat."* (NRMLD p1). [Emphasis added]. The FEIS for the NRLMD provided a map for the Northern Rockies Lynx Planning Area which is inserted as Figure 1. The CA provided this, *"As recommended in the LCAS, appropriate actions, including research, administrative studies, or monitoring, will be taken to verify the effectiveness of the lynx conservation measures."* (CA p7). We have seen none of these monitoring or other studies that have addressed effectiveness of lynx conservation measures, while monitoring of lynx and snowshoe hare occurrence and populations in the DPS is lacking.

In the NRMLD (p3) there is reference to a FWS *"Clarification of Findings"* in a Remand Notice which basically explains away most forest activities as impacting lynx or lynx habitat, i.e. a *"threat"* to lynx. The NRMLD puts it this way:

> *After the LCAS was issued the FWS published a Clarification of Findings in the Federal Register (FEIS, Vol. 1, Appendix P), commonly referred to as the Remand Notice. In the Remand Notice the FWS states, "We found no evidence that some activities, such as forest roads, pose a threat to lynx. Some of the activities suggested, such as mining and grazing, were not specifically addressed [in the Remand Notice] because we have no information to indicate they pose threats to lynx" (p. 40083).*
>
> *Further on in the Remand Notice they state, "Because no evidence has been provided that packed snowtrails facilitate competition to a level that negatively*

[7] USDA Forest Service. 2007. National Forests in Montana, and parts of Idaho, Wyoming, and Utah. Northern Rockies Lynx Management Direction Record of Decision.
[8] USDA Forest Service and USDOI Fish and Wildlife Service. 2006. Canada Lynx Conservation Agreement. USFS Agreement #OO-MU-11015600-0 13.

affects lynx, we do not consider packed snowtrails to be a threat to lynx at this time" (p. 40098).

In regards to timber harvest the FWS states, "Timber harvesting can be beneficial, benign, or detrimental to lynx depending on harvest methods, spatial and temporal specifications, and the inherent vegetation potential of the site. Forest practices in lynx habitat that result in or retain a dense understory provide good snowshoe hare habitat that in turn provides good foraging habitat for lynx" (p. 40083).

These findings by FWS narrow the focus from the concerns first published in the LCAS (discussed above) about what management direction is needed to maintain or improve Canada lynx habitat. We considered this information in the development of the selected alternative, and in our decision.

So, in one fell swoop, FWS and then the USFS thru the NRMLD adopted guidance that removes the majority of Forest Service actions or permitted activities from consideration as impacting lynx. We are to believe that lack of evidence is proof these activities have no impact on lynx or their habitat. Yet, the scientists who published the Science Report[9] which was used as the basis for the NRLMD had determined these activities adversely affect lynx and lynx habitat.

What we have observed is a gradual easing of requirements and population status of lynx over the years. Absence of lynx in SE Idaho is a foregone conclusion if you manage them out of existence by denying their presence thru history then deny impacts from logging, snowmobiles across the landscape, off road vehicles speeding thru forest roads, and that *"mining and grazing, because they were not specifically addressed … because we have no information to indicate they pose threats to lynx."* In this way, the agencies have relieved themselves of most responsibility to maintain or restore lynx, its habitat, and connectivity. We have reviewed the Science Report and find that the information in that report does not say roads, snowmobiles, timber harvest, mines and grazing do not impact lynx or lynx habitat. We discuss these as part of the narrative below.

Further in the NRLMD there are clarifying statements such as that standards and guidelines only apply to occupied habitat, while they can be considered for unoccupied habitats. (NRLMD p6). Regarding vegetation management direction, it *"conserves the most important component of lynx habitat: a mosaic of early, mature, and late successional stage forests, with high levels of horizontal cover and structure."* (NRLMD p21). The objectives, standards and guidelines do not *"apply to linkage areas"*. (NRLMD Att 1 p2). Livestock grazing *"may reduce or eliminate foraging habitat in areas that grow quaking aspen and willow in riparian areas….These localized changes in habitat may affect individual lynx; however, no information indicates grazing poses a threat to overall lynx populations…"* (NRLMD p21). Livestock management

[9] Ruggiero, Leonard F.; Aubry, Keith B.; Buskirk, Steven W.; Koehler, Gary M.; Krebs, Charles J.;McKelvey, Kevin S.; Squires, John R. 2000.. Ecology and conservation of lynx in the United States. General Technical Report RMRS-GTR-30WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. https://www.fs.usda.gov/research/treesearch/50623 Accessed on January 21, 2023.

objectives and guidelines do not apply to linkage areas. (NRLMD Att 1 p5). Over snow recreation *"Emphasizes not expanding snow compacting human uses into non-compacted areas."* Guideline G11 *"discourages the expansion of designated over-the-snow routes and play areas into uncompacted areas." "An alternative to drop all direction limiting snow compaction was not developed in detail because there is evidence competing predators use packed trails, suggesting a potential effect on individual lynx."* (NRLMD p23). Mineral and Energy Standard does not apply to linkage habitat. (NRMLD Att1 p5).

As these statements make clear, lynx habitat, including linkage areas have virtually no protections, standards, or guidelines under the NRLMD. While it does acknowledge that there is evidence of lynx competitors using packed snow trails it does not address landscape level snow machine access, the increase in motorized recreation with fast, high-powered machines, and landscape-level use such as occurs in 97% of the CNF since the Science Report data and information was assembled. A recent paper by Olson et al (2018)[10] acknowledges that lynx avoid areas of ski resort development and they altered their behavior to spend less time in areas of motorized recreation or used them at night when there was less use. The Forest Service Rocky Mountain Research Station has said, *"Lynx appear to have an upper threshold of recreation intensity which they can tolerate, and above this level, lynx may be less able to coexist. Managers, then, should keep in mind that developed or dispersed areas with very high use may displace lynx from habitat."*[11] We note that the phosphate mines in SE Idaho operate 24 hours per day, 7 days per week for up to 30 years at an individual mine with some 400 blasts of explosives each week at each mine.[12] Haul roads further fragment the habitat, operating continuously.

Since these studies used in the Science Report, three decades have passed with ever increasing snowmobile and off-road vehicle use. A report by Winter Wildlands Alliance for USDA noted that snowmobile use more than doubled between the early 1980s and 2004.[13] Cross-country skiing and snowshoeing experienced a similar increase. In the 1990s more powerful snow machines made access available to *"dominate terrain only accessible by backcountry skis or snowshoes."* High-marking and acrobatics are common in areas previously inaccessible. Highmarking is the "*recreational maneuver of attempting to reach the highest point of a snow-covered feature such as a mountain, on a snowmobile.*"[14] Groomed trails now are over 20,000 miles in the 11 Western Snow Belt States. Today, there are 1.3 million registered snowmobiles in the US and 601,000 in Canada.[15] As acknowledged above, this increased access allows

[10] Olson, L.E.; Squires, J.R.; Roberts, E.K.; Ivan, J.S.; Hebblewhite, M. 2018. Sharing the same slope: Behavioral responses of Canada lynx to winter recreation. Ecology and Evolution. 1-18.
[11] USDA RMRS. 2023. Winter Sports and wildlife: Can Canada lynx and winter recreation share the same slope? https://www.fs.usda.gov/rmrs/winter-sports-and-wildlife-can-canada-lynx-and-winter-recreation-share-same-slope Accessed on January 16, 2023.
[12] USDA and DOI. 2019. Final Environmental Impact Statement Proposed Dairy Syncline Mine and Reclamation Plan. https://app.box.com/s/jmod5pcq1txhv4wmply3oxuazlm16tau Accessed on January 16, 2023.
[13] Winter Wildlands Alliance. 2006. Winter Recreation on Western National Forest Lands. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd528883.pdf Accessed on January 16, 2023
[14] https://en.wikipedia.org/wiki/Highmarking
[15] ISMA. 2022. Snowmobiling Fact Book. https://www.snowmobile.org/docs/isma-snowmobiling-fact-book.pdf Accessed on January 17, 2023.

trapping and hound hunting to occur across the landscape. In Idaho there were 1,830 trapping licenses issued for the 2017 - 2018 season[16], up from 638 in the 1995-1996 season.[17]

We looked up some brief history of ATV and UTVs. These come from industry websites. The first four wheeled atv was produced in 1982 by Suzuki.[18] This quickly turned to an emphasis on speed in 1987 with a model that could attain almost 80 mph. *"Naturally, as high-performance ATVs gained popularity, Quad Racing and ATV Motocross enjoyed massive growth and exposure in the late 1980s."* The first UTV, the Kawasaki Mule was introduced in the late 1980s.[19] A racing emphasis came about with the introduction of the Polaris RZR in 2007. Today, sales of these vehicles are around 800,000 annually with about half in the US. This is an estimate, since in many states they are not registered.[20]

The point of this is that there are millions of snowmobiles, atvs, utvs, and dirt bikes in the US today. Add to this the pickup truck and SUV market with their TV commercials emphasizing the backcountry and off-roading. These were present only minimally during the time of most of the studies in the Science Report. The implication of this is that conclusions about forest roads and snowtrails are out the window today since these are loud, fast, and powerful machines capable of accessing most terrain and are present in large numbers. For instance, in 2017, we funded a research project at Kiesha's Preserve to evaluate traffic on a CNF Forest access road in SE Idaho. Over 300 vehicles per day were using the road with many traveling at high rates of speed.[21] Sound levels were over 100 DbC. In winter, snowmobiles were creating noise levels of over 100 DbC. These roads today are not quiet, low frequency roads, but as we like to say, they have become an analog to a motocross where there is no enforcement of speed, noise or even checking registrations. How are lynx to occupy an area with this level of disturbance?

The Conservation Agreement (CA). addresses its scientific basis as:

> *In March of 1998, an interagency lynx coordination effort was initiated in response to the emerging awareness of the uncertain status of lynx populations and habitat in the conterminous United States and the onset of the listing process. The U.S. Fish and Wildlife Service (FWS), USDA Forest Service (FS), Bureau of Land Management (BLM), and the National Park Service (NPS) have participated in this effort. Three products important to the conservation of lynx on federally managed lands have been produced through this effort: (1) "The*

[16] IDFG. 2018. Idaho Department of Fish and Game Furbearer. https://collaboration.idfg.idaho.gov/WildlifeTechnicalReports/Furbearer%20Statewide%20FY2018.pdf Accessed on January 16, 2023.
[17] Melquist, W.E. 1997. Idaho Department of Fish and Game Furbearers Study III, Job 1. https://collaboration.idfg.idaho.gov/WildlifeTechnicalReports/Furbearer%20PR94.pdf Accessed on January 16, 2023.
[18] https://www.hqpowersports.com/blog/history-of-the-modern-atv-and-utv/ Accessed on January 17, 2023.
[19] https://shocktherapyst.com/blog/a-brief-history-of-utvs/ Accessed on January 17, 2023.
[20] https://www.motorcyclesdata.com/2022/12/27/all-terrain-vehicles/ Accessed on January 17,2023.
[21] Unpublished data. 2017. Utah State University in Association with Kiesha's Preserve.

Scientific Basis for Lynx Conservation" (Ruggiero et. al. 2000)[22], hereafter referred to as the "Science Report"; the Lynx Conservation Assessment and Strategy (LCAS); and this Lynx Conservation Agreement (CA). Several States within the range of the lynx have contributed to this effort through interactions with participants and review of draft products.

The Science Report, prepared by an international team of experts in lynx biology and ecology, is a compendium and interpretation of current scientific knowledge about the Canada lynx, its primary prey and habitat relationships. This document serves as an important scientific reference for the various lynx activities of the cooperating Federal Agencies.

The LCAS builds upon this scientific base and identifies the risks to the species that may occur as a result of federal land management. It recommends conservation measures that could be taken to remove or minimize the identified risks. It was developed to provide a consistent and effective approach to conservation of Canada lynx on federal lands in the conterminous United States.

The LCAS and Science Report constituted the best available knowledge and were incorporated into the CA. The Science Report (p12) addressed uncertainty by suggesting that "*the burden of proof be shifted so that uncertainty favors, or at least is not destructive to conservation…*". As we pointed out above, the LCAS identified risk factors, which are now excluded by the NRLMD and Remand Notice. These exclusions have arbitrarily discounted nearly all activities as affecting lynx and lynx habitat. Lack of regulatory mechanisms was identified as a cause in the listing notice (FR Vol 65 No 58 p16052) stated as,

The contiguous U.S. Distinct Population Segment of the lynx is threatened by the inadequacy of existing regulatory mechanisms. Current U.S. Forest Service Land and Resource Management Plans include programs, practices, and activities within the authority and jurisdiction of Federal land management agencies that may threaten lynx or lynx habitat. The lack of protection for lynx in these Plans render them inadequate to protect the species.

[22] Ruggiero, Leonard F.; Aubry, Keith B.; Buskirk, Steven W.; Koehler, Gary M.; Krebs, Charles J.;McKelvey, Kevin S.; Squires, John R. 2000.. Ecology and conservation of lynx in the United States. General Technical Report RMRS-GTR-30WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. Available at: http://www.fs.fed.us/rm/pubs/rmrs_gtr030.html

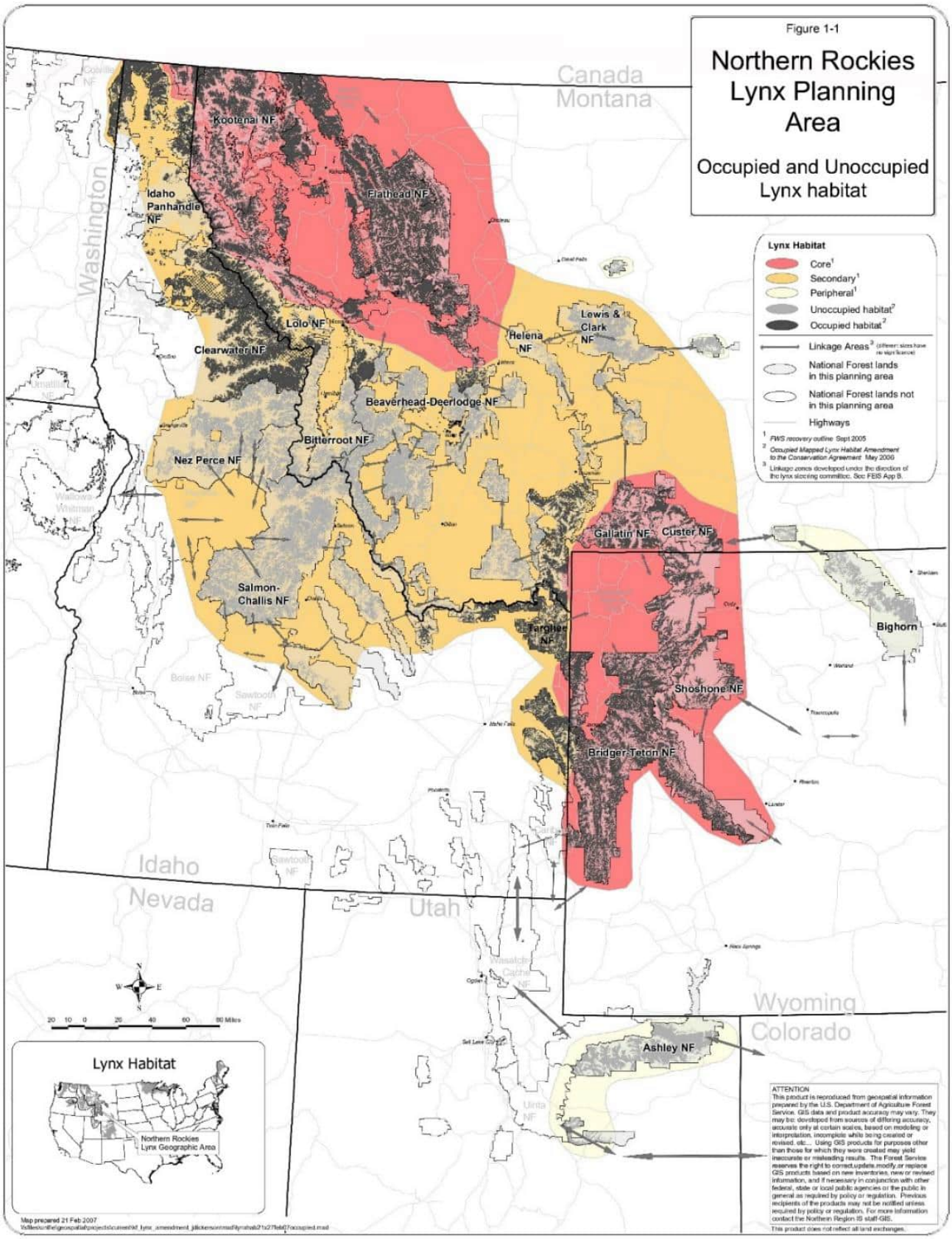


Figure 1. Map of Lynx Habitats from the FEIS for the NRLMD

The Science Report (SR) addresses fragmentation as *"reduction of total area, increased isolation of patches, and reduced connectedness among patches or natural vegetation…"* (SR p84*). "habitat fragmentation is the most serious threat to biological diversity and is the primary cause of the present extinction crisis."* (SR p85). *"rare species associated with wilderness, such as the lynx, generally are considered most susceptible to fragmentation."* (SR p86). *"generalist predators tend to dominate the predator guild in fragmented landscapes."* (SR p86). Coyotes and lynxes are separated by snow conditions, but *"this separation may break down where human modifications to the environment increase access by coyotes to deep snow areas. Such modifications include expanded forest openings throughout the range of lynx in which snow may be drifted, and increased snowmobile use in western mountains. Recreational snowmobile use has expanded dramatically in the United States in the past 25 years, with hundreds of thousands of km of trails (>19,000 km of groomed trails in Maine alone) within the pre-settlement range of the lynx…"* (SR p94). *"Fragmentation of habitats occupied by lynx (including increased openings, higher road densities, exurban residential development, and wider use of snowmobiles and devices that compact snow in areas with deep, soft snow) is a plausible mechanism for the questionable conservation status of the lynx in the contiguous United States."* (SR p95).

The data and information included in the Science Report had mostly been generated by the early 1990s, much in the 1970s and 1980s. The studies describing road density and snowmobile effects were very limited. The single study in the Science Report (p308) was based on data from the 1980s and stated that *"Road densities had no significant effect on habitat selection, and lynx crossed roads at frequencies that did not differ from expectation."* There was no data on use of these roads by vehicles in summer or snowmobiles in winter. Road density averaged 1.28 miles/sq.mi. As noted above, snowmobile use was expanding. The Science Report (p391) noted that *"Roads in the study area were of primitive standards that received little use in summer but were frequently used by snowmobilers in winter."* The Science Report (p295) said, *"Snowmobiles became readily available in the late 1950s and early 1960s, likely influencing trapper coverage, access, and attitudes."* Science Report (p391*), "Although legal harvest is no longer a conservation concern, human-caused mortality is believed to be additive in the low-density lynx populations characteristic of southern boreal forests (Koehler 1990; Table 13.3). If so, illegal or incidental harvest could significantly reduce population numbers of lynx in southern regions."*

2017 Species Status Assessment (SSA). The USFWS published a species status assessment (SSA)[23] for Canada lynx in 2017. The SSA recognized the lack of regulatory mechanisms was the reason for listing. (SSA p1). It stated:

> Factors affecting lynx that were evaluated in the SSA *"include the adequacy of existing regulatory mechanisms (the factor for which the DPS was listed); climate change, vegetation management, wildland fire management, and habitat loss and fragmentation (the factors considered by the Interagency Lynx Biology Team [ILBT] to have the potential to exert population-level effects on the DPS); and other factors that could influence the continued ability of particular geographic units to support resident lynx."* (SSA p3).

[23] U.S. Fish and Wildlife Service. 2017. Species Status Assessment for the Canada lynx (Lynx canadensis) Contiguous United States Distinct Population Segment. Version 1.0, October, 2017. Lakewood, Colorado.

> *"The lack of regulations protecting lynx habitat from potential threats on Federal lands at the time of listing has been largely addressed by formal and binding amendments or revisions to most Federal land management plans within the DPS range. Although uncertainty remains about the efficacy of this improved regulatory framework, Federal lands are now being managed specifically to protect and restore lynx habitats, with the goal of supporting continued lynx presence on these lands."* (SSA p231).

This last statement is incredibly dismissive of the main cause of lynx habitat degradation, lack of adequate regulation, and instead, dismisses almost all actions that the Science Report acknowledged adversely affect lynx and lynx habitat. We searched online for evidence that the CNF has adopted the NRLMD or provided any Forest Plan amendments for lynx protection. There were none to be found. Y2U sent a letter to Mel Bolling, Forest Supervisor of the Caribou Targhee NF (CTNF) requesting updated analysis of the lynx status in the CTNF, including its historical occurrence, migration corridors and connections between habitats. The letter outlined our desired analysis and mapping to include human fragmentation and historical lynx habitat use.[24] The response from Mr. Bolling explained the current situation in the CTNF.[25]

Mr. Bolling explained some of the history of the lynx listing, the Science Report, LCAS and the 2013 revision of the LCAS which is now considered the primary guidance for land management agencies. His letter pointed out that the Targhee NF RFP was amended by the NRLMD in 2007. A National Lynx Survey was conducted on both the Forests in 1999 and determined that the Targhee NF met criteria for management as an occupied forest, but the Caribou did not. Therefore, the Caribou NF was not subject to the NRLMD and *"No LAU's or lynx habitat is mapped on the Caribou due to the designation of the Caribou NF as an unoccupied forest in 2002."* (p2). The conservation measures in the CNF RFP were *"deemed sufficient: by the USFWS through consultation on the RFP Biological Assessment to address threats to Canada lynx and provide regulatory mechanisms to ensure the continued persistence of Canada lynx on the Caribou National Forest."* Under this arrangement, therefore it appears that the provisions of the CNF RFP would be central to analysis of lynx habitat because other protections are dismissed due to what appears to be an arbitrarily determined occupancy status that ignored historical lynx observations and only relied on absence determined by the National Lynx Survey in 1999 which occurred long after historical reported occupancy. We address this further on.

Mr. Bolling's response included reference to a paper by Olson et al (2021)[26] which used lynx observations in the west, climate, and human induced factors to model lynx habitat. Using lynx GPS and tracking data from Idaho, Wyoming, Montana, Washington, and British Columbia, the study found that lynx habitat is made up of a complex array of environmental conditions, not primarily vegetation type and elevations as currently mapped. They included an index of

[24] Carter, J., Garrity, M., Johnson, S., and Fite, K. 2021. Request for Response on Lynx Analysis in the CTNF. Letter on behalf of Yellowstone to Uintas Connection, Native Ecosystems Council, Alliance for the Wild Rockies, and Wildlands Defense. Dated August 15, 2021.
[25] Bolling, M. 2021. Response to letter requesting information on Canada lynx. Dated September 13, 2021.
[26] Olson et al. 2021. Improved prediction of Canada lynx distribution through regional model transferability and data efficiency. Ecology and Evolution 11:1667 – 1690.

summer vegetation production, percentage of tree cover, road density and night light intensity as indices of anthropogenic influences. One confounding issue is their assumption of boreal forest soil pH as a factor due to the wetter conditions in boreal forests. However, we know lynx use a variety of forested types and this factor might disqualify habitats unnecessarily. The model provides insight and a basis for more detailed analysis of lynx potential habitat and its fragmentation within the linkage in SE Idaho in the CTNF. We have included an Olson et al map from that paper as Figure 2 below. It illustrates a high probability of suitable lynx habitat in SE Idaho and the CNF. So, by this model, lynx habitat is present in SE Idaho. Why are there no lynx here? It is up to the FWS in its current Species Status Assessment and review to determine this.

Our review of the 2017 SSA finds a tenor of finding continued habitat fragmentation and degradation as unimportant to persistence of lynx, while only implicating climate change as problematic. But climate change is superimposed on all the existing insults to habitat and heightens their importance in the decline of lynx and lynx habitat. For example, the SSA contends that lynx only occurred in Colorado during *"irruptions from Canada…in the early 1960s and 1970s"* concluding that there is doubt that the population in Colorado *"will receive the demographic and genetic support from the north that is thought to be important to the DPS populations."* (p227).

There are two competing hypotheses operating regarding lynx presence in Colorado.

> H1. Lynx had been present in the Southern Rockies (south of Idaho-Wyoming) in a self-sustaining population for millennia but were slowly extirpated as a result of human activities, including trapping and livestock grazing, from early 19th century through mid-20th century.
>
> H2. The presence of lynx in the Southern Rockies in the 19th and 20th centuries prior to lynx reintroduction into the San Juan Mountains, was due mostly or entirely to periodic influxes of lynx from Canada.

Two bodies of evidence (I & II) support H1 as the correct hypothesis.

> I. There is a general lack of evidence of lynx population cycles in Canada being correlated with lynx population dynamics in the U.S., let alone in Colorado. The Science Report (p242) comments on the immigration hypothesis.
>
> *"In the Canadian provinces, Alaska, Montana, and Washington, we know that there are local reproductive populations, knowledge that invalidates a pure immigration hypothesis. For these areas, we can only state that they appear to be a part of a population in which lagged synchronous dynamics occur. Because we do not know why these dynamics occur, we cannot say to what extent they are affected by changes in local dynamics and the role that immigration might play.*
>
> *. . . the lack of lynx occurrence records associated with a large population peak occurring in the central provinces during the early 1980s. This population peak*

was higher than any recorded in the 20th century prior to 1959, but there was no evidence from museum specimens, verified mortality records, or anecdotal observations that unusual numbers of lynx occurred in any portion of its range in the contiguous United States."

II. Since lynx reintroductions in Colorado, lynx have reproduced and become established there. Prognostications of the eventual disappearance of lynx from Colorado are speculative and have nothing to do with whether Colorado was or is capable of supporting a self-sustaining population of lynx.

The Science Report in describing the population cycles made this observation regarding the Minnesota population: *"a three-year lag with data from the south-central Canadian provinces resulted in a strong correlation for the most recent period (r = 0.73, 1960-1983) but the pattern is out of phase in the previous 26 years… ."* (SR p238). We note that lynx were present in the DPS during large blocks of time other than in the 1960s and 1970s.

The 2013 LCAS. We reviewed the 2013 LCAS.[27] It emphasizes protection of core areas which support persistent lynx populations and "*less stringent protection and greater flexibility in secondary/peripheral areas…*" (p2). The only conservation measures provided for these peripheral areas were for vegetation management, which are general and unenforceable statements such as "*Vegetation treatments should be designed with consideration of historical landscape patterns and disturbance processes. Design timber harvest, planting, and thinning to include some representation of young densely stocked regenerating stands in the mosaic for snowshoe hare production areas"* (p95). The 2013 LCAS provided conservation measures for core areas and stated that projects "*must be consistent with the management direction contained in the forest plan."* (p89). This would mean the analysis would be consistent with the CNF RFP and its FEIS. Conservation measures for core areas included (only examples cited, for full list see the LCAS):

1. Delineate LAUs (p89)
2. Vegetation management (includes several measures including landscape evaluation to identify opportunities for adaptation to climate change). (p89)
3. Wildland fire management (p93)
4. Habitat fragmentation (promote or retain large contiguous blocks of lynx habitat, identify linkage areas to maintain connectivity, minimize large scale development, and others (p93)
5. Recreation management (direct recreational activities away from identified linkage areas (p94).
6. Minerals and energy (locate facilities and roads outside of lynx habitat and linkage areas where possible) (p95)
7. Backcountry roads and trails (Avoid Road reconstruction and upgrades that substantially increase speeds) (p95).
8. Livestock grazing (manage in riparian areas to maintain snowshoe hares) (p95).

[27] Interagency Lynx Biology Team. 2013. Canada lynx conservation assessment and strategy. 3rd edition. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication R1-13-19, Missoula, MT. 128 pp.

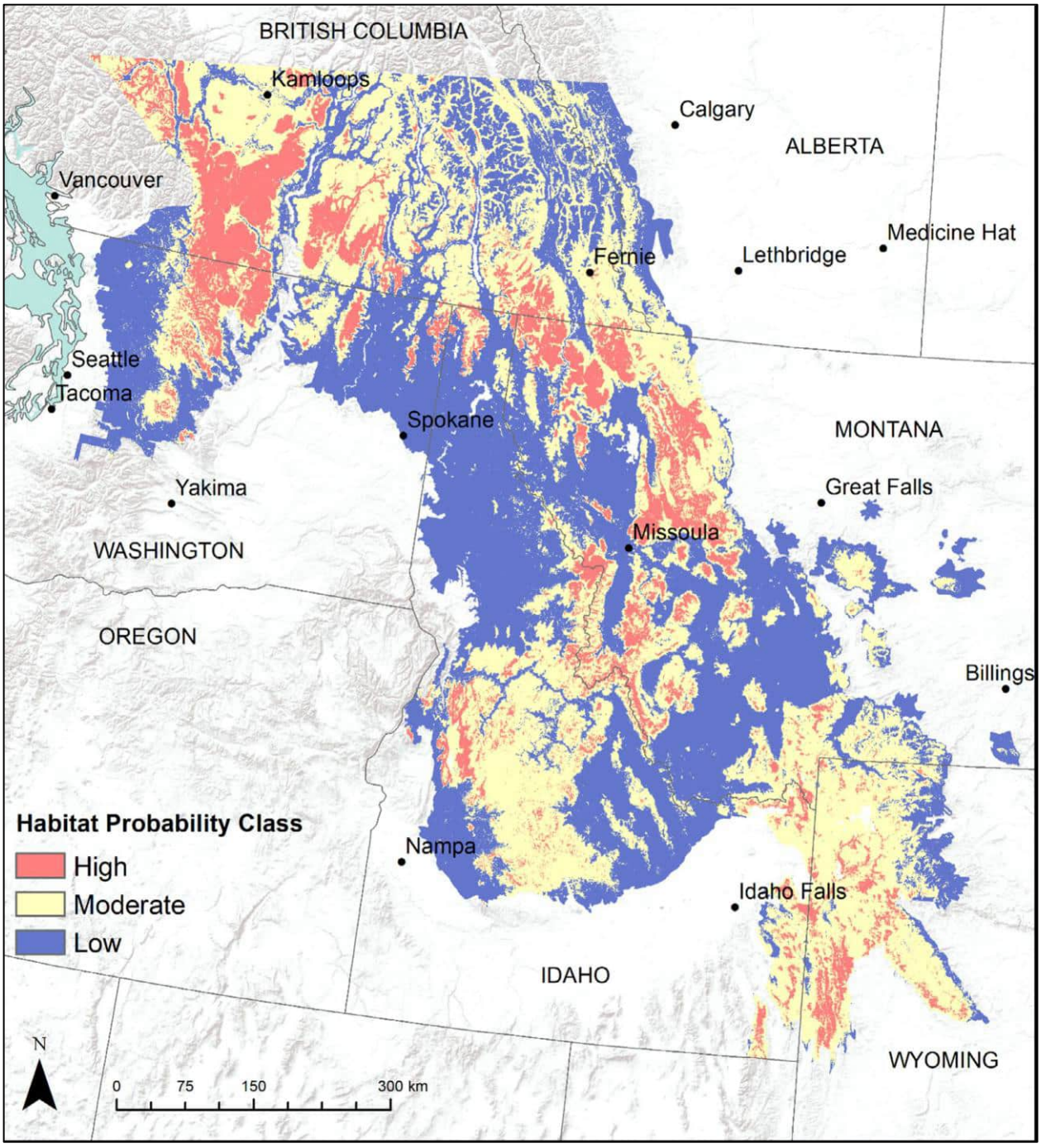


Figure 2. Prediction of Canada Lynx Habitat Probability from Olson et al 2021.

In the past two years we have seen several National Forests, the Caribou Targhee NF, the Ashley NF come out with prescribed fire and other forest manipulations that cover most, if not all, of the acreage within those Forests. These add up to nearly 2 million acres. This is happening across the West.

We have included Figure 3.1 from the 2013 LCAS here as Figure 3. That map does not show any linkage habitat. While it refers to the USFWS Recovery outline, there is no analysis of how to recover lynx. The 2013 LCAS does address factors that compromise lynx habitat and movement under the umbrella of *"anthropogenic influences"*(p68). It admits that not every human activity has been examined, but groups the activities into two tiers that can negatively affect lynx populations and habitat. The specialization of lynx on snowshoe hares and lynx *"low densities and in small populations throughout their range in the contiguous United States .. increase their susceptibility to local extirpations."* (p68). First tier factors include climate change, vegetation management, wildland fire and habitat fragmentation *"can directly effect (sic) both snowshoe hare and lynx population dynamics."* (p68).

"Federal agencies have amended or revised land management plans across much of the range of the lynx to provide direction to conserve lynx and lynx habitat. Thus, the impacts of anthropogenic influences have been substantially reduced." (LCAS p68). The Caribou NF has not demonstrated that its RFP has *"conserved lynx and lynx habitat"* or reduced *"anthropogenic influences"* while continuing to propose and approve projects across the CNF, including phosphate mines, timber and prescribed fire, and off-road vehicle trails. In no case have lynx protections or criteria been invoked or analyzed and no habitat analysis of the linkage capability has been performed, and in every case when consulted, the FWS has signed off on these projects. FWS must do a better review of these projects and their implications to lynx habitat, including requiring that land management agencies conduct the proper monitoring, quantitative habitat descriptions and analysis of habitat structure and function prior to approving future projects.

The 2013 LCAS describes how these first-tier factors affect lynx and lynx habitat. Climate change is a factor which is overriding other impacts and can cause shifts in distribution, changes in snowshoe hare cycles, reduction in lynx habitat and population, among other outcomes. (LCAS p69). Vegetation management alters stand structure, composition and arrangement and occurs across the range of the lynx. (LCAS p71). Wildland fire management can result in similar alterations. (LCAS p76). Habitat fragmentation, *"accentuates the viability risk inherent in a small population and increases its vulnerability to local extirpation."* (LCAS p76). Examples of fragmentation include, *"removal of forest cover, development of highways and associated infrastructure, and intensive minerals or energy development…"* (LCAS p77). Vehicle collisions are a factor in mortality. Here, the LCAS admits these activities have inherent risk to viability for small populations. In a direct contradiction to the Remand Notice, here *"intensive minerals development"* is a factor fragmenting habitats, yet this is excluded from any standards in the NRLMD for linkage habitats.

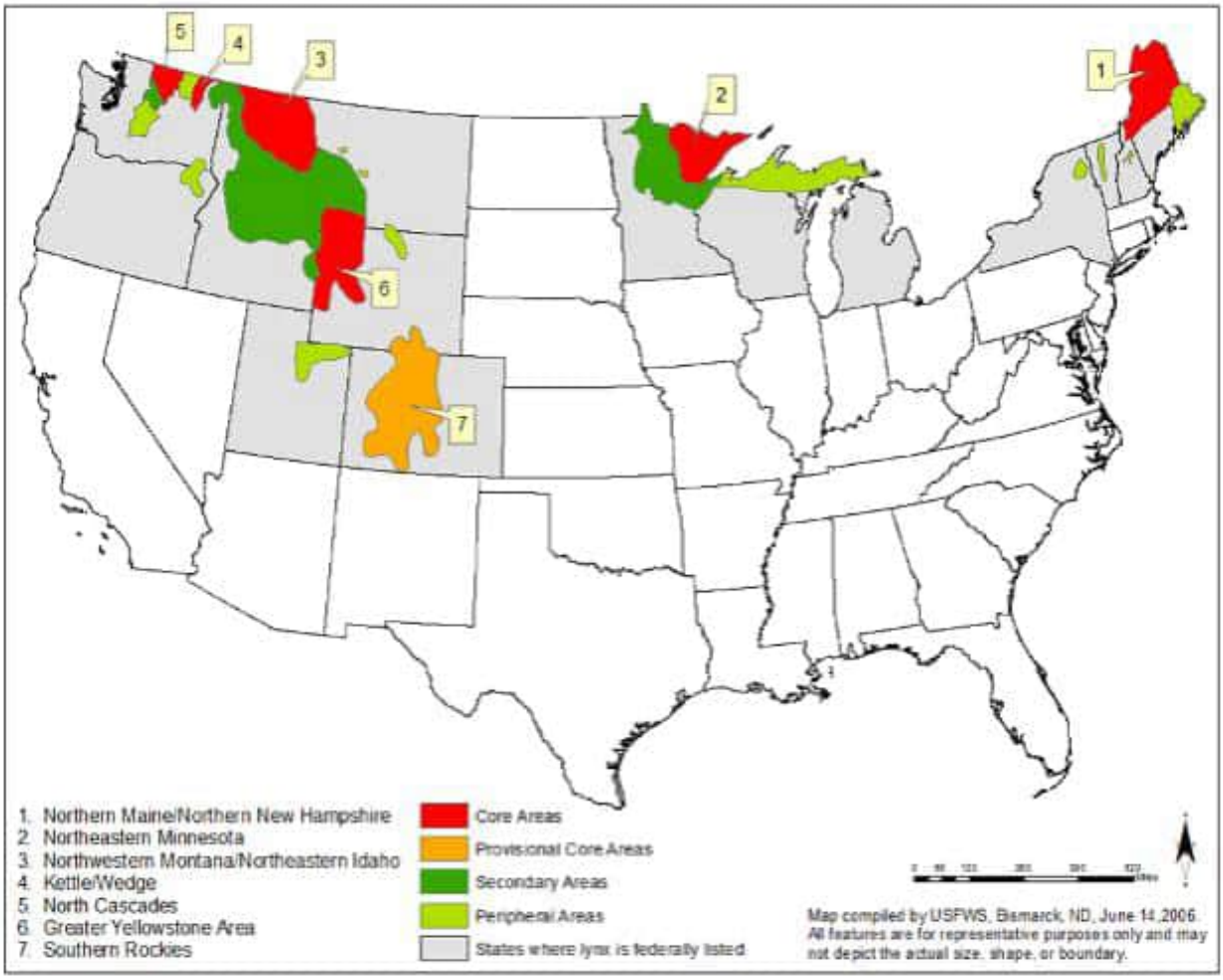


Figure 3. Taken from the LCAS Figure 3.1. Areas identified as core, secondary, and peripheral as depicted in the Canada Lynx Recovery Outline across the states where the lynx is listed (U.S. Fish and Wildlife Service 2005)

The second tier of anthropogenic influences include incidental trapping with rates of trapping *"positively related to average pelt value and appeared additive to nontrapping mortality."* (LCAS p79). It *"can occur in areas where regulated trapping for other species…overlaps with lynx habitats."* (LCAS p79). *"No conservation measures to address incidental trapping are included … because trapping is regulated by the states."* (LCAS p80). Idaho allows trapping of numerous species, hound pursuit and with snowmobile access and groomed trails, winter access is available throughout the CNF. Previously we have noted the increase in trapping licenses in Idaho. This effect is dismissed from consideration.

Recreation is noted to be increasing with millions of participants. (LCAS p80). The data reported in the LCAS is pre-2009. Recreation effects include habitat loss from construction of developed areas, disturbance from human presence with examples of den abandonment, use of

compacted trails in the snow by competitors. (LCAS p80). Minerals and energy development *"could affect lynx habitat by changing or eliminating the native vegetation and contributing to habitat fragmentation. … development of associated roads, powerlines, and pipelines.. could also result in a loss of lynx habitat and contribute to fragmentation."* (LCAS p83).

An illegal shooting example from Colorado is provided, showing over 14% of reintroduced lynx were shot in the first 10 years. (LCAS p84). Forest/backcountry roads and trails with low vehicular or snowmobile traffic *"had little effect on lynx seasonal resource-selection patterns" and lynx traveled on roads "unplowed during winter". "Squires et al (2008) reported that lynx denned farther from all roads compared to random expectation. … occupy dens in early May when many forest roads are still impassable… snowmobiles no longer use the roads because of intermittent and unpredictable availability of sufficient snow."* Finally, *"fewer roads were located in denning habitat and higher road density occurred along forest edges and in managed stands, which lynx avoided…."* (LCAS p84). But these factors are all dismissed as affecting lynx in the Remand Notice and we find no regulatory standards regarding these activities relating to lynx and lynx habitat in the CNF.

Regarding livestock grazing, LCAS (p85) notes the summer diet of snowshoe hares is dominated by herbaceous food including *"forbs, grasses, and shrubs"*. Then claims that *"The habitats used by snowshoe hare that are most likely to be affected by livestock grazing are riparian willow and aspen communities."* The conclusion is that grazing by domestic livestock is *"unlikely to reduce the snowshoe hare prey base…"* This statement can only be produced by those who have never studied the impacts of livestock grazing on ecosystems in the Rocky Mountains. We have studied the effects of livestock grazing in SE Idaho and NE Utah and found extensive habitat degradation, over-utilization of forage, and overstocking. See Appendix 1 for a brief review with photographs showing some of the degraded conditions. Habitats in many of the National Forests in the southern portion of the DPS are terribly degraded by livestock grazing. Riparian areas and other snowshoe hare foraging areas are included.

By laying out these first and second tier anthropogenic effects for core areas, the 2013 LCAS inadvertently explains why lynx may not be found today in southern areas where they existed in earlier times. Lynx have *"low densities and in small populations throughout their range in the contiguous United States .. increase their susceptibility to local extirpations."* (LCAS p68). Almost every anthropogenic activity does have an adverse effect on lynx and lynx habitat as the science provided by the Forest Service and FWS have described in the preceding paragraphs. It is the omission of current monitoring and analysis along with the absence of adequate Forest Service standards that logic dictates is responsible for absence of lynx in places where it was observed in years gone by. We can find no monitoring or analysis of the effects of these activities to comply with the RFP and Travel Management Plan in the CNF. Lack of current data enables the CNF to deny impacts. Since our research has found an absence of recent monitoring and studies on Canada lynx habitat, populations and snowshoe hare habitats and populations across these southern Forests, it is incumbent on the current SSA effort to address this lack of information. **FWS must press for meaningful, ecological based standards, define linkages and corridors, and require they be addressed with detailed habitat, lynx, and snowshoe hare studies. Models such as we discuss later in these comments must be consolidated, evaluated, and applied to define and update core and linkage areas.**

Lynx Observations. The 2013 LCAS briefly describes lynx occurrences in the Northern Rockies. In Wyoming, lynx is a species of *"greatest conservation concern" and "has been documented historically and currently in western Wyoming…"* In Idaho lynx *"are classified as an S1 species of greatest conservation need."* Most of the 35 verified records in Idaho came from north of the Snake River with 2 from Caribou and Bonneville Counties along the Wyoming border. Recent snow tracking surveys have detected no lynx. (LCAS p57). Two lynxes were captured in traps in 2012 and 2013, one was released alive, and the other was shot due to being misidentified as a bobcat. In Utah, the LCAS reports only a few historical records from the early 1900s with later records all from northwestern Utah near the borders with Wyoming and Idaho. (LCAS p58).

Lynx observations were summarized in McKelvey et al (2000)[28]. McElvey et al used "*written accounts, trapping records, and spatially referenced occurrence data…"* (SR p207). They limited consideration of trapping records due to lack of constant effort and confusion with bobcats and where high reliability is needed, *"we used a subset of these data we call 'verified records"*. Verified records were those *"only if it was represented by a museum specimen, or a written account in which a lynx was either in someone's possession or observed closely….neither tracks nor sighting reports were considered to be a verified record."* (SR p209). Yet, today tracking surveys are used.

We have extracted McKelvey's data from Table 8.1 of their chapter and summarized the percent of observations that are *"verified"* and *"reliable"*. An extremely low percentage of total spatially referenced occurrences were *"verified"*. (Table 1). Hundreds to thousands of observations are not counted when determining lynx historical occupancy. Are we to believe they were all wrong? An example of this comes from a BLM report.[29] Of interest is an account by Harold Wadley, who was a Forester working for the U.S. Forest Service in Idaho and in the Uinta Mountains in Utah. Harold worked in the Uinta Mountains in 1957 and 1958. He used dogs and traveled by snowshoe to track and tree lynx. His records show he treed 20 Canada lynx in those two years. Harold encountered Canada lynx along the entire north slope of the Uinta Mountains. He estimated that there were 15 Canada lynx on the north slope of the Uinta Mountains between the West Fork of the Bear River and the Little East Fork of the Black Fork River. This essentially was the area within his ranger district. Was his report even considered? It is hard to tell. Do we just discount this as unreliable? After all, Harold worked for the U.S. Forest Service and knew lynx as do most trappers are likely to be able to do. His observations in the 1950s indicate a resident population occurred on a portion of the north slope of the Uinta Mountains at that time. This was prior to the irruptions from Canada in the 60s and 70s.

In the following paragraphs, we use an example of how one should approach these arguments surrounding whether lynx ever resided in the Uinta Mountains that was provided by Dr. Kirk

[28] McKelvey, K.S., K.B. Aubry, and Y.K. Ortega. 2000. History and distribution of lynx in the contiguous United States. Pages 207-264. Chapter 8. In Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires (Tech Eds). Ecology and conservation of lynx in the United States. Univ. Press of Colorado. Boulder, CO. 480 p.

[29] Lewis, L. and Wenger, C.R. 1998. Idaho's Canada Lynx: Pieces of the Puzzle. Idaho Bureau of Land Management Technical Bulletin No. 98 - 11 in cooperation with the U.S. Forest Service.

Robinson in one of our joint efforts to address domestic sheep grazing in the Uinta Mountains of Northwest Utah.[30]

Table 1. Spatially Referenced Occurrence Data from McElvey et al 2000.

State and time span	Total Spatially Referenced Occurrences	Verified Records	Verified as Percent of Total/Reliable
Colorado 1878 - 1974	196 Total 84 Reliable	17	8.7/20.2
Idaho 1874 - 1991	234 Total 228 Reliable	74	31.6/32.4
Utah 1916 - 1991	27 Total 17 Reliable	10	37.0/58.8
Montana 1887 - 1999	1,542 Total 1,169 Reliable*	84	5.5/7.1
Washington 1896 - 1999	765 Total 571 Reliable**	134	17.5/23.4
Wyoming 1856 - 1991	361 Total 288 Reliable	30	8.3/10.4

*Note that trapping records showed 3,012 reported between 1950 – 1997
**Trapping records show 215 between 1960 - 1989

Dr. Robinson's logical analysis examines the use of verified vs reliable accounts, or observations. He puts it this way:

> *There may have only been 10 verified records of lynx occurrence in the Uintas in the 20th century, but there have been an additional 17 reliable reports of lynx in Utah in the 20th century, based on physical remains (including photographs), visual sightings and track identifications, plus another 10 of unknown reliability. The total number of records is 37. Most of these lynx occurrences were on the north slope of the Uintas, in or near the West Fork of Blacks Fork. Even if we discount the 10 reports of unknown reliability, we still have 17 reliable reports and 10 verified records of lynx, for a total of 27, most of which located the lynx in the Uintas! In other words, the historical evidence indicates a minimum of 10-37 lynxes in the Uinta Mountains over the last 103 years (not counting dispersers from Colorado). Thus, there can be little doubt that the actual number of "sightings" was greater than 10. 30 would be much more probable.*
>
> *Why arbitrarily exclude the "reliable" sightings? What does "reliable" mean if you can't rely on what is reliable? Yet the FS chooses not to rely on them for the purpose of the DEIS—a decision that would seem to be based not so much on a desire for accuracy as a desire to minimize the presence of lynx in Utah in order to make room for Alternative 2.*

[30] Coalition comments on the High Uintas Domestic Sheep Analysis Project. 2019. Provided to the Uinta Wasatch Cache National Forest. August 5, 2019. Access at: https://app.box.com/s/797x21rggtx1t6yayr0gi9kpbouis4sr

> *At this point we should ask ourselves how many records—verified records, if you like—it would take to establish that there was a resident population of lynxes in the Uintas during some part of the 20th century. Does anyone have even the slightest clue? Of course not. And the reason is that there are no empirical data for establishing a baseline on which to base a prediction. Surely all we can reliably say is that the more records (verified + reliable), the higher the probability. Thus, this premise commits the fallacy of begging the question by presupposing what is to be proved.*

As we review the table 8.1 from McKelvey, it is apparent that most historical observations and accounts are dismissed out of hand and have become the basis of today's claims by FWS and the Forest Service that there are not (and perhaps never were) resident lynx in Utah and Idaho, or Colorado for that matter even though the reintroduced population survives there today and appears stable or increasing according to the Forest Service website cited earlier.

McKelvey et al (2000) also provide a narrative describing lynx records in Idaho, totaling 73 records. Some records such as reported in Lewis and Wenger (1998), are apparently not included. The following are extracted from McElvey et al:

> From 1874 – 1917, there are 22 museum specimens from areas north of the Snake River Plain. In 1939 and 1940 specimens were collected in central Idaho in Valley County and Idaho County. In 1954 and 1955 specimens were located from Bonner and Shoshone Counties. Other verified records include one from Shoshone County in 1901, one from Boundary County in 1919, one from Idaho County in 1936, one from northwest Idaho in 1939, one from Clearwater County in1942, five from Caribou County in 1947, two from Bonneville County in 1955. (SR p225 - 226).

> *"There are 35 verified records from 1960 to 1991: four from 1962 to 1969, 18 from 1970 to 1979, 10 from 1982 to 1989, and three from 1990 to 1991; there are no verified records of lynx in Idaho since 1991 (Anonymous 1999, unpublished). Although most of these records are from the northern and central regions of Idaho where lynx occurred historically, six are from counties in the Snake River Plain, in areas where forest types occupied by lynx are absent or very fragmentary in extent (see "Lynx Associations with Broad Cover Types"). These include records from Blaine, Butte, Jerome, and Twin Falls Counties in 1972; one from Blaine County in 1984; and one from Power County in 1990".* (SR p227).

The Lewis and Wenger (1998) report provided numerous accounts of lynx and lynx tracks in Idaho. They noted that little is known about Canada lynx in Idaho and that *"the lack of Canada lynx studies…only adds to the puzzling nature of the species"*. It was based on interviews with individuals *"familiar with Canada lynx habitat and local fauna in general."* (pi). These were individuals documented by Idaho Fish and Game as *"having harvested Canada lynx"*. While the report covers several areas of Idaho, it also includes Eastern Idaho accounts by 18 individuals. These are provided here for the SE Idaho area. They included accounts from residents in Island Park, St. Anthony, Rexburg, Georgetown, Ashton, Preston, Swan Valley,

Paris, Montpelier, and Alta, Wy. The reports included those who observed lynx in SE Idaho in Georgetown Canyon, Tincup Creek, and Henry's Fork, many of whom killed lynx or observed their tracks. The report paints a broad picture of lynx across much of Eastern Idaho as well as other areas of the state. Here is one from Oliver Peterson of Montpelier who was trapping prior to the 70s when lynx sightings were claimed to be due to movement from Canada due to hare cycle lows. It appears very convenient today to claim there were never resident lynx in these areas.

> *Oliver Peterson, Montpelier, ID —Oliver began trapping in 1945 and did most of his trapping in the 1950s and 1960s. During a one-week period in 1947 or 1948, he caught five Canada lynx ten miles northeast of Soda Springs. He trapped four Canada lynx in the 1950s and 1960s, one in the same area where he caught the five Canada lynx. He caught three Canada lynx farther east near Georgetown. Except for one Canada lynx trapped near timberline, the remaining Canada lynx were caught in areas with a mosaic of aspen, conifer, and mountain brush. (p8). He speculated that during those years there were no snowmobiles and atvs and that the demise of lynx was due to increased access and by snowmobiles, atvs, and the lack of snowshoe hares. Traplines were accessed by snowshoe or skis and now (the 1990s) there is "intensive snowmobile and atv use". He believed this was a primary factor in the demise of lynx since the 1970s.* (p17).

The interviews provided information on lynx prey including jackrabbits, grouse, red squirrels, voles in addition to snowshoe hares indicating the use of alternate prey appears greater than in Canada and Alaska. The authors suggest scenarios relating lynx behavior to jackrabbit populations by lynx following jackrabbits into shrub steppe far from typical coniferous forest habitats and end up near other habitats occupied by snowshoe hares and/or may exploit jackrabbit population highs without leaving traditional habitats resulting from jackrabbits dispersing into those habitats.

They also discuss livestock grazing, noting that studies show that livestock reduce forage availability, that elk and livestock eat many of the same species as do black-tailed jackrabbits and reduce forage to the point it limits jackrabbit densities. *"Grazing of the same areas by both species may have cumulative effects on both snowshoe hare and jackrabbit habitats."* (p17). *"Utilization of forage by both elk and livestock may thus have a significant impact on hare habitats. This may be particularly true in the southern-most portions of the Canada lynx range where grazing becomes a more dominant use."* (p18).

In conclusion, Lewis and Wenger (p19) state, *"there is no 'smoking gun' factor in the decline of Canada lynx in Idaho. Many variables appear to limit Canada lynx numbers in this state. The most important of these appear to be timber harvest practices; high numbers of coyotes, mountain lions, and elk; increasing motorized and nonmotorized recreational use; incidental trapping; and reduced numbers of alternate prey, including species that are not documented as Canada lynx prey in existing research. These include jackrabbits, beavers, and porcupines."*

Lynx, the ESA and Forest Service Manual. The ESA promulgated regulations at 50 CFR § 402.12 delineate the purpose of a Biological Assessment (BA) as to *"evaluate the potential effects of the action on listed and proposed species and designated and proposed critical habitat…"*. It describes the contents as *"discretionary"* and depends on the nature of the federal action with consideration for including (1) results of on-site inspections; (2) views of recognized experts; (3) review of the literature; (4) analysis of the effects of the action on species and habitat, including cumulative effects and the results of related studies; and (5) analysis of alternate actions considered by the Federal agency.

In a recent typical example in the CNF in a Decision for a phosphate mine, the Husky 1 North Dry Ridge mine, the BA only based its brief analysis on the proposed action, not the suite of alternatives contained in the FEIS.[31] It included minimal analysis. The intent of the ESA was avoided and if one applied the NEPA standard for a hard look or cumulative effects to this aspect of the analysis, the analysis would fail. *"Discretionary"* cannot be used to avoid taking a hard look in the analysis. This project, combined with other projects that are listed in the FEIS for H1NBR in addition to roads, timber harvest, and recreation, occurs within a linkage area connecting to critical habitat for lynx immediately east of the project. Figure 4 illustrates this and shows some of the phosphate leases in the CNF lynx linkage for illustration. The loss of this connection due to habitat fragmentation means the loss of the genetic connection between the critical habitat and other peripheral habitat such as in the Uinta Mountains which then connect to the current Colorado population. **How can regulations or land use plans be effective when they are *"discretionary"* for the project proponents? This must be addressed.**

The Forest Service Manual[32] cites the ESA as *"the Act directs federal departments and agencies to ensure that actions authorized, funded, or carried out by them are not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of their critical habitats."* (FSM 2670.11). The FSM (2679.12) cites Departmental Regulation 9500-4 as (1*) "Manage 'habitats for all existing native and desired nonnative plants, fish and wildlife species in order to maintain at least viable populations of such species.'"* (2*) "Conduct activities and programs 'to assist in the identification and recovery of threatened and endangered plant and animal species.'"* (3) *"Avoid actions 'which may cause a species to become threatened or endangered'"*. The CNF provided guidance in its RFP FEIS to address this connectivity but has ignored its own guidance in approving the H1NDR and all the other projects we have reviewed. How can the CNF dismiss impacts to Canada lynx without actually conducting an analysis? The current analysis for H1NDR and other projects does not *"ensure"* that actions do not further endanger or adversely modify habitat. Only in the industry bias world of today's Forest Service could total destruction of habitat not be considered an "adverse" impact. Degrading and fragmenting this linkage habitat compromises lynx migration and habitat adjacent to and bordering lynx critical habitat and must be considered in that context.

FSM 2670.31 provides additional guidance for T&E species.

[31] https://www.fs.usda.gov/project/?project=37878 Accessed on January 17, 2023.

[32] USDA Forest Service. 2005. Forest Service Manual National Headquarters (WO) Washington DC. FSM 2600 – Wildlife, Fish, and Sensitive Plan Habitat Management Chapter 2670 – Threatened, Endangered and Sensitive Plants and Animals (September 23,2005).

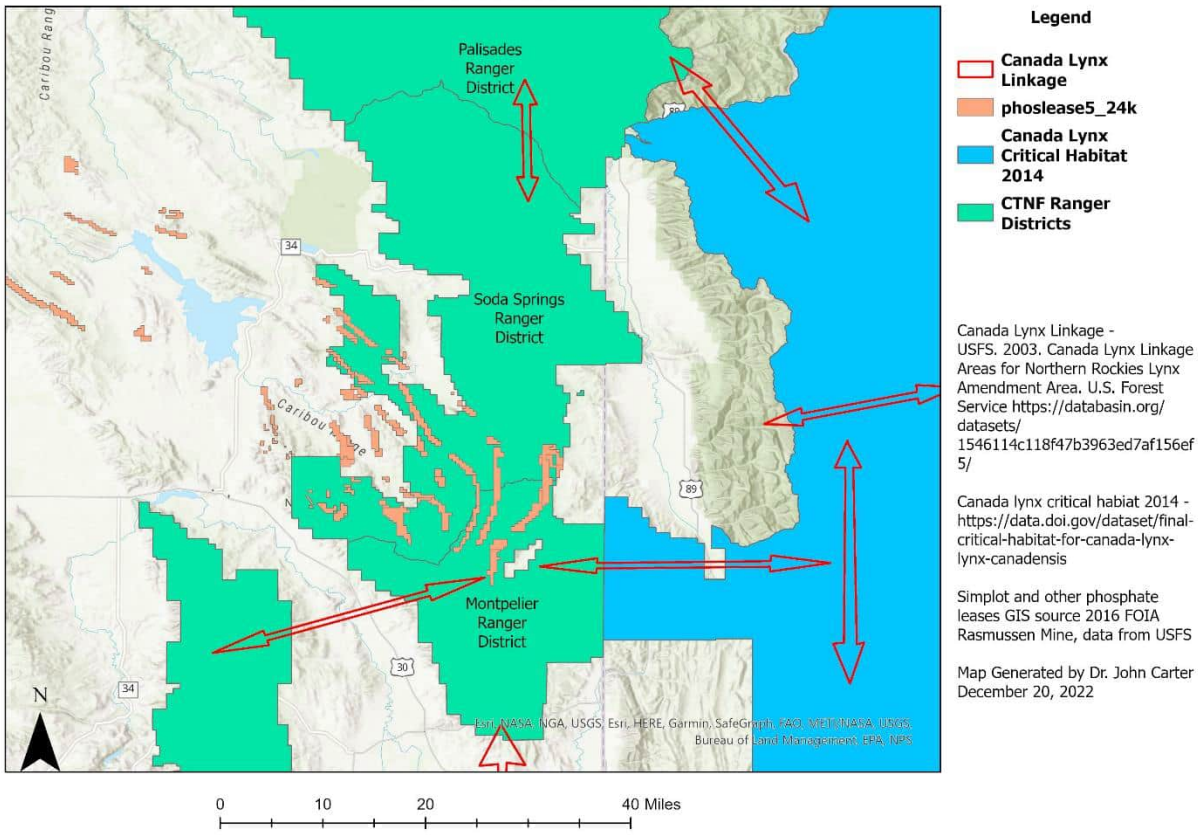
(1) *"Place top priority on conservation and recovery of endangered, threatened, and proposed species and their habitats."* (2) *"Establish, through the Forest planning process, objectives for habitat management and/or recovery of populations."* (4) *"Avoid all adverse impacts on threatened and endangered species and their habitats, except when it is possible to compensate adverse effects totally through alternatives identified in a biological opinion."* (6) *"Identify and prescribe measures to prevent adverse modification or destruction of critical habitat and other habitats essential for the conservation of endangered, threatened, and proposed species. Protect individual organisms or populations from harm or harassment as appropriate."*

Once again, the CNF has not placed top priority on conservation and recovery, has not established meaningful objectives with enforceable standards for lynx habitat, has not designated LAUs with standards to protect preferred habitats and linkages, has ignored the effect of this linkage area on the adjacent critical habitat, thus compromising the integrity of that critical habitat and what remains of the core population in the DPS. The CNF by allowing snowmobile use on 97% of the Forest is not preventing harm or harassment of lynx, wolverines or other species which are affected by snowmobile use and the associated trapping, shooting and harassment. We have witnessed multiple snowmobiles trespassing on Kiesha's Preserve chasing and harassing a coyote and deer in an effort to "whack" the coyote and at other times, releasing dogs carried in their sleds to chase mountain lions while trespassing. With the groomed trails throughout the mountains, one hunter can cover a hundred miles in one day looking for tracks to turn out his dogs.

The FSM 2670.5 provides definitions of terms that are useful in interpreting the efficacy of the agency analysis. An **adverse effect** includes *"Any action that directly alters, modifies, or destroys, critical or essential habitats or renders occupied habitat unsuitable for use by a listed species, or that otherwise affects its productivity, survival, or mortality."* **Essential habitat** is defined as *"Those areas designated by a regional forester as possessing the same characteristics as critical habitat without having been declared as critical habitat by the Secretary of the Interior or Commerce. The term includes habitats necessary to meet recovery objectives for endangered, threatened, and proposed species and those necessary to maintain viable populations of sensitive species."* A **viable population** is defined as *"A population that has the estimated numbers and distribution of reproductive individuals to ensure the continued existence of the species throughout its existing range (or range required to meet recovery for listed species) within the planning area."*

The CNF has not designated Essential Habitat, but it has designated linkage for lynx. It has not identified recovery objectives or evaluated how a project leads to recovery of lynx. The analysis we have provided shows actions by the Forest Service have had an "adverse effect" as demonstrated by the lack of lynx observations and presence in SE Idaho. Given the lack of lynx observations in the recent decades, it is apparent that human activity is occurring in such a manner that lynx populations are being affected. Otherwise, why are lynx not being found here today? This example is illustrative of failures by both the Forest Service to comply with the intent of its RFP and FWS failure to require detailed analysis and protections in its role of consultation.

Figure 4. Canada Lynx Critical Habitat, Phosphate Lease Locations, Linkage Area including Soda Springs and Montpelier Ranger Districts Based on FEIS for 2003 Caribou Revised Forest Plan



FSM 2671.44 describes determination of the effects on listed species. Biological evaluations are to *"conduct and document the program and activities review necessary to ensure that any action … is not likely to jeopardize the continued existence of any listed or proposed species or to result in the destruction or adverse modification of critical or proposed critical habitat."* Internal *"biological expertise"* and *"informal consultation"* are to be used to reach *"supportable determinations of effect"*. Finally, *"Consider effects on suitable unoccupied habitat essential to recovery of the species when doing the biological evaluation."* We do not see CNF analysis of the linkage, or "suitable unoccupied habitat" or any effort to address its current vs historical condition as delineated in the CNF RFP FEIS. FWS is not addressing failures such as these.

The lack of adequate regulatory mechanisms to protect lynx habitat and connectivity has been implicated as a central issue for lynx being able to maintain populations.[33] (FR p16052). The FSM described above makes the point that the Forest Service should establish through planning,

[33]DOI USFWS. 2000. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Contiguous U.S. Distinct Population Segment of the Canada Lynx and Related Rule. Fed. Register Vol. 65, No. 58.

objectives for habitat management and/or recovery of populations and prescribe measures to prevent adverse modification of habitat essential to the conservation of T&E species. This remains to be done and the FWS should ensure that not only the CNF, but all Forests and BLM land management plans are quantitatively addressing lynx habitat and connectivity needs.

What the CNF provides for lynx linkage in its RFP is summarized below.

Caribou NF Direction for Canada Lynx. The Caribou RFP FEIS laid out a process for addressing connectivity. We have reviewed the RFP for standards or objectives relating to lynx and its habitat. Overall, these are quite generic and not specific to the habitat of lynx. The direction specified to maintain linkages for Canada lynx is found in (1) Vegetation Desired Future Conditions, (2) Vegetation Goals 1 – 4, (3) Vegetation Standard 2, (4) Wildlife Goals 2, 3, and 5, (5) Vegetation Goal 7, (6)Lands Objective 1, and (7) Lands Standard 1. (RFP 3-28) We reviewed each of these for specifics regarding lynx habitat. They are summarized below:

1. **Vegetation DFC** (RFP 3-17) to retain diversity of structure and composition, 30 – 40% of conifers in mature and old classes (FEIS notes this will not be attained), functional corridors are present, aspen managed to 20 – 30% mature and old, non-forested vegetation within site potential and within HRV, restoration of native shrub communities accomplished, woodland types are multi aged with balanced shrub/herbaceous understory and within HRV.

2. Vegetation Goals 1 – 4, 7 (RFP p3-17 – 3-18) to have diverse forested and non-forested ecosystems within HRV and/or restored through time, aspen managed to reduce or halt decline, forested ecosystems moving towards a balance of age and size classes in each forested type on a watershed or landscape scale, sage-steppe and mountain brush moving towards a balance of age, canopy cover, and size class on a watershed or landscape scale and within HRV, biodiversity maintained or enhanced.

3. Vegetation Standard 2 (RFP 3- 19*) "In each 5th code HUC which has the ecological capability to produce forested vegetation, the combination of mature and old age classes (including old growth) shall be at least 20 percent of the forested acres. At least 15 percent of all the forested acres in the HUC are to meet or be actively managed to attain old growth characteristics."*

4. Wildlife Objective (RFP 3-24) *"The Forest provides habitat that contributes to state wildlife management plans; Forest management contributes to the recovery of federally listed threatened, endangered, and proposed species and provides for conditions, which help preclude sensitive species from being proposed for federal listing."*

5. Wildlife Goals 2, 3, and 5 (RFP 3-24) states that wildlife biodiversity is maintained or enhanced by managing for vegetation and plant communities within their HRV, maintain multiple vegetation layers in woody riparian habitats, maintain, and "*where necessary and feasible, provide for habitat connectivity across forested and non-forested landscapes."*

6. Lands Objective 1 (RFP 3-8) *"Identify land adjustments and rights-of-way to improve management, public access, and/or wildlife connectivity annually."*

7. Lands Standard 1 (RFP 3-9) *"Priority shall be given to acquiring lands having special importance or unique characteristics such as riparian areas, historic sites, habitat for federally listed species, recreation sites, etc."*

There is no specific direction and no enforceable standards regarding lynx habitat and linkage (which the Forest Plan itself mapped). These appear as mere afterthoughts with no relation to research on lynx or hare habitat. We have seen no evaluation in any project as to whether these have any relation to the habitat needs of lynx. In our example, the H1NDR NEPA process did not analyze these provisions or reveal how they have been applied across the affected watersheds and landscape where lynx formerly have been found, or in the linkage shown in the CNF RFP FEIS. In our example of the H1NDR FEIS, the analysis did not use the guidance in the CNF RFP FEIS on connectivity and how to analyze it. It did not analyze the risk factors described in the LCAS and the combined impact of all the various uses and projects on this linkage area. A review of IRAs in the CNF finds they are rarely different in management than other forest lands, with many user-created roads and trails, past timber harvest, mining, and livestock grazing. For example in our comments on the Dairy Syncline DEIS (p43) we cited the Idaho roadless rule description of the Huckelberry Basin IRA which was to be fragmented for a tailings pond.[34] *"Remoteness and solitude rate as low, because of development." .. "Manageability of the area is considered poor, due to road intrusions and timber harvest activities."* (Idaho roadless rule FEIS C5-46). This is typical of the characterization of IRAs under the Idaho Roadless Rule. So, if IRAs are fragmented by all these activities, where are the intact habitats for lynx and other special status species in IRAs and other habitats presumed to have lower levels of protection? **A thorough review of the science on lynx habitat characteristics needed for recovery and connectivity should be completed and used to compare current conditions in the CTNF to those needed for lynx.**

LYNX REGIONALLY SIGNFICANT WILDLIFE CORRIDOR (Y2UConn)

The following discussion is about the need to define, protect and restore a corridor or corridors, and provide standards for habitat to provide connectivity to the southern population of lynx. This is focused on the Y2UConn (higher elevation) corridor passing through SE Idaho and NE Utah to connect critical habitat in the GYA to the Colorado lynx population.

The Colorado Division of Wildlife tracked radio-collared lynx released in Colorado.[35] According to the Rocky Mountain Research Station, *"By 2010, all indications were that the vast majority of animals relocated there had stayed in the state and they seemed to be surviving and reproducing well enough that the population was on a slight upward trajectory."*[36] That

[34] USDA. 2008. Roadless Area Conservation National Forest System Lands in Idaho Final Environmental Impact Statement Appendix C.
[35] Devineau P, Shenk T.M., White, G.C., Doherty Jr., P.M. and R.H. Kahn. 2010. Evaluating the Canada lynx reintroduction programme in Colorado: patterns in mortality. Journal of Applied Ecology. doi: 10.1111/j.1365-2664.2010.01805.x 8 p.
[36] USDA RMRS. 2023. Winter Sports and wildlife: Can Canada lynx and winter recreation share the same slope?

link also noted that lynx were extirpated or greatly reduced in Colorado by the 1970s. The web report noted that *"managers really understand the need to provide for connectivity in these critical areas we've identified."* Do they? Are they? Where is the evidence? FWS should require evidence.

Devineau et al (2010) show that lynx telemetry records confirm that there is a *"hot spot"* of lynx occurrences at the western end of the Uinta Mountains, where collared lynx from Colorado remain for a time before moving on. As of 2009, at least 22 individuals had made at least 27 visits to the state of Utah, recorded by air telemetry and satellite.[37] The highest concentration of lynx locations in Utah, as identified by telemetry, is in the Uinta Mountains. *"The use-density surface for lynx use in Utah indicates the primary area of use being located in the Uinta Mountains."*[38] A recent report by Colorado Parks and Wildlife (CPW) using information from the tracking devices found that 19 males and 10 females reintroduced into Colorado between 1999 - 2006 were located in Utah.[39] Because some of these were single data points, CPW chose to evaluate 11 males and 6 females that were located in Utah between 2000 and 2010. Most of the individuals *"entered and exited Utah via the Uinta Mountains in the northeast, Abajo Mountains in the southeast, or the East Tavaputs Plateau in the east-central part of the state…."* The report points out that a male and female occupied the same area in the Uinta Mountains for >200 days, but it is not known if there was denning or reproduction. *"Those that spent a considerable amount of time in Utah tended to find and traverse the high country running north – south through the central portion of the state."* *"There were likely other individuals who made the trip. Also, CPW stopped monitoring collared lynx in April, 2011. Movements into Utah may or may not have continued since then, but we have no documentation."* (p3).

The Science Report (Chapter 10) discusses the history of lynx occurrence in Colorado. *"… boreal forest habitat in Colorado is insular in nature and isolated from similar habitat in Utah and Wyoming by more than 150 km of lower elevation habitats in the Green River Valley and Wyoming Basin (Findley and Anderson 1956). All but a few specimen records are from the center of this island of boreal forest habitat in west-central Colorado."* (SR p230). There were 15 specimens found between the 1800's and 1936 with none thereafter until 1969, 1972, and 1974 when four additional specimens were identified. Despite snow tracking efforts, there have been no verified records in Colorado since 1974. (SR p231). As we summarized in Table 2, out of 196 records in Colorado between 1878 – 1974, there were 17 verified records, but 84 reliable records.

Figures 8.19 and 8.20 in the Science Report (p247) depicts lynx occurrences overlaid on Kuchler (1964) vegetation classes in the western U.S. It is noted that Rocky Mountain Conifer cover type enclosed 82% of lynx occurrences. Those Figures and Figure 8.17 show dense patterns of lynx occurrence in Colorado, western Wyoming and the GYA, western Montana, northern Idaho, and Washington bordering Canada. A pattern of occurrence also is shown in northeast Utah and

https://www.fs.usda.gov/rmrs/winter-sports-and-wildlife-can-canada-lynx-and-winter-recreation-share-same-slope Accessed on January 19, 2023.

[37] Colorado Department of Wildlife (CDOW) Report, 2006-7, Tables 4 and 6, pages 23 and 24.

[38] Ibid. page 10; see also Figure 2, page 29.

[39] Ivan, J. 2019. Summary of movements of Colorado lynx in Utah. Colorado Parks and Wildlife, Fort Collins.

along the border between Idaho and Wyoming. Connecting these populations is critical for the DPS to recover and maintain gene flow.

We have been addressing connectivity in the Yellowstone to Uintas Connection since our organization was founded. The Y2UConn leg of the Regionally Significant Corridor is the high elevation, conifer dominated link needed to connect the GYA and northern Rockies to the Uinta Mountains and Southern Rockies. The CNF Forest Plan FEIS (pD-5)[40] summarizes the history/knowledge of this corridor through SE Idaho into NE Utah.

> *Most of the efforts to date to map corridors have focused on large-scale dispersal corridors generally from the Northern Rockies (Glacier NP) to the Greater Yellowstone Ecosystem. The USFWS, in efforts to conserve large carnivores in the Northern Rocky Mountains, has developed the concept of linkage zones. The linkage zone is an area between habitat fragments able to support both movement and low-density occupancy. The distinction between linkage zone and corridor is the width of habitat—that is the ability to support low density occupancy by species (Samson et al, 1997).*
>
> *Ruediger, et al, 2000 drafted a map titled "IGBC Wildlife Habitat Linkage in the Northern Rocky Mountains." This map also includes the northeastern portion of the Caribou in the mapped north-south linkage zone. Other agencies and groups have done mapping as well.*
>
> *In May 2000, a meeting was held with several state and federal agencies as well as other interested groups, to discuss developing common criteria to help identify linkages of highest importance (Ruediger, 2000). They recommended factors to consider when identifying wildlife habitat linkages; 1) consider all scales, 2) landforms and topography are important, mountain passes, river bottoms and major ridges are often natural movement corridors, 3) vegetation is important, many species use forested areas for cover, 4) quality of habitat is important, 5) areas with low road densities and low levels of human use are important, 6) need data and 7) maintain large intact blocks of habitat (Ruediger, 2000)*
>
> *The Wasatch-Cache National Forest in Utah looked at a north-south corridor passing through the Forest. They used McNab, et al, (1994) to identify Province M331 "Southern Rocky Mountain Steppe" as main north-south corridor (Williams, Forest Biologist pers. comm.) Part of this province (M331) passes through part of the Caribou NF in the Caribou/Webster/Preuss subsections. This same area has been mapped as part of the Greater Yellowstone Ecosystem and was included on Ruediger's "IGBC Wildlife Habitat Linkages" map.*

The 2003 Revised Forest Plan and FEIS for the Wasatch Cache National Forest provides this map along with a map of LAUs in the Wasatch-Cache NF, Uinta NF, and Ashley NF on its

[40] USDA Forest Service. 2003. Final Environmental Statement for the Caribou National Forest Revised Forest Plan.

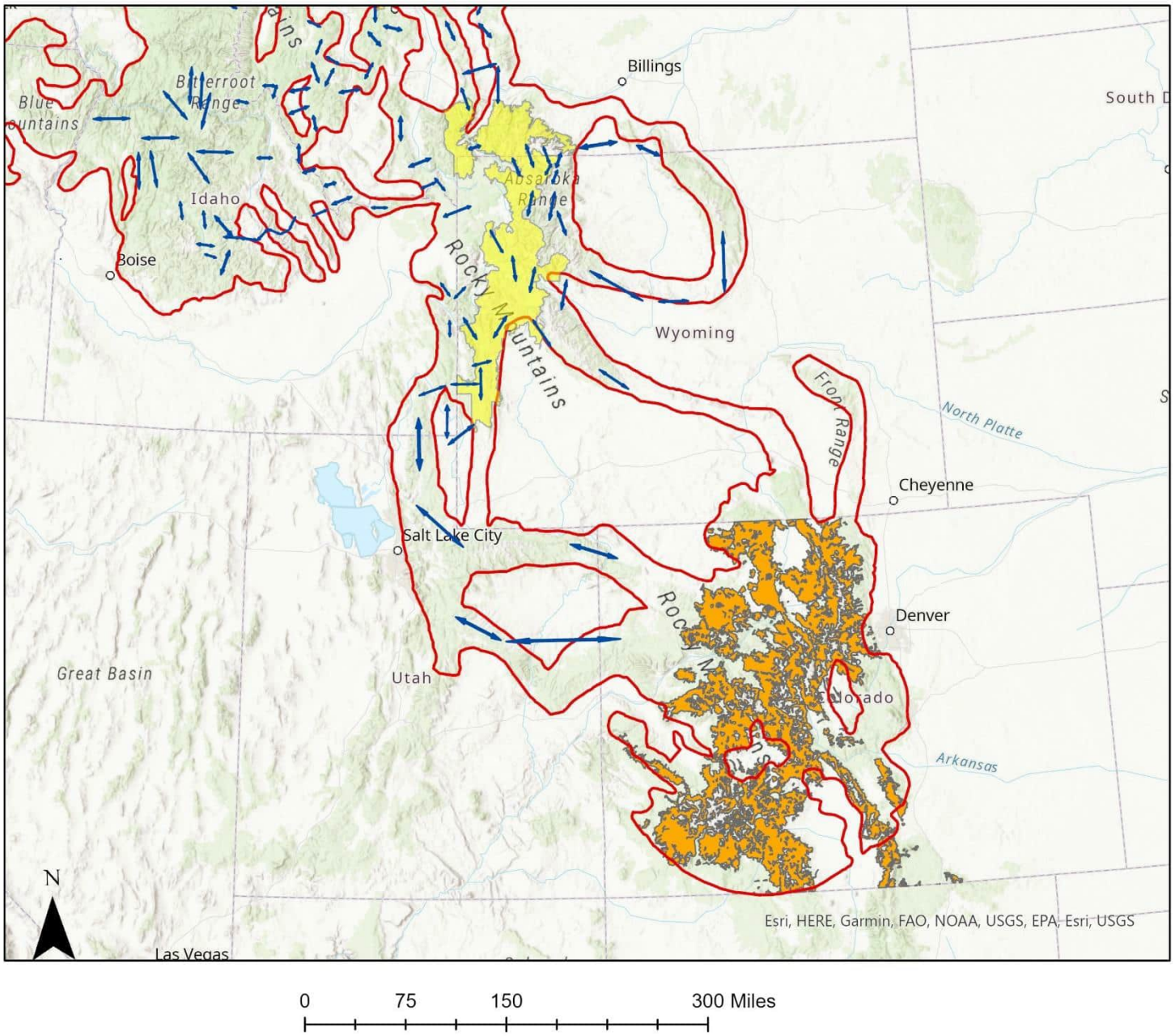
website.[41] Figure 5 illustrates this Regional Corridor and its connections. Figure 6 illustrates the Kuchler RMC type, and Figure 7 the topography. These maps show that the Science Report ignored this conifer dominated, high elevation connection in its claim that the Colorado boreal forest (Kuchler?) is *"isolated from similar habitat in Utah and Wyoming by more than 150 km of lower elevation habitats in the Green River Valley and Wyoming Basin."* Distances between higher elevation forested areas are much less in the western leg (Y2UConn) than across the Green River Valley and other northern areas from Colorado.

Colorado Parks and Wildlife summarized lynx movements from the reintroductions in Colorado to Wyoming.[42] Locations from 16 male and 15 female lynx that were released in Colorado between 1999 -2006 and were located in Wyoming between 1999 – 2010. (p2). It is interesting to note that the reintroduced lynx came from Canada populations to the north. Inspection of the maps in the report give the impression these lynx are attempting to find their way back north. As the report describes, *"Most of these individuals entered and exited Wyoming via the Medicine Bow Mountains or the Park Range and traveled no farther into the state than the northern extent of these ranges… . At least 8 lynx made it to the Greater Yellowstone Area and beyond. A few entered/exited via the Uinta Mountains in Utah… ."* The report notes that there were likely other individuals that made the trip, but there is no documentation since that time. (p3). Inspection of the figures in the report shows that some lynx apparently did cross the wide lower elevation valleys between the Medicine Bow Mountains and GYA, but there was no consistent path being followed and there were few conifer or high elevation areas. (Figure 6).

A least-cost path analysis of lynx connectivity between the San Juan Mountains in Colorado and the Greater Yellowstone Area reviewed the negative effects of habitat loss and fragmentation on wildlife populations and the resulting isolation of those populations.[43] The role of landscape linkages in providing connections and gene flow was addressed. Using GIS, current spatial data for habitats, human factors affecting lynx movement, and potential travel corridors between core patches of lynx habitat in the southern and northern Rockies were identified. Habitat suitability analysis identified the best core areas for lynx based on vegetation type and road density. Habitat types suitable for lynx were identified and scored. We have provided a general overview map in Figure 8 showing these core and corridor areas of the least cost path overlaid with the Y2UConn leg of the Regional Corridor. These are well aligned with each other. Detailed maps of vegetation classes, road densities, core areas, housing density, slope, habitat permeability, and least cost corridors are provided in the report. The analysis provides an assessment of the probability of successful dispersal for lynx as it assessed the entire landscape, while *"an animal traveling on the ground may not have prior knowledge of the territory it is crossing or obstacles it may come upon."* (p21). The model is suitable for making conservation and management decisions.

[41] https://www.fs.usda.gov/detailfull/uwcnf/landmanagement/planning/?cid=stelprdb5076923&width=full
[42] Ivan, J. 2017. Summary of movements of Colorado lynx in Wyoming. Colorado Parks and Wildlife.
[43] Bates, W. and Jones, A. 2007. Least-Cost Corridor Analysis for Evaluation of Lynx Habitat Connectivity in the Middle Rockies. Report to the Nature Conservancy by the Wild Utah Project, Salt Lake City. https://app.box.com/s/0g8b1ryqg1iz6r1fd61rdkc8fso97oh5

Figure 5. **Regionally Significant Wildlife Corridor, Lynx Linkage and Colorado Potential Habitat**



Lynx Critical Habitat
Regional Corridor
Canada Lynx Linkage
Lynx Potential Habitat

Regional Corridor - Referenced in USDA. 2003. Revised Forest Plan Wasatch-Cache NF.

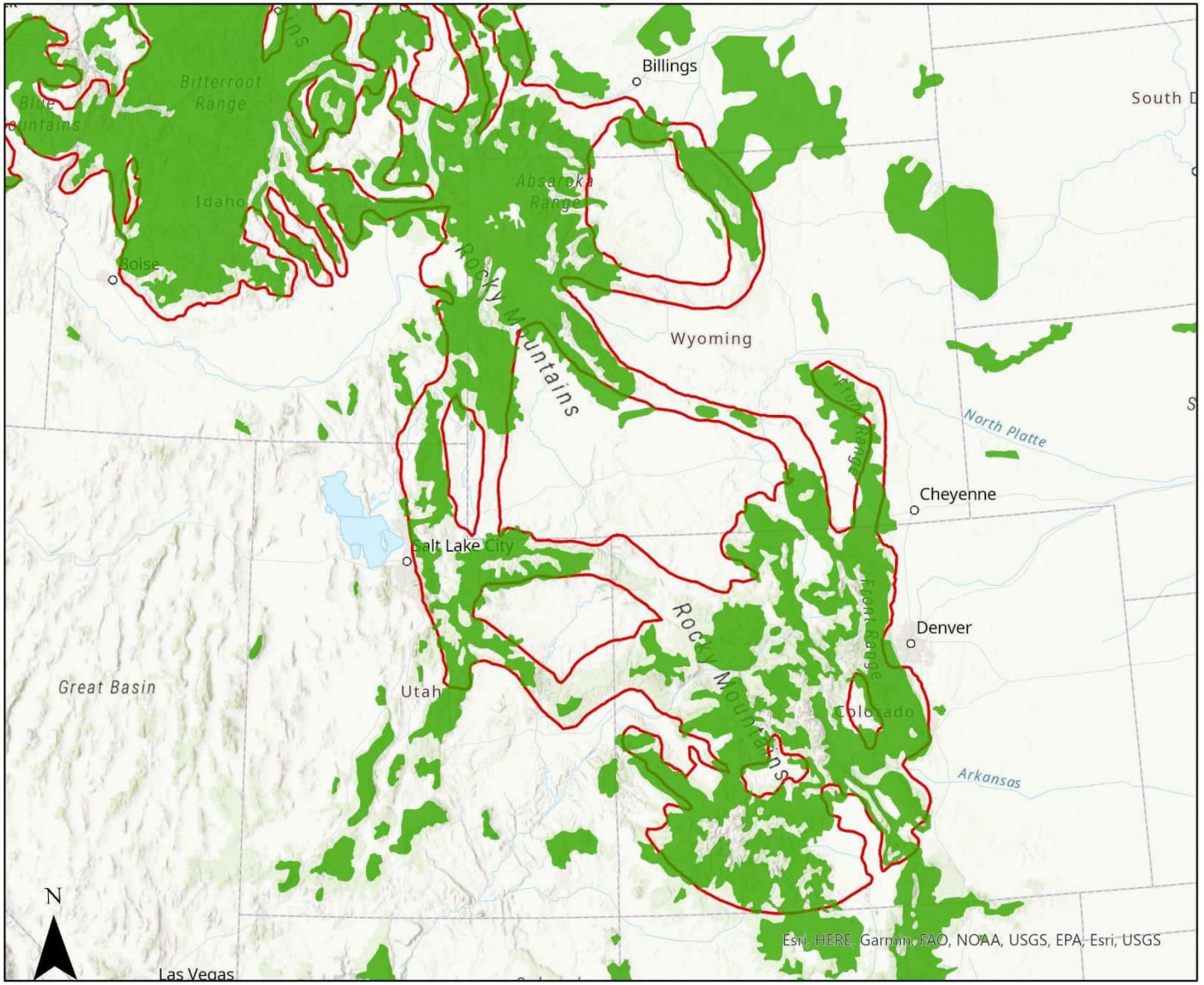
https://www.fs.usda.gov/detailfull/uwcnf/landmanagement/planning/?cid=stelprdb5076923&width=full

Canada Lynx Linkage - USDA Forest Service Northern Region. November 13, 2003. Canada lynx linkage areas for the Northern Rockies Lynx Amendment.

Lynx Potential Habitat - Colorado Parks and Wildlife

Critical Habitat - Fish and Wildlife Service designation. See Federal Register Citation Number 79 FR 54782, published 20140912 for the legal critical habitat information.

Figure 6. **Regionally Significant Wildlife Corridor and Kuchler Rocky Mountain Conifer**

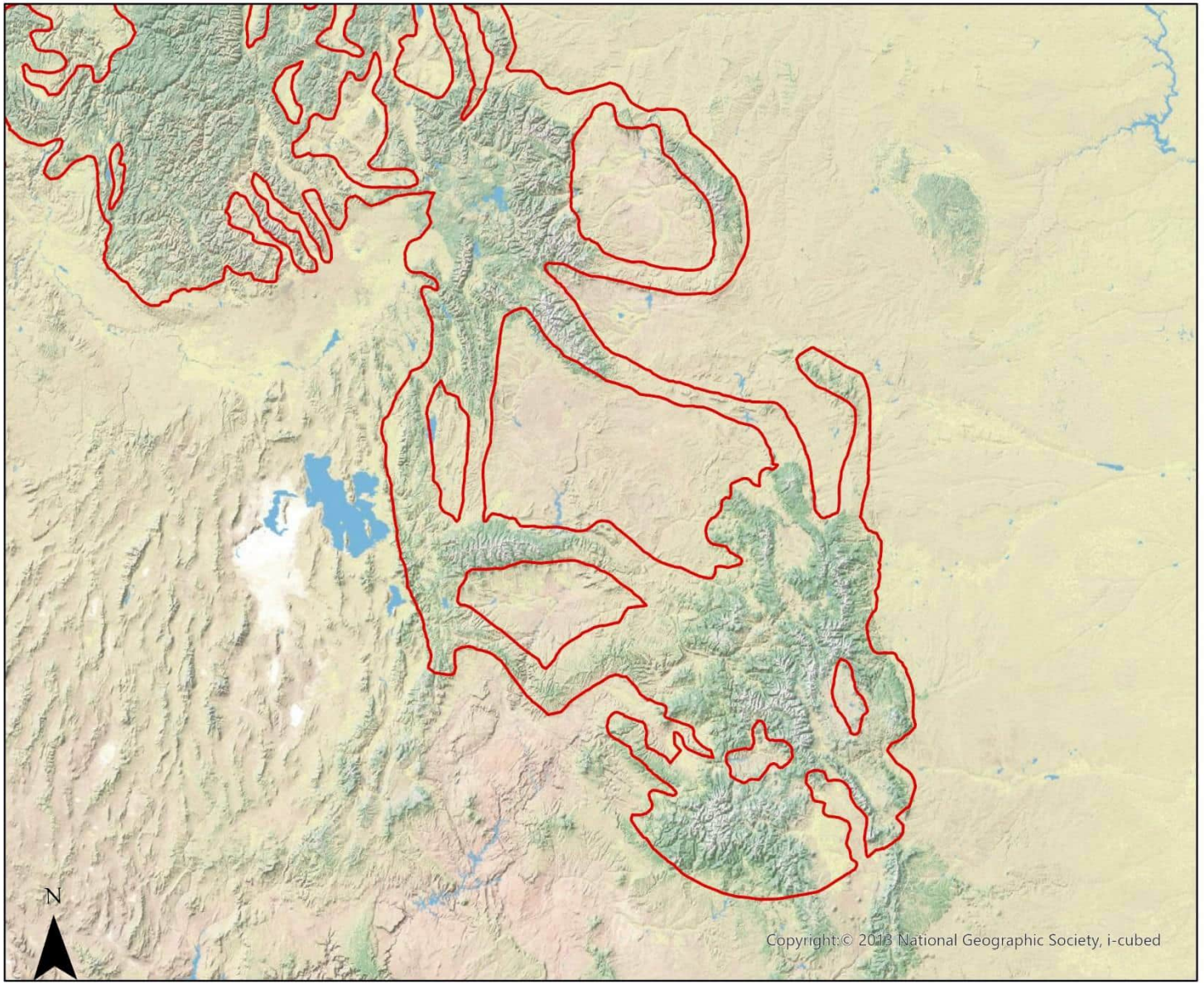


Regional Corridor - Referenced in USDA. 2003. Revised Forest Plan Wasatch-Cache NF.

https://www.fs.usda.gov/detailfull/uwcnf/landmanagement/planning/?cid=stelprdb5076923&width=full

Kuchler type GIS files from Data Basin. http://app.databasin.org/app/pages/datasetPage.jsp?id=1c7a301c8e6843f2b4fe63

Figure 7. **Regionally Significant Wildlife Corridor Topographic Relief**



Regional Corridor

Regional Corridor - Referenced in USDA. 2003. Revised Forest Plan Wasatch-Cache NF.

https://www.fs.usda.gov/detailfull/uwcnf/landmanagement/planning/?cid=stelprdb5076923&width=full

Topographic Map
ESRI land cover imagery for the world and detailed topographic maps for the United States

Colorado Parks and Wildlife engaged in a similar effort to map predicted use areas in Colorado.[44] They used location data from reintroduced lynx fitted with transmitters, filtered those data to remove locations for the first six months to account for habituation, considered elevations above 8,000 feet, and included factors for housing and road density, slope, distance to forest patches and vegetation types. Summer and winter data were used to generate models for both seasons. Figures 9 and 10 are reproduced from that report.

A map of the predicted distribution for Canada lynx in the 2050's based on modeled climatic conditions is provided in Figure 11.[45] This dataset represents the predicted distribution for Canada Lynx (Lynx canadensis) for the 2050's (ten year period average), based on the agreement (spatial average) of 5 niche modeling techniques (BIOCLIM, Climate Space Model, Envelope Score, Environmental Distance, SMV) and monthly precipitation and average temperature from 12 GCM's from the A2 emission scenario. Localities used to produce the model were resampled from the core area (highest probability) of the predicted distribution based on 48 Worldclim 1.4 climatic variables and BIOCLIM. CPW (Ivan) have also produced maps of summer and winter predicted habitat above 8,000 ft in Colorado.

Modeling and analysis such as these examples provide should be used to delineate the final configurations for regional corridors needed to maintain connectivity for these lynx populations. The Y2UConn leg of the corridor is a viable option for the higher elevations and snow cover needed by lynx. It also includes the potential core area of the Uinta Mountains where historical observations indicate a lynx population existed there in the early 1800's prior to trapping and exploitation by people. It connects to Critical Habitat in Western Wyoming where studies documented lynx present in 2004/2005 along with populations of snowshoe hares.[46] A follow-up effort in the winter of 2008/2009 also detected lynx in the Greater Yellowstone Area.[47]

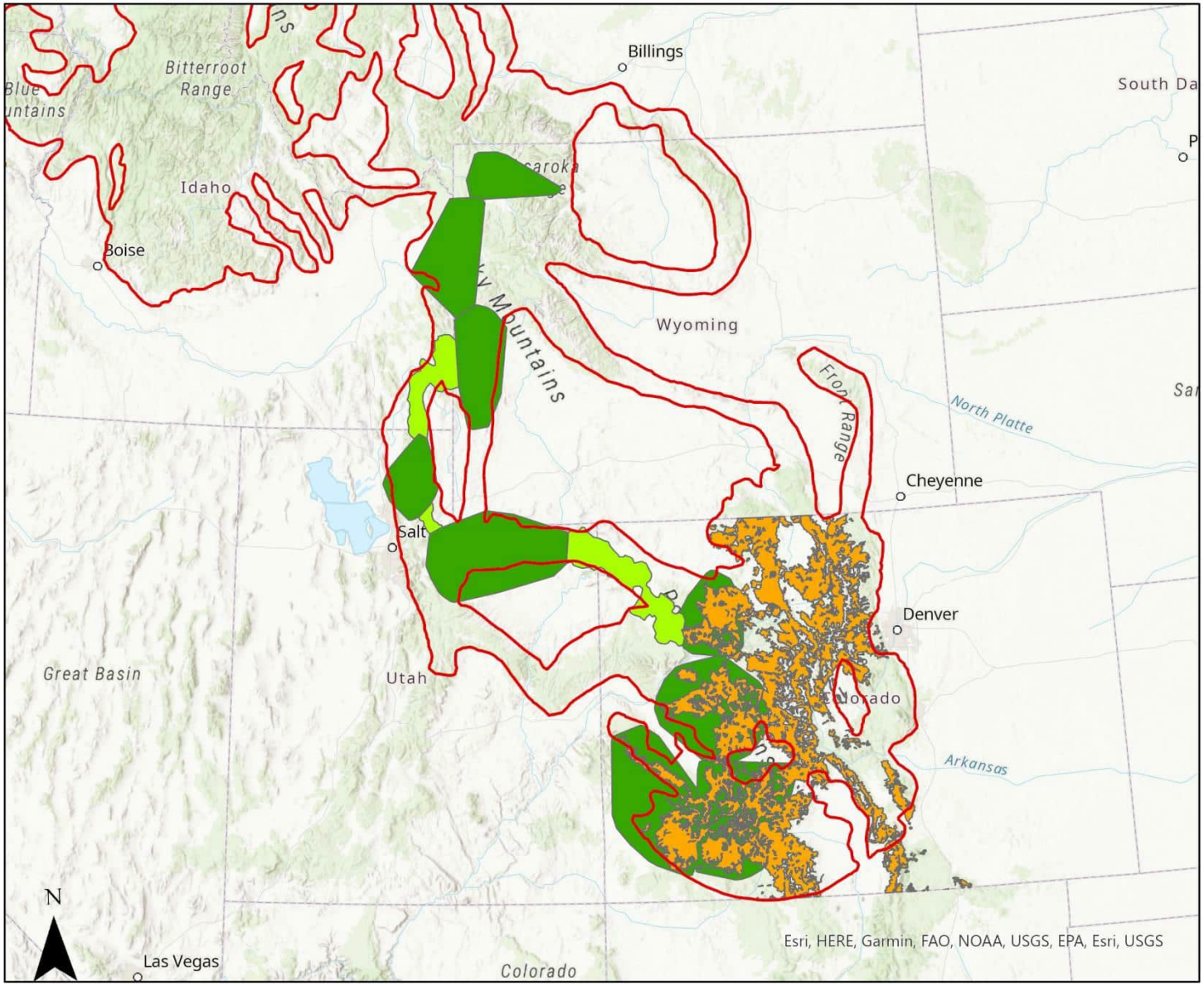
[44] Ivan, J., Rice, M., Shenk, T., Theobald, D., and Odell, E. Undated. Predictive Map of Canada Lynx Habitat Use in Colorado. Colorado Parks and Wildlife. Accessed on January 20, 2023. https://cpw.state.co.us/Documents/Research/Mammals/Publications/CPWPredictiveLynxMapReport.pdf

[45] Hamilton, H. 2008. Predicted Distribution of Canada Lynx (Lynx canadensis) - A2 emissions scenario - 2050's. California Academy of Sciences 07.29.2008. Map data from https://databasin.org/datasets/3674ed71-f5b7-45a3-a778-dfc2f0990235/ Accessed on January 20, 2023.

[46] Berg, N.D., Burghardt, J., Gray, R., and Smith, B. 2005. The Greater Yellowstone Lynx Study 2004/2005 Annual Report. The Endeavor Wildlife Research Foundation.

[47] Holmes, M. and Berg, N. 2009. Greater Yellowstone Ecosystem Lynx Study. Endeavor Wildlife Research Foundation. https://yellowstone.co/pdfs/lynxstudy2009.pdf Accessed on January 22, 2023.

Figure 8. **Regionally Significant Wildlife Corridor, Lynx Linkage and Colorado Potential Habitat**



Regional Corridor
Lynx Potential Habitat
CanadaLynxCorridors
CanadaLynxCores

Regional Corridor - Referenced in USDA. 2003. Revised Forest Plan Wasatch-Cache NF.

https://www.fs.usda.gov/detailfull/uwcnf/landmanagement/planning/?cid=stelprdb5076923&width=full

Canada Lynx Linkage - USDA Forest Service Northern Region. November 13, 2003. Canada lynx linkage areas for the Northern Rockies Lynx Amendment.

Lynx Potential Habitat - Colorado Parks and Wildlife

Bates and Jones (2007) Least-Cost Corridor Analysis for Evaluation of Lynx Habitat Connectivity in the Middle Rockies.

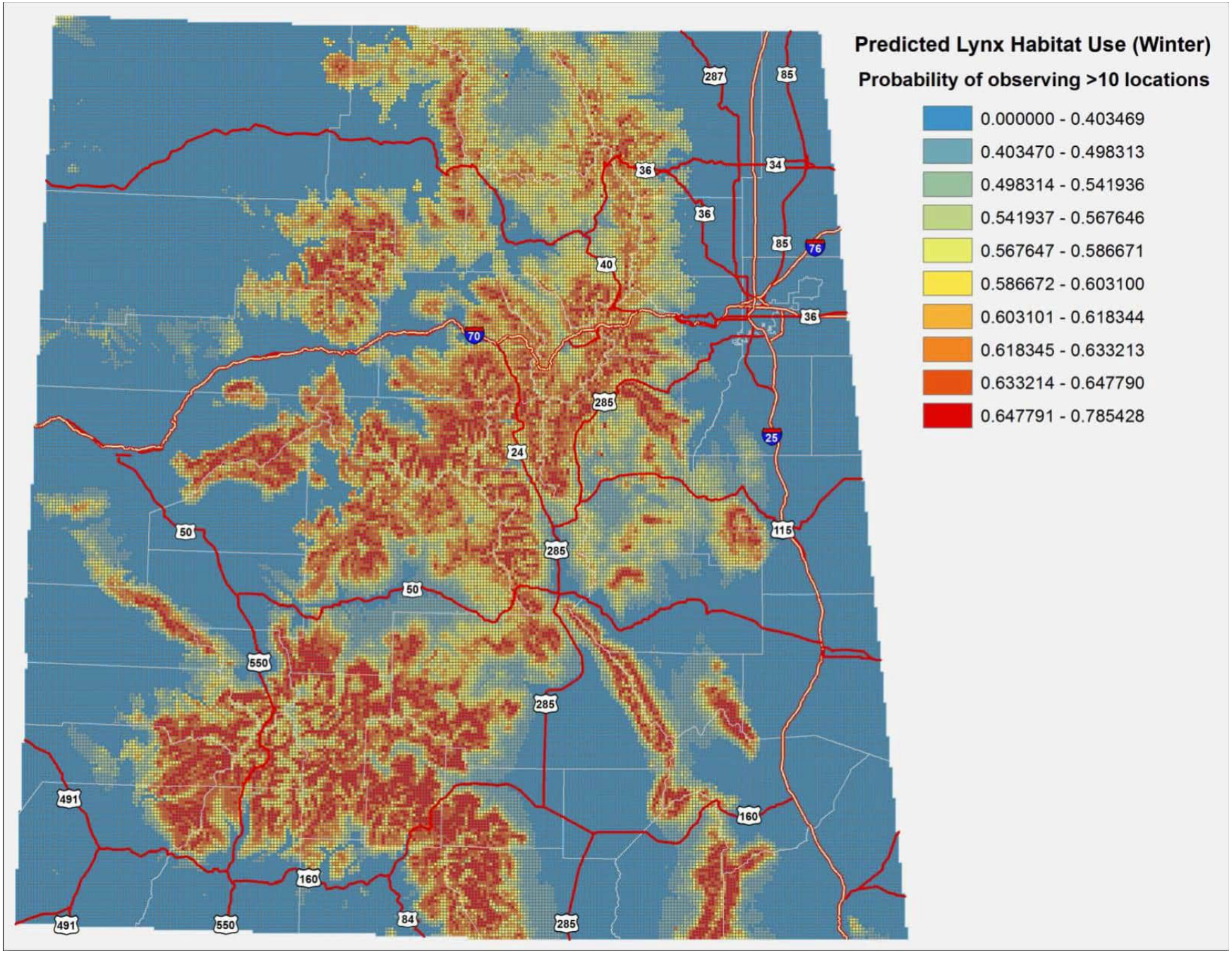


Figure 9 . Predicted winter use by Canada lynx in western Colorado. (From Ivan et al Figure 2)

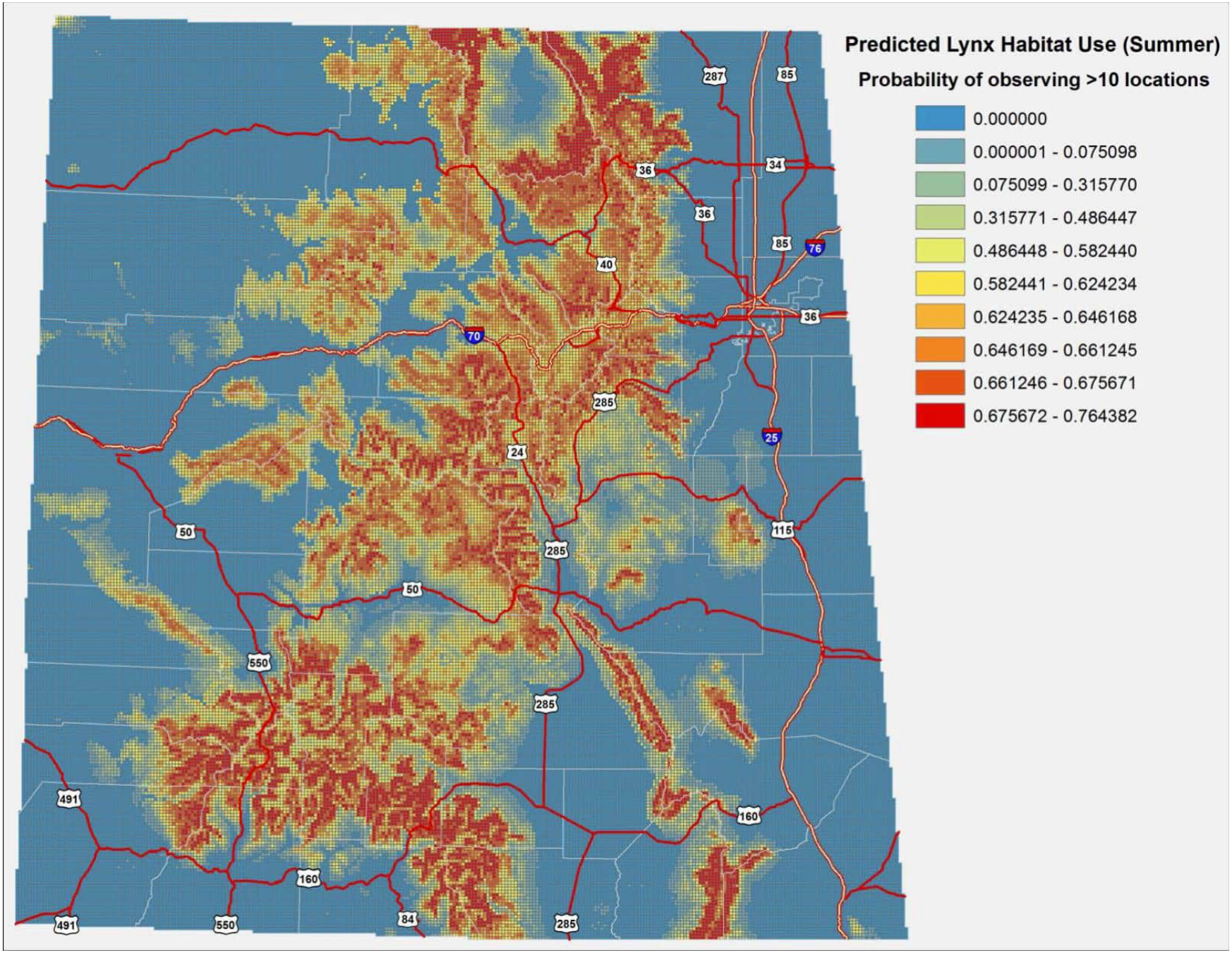
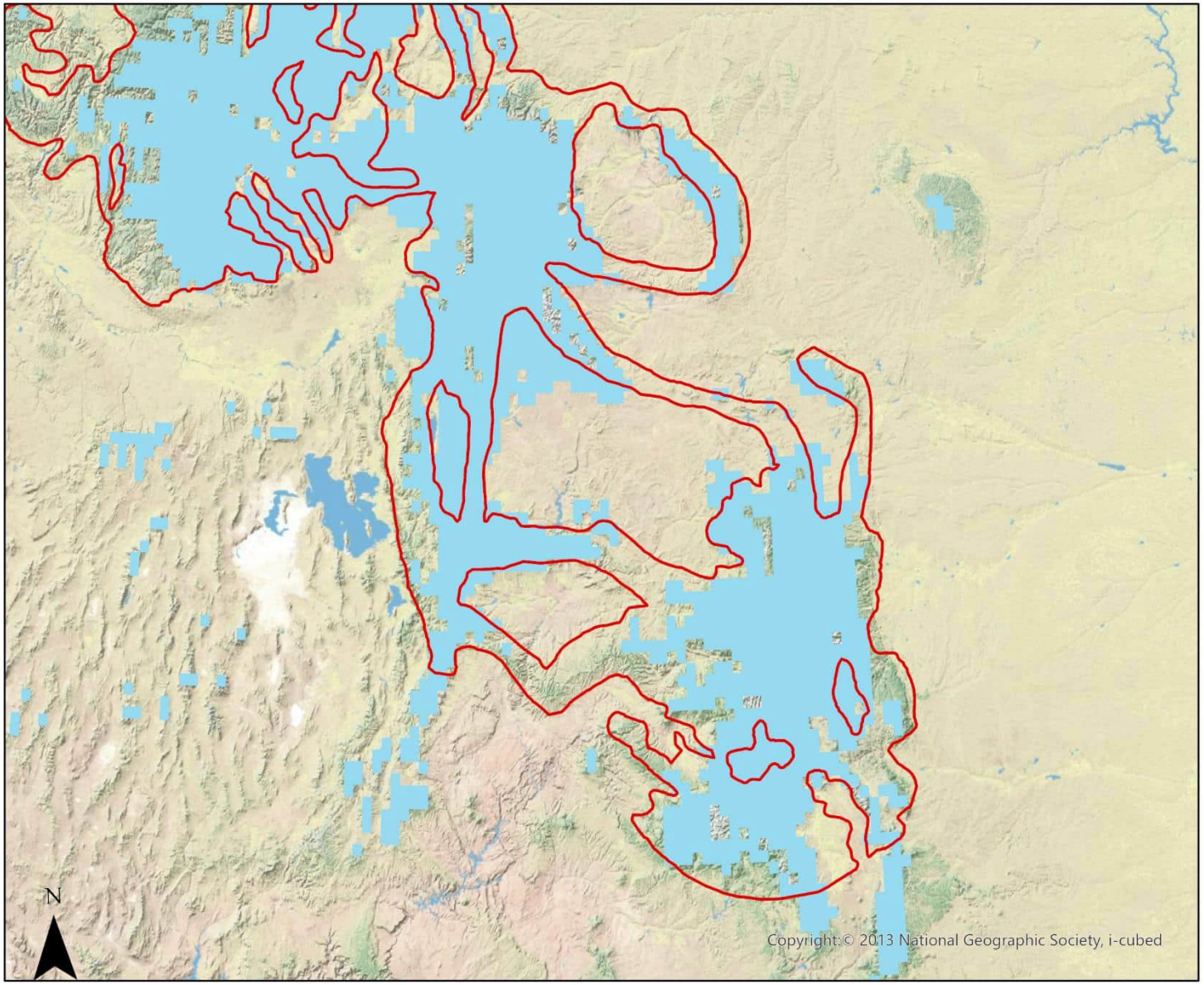


Figure 10. Predicted summer use by Canada lynx in western Colorado. (From Ivan et al Figure 3)

Figure 11. **Regionally Significant Wildlife Corridor Predicted Lynx Distribution in 2050s Using Climate Model**



PROVIDING FOR CANADA LYNX IN IDAHO, UTAH, WYOMING, AND COLORADO

These four states are those historically used or occupied by Canada lynx that do not border the Canadian Provinces (excluding northern Idaho) and the forested habitats where the larger populations of lynx have survived. Ensuring connectivity and habitat protection in these southern core and corridor areas that are disconnected from habitats in Canada is critical to maintain the isolated meta-populations in the south. The Colorado reintroductions show lynx can survive in this southern portion of the DPS, yet research and monitoring are lacking for these areas. The Science Report (SR p338) reported only seven studies with two of those being for bobcats. In the following, we just touch on a few parameters to place some degree of definition on lynx habitat, prey, and demographics for context to illustrate some of the quantitative parameters that need to be incorporated into agency requirements.

The Science Report Chapter 13 reviewed the ecology of lynx in these southern areas and compared them to the taiga in Canada. In both regions, lynx occurred where snowshoe hares were abundant. In the southern region, lynx were known to make exploratory movements prior to dispersal. The Colorado tracking data clearly illustrate these exploratory movements. Habitats in the southern region are patchier and lynx make more use of alternate prey. For instance, lynx scats collected in north-central Washington contained 79% snowshoe hare and 24% red squirrel. (SR p376 - 377). Snow tracking studies in the southern Canadian Rocky Mountains found prey consisted of 52% snowshoe hare, 30% red squirrels, and the rest were flying squirrels, martens, voles, and grouse plus unknowns. Snowshoe hare densities were estimated to range from 0.01 - 0.47 hares/ha. (SR p377). *"In southern boreal forests, limited data suggest that because snowshoe hares typically occur at low densities (Chapter 7), alternative prey may always be important components of lynx diets, especially in the western mountains."* (SR p378).

We previously referenced the association between lynx locations and habitat. The predominant association was with Rocky Mountain Conifer in these western interior states. Lynx use a variety of habitats and elevations between summer and winter. Generally, they use higher elevations in more southerly locations and between summer and winter. Most conifer types are included in areas used by lynx and can include Douglas-fir, western larch, lodgepole pine, subalpine fir, whitebark pine, and Engelmann spruce. Occasionally, they will occur in non-forested areas such as shrub-steppe. (SR p379). Snow tracking in Washington found that lynx traveled around meadows and used thinned stands that contained several hundred trees per ha. (SR p381).

Home ranges in these southern areas are larger than in the north. The average for males is 151 km^2 and females, 72 km^2. In west-central Wyoming they were smaller at 90 and 66 km^2. (SR p383 – 384). In Washington, home ranges were bounded by rivers, ridges, and major highways. (SR p385). Exploratory movements in Montana ranged from 17 to 38 km. (SR p386). Dispersal can take place over larger distances of several hundred km. (SR p386 -387). In the north-central Washington study, 8 kittens were documented in a population of 23 lynx during the three-year study. Estimates of total lynx density for the 1,161 km^2 area was 2.4 lynx/100 km^2. (SR p387). Comparisons are made to northern populations during the lows in hare cycles, indicating similar demographics occur in the southern populations compared to these lows. (SR p389).

Because lynx are highly dependent on snowshoe hares, we have looked for information on hare density in these southern states. Chapter 11 of the Science Report summarizes densities in Montana as well as the Wyoming Range. (SR p346). These ranged from 0.6/ha to 1.4/ha. Two studies cited from Utah gave densities ranging from lows in aspen with dense understory of 0.22/ha to 2.7/ha in spruce-fir habitat. Intermediate numbers occurred in Douglas-fir (0.57/ha and subalpine fir of 0.99/ha). These were estimated from pellet counts while the higher numbers from spruce-fir were from live trapping. Pellet plots in Colorado ranged from 0.26/ha in aspen, to 0.46 in Engelmann spruce. (p185).

These southern hare densities compare to population lows in areas of Canada with persistent lynx populations. For example, from the Science Report (SR p362), *"Hare densities in the southwest Yukon declined from 8.0 to 10.7/ha to 0.2 to 0.5/ha during one cycle (Ward and Krebs 1985), and another population fell from 7.5/ha to 1.3/ha during the next cycle (Slough and Mowat 1996). Similarly, a population in the Northwest Territories fell from 7 to 9/ha to 0.4 to 1.0/ha during the early 1990s (Poole 1994), and a northern Alberta population declined drastically from about 17/ha to 0.34/ha during the early 1970s (Brand et al. 1976)."* Apparently hare densities in these studies were sufficient to support lynx populations in the DPS, but the absence of recent hare studies leaves open the question as to the status and extent of current hare densities in the southern portion of the DPS. Whether snowshoe hares exist in sufficient numbers in these southern regions needs to be determined along with factors (deforestation, livestock grazing, predation, etc.) driving their population density.

A recent study looked at forest characteristics centered around lynx reproductive success.[48] Concerns were habitat fragmentation and loss of connectivity. In particular, the natural patchiness of lynx habitat at the southern extent of its range is *"subject to loss and fragmentation by some forest management practices (i.e. regeneration harvests, pre-commercial and commercial thins, prescribed burns), wildfires and insect infestations, and climate change…."* (p2). There are data gaps on the abundance and arrangement of lynx habitat and how these relate to reproductive success. The research was conducted in the Swan, Mission, and Purcell Mountains in Montana and included low to mid-elevation ponderosa pine and Douglas-fir to high-elevation subalpine fir, spruce and lodgepole pine. (p3 - 4). Thirty - six female lynx were radio collared and monitored and produced 36 litters with an average of 2.46 kittens during the 14 year period 1998 – 2012. (p12 – 13*).* Mature forest was the dominant structure in core areas and home ranges with 49 and 50% of core and home ranges with young regenerating forest averaging 13 and 11% of core and home ranges, respectively. (p13). When the proportion of young regenerating forest reached 10 – 15% of the core area, the probability of producing a litter declines. (p14). Females with larger surviving litters *"had less fragmented home ranges, lower moisture variance, young regenerating forest patches with low perimeter-area ratio, and lower percent composition of old regenerating forest than home ranges of females with smaller surviving litter sizes"*. (p15). *"…connectivity of mature forest, percent composition of young regenerating forest and young regenerating forest patches with low perimeter-area ratio, and adjacency of mature to young regenerating forest types were the most important predictors for overall lynx reproductive success in our study areas."* (p16).

[48]Kosterman, Megan K., "Correlates of Canada Lynx Reproductive Success in Northwestern Montana" (2014). Theses, Dissertations, Professional Papers. Paper 4363.

The Northern Rockies Lynx Management Direction Record of Decision (NRLMD ROD) and its standards and guidelines provided no adequate standard for levels of mature forest habitat within LAUs and provided nothing for habitat not designated in LAUs. While it states that habitat connectivity will be maintained, there is no definition of what constitutes connected habitat, even though this can be defined by current science. The NRLMD ROD does not clearly define what qualifies as unsuitable lynx habitat, which is limited to no more than 30% of an LAU (VEG S1) with no more than 15% unsuitable habitat created in 10 years (VEG S2). The glossary at 12 also defines lynx habitat in an unsuitable condition as the stand initiation structural stage but notes that unsuitable habitat can also be created by shelterwood cuts and commercial thinning depending on the resulting stand composition and structure. The ROD at 9 defines lynx habitat in an unsuitable condition as those forests in a stand initiation structural stage that are too short to provide winter snowshoe hare habitat; these conditions are created by stand-replacing wildfires, prescribed burns that remove all vegetation, or regeneration timber harvest. The ROD at 10 states that the definition of VEG S2 was changed to clarify that it only applies to timber management practices that regenerate a forest, as clear-cut, seed tree, shelterwood, and group selection. The VEG S2 standard applies to all timber management projects that regenerate forests, including clear-cuts, seed tree, shelterwood and groups selective cuts. The NRLMD does not ensure persistence of lynx, since there are no restrictions on the amount of an LAU that can be converted to habitats that are avoided by lynx, and to habitats that reduce habitat connectivity via mature forests.

The 30% clear-cut standard for lynx habitat in the NRLMD is based on habitat recommendations published in 1989, while other key recommendations were ignored. Although these recommendations noted that monitoring was required to determine if they would be effective, we found no evidence such monitoring was ever done before they were partially included in the LCAS and the NRLMD. Currently, the best available science demonstrates that the 33% opening level allowed by these recommendations are invalid, while the unused recommendations of maintaining a high level of forest cover of 69% has been validated. The 1989 Brittell recommendations for lynx habitat defined a level of habitat connectivity for lynx, which included denning, travel, and stalking habitat as 66% of each square mile of lynx habitat, not an entire LAU of many square miles with no guidance as to where within that LAU habitat should be maintained.[49]

While clear-cuts and sparse forests may receive some lynx use, their suitability for lynx is significantly reduced for a significant amount of time. It has been shown not only that those clear-cuts and sparse forest are strongly avoided by lynx but that restoration of lynx habitat use in these logging areas to 50% of previous use takes 20 years in forest thinnings, and 34-40 years for selection cuts and clear-cuts. Also, all logging treatments are avoided by lynx for at least 10 years.[50] Predictors for lynx reproductive success within occupied female home ranges were the connectivity of mature forest, intermediate (10 - 15%) amounts of young regenerating forest, young regenerating forest patches with low perimeter - area ratios, and the adjacency of mature

[49] Brittell, J.D., R.J. Poelker, S.J. Sweeney, G.M. Koehler. 1989. Native cats of Washington. Washington Department of Wildlife, Olympia.
[50] Holbrook, J.D., Squires, J.R., Bollenbacher, B., Graham, R., Olson, L.E., Hanvey, G., Jackson, S., Lawrence, R.L., 2018. Spatio-temporal responses of Canada lynx to silvicultural treatments within the Northern Rockies, U.S. For. Ecol. Manage. 422, 114–124.

forest to young regenerating types. Female lynx home ranges with greater than 50% mature forest and 10 - 15% young regenerating forest appear to be the optimum. [51]

More recent work has characterized habitat quality of Canada lynx at their "range periphery".

> *Our results indicated that the probability of a female producing kittens was most associated with the connectivity of mature, multistoried forests (composed of mostly spruce-fir). However, the variation among female lynx accounted for ≈62% of the total variation explained in litter production, suggesting substantial individual-level variation. Thus, managers can contribute to increased reproductive success of female Canada lynx by facilitating the development of mature forests but measuring that success will be difficult given the individual variation. In core areas of high-quality females (i.e., produced kittens frequently), mature forest was 17% more abundant (i.e., ≈60% of the total core area), more connected, less clumpy, and exhibited 2.25-times larger patch sizes than the core areas of low-quality females. At the home-range extent, patterns were less pronounced while the abundance of mature forests remained high (≈50%) for high quality females. Additionally, we demonstrated that the relative density of snowshoe hares was ≥2.8 times higher in advanced regenerating forests compared to all other structural classes, including mature forest. Advanced regenerating forests accounted for ≈18–19% of the core area and home range of high-quality female lynx. Combined, our results suggest that a high-quality mosaic for female Canada lynx contains ≈50–60% mature forest and ≈18–19% advanced regenerating forest. Furthermore, we used Forest Inventory and Analysis data to characterize the approximate age distribution of advanced regeneration and mature forest, which was relevant for rotation schedules of forest silviculture. Results indicated that advanced regeneration was ≈20 to 80 years old while mature forest was ≈50 to ≥200 years old.* [52]

In addition, lynx spend a significant amount of time at the interface between mature and advanced regeneration forest. This is likely because advanced regeneration forest provides the most hares, but mature forest habitat makes these hares more accessible. This indicates that advanced regeneration forest subsidizes the occurrence of hares in adjacent mature forest where they are more accessible to lynx.[53]

What is lacking today is the inclusion of current knowledge of what is known about lynx, snowshoe hare, red squirrels and their habitats into quantitative criteria that define these

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[51] Kosterman, M.K. 2014. Correlates of Canada Lynx Reproductive Success in Northwestern Montana.Graduate Student Theses, Dissertations, & Professional Papers. 4363. https://scholarworks.umt.edu/etd/4363 Accessed on January 22, 2023.

[52] Holbrook, J.D., Squires, J. R., Bollenbacher, B., Graham, R. O., Lucretia E., Hanvey, G., J, S., Lawrence, R.L., Savage, S. L. 2019. Management of forests and forest carnivores: Relating landscape mosaics to habitat quality of Canada lynx at their range periphery. Forest Ecology and Management. 437: 411-425. https://doi.org/10.1016/j.foreco.2019.01.011 Accessed on January 22, 2023.

[53] Holbrook, J.D., Squires, J.S., Olson, L.E., Lawrence, R.L., Savage, S., 2017. Multi-scale habitat relationships of snowshoe hares (Lepus americanus) in the mixed conifer landscape of the Northern Rockies, USA: cross-scale effects of horizontal cover with implications for forest management. Ecol. Evol. 7, 125–144.

habitats and their overlap in the southern DPS. The NRLMD and current Forest Plans are badly out of date and based on the omission of critical information. This is especially true in those areas not bordering the Canadian populations. While the Science Report has pointed out study and research needs, there has been a lack of definitive work in the southern-most states, particularly in SE Idaho, NE Utah, Colorado and the linkages or connections between these areas. Since these areas are heavily used by livestock as opposed to the situation further north, the effects of livestock on habitats important for cover and forage for snowshoe hares, and cover for lynx need to be determined. Also, the effects of over-snow travel, cross-country skiing, summer recreation and road density must be studied because the earlier data in the Science Report and the conclusions represented in the NRLMD, both LCAS, the 2017 SSA and the Remand Notice were based on earlier times in the absence of the levels of activity currently flooding throughout the western National Forests and BLM lands. We have regularly asked for data and maps of old growth forest residuals in these forests without success, apparently because these have not been developed. We have regularly asked for identification of the status of mined land reclamation, forest and vegetation manipulations, mapping of non-system roads and trails, temporary roads on National Forests without result.

It is in this vacuum of current data and information that the FWS must evaluate the status of Canada lynx in the DPS. Continuing to cast doubt on the historical presence of lynx in these southern areas cannot be used as a mechanism to reduce the area of potential lynx habitat, the habitat connections needed, or regulatory requirements. Instead, the current existing database and science must be applied to map and describe these areas of historical observations (not just verified records), their current habitat status and fragmentation by human uses as compared to what is known about the habitat needs of lynx. Studies and data collection need to happen to answer the questions and fill the data needs.

The criteria for identifying and managing LAUs needs to change to more specific, quantitative limitations on timber harvest, road density, mining, recreation use, perhaps using blocks of contiguous habitat and connections. Currently “unoccupied” or “peripheral” areas that had historical lynx observations must have potential lynx habitat mapped into LAUs, watershed areas, or blocks of habitat with definitive and quantitative criteria and standards reflecting what is known about lynx habitat. The parameters defining lynx habitat in places such as those studies we have cited in the contiguous states could be used to define current standards. Forest Plans and BLM Resource Management Plans must be amended with new standards to correct the current lack of regulatory requirements we have identified in our example of the Caribou NF. Corridors must be mapped and defined following the examples cited herein in which models have been used to identify lynx habitat, corridors, and connections. Those should have the same standards as occupied habitat.

Until these things are done, the Status Assessment for lynx must be that they are not only “threatened” in the western states DPS, but “endangered” and a recovery plan put in place to retain lynx in its historical habitat.

APPENDIX 1 -LIVESTOCK GRAZING STUDIES IN LINKAGE AND PERIPHERAL AREAS IN SE IDAHO AND NE UTAH BY DR. JOHN CARTER & ASSOCIATES

Since the late 1980s we have been engaged in collecting data on habitat in NE Utah and SE Idaho, particularly focused on the Bear River Range and Uinta Mountains. These are areas located in the linkage and peripheral habitat described for lynx in the CNF RFP and WCNF RFP. The 2013 LCAS (p68) stated that, *"Federal agencies have amended or revised land management plans across much of the range of the lynx to provide direction to conserve lynx and lynx habitat. Thus, the impacts of anthropogenic influences have been substantially reduced."* The presumption is that putting it in a forest plan means it will be so. The data and observations we have made over the past four decades and even earlier as we have backpacked and explored the national forests in Idaho, Utah, and Wyoming refute that presumption. Following are descriptions of some of our reports and data showing that livestock grazing management in this linkage habitat is abysmal. Figure A1 shows the National Forests occurring in the high elevation Regionally Significant Wildlife Corridor, which are where much of this data and observations have occurred. This corresponds to the linkage habitat and peripheral habitat.

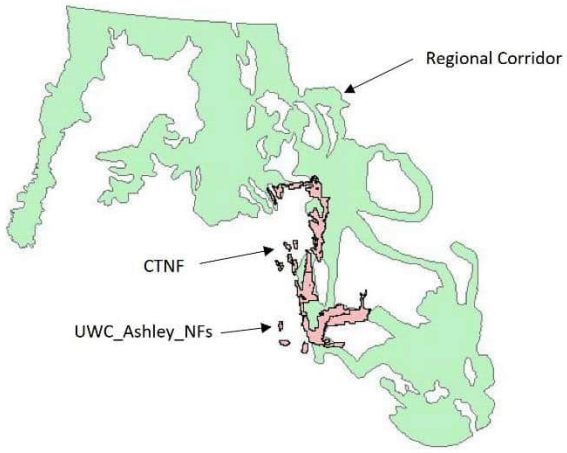


Figure A1. Forests in Which Livestock Grazing Studies Occurred

We completed a survey in the Caribou NF in 2001 with a report (Report) issued in 2002.[1]. This study showed tremendous degradation of plant communities and riparian areas. Monitoring in this and other areas in the Caribou and Targhee Zones and in NE Utah in the Uinta Wasatch Cache NF and Ashley NF since that time has shown no progress. When we measure use by livestock it is typically higher than sustainable levels and livestock are the base of the pyramid of damaging actions the Forest Service allows to continue. The photos in Figures A2-A6 below were taken during the 2001 survey and are from the Report. They show examples of the (a) impact of livestock grazing and water developments on vegetation, soils and aspen understory and recruitment, (b) conifer understory, and (c) riparian areas. Photo links are provided in the referenced Report for all locations surveyed.

In preparing this survey, we relied on Forest Service monitoring reports, the Draft EIS for the Revised Caribou Forest Plan[2] and literature characterizing livestock impacts on upland and riparian habitats. In the late 1990's, the Forest Service had prepared Regional and Sub-Regional

[1] Carter, J., Chard,B. and J. Chard. 2002. Assessment of Habitat Conditions Bear River Range Caribou National Forest, Idaho. https://app.box.com/shared/5q2hazcnfu

[2] USDA. 2001. Draft Environmental Impact Statement for the Caribou National Forest Revised Forest Plan Draft Revised Forest Plan. Caribou-Targhee National Forest.

Reports characterizing departures from Proper Functioning Condition (PFC) for aspen, conifer, tall forb, sagebrush/grasslands, riparian, and wetland areas. They found livestock grazing and past timber harvest in conifer forest were fundamental issues leading to loss of PFC in these communities.[3] [4] Our Report (p18) described the structure and compositional characteristics of these habitats needed for PFC.

We assessed 86 locations for PFC in the Bear River Range including uplands, riparian areas, open basins/meadows, aspen and conifer stands. These were within one mile of water sources in areas considered "capable" for livestock based on slope and distance to water. Mapping analysis predetermined the locations at which we surveyed each habitat type present. We compared observable conditions to the Caribou RFP Draft EIS PFC guidelines. Table A1 below is reproduced from the Report and shows the number of locations of each habitat type assessed. A total of 310 individual habitats were assessed. As shown, a small percentage met the Forest Service guidelines for PFC, most did not.



Figure A2. Sheep watering and bedding area showing complete loss of understory, loss of aspen recruitment and high-lined aspen. The soil is completely exposed. Sheep are bedded in a different location each day throughout the season, leading to widespread damage that is not documented by the Forest Service.

[3] USDA. 1996. Intermountain Regional Assessment: Properly Functioning Condition. USDA Forest Service, Region IV, Ogden, Utah.
[4] USDA. 1998b. Draft Sub-regional Assessment of Properly Functioning Condition for Areas Encompassing the National Forests of Northern Utah. USDA Forest Service, Region IV, Ogden, Utah



Figure A3. Aspen stand in valley bottom. Cattle have denuded the area, browsed suckers and essentially created a single aged stand that will die out unless livestock are excluded and recruitment allowed to occur. No understory cover or herbaceous vegetation is left.



Figure A4. Grazed conifer stand with little herbaceous vegetation present



Figure A5. Grazed riparian area with barren banks, little vegetation left in riparian zone



Figure A6. Sediment-laden stream substrate from trampled and eroding banks, adjacent roads

Table A1. Results of Bear River Range PFC Assessments

Habitat type	Number of locations	Number in PFC	Percent in PFC
Aspen forest	71	17	24%
Conifer forest	68	14	21%
Forb meadow	44	2	4.5%
Sage – grass	73	8	11%
Riparian	54	12	22%

We measured ground and canopy cover along transects at 55 locations in sagebrush-grassland and tall forb habitats. Tables A2 and A3 below are reproduced from that report. Bare soil averages above 50% show ground cover is well below potential. These averages included some ungrazed exclosures, which if omitted from the analysis, would have resulted in even lower soil cover values. The Sub-Regional Assessment by the Forest Service indicated ground cover potential ranges between 80 - 95%. In our surveys of un-grazed areas in the Bear River Range and on Kiesha's Preserve, potential ground cover is near 100% in all habitats. See our Kiesha's Preserve website for photographs of these ungrazed conditions.

Table A2. Cover Data for 45 Sagebrush Locations

Cover type	Range	Average	Standard Deviation
Bare Ground	86.2 – 10.7	51.6	19.0
Litter	68.2 – 2.0	31.5	15.2
Grass	23.2 – 0.3	5.1	5.3
Forb	14.7 – 0.5	4.5	3.4
Shrub	16.7 – 0	4.7	3.6
Rock	11.9 – 0	2.2	2.8
Crust/moss	10.4 – 0	0.4	1.6
Shrub Canopy	43.0 - 0	12.4	9.0

Table A3. Cover Data for 10 Locations in Tall Forb

Cover type	Range	Average	Standard Deviation
Bare Ground	78.8 – 5.5	54.1	22.6
Litter	55.0 – 4.9	24.2	15.5
Grass	16.5 – 1.0	6.0	5.6
Forb	21.1 – 2.8	11.6	5.2
Shrub	10.3 - 0	3.0	3.4
Rock	3.6 - 0	0.8	1.2
Crust/moss	1.9 - 0	0.3	0.6

Data collected in this 2001 study as well as other surveys we have conducted in the area demonstrate that all Forest habitats grazed by livestock are well below potential. Compared to the Draft Caribou RFP EIS and other PFC manuals for Riparian Areas the best we could say is they are functioning at risk with many in non-functioning condition

We have measured utilization by livestock in numerous locations in the Bear River Range and adjacent public lands such as BLM. Compared to Forest Plan or BLM land use plan standards allowing 30 – 50% use in upland and riparian areas, universally we find utilization in riparian areas and meadows near 100% and in uplands 70 – 80%. A summary of studies is listed:

1. Unpublished data for Bear River Range riparian areas (12) using paired plots found utilization rates averaging 81%.[5]

[5] Carter, J. 2009. Unpublished utilization data for Riparian Areas in the Bear River Range.

2. 2011 Monitoring Report 1st Hollows and Paris Canyon Allotments.[6] I found utilization ranges from 75 – 92% in meadows, riparian area use was 63 and 82.6% at two locations monitored, upland low sagebrush sites ranged from 49 to 69%, and upland big sagebrush sites ranged from 85 to 88%.
3. Multiyear study in the Bear River Range in northern Utah looked at livestock grazing effects on plant production, soil nitrogen and carbon.[7] That study documented losses in plant cover, plant production, soil carbon and nitrogen in areas grazed by livestock compared to long term ungrazed areas.
4. Summary of utilization data for riparian areas on the North Rich Allotment in the Bear River Range.[8] Over a four-year period these remained nearly constant at 83 – 93%.
5. A multiyear study on a BLM managed allotment (Duck Creek) in the lower elevation foothills adjacent to the Bear River Range in Utah. We evaluated government monitoring by collecting data on grazed and ungrazed paired plots and critiqued the government monitoring effort. We found the BLM understated utilization and native plant production was greatly reduced by decades of improper management.[9]
6. A paper illustrating upland and riparian outcomes from BLM management of the Duck Creek allotment showed the installation of upland water and a deferred rotation grazing system resulted in increased use on the riparian greenline, bank alteration by trampling remained at 80%, riparian utilization remained near 100%, and upland utilization increased to near 80%.[10]
7. A report summarizing multiple years of data collection in the High Uintas Wilderness.[11] This study documented depleted alpine ground cover in grazed areas compared to those that had been excluded from sheep grazing for decades. Grazed areas had over 50% bare soil compared to 0.2% in long term rested areas. Streambanks were scoured by high runoff events due to loss of stabilizing vegetation in the watershed and stream banks. Most of the soils in the allotment are considered as high to extremely high in erosion potential, resulting in loss of the productive upper horizon.
8. A paper on livestock grazing impacts in the High Uintas Wilderness which is in designated LAUs and Peripheral habitat.[12] While all lands in this 160,000 acre set of domestic sheep allotments are grazed by domestic sheep, we determined that only a small fraction of the area

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[6] Carter, J. 2012. 2011 Monitoring Report 1st Hollows and Paris Canyon Allotments. Report prepared for Western Watersheds Project and Yellowstone to Uintas Connection. Dated March 1,2012.

[7] Carter, J., Chard, B., and Chard, J. 2011. Moderating livestock grazing effects on plant productivity, nitrogen and carbon storage. In Monaco, T.A. et al. comps. 2011. Proceedings – Threats to Shrubland Ecosystem Integrity; 2010 May 18-20; Logan, UT. Natural Resources and Environmental Issues, Volume XVII. S.J. and Jessie E. Quinney Natural Resources Research Library, Logan Utah, USA.

[8] Carter, J. 2009. Allotment Summary North Rich Allotment Riparian Areas.

[9] Catlin, J., Carter, J., and Jones, A. 2011. Range management in the face of climate change. In Monaco, T.A. et al. comps. 2011. Proceedings – Threats to Shrubland Ecosystem Integrity; 2010 May 18-20; Logan, UT. Natural Resources and Environmental Issues, Volume XVII. S.J. and Jessie E. Quinney Natural Resources Research Library,
Logan Utah, USA.

[10] Carter, J., Catlin, J., Hurwitz, N., Jones, A., and Ratner, J. 2017. Upland water and deferred rotation effects on cattle use in riparian and upland areas. Rangelands 39(4):112-118.

[11] Carter, J. 2006. Watershed Conditions Uinta's Wilderness, Utah. Report for Western Watersheds Project. https://app.box.com/s/944957604b8618539585 Accessed on January 21, 2023.

[12] Carter, J., Vasquez, E. and Jones, A. (2020) Spatial Analysis of Livestock Grazing and Forest Service Management in the High Uintas Wilderness, Utah. Journal of Geographic Information System, 12, 45-69. https://doi.org/10.4236/jgis.2020.122003

(6%) is capable for grazing when we applied the Forest Service criteria for determining capable acres. The current forage on the allotments provides only 10% of the demand. The result of this is accelerated erosion, sedimentation of lakes and streams, depletion of the native plant community to below its potential. Based on the two scenarios we evaluated, the stocking rate would need to be reduced between 90 – 97%.

There were other surveys and reports with data provided to the Forest Service and BLM. No management changes have resulted from this input now decades after we first began monitoring and submitting data to the agencies. The habitats are depleted of the forage and horizontal cover needed by snowshoe hares and other wildlife. The Desired Future Conditions and Standards provided in the Forest Plans for these places have resulted in no positive change. Yet, the FWS and Forest Service claim that provisions in Forest Plans protect lynx habitat.

EXHIBIT 6

“A Process for Finding Management Solutions to the Incompatibility Between Domestic and Bighorn Sheep”

August 2001



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"A PROCESS FOR FINDING MANAGEMENT SOLUTIONS
TO THE INCOMPATIBILITY BETWEEN DOMESTIC AND BIGHORN SHEEP"

Tim Schommer and Melanie Woolever
August 2001

INTRODUCTION

Scientific research has proven that when bighorn sheep intermingle with domestic sheep, large numbers of bighorn sheep die (Ashmanskas 1995). Major bighorn sheep die-offs have occurred in every western state and have been reported from the mid 1800's to the present (Martin et al. 1996). In recent years, biologists and veterinarians have shown that even casual contact between bighorn and domestic sheep may lead to respiratory disease and fatal pneumonia in bighorns (Onderka and Wishart 1988). The role domestic sheep play in causing pneumonia in bighorn sheep is an important issue in multiple use management (Foreyt et al. 1994).

Presently, about 90 percent of all Rocky Mountain bighorn sheep and 20 percent of desert bighorn sheep in the United States spend all or part of their lives on National Forest System lands. Although domestic sheep allotments on National Forests in the west have greatly declined in number, they are still numerous in some areas. Many bighorn and domestic sheep managers are struggling with this issue because they don't have a good understanding of the incompatibility between the two species, and/or don't know how to address these issues and find potential solutions. Solutions are often difficult to develop and may become politically charged.

The purpose of this document is to describe a process for finding management solutions to the incompatibility between bighorn and domestic sheep. This paper is designed to be used by biologists and range conservationists at the Forest level. The process is divided into 3 parts: (1) disease overview, (2) collaborative approach to identify issues and opportunities, and (3) developing workable solutions. All parts are essential and must be intertwined to become an effective tool for solving domestic/bighorn issues. Overall recommendations are included as well as a question and answer section.

HISTORICAL PERSPECTIVE

Bighorn sheep were once abundant throughout Western North America. Archaeological studies indicate wild sheep were a significant ungulate food item for Native Americans (USDA Forest Service Report 1991). Bighorn populations began to decline dramatically in most areas about 1880. By 1900, many populations were eliminated (Buechner 1960). These historic population declines are attributed to over hunting, parasites, disease, competition with domestic livestock for forage, and competition with humans for space (Buechner 1960, Honess and Frost 1942).

Bighorn populations did not recover following enormous declines in the late 1880's and early 1900's. This is in contrast to the resilience of many other wildlife species such as deer and elk. Bighorns

have demonstrated less tolerance than other native North American ungulates to poor range conditions, interspecific competition, over hunting and stress related to habitat loss (Desert Bighorn Council 1990). Most importantly, they have shown a much greater susceptibility to diseases (Goodson 1982).

In the last century, wild sheep populations have suffered from a wide variety of diseases, some that they have contracted from domestic sheep (Geist 1971). These include scabies, chronic frontal sinusitis, internal nematode parasites, bacterial pneumonia, foot rot, parainfluenza III virus, bluetongue virus, and contagious ecthyma (Desert Bighorn Council 1990).

Bighorn sheep recovery began during the 1960's and 1970's. State wildlife departments in partnership with land management agencies have ongoing efforts that include transplants into unoccupied habitat, augmentation of existing herds, and habitat manipulation. These efforts have had varying success rates; however, success has been consistently poor in areas where contact with domestic sheep occurred. Even with the ongoing recovery effort, current bighorn sheep numbers in the Western United States are estimated to be less than 10 percent of pre-settlement populations.

Historically, bighorn sheep played an ecological and social role. They were part of the prey base for the wolf, cougar, coyote, bear, and golden eagle. Vegetation abundance, evolution, and succession were influenced by herbivores including bighorn sheep. They were widely depicted in rock art indicating their significance to Native American people. Today, bighorn sheep continue to play an ecological role although a smaller one based upon their low numbers. They also continue to be highly prized socially as demonstrated by their extreme recreational value for hunting, wildlife viewing, and photography.

PART I DISEASE OVERVIEW

The following is a brief summary of the current information concerning disease transmission. Viruses, parasites, and bacteria can weaken or kill bighorn sheep. However, bacteria, primarily Pasteurella spp., have led to massive all age die-offs of bighorn sheep in every western state (Martin et al. 1996). Of the numerous pathogens affecting bighorn sheep, Pasteurella haemolytica is by far the most important respiratory pathogen of bighorn sheep leading to pneumonia and death (Foreyt 1993). Pasteurella multocida can also be important in the pneumonia complex.

There are over 70 varieties of P. haemolytica classified in either Biotypes A or T. Each biotype can have many serotypes or strains. Biotype T strains of P. haemolytica are found predominately in bighorns and other wild ruminants, while Biotype A strains are predominately in domestic sheep (Foreyt 1993, Jaworski et al. 1998). Research has shown that P. haemolytica (usually biotype A, serotype 2) is the major pathogen responsible for death in bighorn sheep after contact with domestic sheep. Martin et al. (1996), summarized over 30 published cases where bighorn die-offs are believed to have resulted from contact with domestic sheep. In most cases, between 75 and 100 percent of the bighorn herd died. Domestic sheep always remained healthy.

DNA fingerprinting was recently used to pinpoint the origin of bacteria leading to death in bighorn sheep (Foreyt et al. 1994, Jaworski et al. 1993). Pasteurella DNA isolated from dead bighorns originated in domestic sheep and had not been present in bighorn sheep before they were exposed to domestic sheep. The source of DNA was P. haemolytica (biotype A, serotype 2). Studies at

Washington State University, Edmonton, Canada, and at the Caine Veterinary Center, Boise, Idaho, have shown that specific types of P. haemolytica and P. multocida can be directly transmitted to bighorn sheep from domestic sheep (Onderka and Wishart 1988, Foreyt 1989, Foreyt 1990, Foreyt 1992, Hunter 1995a).

In wild situations, domestic sheep and bighorn sheep association almost always results in deaths of bighorns without affecting the domestic sheep. The finding of a shared P. haemolytica by DNA fingerprinting between domestic sheep and bighorn sheep in a Nevada study indicates this bacteria was transmitted between the two species under field conditions (Hunter 1995b). DNA analysis in the winter of 1995-96 in Hells Canyon during a bighorn die-off revealed that a feral goat and two bighorn sheep shared a genetically identical P. multocida and P. haemolytica (Rudolph et al. 1998). The subsequent die-off resulted in the death of in excess of 260 bighorn sheep in an eight-week period. The disease spread over 30 air miles and affected six bighorn sheep herds.

When bighorn sheep experience a pneumonia episode, all age mortality normally occurs. Lambs born to surviving ewes generally experience low survival rates for three to five years after the initial episode (Foreyt 1990, Coggins and Matthews 1992, Ward et al. 1992, Foreyt 1995, Hunter 1995a). Research indicates that lambs born in bighorn sheep herds that experienced a pneumonia episode usually die before three months of age (Foreyt 1990). It is likely that ewes surviving pneumonia remain carriers of pathogenic P. haemolytica for several years and transfer the bacteria to their lambs through nasal secretions. Lambs are protected by passive colostrum immunity early in life, but when this immunity wanes at six to eight weeks of age, they die from pneumonia. Low lamb survival rates usually continue for three to five years, delaying population recovery for many years.

All ungulates, except llamas, carry some strains of P. haemolytica (Foreyt 1995). However, experimental exposure of bighorn sheep to elk, deer, mountain goat, cattle, llama, and domestic goats has not resulted in pneumonia in bighorn sheep (Foreyt 1992, Foreyt 1993, Foreyt 1994). Bighorn sheep also appear to be attracted to domestic sheep and goats, but not cattle or llamas. Since Pasteurella transmission requires nose-to-nose contact or transfer of mucus through coughing or sneezing, it is most likely to occur between bighorn sheep and domestic sheep or goats. There are isolates of P. haemolytica from domestic sheep that are not lethal in bighorn sheep (Foreyt 1993). In addition, certain kinds of Pasteurella spp. are not toxic to one bighorn, but may be deadly in another.

Bighorn sheep die-offs due to pneumonia have occurred without any known association with domestic sheep (Goodson 1982, Onderka and Wishart 1984**,** Foreyt 1989, and Ryder et al. 1994). These die-offs were typically from P. haemolytica biotype T and serotypes 3, 4 and/or 10. The majority of these T-type die-offs are apparently triggered by some type of stressor, such as severe winter or drought conditions, population in excess of carrying capacity. The major difference between A- and T-type die-offs is the percent of the population lost. T-type incidents usually kill between 15 and 35 percent of the herd whereas 75 to 100 percent of the herd is typically lost in A-type incidents.

No studies report any bighorn sheep herds, fenced or free ranging, that have come into contact with domestic sheep and remained healthy. Several co-pasturing studies revealed that 40 of 42 (95 percent) bighorn sheep died from pneumonia after association with domestic sheep (Foreyt 1995). All domestic sheep remained healthy. Of all animals tested, only domestic sheep and mouflon sheep have been found to be incompatible with bighorn sheep.

No vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with deadly strains of P. haemolytica. Attempts have been made to develop such a vaccine for several years and are ongoing.

The incompatibility between domestic and bighorn sheep was tested in the United States District Court (Oregon) in 1995. The following summarizes United States Magistrate Judge Donald C. Ashmanskas' findings. "Scientific research supports a finding that when bighorn sheep intermingle with domestic sheep, large numbers of bighorn sheep die. While the exact reason for this result may be in question, it is clear that the die-offs occur. An incompatibility exists between the two species and there is no way to avoid the incompatibility other than to keep the domestics and the bighorns separate."

Most wildlife biologists and veterinarians have now concluded that bighorn and domestic sheep should not occupy the same ranges or be managed in close proximity to each other (Jessup 1980, Foreyt and Jessup 1982, Goodson 1982, Jessup 1982, Kistner 1982, Wishart 1983, Coggins 1988, Onderka and Wishart 1988, Foreyt 1989, Foreyt 1990, Desert bighorn Council 1990, Callan et al. 1991, Coggins and Matthews 1992, Foreyt 1992, Foreyt et al. 1994, Foreyt 1994, Pybus et al. 1994, Hunter 1995a, Onderka 1986, Hunt 1980, Foreyt 1995, Martin et al. 1996). Consequently, our current recommendation for minimizing pneumonia outbreaks in bighorn sheep is to maintain spatial or temporal separation between bighorn and domestic sheep on native ranges at all times. This is consistent with the following recommendations from leading bighorn sheep disease experts.

Valerius Geist, PhD, University of Alberta: "Domestic sheep are virtually toxic to bighorn sheep. The two species have to be kept apart and cannot be permitted to share any common ground."

William J. Foreyt, PhD, Washington State University: "If the wildlife management objective is to keep bighorn sheep alive, absolutely no physical contact with domestic sheep should be permitted."

Michael W. Miller, DVM, PhD, Colorado Division of Wildlife: "I believe segregating bighorn and domestic sheep on native ranges remains the single most effective management tool for preventing pneumonia epidemics in free-ranging bighorn sheep."

PART II COLLABORATIVE APPROACH

Management of bighorn sheep and domestic sheep in order to avoid physical interactions is often complex and potentially volatile issue. The intent of this paper is to describe a process managers can use in finding solutions benefiting both bighorn sheep and livestock operators. The live-stock industry and the associated ranch families in the western United States are important to America for many reasons. Ranching operations bolster local economies, preserve open spaces, provide critical winter range for big game and habitat for a multitude of wildlife species. They are an important part of Western heritage. The lifestyle that is so important to rural western citizens cannot occur without associated farms and ranches. Likewise, bighorn sheep are an important component of the west as well. They are important to the local residents, wildlife managers, hunters, conservationists, and to the many recreationists that visit or live in the western United States. Bighorn sheep are majestic symbols of the value of National Forests. Healthy bighorn populations are evidence that management for multiple use is working, providing an environment where wildlife can thrive in balance with other uses and values.

Forming a team of key participants that will work together from beginning to end to achieve mutually acceptable solutions is paramount. Although participation is totally voluntary, everyone who should be involved is invited to participate from the outset. Key participants will vary in each situation, but usually involve Forest Service line officers, biologists and range conservationists, livestock permittee(s), and State agency biologists and administrators. Agency managers work shoulder to shoulder with all participants to develop ideas and solutions.

Probably the most essential step in this sheep-specific process is to reach common understanding among all involved that incompatibility between domestic sheep and bighorn sheep exists and mixing the two species will eventually result in a bighorn sheep die-off. Without this fundamental understanding of the problem, collaborative efforts to develop potential solutions will probably not occur. It would be helpful in gaining understanding for all involved to have copies of the pertinent literature well before the initial meeting.

Each participant needs to recognize and respect the positions, needs, and concerns of others. It is the exchange of values and viewpoints to address problems and develop alternative solutions that is essential. Livestock permittee(s) may have been on the allotment for many years and the allotment and the way it is managed often has deep personal meaning. It is often not only life-style but deeply held cultural and social values that are at stake. High values are often associated with the existing ranch, and the allotment may be paramount to that value. Consequently, this issue often poses a significant threat to the permittee.

Biologists and interested publics, such as hunting organizations, have equally strong values associated with bighorn sheep. Die-offs represent many years of costly recovery effort lost. Full population recovery following a die-off requires many years**.** Loss of genetic diversity and herd memory of historical migration routes may be irreplaceable. Economically, the loss of potential hunting and wildlife viewing and photography may represent hundreds of thousands of dollars lost in essential State wildlife agency revenue, as well as lost revenue to local economies associated with these uses. In extreme cases, such as Sierra Nevada bighorn sheep, there is even the potential of federal listing as an endangered species with all that entails.

Discussions need to be open and objective to be productive. The goal is to look for long term solutions, not short term, quick fixes. The objective is to achieve reasonable alternatives keeping woolgrowers economically viable while protecting bighorn sheep. Bighorn sheep range may be on private, state, and federal lands, so solutions may include all of these lands. Decisions made in this process should be by consensus.

Other efforts employed to resolve resource management conflicts, such as outlined in the Coordinated Resource Management Guidelines (Cleary and Phillippi 1993), produced by the Society for Range Management (SRM), have developed rules for successful application of these types of processes. The following "cardinal rules" from that document should be considered:

- **Management by Consensus**. Participation is voluntary and consensus goes hand in hand with volunteerism. If everyone doesn't agree, you go back to the drawing board and listen further to the dissenter's needs.

- **Commitment**. All participants must be committed to the success of the program. Many will come in reserving judgment and keeping their options open to some extent, but at the very

least they must have an open mind to accommodate commitment when the collective behavior of the group warrants it. Undermining the group is not acceptable.

- **Broad Involvement**. All interested parties should participate. To leave some caring interest out is to invite attack. If they too have needs, best to bring them in and hear them out. If their needs are not legitimate, you will eventually flush that out too.

- **Express Needs, Not Positions**. Expressing "positions" generates confrontation. Expressing "needs" generates compassion, trust, and group will to take care of legitimate needs. The group needs to discipline itself by reminding each other to express themselves in terms of needs rather than an expression of positions typical in adversarial posturing.

Techniques for conflict resolution and the basics of consensus development are discussed by Cleary and Phillippi, 1993. Many other sources are available and should be consulted when embarking on the process. Directly connected to the four cardinal rules are operating guidelines for interpersonal relationships that also might prove useful.

- Respect each other in words, tone, and expression.
- Discuss issues forcefully and pointedly, but not personally.
- Maintain a positive outlook, a positive approach.
- Avoid disparaging remarks about colleagues, organizations, agencies, the meeting.
- Be sensitive to other's feelings.
- Take time to affirm what you like, to affirm the good ideas.
- Take time for clarification and understanding.
- Take time to resolve problems and disagreements.
- Disagree without disdain.
- Don't leap to engage an issue – listen and clarify first.
- Avoid side conversations.
- Be open to other's points of view.
- Maintain flexibility.
- Maintain and share your sense of humor.
- Each person is responsible for their own and the group's adherence to these guidelines.

It might be important to consider recruiting an unbiased facilitator or moderator familiar with these types of processes. Skills necessary will include meeting management, communication, role clarification, teambuilding, working with diverse audiences and sometimes difficult people, visioning, goal and objective setting, decision making, and group maintenance. As an additional suggestion, if possible, selection of an unbiased individual that has trust already established with the group that is most fearful entering the process might accelerate teambuilding. Remember that collaboration flourishes in a climate of trust. Because the development of trust takes time, teamwork takes time. Although the collaborative process is time consuming and tedious, the results achieved have a much higher probability of being win-win for all involved. More complete information can be found in the 1993 SRM document.

PART III DEVELOPING WORKABLE SOLUTIONS

This section will be divided into five areas: steps of the process, complexity evaluation, examples, possible solutions, and development of a management strategy.

A. Steps Of The Process

The following steps have been successful in developing workable solutions:

- Step 1. Identify key parameters such as bighorn sheep herd specifics, maps, habitat descriptions, natural barriers, migratory behavior, domestic sheep numbers, and other specifics of the operation.

- Step 2. Identify areas of overlap and potential conflict.

- Step 3. Evaluate management complexity.

- Step 4. Develop site specific solutions for each bighorn sheep herd and domestic sheep allotment.

- Step 5. Develop a management strategy appropriate for the complexity of the management situation.

B. Complexity Evaluation

A complexity evaluation will be based on information supplied by key participants. Each participant will have a critical role in identification of final solution components. The permittee will provide information about his operation in terms of overall allotment management and long-term interest in domestic sheep grazing including interest in converting to cattle, allotment consolidation, allotment location preferences, economic considerations, and any other needs. The State wildlife management agency will need to have maps of occupied and historic sheep range, herd size, home range, migratory behavior, and lambing sites. It will also be important that the State prioritizes existing and potential herds. The Forest Service will supply allotment maps, trailing areas, timing and numbers of livestock on the allotment, details of the allotment management plan, whether bighorn habitat is continuous or isolated and whether any natural barriers to sheep movement exist. This usually will be done cooperatively with the state wildlife agency because sheep movements generally extend beyond the Forest boundary.

This evaluation will identify the complexity of the management situation and the areas of overlap where there is a potential for conflict. Design of a site-specific management strategy will then be based upon these parameters reflecting the level of complexity.

An initial stage of strategy development is to recognize the gradient of risk. As the complexity of the on-the-ground situation increases, the risk of a bighorn sheep die-off also increases as there is greater opportunity for contact between domestic sheep and bighorn sheep.

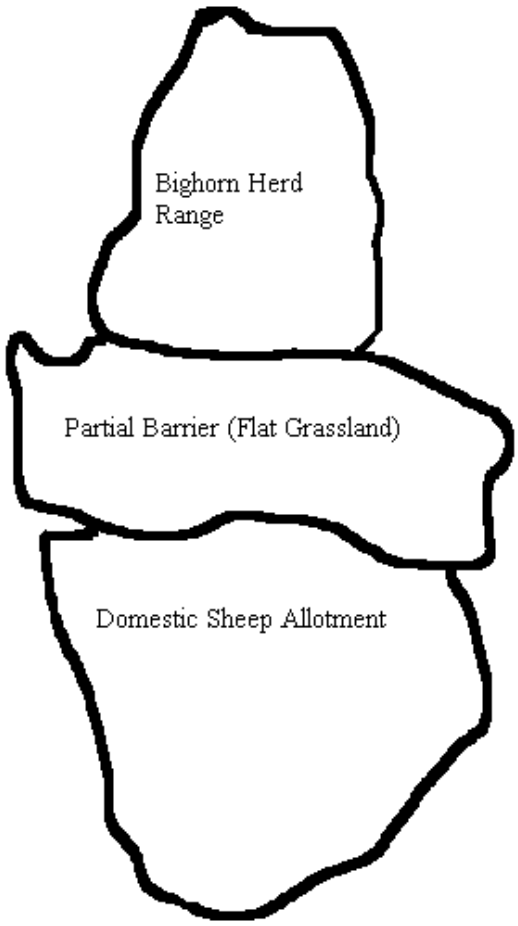
C. Examples

The following are real examples of a simple and complex situation used to illustrate steps 1 through 5 above:

Simple Management Situation:

- Bighorns -- One non-migratory herd with a small home range on isolated habitat.
- Domestics -- One six-month season allotment with no trailing and a cooperative permittee.
- Partial natural barrier available to help maintain separation of wild and domestic sheep.
- Primary conflict is the potential for the two species to mix in the fall when bighorn approach the flat grassland for water. The following illustration shows the situation graphically:

Figure 1. Simple Situation



The solutions identified to solve this potential use conflict were to use the partial barrier in combination with changing the rotation of the domestic sheep on the allotment to effectively increase the distance between species in the fall. The permittee returned to the pasture after livestock were removed to ensure that all stragglers were gathered. Water was developed at a remote site within bighorn habitat to reduce the need to go to water adjacent to domestic sheep. The permittee agreed to notify the State or Forest Service if bighorns were found near the domestic sheep.

Complex Management Situation:

Bighorns:

- Several migratory and non-migratory herds in continuous, large acreage habitat. Significant interchange among herds.
- Large areas of unoccupied historic habitat.
- State agency objectives to restore bighorn sheep to historic habitat using transplants at more than 20 unoccupied sites within the 1.2 million acres.

Domestics:

- Three large allotments trailing livestock up to 50 miles.
- Permittee wants to stay in the area. Area is not suitable for cattle.
- Four small farm flocks on private land.

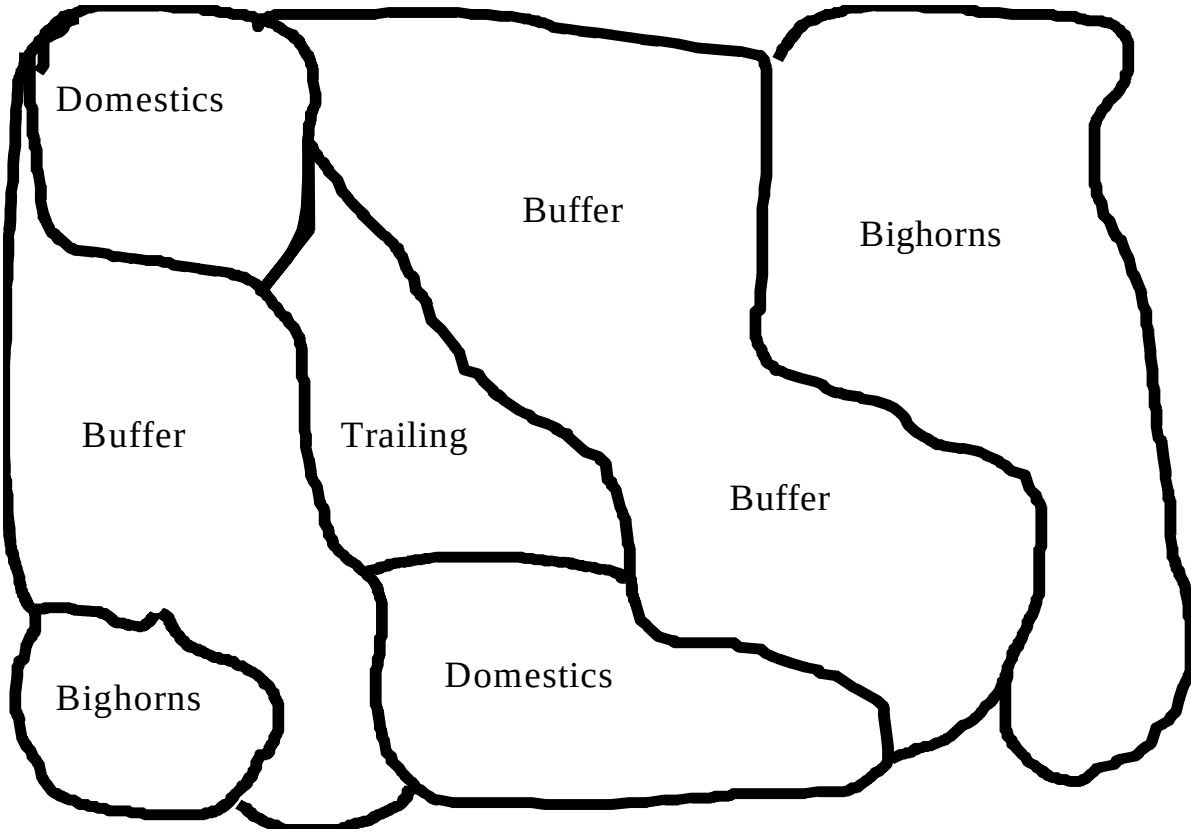
Habitat:

- No natural barriers.
- Previous management separated bighorn sheep and domestic sheep with 25-mile buffers.
- Die-offs continued in spite of buffers.

Repeated exchange between domestic and bighorn sheep has resulted in several minor and major die-offs over a 20-year period.

The following illustration shows the situation graphically.

Figure 2. Complex Situation.



The above example from Hells Canyon is approximately 50 square miles. Solutions included 25 mile buffers and very restrictive domestic management requirements. Both continued to be ineffective in keeping the two species separate. Other options considered were conversion to cattle, finding the permittee a replacement allotment elsewhere, economic incentive packages provided for the permittee to waive the permit back, closing the allotment thereby displacing the permittee, or simply living with continued die-offs. In this very difficult situation, and after 20 years of struggling to balance uses, three allotments were closed, the permittees were relocated to nearby large cattle allotments and/or economic incentives to waive the permit back to the government were supplied by an interested group. This decision was litigated and upheld.

D. Possible Solutions To Consider

The following is designed as a starting point for consideration when developing collaborative solutions. It is not all inclusive.

1. Changing components of the domestic sheep operation
   - Trucking vs. trailing sheep
   - Changing rotations
   - Intensive effort to gather strays
   - Timing and/or duration of use
   - Herding or improving the current herding situation
2. Moving domestic sheep to another allotment or dropping pastures
3. Conversion to cattle
4. Consider using natural barriers if topography allows for them
5. Habitat improvements
   - Burning
     - forage improvement
     - reduce conifer encroachment
     - reestablish migration corridors
   - Water developments
   - Salting

E. Development Of A Management Strategy

A "management strategy" is intended as a broad Forest approach to guide site specific bighorn and domestic sheep management. It is recommended in all situations, but is absolutely necessary in complex situations. It is in addition to developing site specific herd solutions. In most cases, the management strategy will result in a Forest Plan amendment. Many Forests are approaching the Forest Plan revision period. In these cases, revision provides a perfect opportunity to begin solving these types of conflicts through a suitability analysis. Regardless of the status of the Forest Plan, consider the following components for the strategy.

- Allotment management guidelines for domestic sheep that reduce the potential for interaction with bighorn sheep.
- Identify "domestic sheep emphasis" areas.
- Identify "bighorn sheep emphasis" areas.
- Identify a process for allotment review.

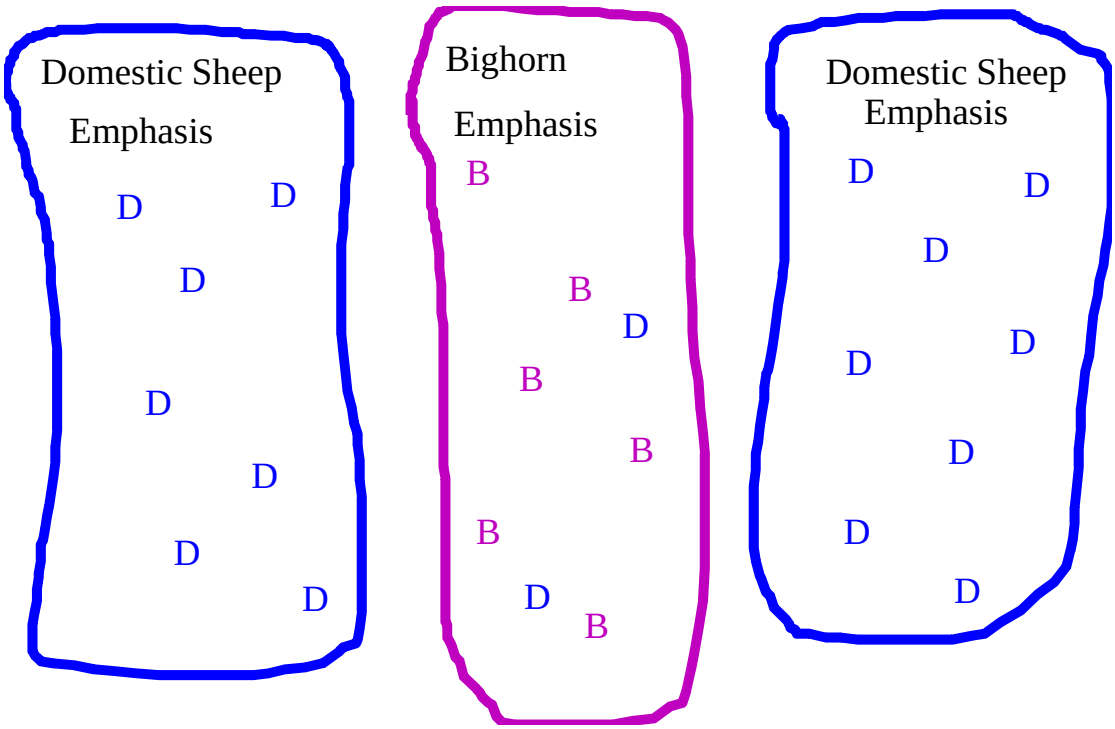
- Identify Forest Plan standards and guidelines to reduce conflicts between domestic and bighorn sheep.

Four key factors are important to identify primary emphasis areas for bighorn sheep and domestic sheep:

- Bighorn home ranges and movements.
- Domestic sheep locations, trailing areas, and grazing rotations.
- Natural barriers to bighorn movements, such as lakes, reservoirs, large continuous forests, or desert.
- Suitable or historically occupied habitat.

Figure 3 below illustrates the emphasis area concept graphically. In this example, each of the 3 areas represent a large mountain range. The symbols D and B show the current locations of domestic sheep allotments (D) or bighorn sheep herds (B). Through a collaborative process, emphasis areas were completed and agreed upon. The two outside mountain ranges will continue to be managed for domestic sheep. No bighorn sheep will be introduced. In the center mountain range, alternatives were explored for reducing the contact between bighorn and domestic sheep. These alternatives took a few years to implement and included: incentives, converting to cattle, and moving to vacant allotments in the other two mountain ranges. Now completed, the center mountain range only contains bighorn sheep. A detailed example of how to develop emphasis areas and a management strategy is contained in Appendix A "Bighorn/Domestic Management Strategy for the Wallowa-Whitman National Forest."

Figure 3. Example of Emphasis Areas
D = Domestic Sheep Allotment B = Bighorn Herd



PART IV SUMMARY OF RECOMMENDATIONS

- Reach a common understanding with all key players concerning the incompatibility of domestic and bighorn sheep.

- Use a collaborative approach to develop solutions.

- Develop strategies to keep the species separate at all times.

- No matter how complex the management situation is, develop site specific solutions for each bighorn sheep herd.

- Develop management strategies when the situation is complex.

- Maintain management flexibility and opportunities for the livestock industry by leaving vacant sheep allotments open when they are not in conflict with other resource uses.

PART V QUESTIONS AND ANSWERS

1. Is the potential for bighorn die-offs higher when bighorn sheep population densities are high?

   Yes, especially when bighorn sheep populations are above carrying capacity. We encourage State agencies to keep population densities below carrying capacity for several reasons. High ram ratios can lead to more pioneering by young rams, especially in unhunted herds. This behavior can increase the risk of nose-to-nose contact with domestic sheep. In addition, bighorn die-offs have also occurred without association with domestic sheep when bighorn sheep densities were above carrying capacity. This appears to be a density related phenomenon.

2. How should small farm flocks be handled?

   Small farm flocks may or may not be a potential conflict. In most cases, gaining support is best done through educating owners of the risks and consequences of physical contact between the species. Personal contact and dialog is the best approach. A brochure titled "The Compatibility between Bighorn and Domestic Sheep" is available to use when making these contacts. It is available from the Foundation for North American Wild Sheep (FNAWS).

3. Should State agencies assume the risks of die-offs when reintroducing bighorn sheep where any potential for mixing with domestic sheep occurs?

   Yes. Several states have established a policy where they will assume this risk. Bighorns coming in contact with domestic stock are removed or destroyed. This is to prevent spreading disease to healthy bighorns. Encourage your cooperating State agency to adopt this policy.

4. Can different migratory behaviors of bighorns be used strategically in transplants to reduce the chance of mixing with domestic sheep?

Yes. Sheep obtained from non-migratory herds can provide more effective separation between the two species. However, remember that just because sheep came from non-migratory stock does not mean that they will not move. Young rams in particular will wander. That wandering may be extensive.

5. How can the Forest Service planning process be used to help eliminate bighorn and domestic sheep conflicts?

   Forest Plan Revisions provide the perfect opportunity to begin solving bighorn and domestic sheep conflicts. Planning regulations (36 CFR 219.20, 1982 planning regulation) require the Forest Service to conduct a "suitability analysis" for both livestock and wildlife. A suitability analysis identifies uses on the Forest that are not compatible. Since bighorns and domestics cannot co-exist in close proximity, Forest Plans should identify areas where conflicts are currently occurring, allocate those areas to either bighorns or domestic sheep, and develop strategies to eliminate the interactions in future years. (Note: Ongoing changes in the NFMA planning regulations may result in a change in this current requirement.)

   If a Forest Plan Revision is not in the foreseeable future, the Forest can decide to conduct a separate National Environmental Policy Act (NEPA) analysis to determine where conflicts exist and amend the existing Forest Plan to adopt strategies that will remedy the conflicts. Whether the analysis is completed through a Forest Plan Revision or through a Forest Plan Amendment, the key to success is looking at the problem at a large enough scale to have some management flexibility. In many situations the analysis might be more effective at a state level or on a multi-forest level.

6. What are some of the management strategies that can be effective in resolving bighorn and domestic sheep interactions?

   There are many options that can be used including:

   - Conversion of livestock kind from sheep to cattle. This must only be done after a completed range analysis indicates the allotment is capable of supporting cattle use. CAUTION: Many good domestic sheep allotments will never be good cattle allotments.

   - Relocating domestic sheep from a conflict allotment to a vacant allotment without bighorn/domestic conflicts. Many National Forests have sheep allotments that are now vacant. These vacant allotments might be used to shift domestic grazing away from conflict areas. CAUTION: Some allotments are vacant due to conflicts with other resources such as wilderness, T & E species, recreation, etc. Do not create or foster other resource problems by putting domestic sheep on a vacant allotment to solve a domestic/bighorn conflict.

   - Where the opportunity exists and can be done in an environmentally sound manner, permittees on conflict allotments can be prompted to move to non-conflict vacant allotments by offering them additional numbers or allotments.

   - There are several organizations that offer grants to the Forest Service to cover costs of solving bighorn/domestic conflicts. Costs that might be covered include NEPA analysis, publications and maps, etc.

- Many conflicts can be solved by modifying the allotment annual operating instructions changing rotation, trailing to trucking or improving herding.

7. When a bighorn die-off begins, is there anything that can be done?

   Maybe. A protocol has been developed by the Hells Canyon Restoration Committee for application of antibiotics and release of the animals on site. It has helped to reduce the losses of bighorn sheep in the wild. The key to its effectiveness is treatment of bighorns before they get into the later stages of pneumonia. It is an emergency measure that is expensive, but can be used as a last resort in an effort to save some of the herd. It may not be applicable in wilderness due to restrictions on use of helicopters. Additional information is available through Vic Coggins (Key Contact List attached).

8. Are there non-local interests that should be involved in conflict resolution with domestic and wild sheep management.

   Yes. FNAWS has been an active partner in bighorn sheep programs. They will be a very useful component as you work through these challenges. Further discussion concerning the value of their involvement is available through Melanie Woolever (Key Contact List attached).

9. Why hasn't the Forest Service adopted the Bureau of Land Management (BLM) Guidelines?

   The Forest Service believes that these issues can be best addressed on a site-specific basis using the Forest Planning process. The needs of bighorn sheep and of the domestic sheep operator can be meshed and balanced in a more effective manner locally. Also, situations vary in size and continuity of sheep habitat, topography, water availability, operator effectiveness, etc. These variations can be better accounted for using site-specific solutions.

10. Why not recommend a minimum buffer distance?

    A minimum buffer is not applicable across all National Forest situations and bighorn sheep habitats. For instance, the minimum buffer in Hells Canyon was 25 miles and yet was not effective in separating the species. Both species tend to wander and this area is a large block of continuous habitat which provides for wandering. On the other hand, the Lostine herd is separated from domestic farm flocks by a distance of about three miles. In this situation where farm flocks are separated by dense forest and topography, three miles is adequate. These examples illustrate why it is so important to develop site-specific solutions to these management challenges.

11. Is trailing of domestic sheep in occupied bighorn sheep habitat a problem? If so, can it be mitigated?

    Yes, it is a problem. Trailing in or near occupied bighorn sheep habitat needs to be prohibited if trailing timing coincides with the presence of wild sheep. The problem arises when trailing through densely vegetated areas. Even close herding is not completely effective in preventing stragglers and pioneers. Close herding can mitigate the impact when the trailing area is in the open and when bighorn sheep are utilizing a different portion of the range at the time.

12. Are there any examples of Forest Plan Standards and Guidelines addressing bighorn/ domestic sheep management?

    Yes. Examples from the Wallowa-Whitman and White River National Forests are provided in Appendices A and B, respectively.

13. Is there a viability issue with small, isolated populations of bighorn sheep?

    It is possible that this could be of concern. The Craig Wildlife Wildlands Institute began work addressing this issue related to the number of rams in the herd and those that actually breed. The risk to small populations increases as they become more isolated without genetic exchange. State agencies may want to supplement smaller herds to provide for genetic diversity. When addressing viability, remember it is most effectively addressed at large scales such as the Forest Planning level, consistent with the definition of viability in the NFMA planning regulation (36 CFR 219.19 of the 1982 planning regulations).

14. Can domestic goats transmit deadly bacteria to bighorn sheep?

    The current information on this issue is not definitive. Co-pasturing trials done by Dr. Foreyt with domestic goats and bighorn resulted in all bighorns remaining healthy. However, the most recent die-off in Hells Canyon was traced by DNA fingerprinting to a domestic goat that had been recently released in the wild. It is important to note that prior to release, the goat had recently been exposed to domestic sheep at a County Fair.

15. What should I do if there is pack goat use on my district?

    First determine if there is a potential for interaction with bighorn sheep. If there is, we recommend the following:

    - Animals should be tended and kept in sight at all times, especially when packing in areas where bighorn sheep are present.
    - Animals should be tethered or penned at night and not allowed to roam freely.
    - When bighorn sheep are in close proximity, pack goats should be moved quickly through the area and the wildlife gently hazed if necessary.
    - If it is determined that the pack goats are or have been in contact with domestic sheep, more stringent restrictions should be considered to ensure the goats do not make contact with the bighorn sheep.
    - Informational signing at trailheads should be used to explain the potential risks.

16. Is there a problem with llamas and disease transmission to bighorn sheep?

    There is not a problem with Pasteurella spp. transmission from llamas. There has been ongoing concern about Johnes disease transmission from llamas to bighorn sheep. However, there is no evidence to support the concern. Only 4 confirmed cases on Johnes disease have been documented in the United States in a population of approximately 100,000 llamas. Transmission requires repeated and prolonged nasal contact to high concentrations of bacteria (10-8 per gram). Animals shedding this number of bacteria are in the terminal stages of the

disease. They are emaciated and weak which is incompatible with a viable pack animal. In short, this is not a problem for our bighorn sheep herds. For additional information, refer to the Johnes Disease Workshop Proceedings March 1996 available from Melanie Woolever.

17. What information can the State wildlife management agency provide that would be helpful in finding solutions?

    The State Agency will be a key player in developing solutions. An example from Wyoming Game and Fish is attached.

18. Are there any models available to help determine bighorn habitat suitability?

    Yes. There are five different Rocky Mountain bighorn sheep habitat models. They are discussed in Gudorf and Sweanor 1996, Shirokauer 1996, Smith et al.1991, Dunn 1993 and Johnson and Ringo 1995.

19. Is there anyone I can contact for help if I have more questions or need additional support?

    Yes. A Key Contact List is attached. Tim Schommer and Melanie Woolever work nationally in the Forest Service FULL CURL program. They are available to help you. Others on the Key List would also be willing to provide necessary support to help you work through this process.

20. Does Pasteurella or any other bacterial or fungal pathogen remain in the environment after domestic sheep leave the area?

    No. These pathogens die quickly outside of the host animal. Nose to nose contact is required for disease transmission to occur.

PART VI KEY CONTACT LIST

- Tim Schommer, Wallowa-Whitman NF, PO Box 907, Baker City, OR 97814, 541-523-1383
- Melanie Woolever, US Forest Service, R-2, PO Box 25127, Lakewood, CO 80225, 303-275-5007
- Vic Coggins, Oregon Dept. Fish & Wildlife, 65495 Alder Slope Rd., Enterprise, OR 97828, 541-426-3279
- Kevin Hurley, Wyoming Game & Fish, 356 Nostrum Rd., Thermopolis, WY 82443, 307-864-9375
- Bill Foreyt, Washington State University, Pullman, WA 99164, 509-335-6066
- Mike Miller, Colorado Division of Wildlife, 317 W. Prospect, Fort Collins, CO 80526-2097, 970-472-4348
- Karen Rudolph, University of Idaho/Caine Veterinary Training Center, 1020 E. Homedale Rd., Caldwell, ID 83605, 208-454-8657
- FNAWS Headquarters, 720 Allen Ave, Cody, WY 82414, 307-527-6261
- Jim deVos (desert bighorn sheep) Arizona Department of Game and Fish, 2221 W. Greenway Road, Phoenix, AZ 85023, 602-789-3247.
- Cal McCluskey, BLM, 1387 S. Vinnell Way, Boise, ID 83702, 208-373-4042
- Forest Service Regional Wildlife and Range Program Managers

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PART VIII APPENDICES

- **A**. Wallowa-Whitman N. F. Bighorn/Domestic Sheep Management Strategy
- **B**. White River NF Forest Plan Standards and Guidelines for Bighorn Sheep Habitat
- **C**. Wyoming Game and Fish Herd Unit Review pages
- **D**. Literature Review Regarding the Compatibility between Bighorn and Domestic Sheep

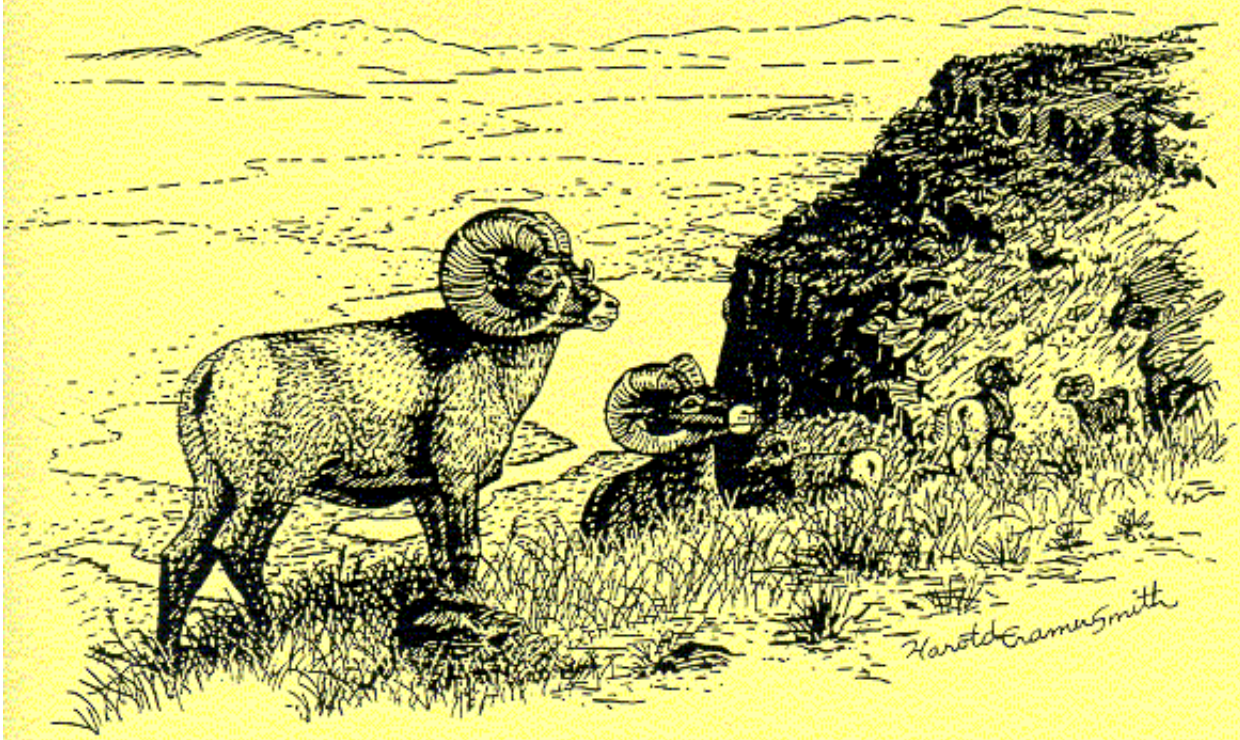
We sincerely appreciate the review and input provided to us by many domestic and bighorn sheep managers working together to solve this difficult management challenge.

APPENDIX A

BIGHORN/DOMESTIC SHEEP MANAGEMENT STRATEGY

FOR THE WALLOWA-WHITMAN NATIONAL FOREST

SEPTEMBER 1991



BIGHORN/DOMESTIC SHEEP MANAGEMENT STRATEGY FOR THE WALLOWA-WHITMAN NATIONAL FOREST 1991

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Adopted by:

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/s/Bob Richmond Date 10/3/91

I. INTRODUCTION

The following "Management Strategy" is intended as a broad Forest approach to guide site specific bighorn and domestic sheep management. This is not an Environmental Assessment document. It is only intended to replace the 1981 Bighorn/Domestic Sheep Guidelines currently in effect. After a 30 day public review process, we incorporated several of their suggested changes.

The document has the following objectives:

1. Develop a Forest Plan amendment which will move bighorn/domestic sheep management forward.

2. Decrease the potential for contact between bighorn and domestic sheep.

3. Allow bighorn reintroduction to proceed on specific areas, with restoration as the goal. Reintroduction would follow site specific analysis of these areas.

4. Identify a process for domestic sheep allotment review which will address bighorn/domestic sheep interaction within the context of NEPA.

5. Establish Forest-wide recognition of all existing bighorn sheep populations.

6. Incorporate this management strategy into the 1991 update of the State of Oregon Bighorn Sheep Management Plan.

A number of events have occurred over the last 20 years which have had an effect on the management of bighorn sheep on the Wallowa-Whitman National Forest (WWNF). In order to provide a basis for development of this management strategy, a brief overview of the history of bighorn sheep and their management is warranted.

Rocky Mountain bighorn sheep (Ovis canadensis canadensis) were native to much of the mountain and canyon country which currently comprises a large proportion of the Wallowa-Whitman National Forest in northeast Oregon and western Idaho. Specifically, historical accounts indicate that bighorns were numerous in the drainages in and around the Wallowa Mountains, the lower Imnaha River, Snake River, Grande Ronde River, Elkhorn Mountains, Powder River, and Joseph Canyon. Archaeological studies indicate wild sheep were the most important ungulate food item for Native Americans.

The California bighorn sheep (O. c. californiana) was found in the Burnt River canyon and on isolated mountains in the southern portion of the Wallowa-Whitman National Forest.

As European people settled the west, many of the activities either directly or indirectly had a negative impact on native bighorn sheep populations. Unregulated hunting, competition for forage with domestic livestock, and parasites and diseases introduced by domestic livestock were all factors which helped eliminate the bighorn from the state. The last native Rocky Mountain bighorn was seen in the Wallowa Mountains in the 1940's.

In Idaho, the Idaho Department of Fish and Game (IDFG) reintroduced 26 Rocky Mountain bighorn sheep into Granite Creek during 1975 and 1976. Seven bighorn ewes were released into nearby Bernard Creek in 1979. Both transplants flourished and reached an estimated herd size of 120 by 1983. In 1984, about 60% of the herd died of pneumonia. This was found to be caused by a disease called Pasteurella hemolytica. The bighorn population did not rebound from die-off. Thus, in 1990, the IDFG supplemented the herd with 31 more bighorns. The current status of the herd has not been evaluated, but IDFG believes it has continued to decline.

In 1971, the Oregon Game Commission reintroduced Rocky Mountain bighorns into the state when transplants were released on the Lostine River and on the Snake River at Battle Creek. The Battle Creek transplant failed within 2 to 3 years. A sizable herd, about 30 bighorns, developed and ranged along the Snake River from Wild Sheep Creek to Sand Creek until one winter in the early 1980's they suddenly disappeared. These sheep were thought to have migrated from Battle Creek. The Lostine River transplant flourished and grew to a herd size of 120 head. Limited hunting of rams was initiated in 1978 and trapping and transplanting to other release sites was initiated in 1977. This was accomplished in order to stabilize bighorn numbers in the Lostine herd while at the same time reintroduce bighorn sheep to additional historic habitats within their former range in Oregon. Some transplanting involved exchanging of Lostine stock for stock from the Salmon River drainage in Idaho so that sheep better suited to a release site and increased genetic diversity could be attained. This activity resulted in additional populations becoming established on the lower Imnaha River, Bear Creek, lower Minim River and the lower Grande Ronde River at Troy.

In 1981, concern for management of bighorn sheep in and around domestic sheep grazing allotments stimulated development of a document called the "White Paper" (Appendix D, #4) which outlined management guidelines designed to reduce potential conflicts between the 2 species.

In 1986, the Oregon Department of Fish and Wildlife (ODFW) developed a Bighorn Sheep Management Plan to provide management direction for reintroductions of bighorn sheep in Oregon and to provide public land management agencies a timeline on which to analyze proposed release sites. This document identifies proposed release sites and provides management direction for bighorn sheep in the future. The plan will be revised every 5 years with the first revision occurring in 1991.

Fifteen California bighorn sheep were reintroduced in 1987 on Bureau of Land Management lands along the Burnt River. The herd is slowly increasing and is now estimated to total about 35. They currently are adjacent to Forest Service lands, but are not known to drift onto the Forest.

An all age die-off of bighorn sheep on the Lostine River occurred in the winter of 1986. The disease agent was identified as Pasteurella hemolytica, which caused Pneumonia, and reduced the herd from 120 to 32 animals. Since Pasteurella hemolytica has remained in the surviving sheep for several years, it has been the primary factor preventing herd recovery to date.

Concern for the health and future of other existing bighorn herds caused ODFW and WWNF to decide to revise the 1981 "White Paper." The overall intent was to bring all concerned parties together in development of a series of management guidelines where all interests could participate equally. The primary area of concern was how to manage bighorn sheep and domestic sheep so contact between the two species could be minimized. The Bighorn/Domestic Sheep Task Force met three times and failed to reach consensus on the white paper revision. At that point, the document was turned over to the WWNF Supervisor and the ODFW NE Region Supervisor for their review and final decision. Immediately upon being jointly approved, implementation of the decision was contested by conservationist groups on the basis that the decision did not afford adequate protection to existing herds of bighorn sheep on the Forest. At that point, the WWNF issued a decision which suspended use of the guidelines, stopped all bighorn sheep transplanting efforts, and restocking vacant domestic sheep allotments, pending a broad Forest approach to the situation.

II. PROPOSED MANAGEMENT DIRECTION

1. Bighorn/Domestic Sheep Management Zones

The Bighorn/Domestic Sheep Task Force developed a "management zone" concept by dividing the lands administered by WWNF into nine Bighorn/Domestic Sheep management zones (see Appendix E). The zones were located to identify areas of higher and lower conflict between bighorn and domestic sheep. Areas of high conflict currently contain active domestic sheep allotments, areas of moderate conflict contain vacant domestic sheep allotments, and areas of low conflict do not contain domestic sheep allotments. A high conflict area would be one having a high probability that sometime during the grazing season domestic and wild sheep will come into close contact.

The use of management zones was developed to facilitate the objectives of restoring bighorn sheep populations and maintaining domestic sheep grazing as outlined in the Forest Plan. In areas where the potential for conflict is 1ow, NEPA analysis could be easily accomplished and bighorn populations restored. In areas where the risk is higher, the analysis process would become more complex. Entire allotments or groups of allotments would be analyzed and decisions would be made on how best to manage the existing and potential resources.

2. Locations of Potential Release Sites

The Task Force identified 20 potential release sites (see Appendix A and F). This list is not exclusive; other sites may be later identified. Not all of these sites are feasible under current management conditions, but are shown here to display potential. Eight of these twenty sites would be supplementing existing populations and 12 would be reintroduction of animals into unoccupied suitable habitats.

3. State Bighorn Sheep Management Plans

The emphasis of the States of Idaho and Oregon is to reintroduce bighorn sheep into all available and suitable habitats. Reintroduction will proceed according to the State Bighorn Sheep Management Plans.

Bighorn sheep will not be reintroduced into locations where it is probable they may come into contact with domestic sheep. Occasionally, bighorn may migrate outside of their designated range. If they come in contact with domestic sheep, bighorns will be considered "at risk" for disease transmission and potential loss of bighorn sheep. There is also the potential for a disease infected bighorn to leave the area and spread the disease to other bighorns. The State agency will assume the responsibility for bighorn losses and further disease transmission. If these situations occur, the State will take whatever action with infected bighorns that it feels necessary to reduce further losses.

Habitat improvement work, such as water developments and controlled burning, will be accomplished as needed, identified in an Environmental Assessment, and will be cooperatively funded when possible.

4. Management of Domestic Sheep Allotments - "Analysis Process"

Introduction: The Forest Plan for the WWNF allocates thirteen allotments as domestic sheep and two allotments for dual use (sheep and cattle). This means that a portion of the forage resources within those allotments are allocated for harvest by domestic sheep under the authority of a proper grazing permit and within constraints imposed by both the Forest Plan and the terms and conditions of the permit. Of the 15 allotments designated in the Forest Plan, five sheep allotments and two dual use allotments are currently stocked by domestic sheep under a permit. In addition, there are eight designated sheep allotments that are in a vacant status.

Analysis of domestic sheep allotments falls into one of two categories: Allotments are either active, indicating that there is a Term Grazing Permit issued that provides for stocking of the allotment by a prescribed-number of domestic sheep for a given season (or a preferred applicant has a priority for issuance of a permit), or the allotment is vacant. An allotment is considered to be vacant when either no Term Grazing Permit is in effect for that allotment or no priority applicant exists. The process for making decisions regarding each of these situations will be discussed separately.

Active allotments

Currently, Sheep Creek, Temperance-Snake, Mud Duck, McCarty, and Spring Creek are active sheep allotments (Appendix B and G). In addition, Mud and Davis Creek are designated for dual use (e.g., stocking is permitted by both domestic sheep and cattle).

Management of active allotments is conducted under the provisions of a Term Grazing Permit. This permit prescribes certain management activities under the Terms and Conditions of the Permit. The Allotment Management Plan is incorporated as a part of the Term Grazing Permit. This Plan sets the stage for prescribing management of the allotment, including the management of the permitted livestock.

The development of an Allotment Management Plan follows a combination of law, policy and direction, including that provided by the Forest Plan and National Environmental Policy Act (NEPA). Specifically, the initial step in the planning process is a public scoping to identify the issues and concerns associated with management of the allotment. From this scoping, a set of data needs is developed and a process for collecting the data is derived. Once the data is collected and analyzed, additional scoping and public involvement leads to development of alternative systems of management that address the issues and concerns. This step includes development of objectives for management and criteria to measure the effectiveness of each alternative against the issues and concerns.

The final part of the planning process involves selection of the preferred alternative by the Line Officer (usually the Forest Supervisor). This is done through completion of the Environmental Analysis and documentation of the decision in a public decision document.

This preferred alternative is then written in the form of an Allotment Management Plan. This plan will contain the objectives for the management of the allotment, prescribed management requirements (grazing systems, constraints, improvement developments, etc.), coordination requirements (such as for wildlife, recreation, etc.), livestock management requirements, etc. The plan will also contain monitoring plans based on short term implementation of standards and guidelines from the Forest Plan (ex: utilization standards), and long term monitoring of the effectiveness of the management practices in meeting the objectives of the plan.

In general, the Allotment Management Plan is expected to cover a ten to twenty year period. However, it is also expected the plan will be updated as needed. This can occur as a minor modification or may require a complete revision.

On the WWNF, all allotments are currently planned for new Allotment Management Plans within a ten year period. This schedule is based on a prioritization process that considers resource problems and conflicts. The more significant the problems or conflicts, the higher the priority assigned to the allotment. This schedule changes slightly from year to year based on accomplishments and budgets. The most up-to-date schedule can be found in the latest amendment to the Forest Plan.

In general, the Temperance-Snake and Mud Duck allotments are scheduled to be analyzed together within the next few years. Sheep Creek Allotment is not currently scheduled within the current five year period but would be scheduled within the second five years. McCarty and Spring Creek have recently completed plan updates and would not normally be re-visited for about ten years. Mud and Davis Creek Allotments are both planned for re-analysis and planning within the next five years.

Vacant Allotments

Currently, the Canyon, Big Canyon, Sheep Rock, Minam River, Standley-Huckleberry, Huckleberry, Indian Crane, and Chicken Hill allotments are designated as sheep allotments in the Forest Plan but are currently in a vacant status.

The process for making decisions on vacant allotments is determined by various laws and policies including NEPA, the Forest Plan, and manual direction on the permit grant process.

For a vacant domestic sheep allotment, there are a number of potential decisions that can be made. First, a Forest Plan decision exists that the allotment is suitable and available for stocking by domestic sheep. Therefore, the Forest Plan recognizes the area as an established domestic sheep allotment.

However, in some cases, there could be reasons for re-considering the kind of livestock to be permitted. This may include economics, potential changes to alleviate other resource problems or conflicts on either the vacant allotment or on other allotments, etc. This determination would be made following an analysis as to the potential suitability of the vacant allotment for other kinds of livestock. This information would be presented and a decision made through the NEPA process which would include public scoping and involvement in the decision making process.

If the preferred alternative, and the subsequent decision is made to change the kind of livestock from domestic sheep to cattle, the allotment would cease to be available for stocking by domestic sheep. Stocking of the allotment would then be conducted under the grant process (explained below) and management would be detailed through the development of an Allotment Management Plan (as described above).

Where there is no decision made to convert the kind of livestock to other than domestic sheep, a process called the grant process must be followed to stock the allotment. This process is basically a priority screening that provides for using the capacity available on the allotment to meet certain obligations including restoring past resource improvement reductions (including on other allotments), correcting overstocking on other National Forest allotments and, meeting the proportionate needs of other resources and values. In order to issue a permit under the grant process, there must be an Allotment Management Plan that meets current Forest Plan Direction and NEPA sufficiency.

This grant process is only a priority screening process that selects a preferred applicant for an allotment area that is already established through the Forest Plan. The decisions regarding stocking levels, seasons of use, management intensities, etc., are made through the NEPA process and are documented in the form of a public decision document and an Allotment Management Plan.

If the capacity, or a portion thereof, is granted under a Term Grazing Permit, the new permittee becomes responsible for compliance with the Terms and Conditions of the Term Grazing Permit and Allotment Management Plan.

Until such time as a NEPA decision is made regarding the allocation of the forage resources, the allotment remains as a designated domestic sheep allotment.

In general, these vacant allotments are considered to be a low priority for analysis and planning on the Forest. This is because certain other active allotments are considered to be in more need of planning to either correct current resource problems or to prevent resource problems and conflicts from occurring. This would generally mean that these vacant allotments would not be scheduled for analysis and planning until the last years of the planning cycle.

Finally, a decision can be made to close specific allotments if analysis shows that the allotment no longer provides suitable range, the allotment is not economically feasible to be stocked under current or projected management systems, the area within the allotment is to be designated for emphasis on a resource or resources where significant conflicts would exist with livestock grazing, or various other reasons. This closure of an allotment would need to occur through the NEPA evaluation process and would result in amendment of the Forest Plan.

III. BIGHORN/DOMESTIC SHEEP MANAGEMENT ZONES

Zone One -

Zone One is located north and northeast of Enterprise and covers approximately 225,000 acres (see Appendix E). Currently there are about 30 bighorns in upper Joseph Creek, 10-15 in lower Joseph, and about 30 adjacent to Cherry Creek (Appendix C and H). All populations are slowly increasing in size. There are no domestic sheep allotments within the zone, only cattle and horse allotments.

The Department considers this zone to have several areas of unoccupied suitable habitat. The task group feels zone one has a low risk for conflict between bighorn and domestic sheep. Consequently, this zone has the highest priority for reintroduction/supplementation. Four sites have been identified as shown in Appendix A.

This zone will be considered available for reintroduction/supplementation subject to a case-by-case Environmental Assessment. All future decisions will address at least the following:

a. Intended and mapped boundary of bighorn year round range and maximum bighorn population objective.

b. Identification and recognition of nearest domestic sheep population of other possible activities that could be a potential resource conflict.

c. An evaluation of range vegetation conditions and year-round forage supplies for the bighorn population size objective.

d. List of habitat improvement opportunities with corresponding map.

If bighorns are reintroduced and migrate outside of zone one, these animals will be considered "at risk." The Department can mitigate some of this potential by selecting non-migrating stock, if available. However, some sheep in any population will "pioneer," and look for new areas. In these cases, the Department will address these potential migrations when they occur.

Zone Two –

Zone Two is located east of Enterprise and continues to the Idaho border, covering about 300,000 acres. There are about 100 bighorns along the lower Imnaha River. This population is increasing slowly. Four of the seven Rocky Mountain bighorn sheep hunting permits allowed in Oregon are permitted in this zone. There is currently one vacant sheep allotment, Canyon, which was last grazed by sheep in 1977. Forty to fifty Forest Service horses currently winter graze a portion of this allotment.

Since this zone contains a vacant sheep allotment, no bighorn or domestic sheep would be reintroduced into the Canyon allotment until the "Analysis Process" is followed. Bighorns could be reintroduced outside of the Canyon allotment in zone two, if the conditions outlined in zone one management were met. If a decision is made to not restock the allotment with domestic sheep, zone one management would prevail. If restocking the allotment with domestic sheep is decided, zone four management would apply.

This zone has five potential reintroduction/supplements. Two of these, H and I, are far enough away from Canyon Allotment that ODF&W feels reintroductions would have a low risk. All five sites are considered high priority by the Department.

Zone Three -

Zone Three is located directly south of Enterprise and covers the entire west side of the Wallowa Mountains, about 400,000 acres. About 45 bighorns are located along the Lostine River (which once numbered 110 head), and about 40 head represent the Bear/Minam herd. Both populations are slowly increasing. This zone has two potential reintroduction sites.

The zone contains several cattle allotments and four vacant domestic sheep allotments (Minam River, Standley-Huckleberry, Huckleberry, and Sheep Rock). Since this zone contains vacant sheep allotments, no bighorn or domestic sheep would be reintroduced until the "Analysis Process" is followed. Bighorns could be reintroduced outside of these vacant allotments within zone 3, if the conditions outlined in zone one were met. If it was decided to not stock any of the 4 vacant allotments with domestics, zone one would apply. Zone four would apply if any of the vacant allotments would be restocked with domestics.

Zone Four -

Zone Four contains about 350,000 acres and lies just southeast of Enterprise. There are only 5 to 10 bighorns remaining in the Upper Hells Canyon herd. Once numbering about 40, there have been a couple of major die-offs since 1983. The Department has identified two areas for possible reintroduction, both of which are considered low priority because of an active domestic sheep operation.

Temperance/Snake and Mud Duck sheep allotments have been active for many years. The sheep winter along the Snake River and move to the upper Imnaha drainage in summer. As long as these allotments remain active, the Department has no plans for reintroducing bighorns. If these allotments ever became vacant, the "Analysis Process" would be followed prior to any restocking of bighorn or domestic sheep.

The existing bighorns or others that move into active sheep allotments in zone four are considered at risk. If bighorns are found in active sheep allotments, the agency that makes the initial finding will immediately notify the WWNF. State agency action in these situations will be to remove or eliminate the bighorns if they consider them a possible source of disease transmission to any established bighorn herd.

The following management guidelines will be used on active domestic sheep allotments to help resolve potential conflicts between domestic and bighorn sheep:

a. Culling of domestic sheep - all obviously sick or lame sheep will be removed from the band prior to entering the National Forest allotment.

b. Upon entering or leaving an allotment or when moving between major grazing areas, the permittee will make every effort to ensure that no domestic sheep are left behind. If strays are found, they will be removed from the allotment, returned to the band, or disposed of by the permittee after the permittee discovers the problem or within 3 days after being notified by the Forest Officer.

c. While on the allotment, domestic sheep will be routed according to the approved annual operating plan and will not be allowed to graze outside the area planned for use. If unforeseen circumstances cause a need to change, the change must be approved in advance by the Forest Service. If domestic sheep are grazed outside the scheduled area without written approval, this will be cause for adverse action against the term grazing permit. In addition, the permittee will be required to move the livestock back into the scheduled area as soon as the problem is discovered or within 3 days following notification by the Forest Officer. The Forest Service will not tolerate non-compliance with the annual operating plan, and appropriate timely corrective actions will be implemented.

d. The domestic sheep permittee will comply with all applicable state laws dealing with interstate transport of livestock. In addition, for situations where the domestic sheep will be grazing in areas near bighorn range, the Forest Service may require tests and veterinarian certification for certain other diseases prior to placement of the sheep on the allotment.

e. All domestic sheep herders will be required to promptly report sightings of any bighorn to the permittee, who will then pass on the information to ODF&W and the Forest Service for appropriate action. The period of time between initial bighorn sighting and reporting to ODF&W will rarely exceed ten days. If bighorn sheep are seen approaching the domestic sheep, the herder will take all precautions to keep the bighorns separate from the herd. These steps may include moving the domestic sheep, chasing off the bighorns, creating noises, or other means of harassment to discourage the approach of the bighorns.

Zone Five –

Zone five is located about 12 miles north of Wallowa and covers only about 38,000 acres. This area currently has no bighorns. Only one site (Mud Creek) has the potential for reintroduction. ODF&W considers this a very low priority for reintroduction because it is an active sheep allotment.

Two dual use sheep and cattle allotments, Mud and Davis Creeks, have been active for many years. As long as these allotments remain stocked with domestic sheep, the Department has no plans for reintroducing bighorns. Animal management for domestic sheep and bighorn strays will be the same as zone four.

Zone Six -

This area is the small fringe Forest land adjacent to the Grande Ronde River. There are currently no bighorn sheep, but there is one low priority location that ODF&W feels could support a small herd. Only one cattle allotment is within the area, and presents no conflicts with any potential bighorn reintroduction. The zone borders the N. end Transitory sheep allotment which could present potential conflicts in the future between wild and domestic sheep. Presently, however, there is a buffer between the two species.

Since most of bighorn habitat lies on the adjacent Umatilla National Forest, this document will defer any bighorn management within this zone to that Forest.

Zone Seven -

Zone seven is the Idaho portion of the HCNRA and covers about 120,000 acres. About 40 to 50 bighorns occupy two locations. Both populations are declining, and their current status is undetermined. The cause of the current die-off is undetermined at this time.

The Idaho Department of Fish and Game (IDFG) has identified three sites: Granite, Bernard, and Sheep Creeks for potential supplementation. Priority for all three sites is considered only moderate, due to Sheep Creek, a currently active sheep allotment. If the allotment no longer had domestic sheep grazing, the sites would have a high priority. Management of this allotment would be similar to zone four.

There is another sheep allotment on the Idaho side, Big Canyon, which has been vacant since 1982. The "Analysis Process" would be followed prior to restocking of either bighorn or domestic sheep.

Zone Eight -

The very southern edge of the Forest, near Dooley Mountain, comprises zone 8. In 1987, about 15 California bighorn sheep were introduced on Bureau of Land Management lands at the base of Hooker Gulch. The herd has grown to about 35 and is staying very close to where they were released. ODF&W does not feel, at this time, the zone has any other potential bighorn release sites.

Currently, there are no domestic sheep allotments in this zone. The 6 cattle and horse allotments should pose no conflicts with bighorns. If ODF&W identifies a potential release site, management of this zone would follow zone one.

Zone Nine -

The rest of the Forest is in this zone. There are no Rocky Mountain bighorn sheep populations. However, historical records show that bighorns occupied the Elkhorn Mountains. ODF&W has identified one moderate priority site in the Elkhorns that has potential to reintroduce bighorns. This is considered a low risk site, because there are no domestic sheep allotments nearby. For this site, zone one management would apply.

The north part of this zone has 2 active sheep allotments (Spring Creek and McCarty), and 2 vacant sheep allotments (Chicken Hill and Indian Crane). Currently, the north part of this zone has very little potential for bighorn reintroductions and ODF&W has no plans to do so.

Management for All Zones

There are a number of private farm and range flocks surrounding the Forest. If bighorns move down into these domestic sheep, it is important that ODF&W biologists are contacted as quickly as possible. ODF&W will take the lead in organizing a public education process that will make the public more aware of the potential for bighorn/domestic sheep disease transmission.

The proximity of private farm flocks to potential bighorn transplant sites on the WWNF will be considered by both agencies in the decision process for future bighorn transplants. If there's a high probability of physical contact between domestic and wild sheep, it may be the best decision to not transplant bighorns in that area.

APPENDIX A

Locations of Potential Reintroductions/Supplements

Map Letter	Zone	Location		State	Priority
A	1	Bear Ridge	Reintro	ODFW	High
B	1	Table Mountain	Supp	ODFW	High
C	1	Cache Creek	Reintro	ODFW	High
D	1	Deadhorse Ridge	Supp	ODFW	High
E	2	Deep Creek	Reintro	ODFW	High
F	2	Tryon Creek	Reintro	ODFW	High
G	2	Pumpkin Creek	Reintro	ODFW	High
H	2	Sheep Divide	Reintro	ODFW	High
I	2	Devils Gulch	Reintro	ODFW	Moderate
J	3	Minam	Supp	ODFW	High
K	3	Cornucopia	Reintro	ODFW	Low
L	4	Sand Creek	Reintro	ODFW	Low
M	4	Battle Creek	Supp	ODFW	Low
N	4	Spring Creek	Reintro	ODFW	Low
O	5	Mud Creek	Reintro	ODFW	Low
P	6	Grande Ronde	Supp	ODFW	Low
Q	7	Granite Creek	Supp	IDFG	Moderate
R	7	Bernard Creek	Supp	IDFG	Moderate
S	7	Sheep Creek	Supp	IDFG	Moderate
T	8	Rock Creek	Reintro	ODFW	Moderate

ODFW - Oregon Department of Fish and Wildlife
IDFG - Idaho Department of Fish and Game
Reintro - Reintroduction of new herds
Supp - Supplement existing herds

APPENDIX B

STATUS OF DOMESTIC SHEEP ALLOTMENTS

Active Domestic Sheep Allotments

Sheep Creek - HCNRA (Idaho portion)

Temperance-Snake - HCNRA

Mud Duck - HCNRA and Eagle Cap RD's

Spring Creek – La Grande RD

McCarty – La Grande RD

Mud Creek (dual use) - Wallowa Valley RD

Davis Creek (dual use) - Wallowa Valley RD

Vacant Domestic Sheep Allotments

Big Canyon - HCNRA (Idaho)

Canyon - HCNRA

Minam River - Eagle Cap RD

Standley-Huckleberry - Eagle Cap RD

Huckleberry - Eagle Cap RD

Sheep Rock - Pine RD

Chicken Hill – La Grande RD

Indian Crane - Baker RD

APPENDIX C

Status of Bighorn Sheep Herds
on or Near the WWNF
September 1991

Herd Name	Management Unit	Population #'s	Population Trends	
Lostine	Minam	45	Slowly increasing	App
Lower Imnaha	Snake River	100	Increasing	App
Upper Hells Canyon	Snake River	5-10	Static	App
Cherry Creek	Chesnimnus	30	Slowly Increasing	Non
Bear/Minam	Minam	40	Increasing	App
Upper Joseph Creek	Sled Sps/Ches	30	Increasing	Non
Lower Joseph Creek	Sled Springs	10-15	Summer range for Wash	XXX
Granite/Three Crks	18	40-50	Declining	App
Sheep Mountain	Pine Creek	30	Slowly Increasing	XXX
Hooker Gulch	Sumpter	35	Slowly Increasing	XXX

App - Release was approved through the environmental assessment process
Non - Not approved through the process.
XXX - On private, state, and/or BLM land

APPENDIX D

LIST OF PERTINENT BIGHORN SHEEP DOCUMENTS

1. Cooperative Management Agreement - Supplemental Release of Bighorn Sheep Snake River 12/14/89.

2. Guidelines for Bighorn/Domestic Sheep Management on the WWNF. 1988.

3. Bighorn Sheep Management Plan written by ODFW. 1986

4. Environmental Assessment for Lower Minam Area Bighorn Sheep Reintroduction 9/10/85.

5. "Whitepaper" - Guidelines for bighorn sheep/domestic sheep management on the Wallowa-Whitman National Forest. 1981

6. Environmental Assessment and Memorandum of Understanding for Reintroduction of Bighorn Sheep in the Imnaha River Drainage 1/2/79.

7. Memorandum of Understanding for Transplant of 20 Bighorns to Black Mountains 1/10/78.

8. Addendum to Environmental Assessment for Reintroduction of Bighorns into Bear Creek 12/28/83.

9. Memorandum of Understanding for Transplant of 25 Bighorns from Lostine River to Bear Creek 12/23/76.

10. Memorandum of Understanding for Reintroduction of 20 Bighorns to Sheep Creek Divide 7/10/86.

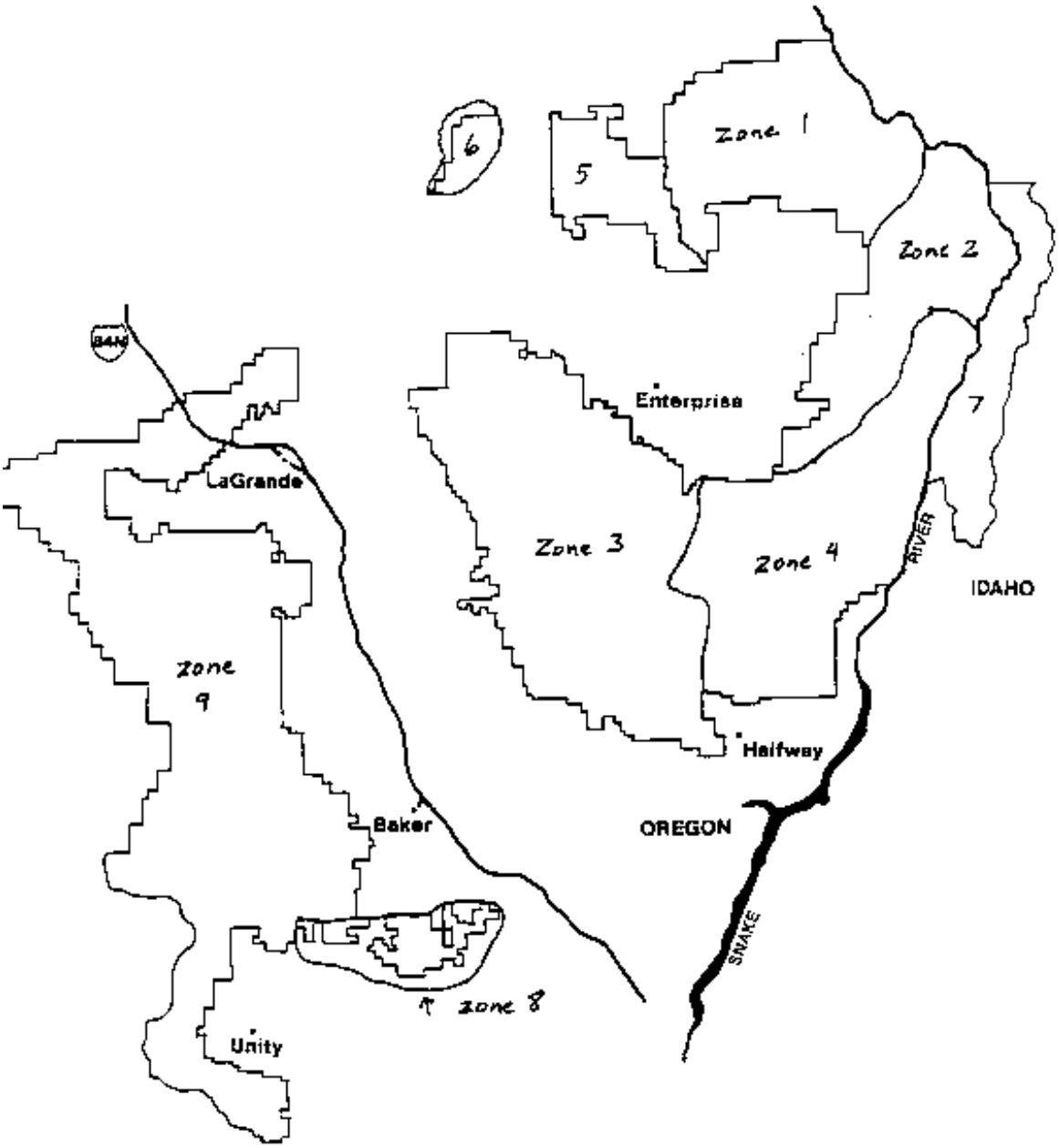
11. Environmental Assessment for Bighorn Reintroduction on Snake River 1/20/76.

12. Multiple Use Survey Report for Bighorn Sheep Transplants 1/70.

13. Lostine River Biological Unit Management Plan 11/10/71.

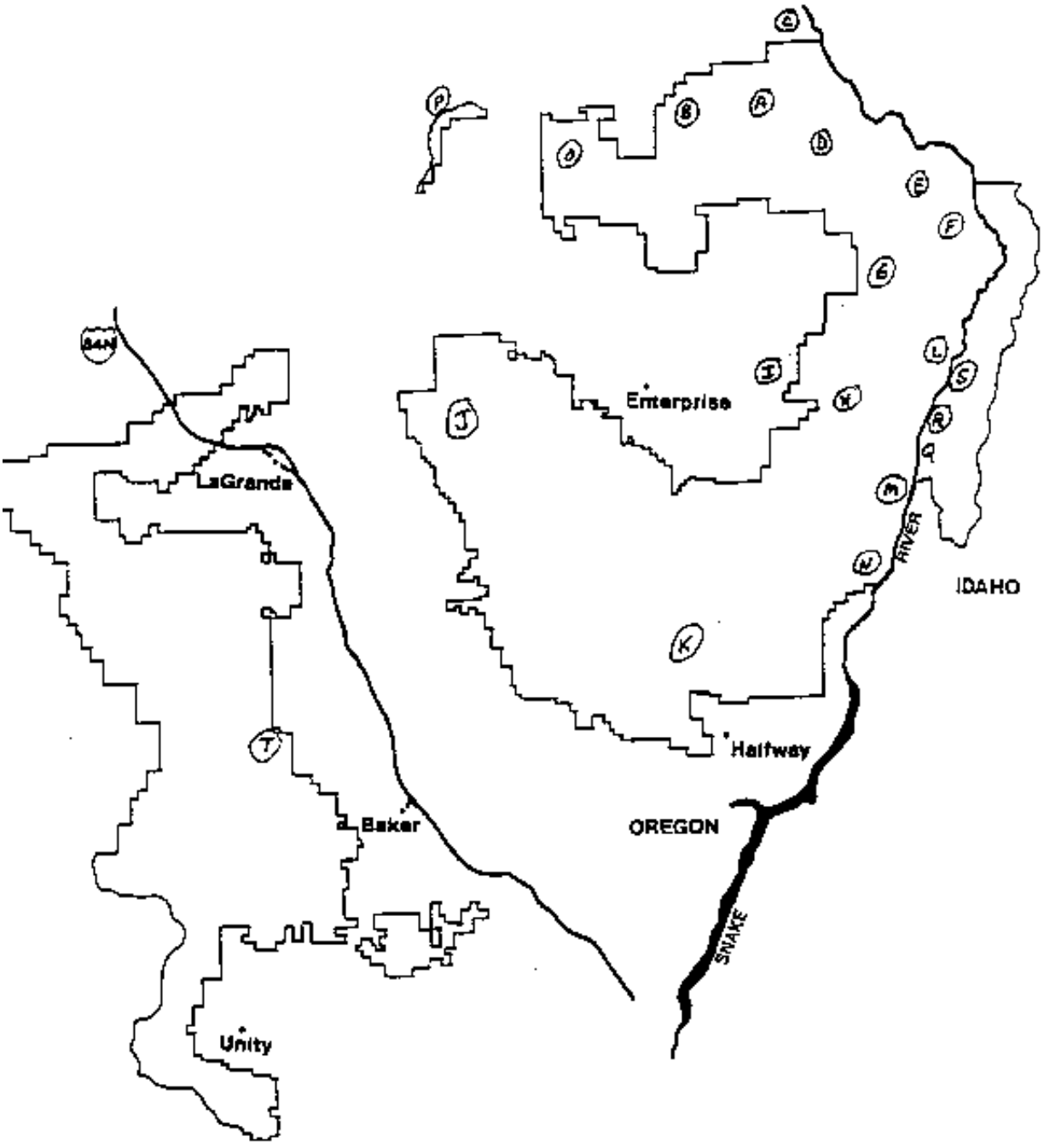
APPENDIX E

BIGHORN/DOMESTIC SHEEP MANAGEMENT ZONES



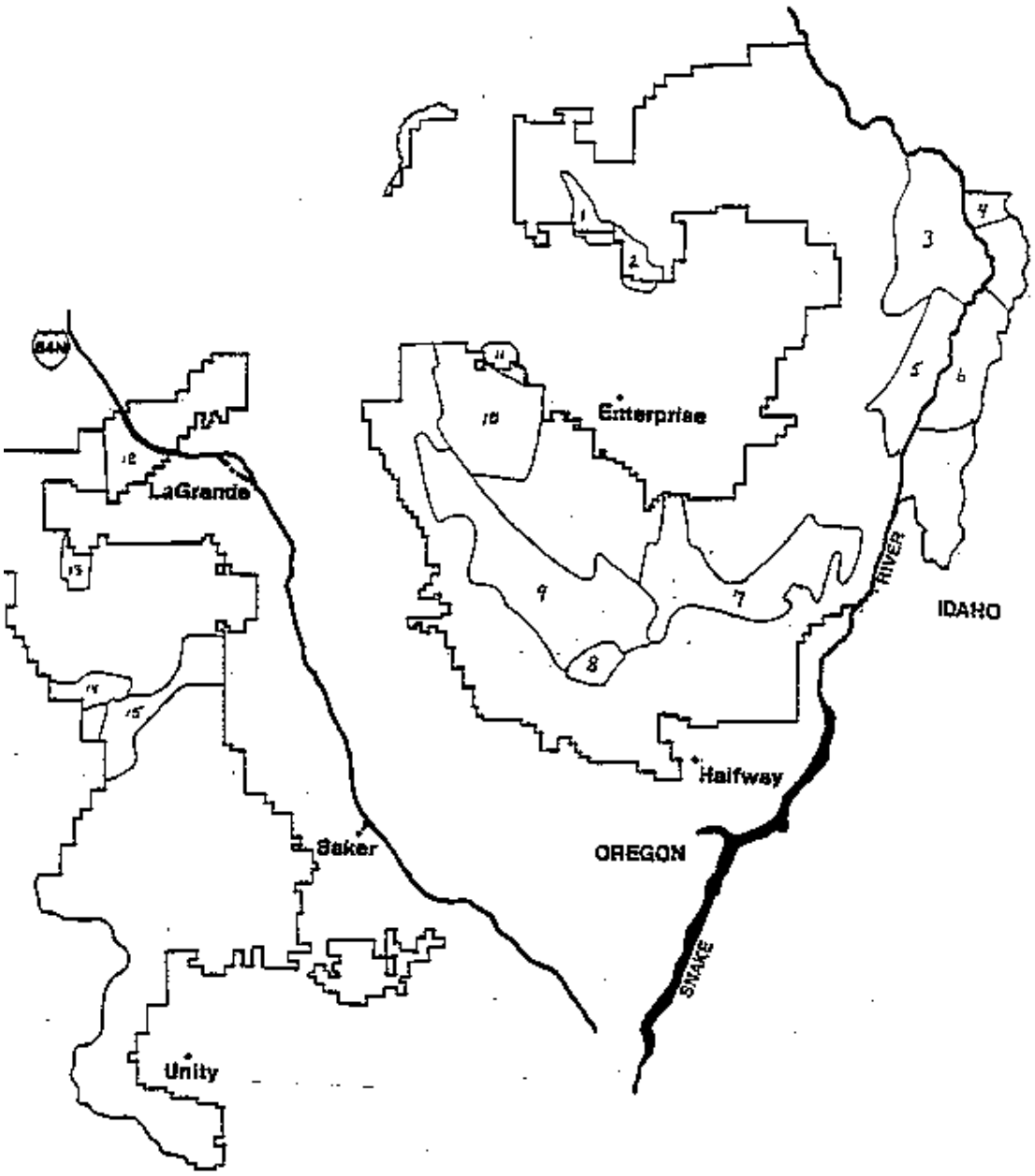
APPENDIX F

POTENTIAL REINTRODUCTION



APPENDIX G

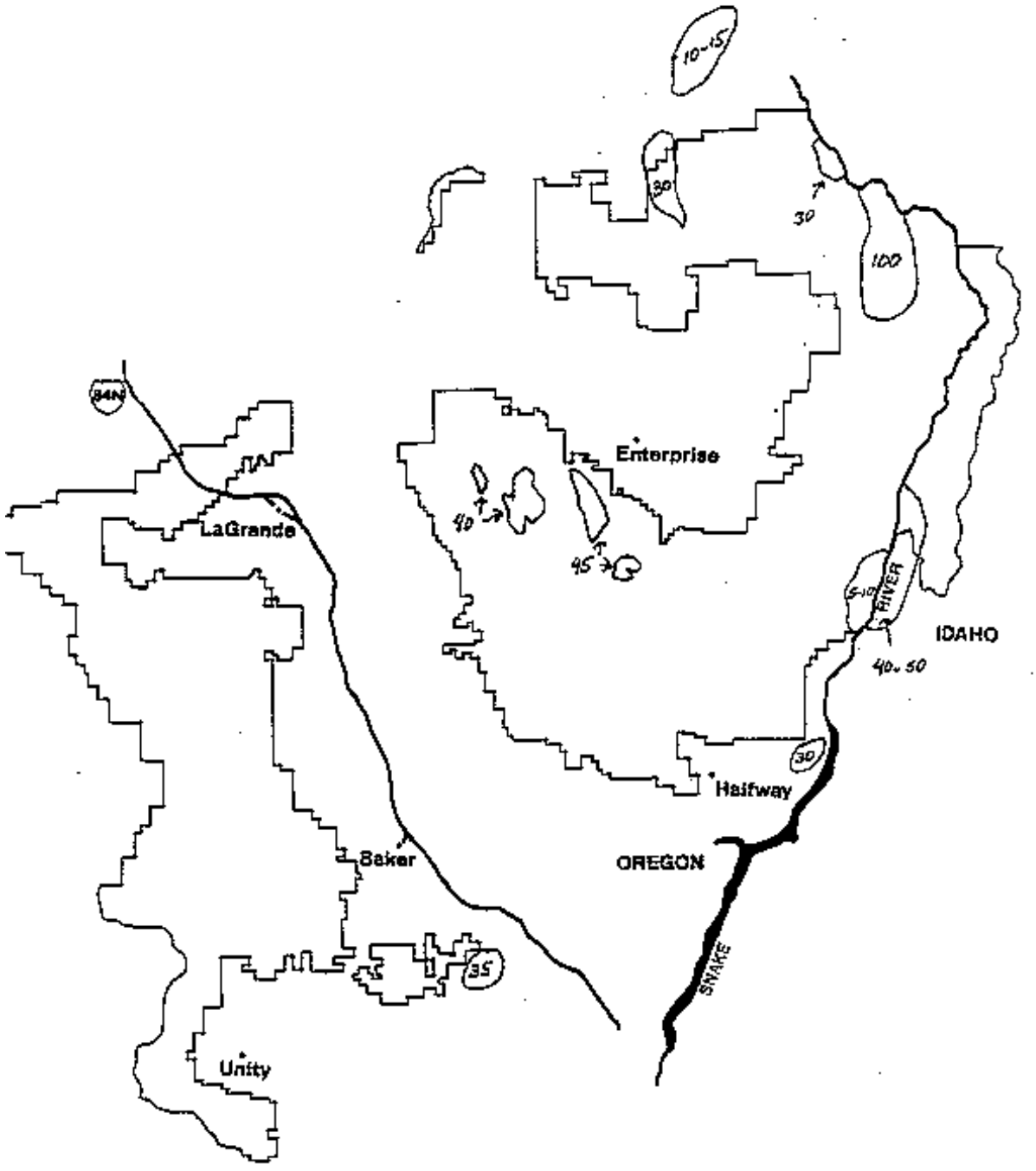
DOMESTIC SHEEP ALLOTMENTS



DOMESTIC SHEEP ALLOTMENTS	
1. MUD CREEK	8. SHEEP ROCK (V)
2. DAVIS CREEK	9. MINAM RIVER (V)
3. CANYON (V)	10. STANDLEY
4. BIG CANYON (V)	11. HUCKLEBERRY (V)
5. TEMPERANCE-SNAKE	12. SPRING CREEK
6. SHEEP CREEK	13. MCCARTY
7. MUD DUCK	14. CHICKEN HILL (V)
	15. INDIAN CRANE (V)

APPENDIX H

BIGHORN HERD LOCATIONS AND SIZES



LIST OF THOSE RESPONDING TO BIGHORN/DOMESTIC SHEEP MANAGEMENT STRATEGY

August 1991

1. Jon Vanderheyden
2. Ed Watters
3. BLM Baker Office
4. Hells Canyon Preservation Council
5. Idaho Department of Fish and Game
6. Umatilla National Forest
7. Art Seamans
8. Paul Morehead
9. Skye Krebs

APPENDIX B

5.42 Bighorn Sheep Habitat

Theme

Management emphasis is to provide adequate amounts of quality forage, cover, escape terrain, and solitude for bighorn sheep and other species, while allowing vegetative manipulation that provides other multiple-use resources.

Management area description

These areas provide habitat for established bighorn sheep herds on the Forest. To ensure bighorn sheep viability, maintaining and improving the habitat upon which bighorn sheep depend is emphasized. Much of the area contains cliffs, rocky points, and benches intermixed with grass, forb, and shrub communities. Forested stands may also be present.

Desired condition

Herd objectives are established in cooperation with the Colorado Division of Wildlife. Interpretive opportunities are provided in established viewing areas.

Vegetation is managed to provide healthy plant communities with a variety of species present for food and cover. Natural and created openings or meadows of various sizes and shapes occur. Prescribed natural fire and management-ignited fire plans are developed in support of habitat improvement.

The recreation opportunity spectrum (ROS) for this management area is primitive, semi-primitive non-motorized, semi-primitive motorized, roaded natural, or rural year-round. For the ROS designation of a particular area, see the ROS maps in Appendix XX. Scenery is managed to provide a range of scenic integrity objectives from moderate to high as shown on the Scenic Integrity Objective maps in Appendix XX.

Standards and guidelines

INFRASTRUCTURE

Standard **1.** Over-the-snow vehicle use is restricted to designated routes.

MINERAL AND ENERGY RESOURCES

Guideline **1.** These areas are available for oil and gas leasing with controlled surface use or timing restrictions.

RANGE

Standards

1. Grazing strategies will be implemented to meet bighorn sheep habitat objectives.

2. Grazing by domestic sheep is prohibited unless adequate temporal or spatial separation can be demonstrated.

RECREATION

Guidelines

1. Recreation activities that disturb bighorn sheep should be restricted.

2. Provide interpretive opportunities in established viewing areas.

VEGETATION MANAGEMENT

Standards

1. These areas are not part of the suitable timber land base.

2. Vegetation management practices will be used to maintain or improve bighorn sheep habitat.

APPENDIX C

BIGHORN SHEEP
HERD UNIT REVIEW

Targhee (Area 6) (BHS106) **Revision Date: 4/17/98**

Estimated Population: 100 (post season 1997)

Population Objective: 125

Most Recent Hunting Regulations: 4 licenses, 3/4 curl ram

Current WGFD Managers: Doug Brimeyer, Steve Kilpatrick, Doug Crawford

JCR Responsibility: Doug Brimeyer

Other Contacts: Mary Oshner (USFS), Garvice Roby (WGFD-Ret.), Steve Cain (NPS)

Previous Studies: Steve Cain (NPS Reports)
N. Fitzsimmons & S. Buskirk (1992)
Mike Whitfield (1984)

Problems:

Habitat - Limited winter range, lack of fire
Domestic Sheep - Buffer zone only 3 miles (enough?)
Predation -
Genetics - Isolated population
Disease -
Migration -
Herbivore Competition -
Recreation/Development Encroachment -
Poor/Inconsistent Classification Data -
Hunting Related - Variable harvest due to land status (Grand Teton National Park)
Other - High natural mortalities (GTNP)

Jackson (Area 7) (BHS107) Revision Date: 4/17/98

Population Estimate: 530 (post season 1997)

Population Objective: 500

Most Recent Hunting Regulations: 20 licenses any sheep

Current WGFD Managers: Doug Brimeyer, Gary Fralick, Doug Crawford, Dallas Jenkins

JCR Responsibility: Doug Brimeyer

Other Contacts: Adrian Villaruz (USFS), Garvice Roby (WGFD-Ret.)

Previous Studies:

Honess and Frost (1942)
Les McCann (1956)
Buechner (1960)

Transplant History:

1934 Transplant - 20 sheep trapped in Flat Creek, released in Bighorn Mountains - Hurley (1996)
1980 Transplant - 14 sheep released at Stinking Springs - Roby (1980)
these sheep were destined for Darby Mtn., but weather conditions precluded their release there, so they were turned out at Stinking Springs
- 11 sheep were released on Flat Creek

Total - 25 sheep released into herd unit

Problems:

Habitat - Habitat conditions (Willow Creek), lack of fire
Domestic Sheep - Yes, potential for contact on south end of herd unit
Predation -
Genetics - Scattered, isolated populations
Disease - Scabies at Camp Creek
Migration -
Herbivore Competition - Elk competition
Recreation/Development Encroachment - Snow machine disturbance
Encroachment on winter range - Stinking Springs
Poor/Inconsistent Classification Data -
Hunting Related -
Other - Recent overwinter mortality

Wapiti Ridge (Area 3) (BHS203) Revision Date: 4/17/98

Population Estimate: 925 (post season 1997)

Population Objective: 1000

Most Recent Hunting Regulations: 44 licenses, 3/4 curl ram

Current WGFD Managers: Larry Roop, Craig Sax, Tim Fagan

JCR Responsibility: Larry Roop

Other Contacts: Dave Henry, Bernie Spanogle (USFS), Kevin Hurley, Scott Smith, Doug McWhirter (WGFD)

Previous Studies: Hurley (1985)
Smith (1988)
McWhirter (1993)

Problems:

Habitat - Private land issues - winter range - reliance on improved meadows, valley, ranch
Fenced in holdings in USFS - Land exchange
CRM - Upper South Fork - USFS initiated
Weed problems on winter range - "toadflax"
Tremendous habitat opportunities - limber pine/juniper, S. Fork side - some on N. Fork, but limited.
Conifer encroachment

Domestic Sheep - Potential for domestic sheep on private lands - easement potential?

Predation - Predation - wolves - Upper South Fork

Genetics –

Disease - Disease – scabies

Migration –

Herbivore Competition - Elk numbers?? South Fork
Livestock issues - Ishawooa Hills

Recreation/Development Encroachment - Winter range encroachment - Recreation (ice climbing, photographers, wildlife viewers)
Worth The Watching - Lots of interest- High profile

Poor/Inconsistent Classification Data –

Hunting Related –

Other - Prospects for trapping - up to 80 sheep

Francs Peak (Area 5, 22) (BHS205) Revision Date: 4/17/98

Population Estimate: 1430 (post season 1997)
Three components: Area 5, Badlands (Area 22), Owl Creek Mountains/ Wind River Indian Reservation (OCM/WRIR)

Population Objective: 1360

Most Recent Hunting Regulations: Area 5-60 licenses any ram, Area 22-4 licenses 3/4 curl ram, OCM/WRIR-8 licenses any ram

Current WGFD Managers: ColeThompson, Pat Hnilicka, Tim Fuchs, Jerry Longobardi, Kevin Hurley, Tim Fagan

JCR Responsibility: Kevin Hurley

Other Contacts: USFWS - Dave Skates, Jeff Kimber, USFS - Joe Hicks, Mark Hinschberger, Dave Henry
BLM - Sue Oberlie, Tim Stephens, Marian Atkins, Kathy Firchow (formerly USFWS)

Previous Studies: Hurley/Firchow (1994)
Smith (1981)

Transplant History:

1970 Transplant - 23 sheep released at Castle Creek -WGFD (1976), Oudin (1996), Hurley (1996)
1973 Transplant - 17 sheep released at the Dennison Place - WGFD (1976), Hurley (1996)
1995 Transplant - 43 sheep released in Wind River Canyon - USFWS (1996), Hurley (1996)

Total - 83 sheep released into herd unit

Problems: Hunt Area 5

Habitat - Habitat opportunity - on and off USFS - on Inberg-Roy WHMA
Domestic Sheep - Livestock - 6 "vacant" domestic sheep allotment - USFS looking to fill these?
Predation - Predation -future? - wolves/ no escape cover (Dennison) Little escape cover on Black Mountain, better escape cover higher
Genetics –
Disease - Disease - minor, scabies
Migration - Reservation - Unoccupied habitat - 40 mile migration lost - from Wind River Canyon to Owl Creek Mtns.
Herbivore Competition - Wild horses on sheep winter range (WRIR)
Recreation/Development Encroachment –
Poor/Inconsistent Classification Data –
Hunting Related –
Other - Unoccupied habitat - 50's-60's - thousands of domestic sheep, slowly coming back in these areas, Reintroduction potential

Problems: Hunt Area 22 (Badlands)

Habitat - Habitat improvement potential high - Wiggins Fork to Badlands
Private meadows
Domestic Sheep -
Predation -
Genetics -

Whiskey Mountain (Area 8, 9, 10, 23) (BHS609) Revision Date: 4/17/98

Population Estimate: 950 (post season 1997)

Population Objective: 1350

Most Recent Hunting Regulations: Area 8-4 licenses any ram, Area 9-8 licenses 3/4 curl ram, Area 10-16 licenses 3/4 curl ram, Area 23-8 licenses any ram

Current WGFD Managers: Pat Hnilicka, Cole Thompson, Bob Yates, Doug McWhirter, Duke Early, Dan Stroud

JCR Responsibility: Pat Hnilicka

Other Contacts: Mark Hinschberger, Barb Franklin (USFS), Sue Oberlie (BLM)

Previous Studies: Thorne et al. (1976)
Thorne et al. (1984)
Ryder et al. (1992)
Ryder et al. (1994)
Corruthers GIS Study (date?)
Hnilicka et al. (1997)

Transplant History:

1,894 sheep have been trapped on Whiskey Mountain winter ranges for relocation elsewhere (1949-1995)
1,878 sheep were released at their respective destinations
99.2% survival for all sheep relocation efforts spanning a 46-year period

1,489 were released in Wyoming, 389 were released in other states - Hurley (1996)

Problems:

Habitat - Forage quality?
Mineral quality?
Heavy forage use on portions of winter range (90%+ on some preferred sites)
Very limited winter range in Upper Green River
Some resident (year-round) use by sheep on Torrey Rim and Torrey Creek

Domestic Sheep - Domestics on Pinedale side, particularly Baldy Lake & North Fork Allotments

Predation -

Genetics -

Disease - Chronic Disease? Pasturella trehelosi present as of 3/97 in 5 of 9 ewes tested

Migration -

Herbivore Competition - Elk Competition

Recreation/Development Encroachment - Recreation - dogs/people

Poor/Inconsistent Classification Data -

Hunting Related -

Other - Poor lamb production (6th year), resulting in declining population
Tenuous access across Wind River Indian Reservation to portions of winter range (Red Creek)

Temple Peak (Area 11) (BHS610) Revision Date: 4/17/98

Population Estimate: 35 (excluding WRIR) (post season 1997)

Population Objective: 250

Most Recent Hunting Regulations: CLOSED

Current WGFD Managers: Tom Ryder, Bob Trebelcock, Chuck Clarke, Doug McWhirter, Tom Christiansen,
Allan Round, Dan Stroud, Dennis Almquist

JCR Responsibility: Tom Ryder

Other Contacts: Bob Lanka, John Emmerich (WGFD), Ken Persson (WGFD-ret.), Jack Welch (BLM-ret.),
Barb Franklin (USFS)

Previous Studies: Smith (1981)
Deibert (1994)
Firchow (1995)
Ryder and Lanka (1997)

Transplant History:

1964 Transplant - 21 sheep released in Sinks Canyon - Ryder & Lanka (1996)
1965 Transplant - 20 sheep released in Sinks Canyon - Ryder & Lanka (1996)
1966 Transplant - 18 sheep released in Sinks Canyon - Ryder & Lanka (1996)
1971 Transplant - 13 sheep released in Cherry Creek - Ryder & Lanka (1996)
1973 Transplant - 39 sheep released in Cherry Creek - Ryder & Lanka (1996)
1987 Transplant - 77 sheep released in Sinks Canyon & N. Fk. Popo Agie - Ryder & Lanka (1996)
1988 Transplant - 47 sheep released in S. Fk. Little Wind River - Firchow (1995)
1993 Transplant - 42 sheep released in S. Fk. Little Wind River - Firchow (1995)

Total - 277 sheep released into herd unit (including WRIR) - summarized in Hurley (1996)

Problems:

Habitat - Lack of Fire

Domestic Sheep - Past exposure to domestics on winter range
Real potential of co-mingling on summer range west of Continental Divide

Predation -

Genetics -

Disease -

Migration - Interrupted migration corridors - conifers

Herbivore Competition -

Recreation/Development Encroachment - Recreation - (Sinks Canyon/N. Fork/Cherry

Crk)

Poor/Inconsistent Classification Data - Data difficult to obtain - inconsistent
Hunting Related -
Other -

APPENDIX D

Bienn. Symp. North. Wild Sheep and Goat Counc. 10:72-77.

LITERATURE REVIEW REGARDING THE COMPATIBILITY BETWEEN BIGHORN AND DOMESTIC SHEEP

KEVIN D. MARTIN, Hells Canyon National Recreation Area, Wallowa-Whitman National Forest, 88401, Hiway 82, Enterprise, OR 97828
TIM SCHOMMER, Wallowa-Whitman National Forest, 1550 Dewey Avenue, P.O. Box 907, Baker City, OR 97814
VICTOR L. COGGINS, Wallowa Wildlife District, Oregon Department of Fish and Wildlife, Enterprise, OR 97828

Abstract: A literature review was conducted regarding the compatibility of bighorn sheep and domestic sheep. In both fenced studies and free ranging herds, most contact between bighorn sheep and domestic sheep has resulted in pneumonia in bighorns and the deaths of all or most bighorns while domestic sheep remained healthy. Published research has shown that *Pasteurella haemolytica* (usually biotype A, serotype 2) is the major pathogen responsible for the death of bighorn sheep after contact with domestic sheep. DNA fingerprinting has proven the transfer of *Pasteurella* spp. between bighorn and domestic sheep under both controlled "experimental" and range conditions. No studies reported any bighorn herds, fenced or free ranging, that have come into contact with domestic sheep and remained healthy. No vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with virulent strains of *Pasteurella.* With the current information, almost all wildlife professionals, wildlife veterinarians and researchers have concluded that bighorn sheep and domestic sheep should not occupy the same ranges or be managed in close proximity to each other, because of the potential adverse effect from disease on bighorn sheep.

BACKGROUND

This is an updated report and literature review of information pertaining to the compatibility of bighorn and domestic sheep. The original review was requested by Regional Forester, John Lowe in 1993, with the content to be used as the basis for future decisions for the management of bighorn sheep and domestic sheep within the boundaries of Hells Canyon National Recreation Area, on the Wallowa-Whitman National Forest.

Current bighorn sheep numbers in the western United States have been estimated to be less than 1% of what they were prior to presettlement (Goodson 1982). Rocky mountain bighorn sheep (*Ovis canadensis canadensis)* were native to much of the mountain and canyon country which currently comprises a large proportion of the Wallowa-Whitman National Forest in Northeast Oregon and western Idaho. Specifically, historical accounts indicate that bighorns were numerous in the drainages in and around the Wallowa Mountains (Bailey 1936), the lower Imnaha River, Snake River, Grande Ronde River, Elkhorn Mountains, Powder River, and Joseph Canyon. The last Rocky Mountain bighorn sheep were gone from northeastern Oregon by 1945 (Oregon's Bighorn Sheep Management Plan 1992). Current numbers of Rocky Mountain bighorn sheep in the Hells Canyon National Recreation Area are also a fraction of what they were historically. Archaeological studies indicate wild sheep were a significant ungulate food item for Native Americans (USDA Forest Service Report 1991).

Following enormous population declines in the United States in the late 1800s and early 1900s, bighorn populations did not recover, in contrast to many other wildlife species. Bighorns have demonstrated less tolerance than other native North American ungulates to poor range conditions, interspecific competition, over hunting, and stress caused by loss of habitat (Desert Bighorn Council 1990). Most important, they have shown a much greater susceptibility to diseases (Goodson 1982).

In the last century wild sheep numbers have declined, their populations suffering from a wide variety of diseases, some that they have contracted from domestic sheep (Geist 1971). Some of these include scabies, chronic frontal sinusitis, internal nematode parasites, pneumophilic bacteria, footrot, parainfluenza III virus, bluetongue virus, and contagious ecthyma (Desert Bighorn Council 1990). Documented bighorn die-offs were recorded as early as the mid-1800s and have continued up to the present (Table 1) (Goodson 1982, Foreyt and Jessup 1982, Coggins 1988, Onderka

et al. 1988, Foreyt 1989, Desert Bighorn Council 1990, Foreyt 1990, Callan et al. 1991, Hunter 1993, Foreyt 1993, Foreyt et al. 1994). Bighorn sheep die-offs have occurred in every state in the western United States. In recent years biologists and researchers have suspected that even casual contact between bighorn sheep and domestic sheep may lead to respiratory disease and fatal pneumonia in the bighorns (Onderka and Wishart 1988). The role of domestic sheep in the epizootiology of bighorn sheep pneumonia is an important issue in multiple use management (Foreyt et al. 1994).

FINDINGS

There is strong evidence (Table 1) that the presence of domestic sheep with bighorn sheep caused the loss of part or all of the affected bighorn sheep population. The lack of compatibility between domestic sheep and bighorn sheep is evidenced by the fact that no bighorn populations exist anywhere in the state of Nevada where domestic sheep are currently being grazed (McQuivey 1978). Goodson (1982) reported that no bighorn sheep herds, that occurred with domestic sheep on their ranges were increasing except those on ranges where use by domestic sheep has been significantly reduced. With the information currently available, most wildlife professionals, wildlife veterinarians and researchers have concluded that bighorn sheep and domestic sheep should not occupy the same ranges or be managed in close proximity to each other, because of the potential adverse effect on the bighorn sheep (Jessup 1980, Foreyt and Jessup 1982, Goodson 1982, Jessup 1982, Kistner 1982, Wishart 1983, Coggins 1988, Jessup 1988, Onderka et al. 1988, Foreyt 1989, Foreyt 1990, Desert Bighorn Council 1990, Callan et al. 1991, Coggins and Matthews 1992, Foreyt 1992, USDI BLM Technical Committee 1992, Ward 1993, Foreyt et al. 1994, Foreyt 1994, Pybus et al. 1994, Hunter 1995, Foreyt 1995, University of Idaho 1995).

Of the numerous pathogens affecting bighorn sheep, *Pasteurella haemolytica* is the most important respiratory pathogen of bighorn sheep, and *Pasteurella multocida* may also be important in the pneumonia complex (Foreyt 1993).

Based on experimental data, bighorn sheep are more susceptible to fatal pneumonia than are domestic sheep. Based on all published experimental data, bighorn sheep die after close association with domestic sheep (Foreyt 1993).

Bighorn sheep are highly susceptible to domestic sheep strains of *Pasteurella spp.* while domestic sheep are refractory to bighorn sheep strains (Onderka 1986). Bighorn sheep die after inoculation with specific "strains" of *P. haemolytica* of "healthy" domestic sheep origin (Onderka et al. 1988, Foreyt et al. 1994). Biotype T strains of *P. haemolytica* (*P. treahola*) are found predominately in bighorns and other wild ruminants, biotype A strains of *P. haemolytica* are found predominately in domestic sheep (Foreyt 1993). In a study at the University of Idaho, Biotypes A, T and 3 were isolated from both bighorn and domestic sheep. In culture positive individuals, biotype T organisms were isolated from 76% of the bighorns and 21% of the domestic sheep, while biotype A organisms were isolated from 30% of the bighorns and 75% of the domestic sheep (Ward et al. 1990). There are many serotypes (10-20 or more) of *P. haemolytica* found in both bighorn and domestic sheep. There are many DNA types (50-100 or more) of P. haemolytica in bighorns and domestics. Different DNA types are present within a serotype and different serotypes are within a ribotype. Most *P. haemolytica* serotypes and DNA types look the same on agar, multiple colonies have to be typed from each animal. Multiple biotypes and serotypes can be isolated from the same animal. Tonsillar (pharyngeal) samples yield the highest isolation rate of *P. haemolytica*, nasal swabs have limited value except for the fact that healthy bighorn sheep rarely have *P. haemolytica* detected by nasal swabs. *P. haemolytica* survives for less than 24 hours in the environment, survival on dead animals and on many swabs, placed in medium, is often less than 24 hours, but tends to be longer on swabs. For the highest isolation rates of *P. haemolytica*, special steps must be taken to assure good sampling and preservation of samples.

Studies at Washington State University, one in Edmondton, Canada, and one at the Caine Veterinary Center, Boise, Idaho, have shown that specific types of *Pasteurella haemolytica* and *P. multocida* can be directly transmitted to bighorn sheep from domestic sheep (Onderka and Wishart 1988, Foreyt 1989, Foreyt 1990, Foreyt 1992, Hunter IDFG Letter Dated October 14, 1993) Table 1.

Foreyt et al. 1994 published the results of a study where DNA fingerprinting was used to pinpoint the origin of bacteria that lead to the death of bighorn sheep. Identified was the specific DNA type that caused the death of the bighorn sheep. The DNA type originated in the domestic sheep and had not been present in bighorn sheep before they were inoculated. The bacteria was *Pasteurella haemolytica* (biotype A, serotype 2).

In wild situations, domestic sheep and bighorn sheep association often results in death of the bighorns and does not affect the domestics. Often this is based on circumstantial evidence, because direct disease transmission is difficult to substantiate under field

conditions. The finding of a shared *Pasteurella* spp. (by DNA fingerprinting) between feral domestic sheep and bighorn sheep in a Nevada study suggests the Pasteurella spp. can be transmitted between the bighorn and domestic sheep under range conditions (Hunter 1995, Hunter 1996 personal communication). Deaths occur in bighorns after association with domestic sheep because strains of *P. haemolytica* that are nonpathogentic in domestic sheep are transmitted from domestic sheep to bighorns resulting in pneumonia and death of the bighorns (Foreyt 1993, Foreyt et al. 1994).

When bighorn sheep experience a pneumonia episode, all age mortality often occurs. Lambs that are born into these populations generally experience low survival rates for approximately 3 to 5 years or more after the initial pneumonia (Foreyt 1990, Coggins and Matthews 1992, Ward et al. 1992, Foreyt 1995, Hunter 1995). Observations of bighorn sheep have provided evidence that pneumonia associated *Pasteurella* infections may contribute to the high lamb mortality (Jaworski et al. 1993).

Essentially all ungulates carry some strains of *P. haemolytica* (Foreyt 1995). Experimentally, elk, deer, mountain goat, cattle, llama and domestic goat association with bighorn sheep did not result in pneumonia in bighorns (Foreyt 1992, Foreyt 1993, Foreyt 1994). Evaluation of samples from Idaho and Alaska bighorn sheep has conclusively demonstrated that free roaming bighorn sheep which have not had contact with domestic sheep are not free of *P. haemolytica* (Ward 1990, Heimer et al. 1992). There are isolates of *P. haemolytica* in some domestic sheep that are not lethal in bighorn sheep (Foreyt -1993).

There are bighorn sheep die-offs due to pneumonia that have occurred without any association with domestic sheep (Goodson 1982, Onderka and Wishart 1984, Foreyt 1989, Ward 1993 and Ryder et al. 1994). Researchers agree that there are five primary factors that cause pneumonia in bighorn sheep. These are: 1) the presence of bacteria such as *P. haemolytica* and *P. multocida*, types indigenous to bighorn sheep, which with other factors can predispose bighorns to pneumonia, 2) the presence of stress, examples include: depleted forage or human disturbance, 3) the presence of lungworms, 4) the presence of viruses, and 5) exposure to a virulent strain of *P. haemolytica* from domestic sheep. Research indicates that the first four factors are relatively common at times for bighorn sheep (Foreyt 1995).

Bighorn sheep, in particular young rams, have a propensity to travel outside their home range. Domestic sheep in rugged terrain have a tendency to stray from the main flock. Because of both behaviors, buffers between the two species, unless very large, have often failed.

Although attempts have been made, no effective vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with virulent strains of *P. haemolytica* (Foreyt 1995).

CONCLUSIONS

1) In both fenced studies and free ranging herds, most contact between bighorn sheep and domestic sheep has resulted in pneumonia in bighorns and the deaths of all or most bighorns while domestic sheep remained healthy.

2) Thirteen fenced studies, some of which were circumstantial evidence, in six states or provinces resulted in: 9 cases where all bighorns died from pneumonia, while from 50% to 83% were lost in the other 4 studies.

3) Additionally, 18 incidents involving free ranging bighorns in 8 states or provinces linked contact with domestic sheep to bighorn die-offs (Table 1).

4) DNA fingerprinting have proven the transfer of *Pasteurella* spp. between bighorn and domestic sheep under both controlled "experimental" and range conditions.

5) No studies reported any bighorn herds, fenced or free ranging, that have come into contact with domestic sheep and remained healthy.

6) Published research has shown that *Pasteurella haemolytica* (usually biotype A, serotype 2) is the major pathogen responsible for the death of bighorn sheep after contact with domestic sheep.

7) No vaccine currently exists that will prevent bighorn sheep from developing pneumonia after contact with virulent strains of *Pasteurella* spp.

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Table 1. Bighorn declines and die-offs believed to have resulted from contacts with domestic sheep.

Location	Cause of die-off	Results	Year(s)	Source
Sun River, Mont.	Unknown	>70 died	1910-35	Goodson (1982)*
Upper Rock Ck., Mont.	Unknown	All died	1965-70s	Goodson (1982)*
Thompson Falls, Mont.	Unknown	All died	1940-60	Goodson (1982)*
Kootenay Natl. Pk. BC., Can.	Pneumonia		1939	Goodson (1982)*
Bull River, BC., Can.	Pneumonia	96% died	1965	Brandy (1968) in Goodson (1982)*
MacQuire Creek, BC., Can.	Pneumonia		1981-82	Davidson in Goodson (1982)*
Lava Beds Natl. Mon., Cal***	Pneumonia	All died	1980	Blaisdell (1982)* and Hunt (1980)
Mormon Mtns., Nev.	Pneumonia	50% died	1980	Jessup (1981)*
Dinosaur Natl. Mon., Colo.	Unknown	All died	1950	Barmore (1962) in Goodson (1982)*
Rock Ck., Mont.	Unknown	8 left	1900-20	Goodson (1982)*
Rocky Mtn. Natl. Pk., Colo.	Pneumonia	All died	1917-30	Packard (1939a), (1939b) in Goodson (1982)*
Methow Game Range, Wash.***	Pneumonia	13 of 14 died	1979-81	Foreyt and Jessup (1982)*
Warner Mtn., Cal.	Pneumonia	All died	1988	Weaver (1988)*
Latir Parks, N.M.	Pneumonia	All died	1978-82	Sandoval (1988)*
Utah St. Univ., Utah**	Pneumonia	All died	1970s	Spillett in Goodson (1982)*
Univ. BC., Can**	Pneumonia	All died	1970s	Herbert in Goodson (1982)*
Colorado St. Univ., Colo.**	Pneumonia	All died	1970s	Hibler in Goodson (1982)*
Lostine, Or.	Pneumonia	70% died	1986	Coggins (1988)
Utah St. Univ., Utah**	Pneumonia	4 of 5 died	1988	T.D. Bunch (Utah St. Univ. Pers. Comm)*
Sheep River Alberta, Can.**	Pneumonia	2 of 2 died	1988	Onderka (1988)
Wash. St. Univ., Wash.**	Pneumonia	6 of 6 died	1989	Foreyt (1989)
Wash. St. Univ., Wash.**	Pneumonia	2 of 2 died	1990	Foreyt (1990)
Utah St. Univ., Utah**	Pneumonia	5 of 5 died	1991	Callan (1991)
Wash. St. Univ., Wash.**	Pneumonia	2 of 2 died	1991	Foreyt (1991)
Wash. St. Univ., Wash.**	Pneumonia	5 of 6 died	1992	Foreyt (1992)
Caine Vet. Cnt., Boise, ID**	Pneumonia	2 of 4 died	1993	Hunter (1993) (IDFG pers. Comm.)
East Range, Nev.	Unknown	85 died	1992-93	Hunter (1993) (IDFG pers. Comm.)
Desatoya Range, Nev.	Pneumonia		1992-93	Tanner (1993) (NDW pers. Comm.)
Tollgate Ram	Pneumonia	died	1994	Hunter (1996) (pers. Comm.)
Hells Canyon Ram (BR95014)	Pneumonia	died	1995	Hunter (1995)

* From Desert Bighorn Council 1990
** University Controlled Conditions
*** Large Pen or Paddock

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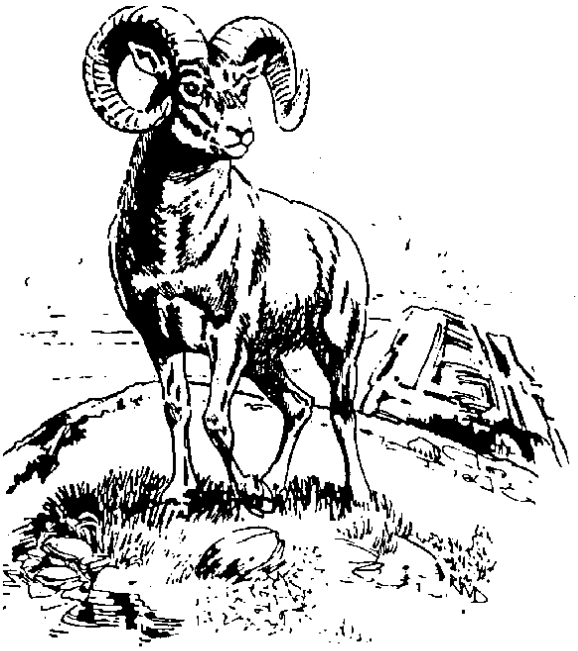


EXHIBIT 7

RECOMMENDATIONS FOR

Domestic Sheep and Goat Management in Wild Sheep Habitat



Prepared by the
Wild Sheep Working Group

Western Association of
Fish and Wildlife Agencies

2012

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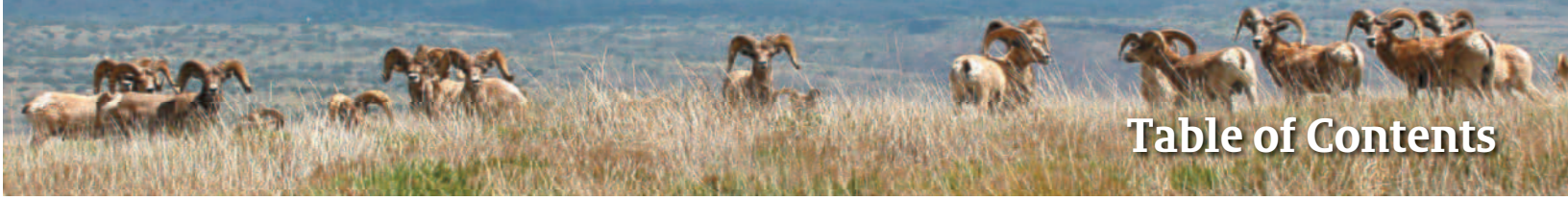


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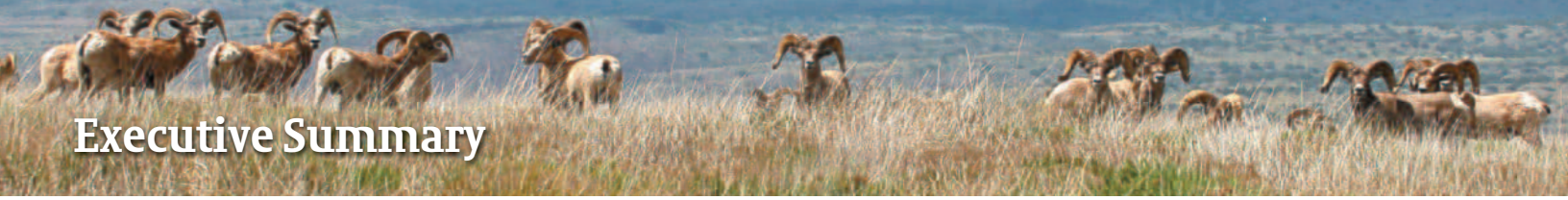
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Executive Summary

Executive Summary

Although the risk of disease transmission from domestic sheep or goats to wild sheep is widely recognized, a unified set of management recommendations for minimizing this risk has not been adopted by responsible agencies. These Western Association of Fish and Wildlife Agencies (WAFWA) recommendations were produced to help state, provincial, and territorial wild sheep managers, federal/crown land management agencies, private landowners and others take appropriate steps to eliminate range overlap, and thereby, reduce opportunities for transmission of pathogens to wild sheep.

Transmission of *Mannheimia haemolytica* from domestic sheep to bighorn sheep was irrefutably demonstrated by Lawrence et al. (2010) and provides justification sufficient for preventing range overlap and potential association of domestic sheep and goats with wild sheep. The higher the conservation value of a wild sheep population (e.g., federally or state listed, "sensitive species" status, native herds, transplant source stock, herds in areas with no history of domestic livestock presence), the more aggressive and comprehensive wild sheep and domestic sheep or goat separation management strategies should be.



Photo by: David Wetzel (Texas Bighorn Society)



Photo by:Tom Carlsen (MDFWP)

Practical solutions will be difficult, if not impossible to achieve until the risk of disease transmission from domestic sheep or goats to wild sheep is acknowledged by those responsible for wildlife and agricultural management. All parties benefit when risk is assessed and actively managed to minimize the potential for transmission of pathogens. The recommendations contained within this report are intended to help achieve that objective to benefit all sectors and are summarized as follows:

WAFWA agencies should:
(1) assess wild sheep conservation value/status and complete risk assessments of interspecies contact in a meta-population context; (2) remove wild sheep that have likely associated with domestic sheep or goats and develop a policy to promptly respond to wild sheep wandering from occupied wild sheep ranges; (3) thoroughly explore demographic consequences of translocations and conduct appropriate analyses of habitat suitability and risk of disease transfer prior to implementing any translocations; (4) coordinate with other agencies, land owners and stakeholders regarding management of domestic sheep or goats on or near ranges occupied by wild sheep; (5) fully consider the risk of disease transmission when issuing or commenting on permits/regulations associated with private lands used for domestic production; and (6) develop educational materials and outreach programs to interpret the risk of association between wild sheep and domestic sheep or goats.

Land management agencies should:
(1) reduce risk of association by eliminating overlap of domestic sheep or goat allotments or grazing permits/tenures within wild sheep habitat; (2) ensure that annual operating instructions or their equivalent include measures to minimize domestic association with wild sheep and confirm appropriate methods to remove stray domestic sheep or goats; and (3) manage wild sheep habitat to promote healthy populations in areas without domestic sheep or goats.

Wild sheep conservation organizations should:
(1) assist with educational/extension efforts to all parties; (2) negotiate alternatives and incentives for domestic sheep or goat grazers on public land to find alternatives to wild sheep habitat; and (3) advocate for and support research concerning disease and risk associated with domestic sheep and goats in proximity to wild sheep.



Domestic sheep and goat permittees/owners should:
(1) implement best management practices (BMPs) to prevent straying by domestic sheep or goats; and (2) establish protocols to respond to straying.

Private landowners should:
(1) educate themselves and work with wild sheep managers and advocates to support effective separation through a variety of site-specific mitigation measures; and (2) promptly report the potential or actual association between domestic sheep or goats and wild sheep.

Introduction

In January 2007, the Western Association of Fish and Wildlife Agencies (WAFWA), comprised of 23 state and provincial wildlife agencies from the western United States (U.S.) and western Canada, established a Wild Sheep Working Group (WSWG) to develop a report titled, "Recommendations for Domestic Sheep and Goat Management in Wild Sheep Habitat" (WAFWA 2007). Unanimously endorsed by WAFWA Directors in July 2007, that report provided recommendations to which state, provincial and federal agencies could tier their management actions. In August 2007, the report was forwarded to the heads of the U.S. Forest Service (USFS), Bureau of Land Management (BLM), National Park Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, and Department of Defense. In July 2010, the report was revised (WAFWA 2010c) and has represented the official position of WAFWA on the management of domestic sheep and goats and wild sheep.

Scientific literature that has become available since July 2010 has been incorporated into this document to ensure that the recommendations contained herein remain current and robust, but the basic purpose, scope, and principles of the document remain unchanged. Additional editorial modifications are intended to improve the readability of the document. Information contained in this report is provided to assist BLM and USFS leadership with development of a unified policy addressing the grazing of domestic sheep or goats in wild sheep habitat on lands under the administration of those agencies. In addition, this document is intended to assist state, provincial, and territorial wild sheep managers, federal/crown land management agencies, private landowners and others take appropriate steps to eliminate range overlap, and thereby, reduce opportunities for transmission of pathogens to wild sheep. This revision was approved by the WAFWA Directors March 29, 2012, and supersedes all previous versions.

In this paper we do not review and synthesize all available literature or evidence pertaining to the issue of disease transmission among bighorn sheep and domestic sheep and goats. We do, however, include relevant citations, results, literature, or analyses published since completion of our previous reports (WAFWA 2007, 2010c). We provide reasonable and logical recommendations based on the best available information to help achieve effective separation between wild sheep and domestic sheep or goats. We recognize it is impossible to achieve zero risk of contact or disease transmission; however, we also recognize there are many ways to reduce the probability of association between these species and, thereby, lower the overall risk of epizootics occurring in populations of wild sheep.



Photo by: Earl Nottingham (TPWD)



Photo by: Dr. Peri Wolff (NDOW)



Photo by: David Wetzel (Texas Bighorn Society)

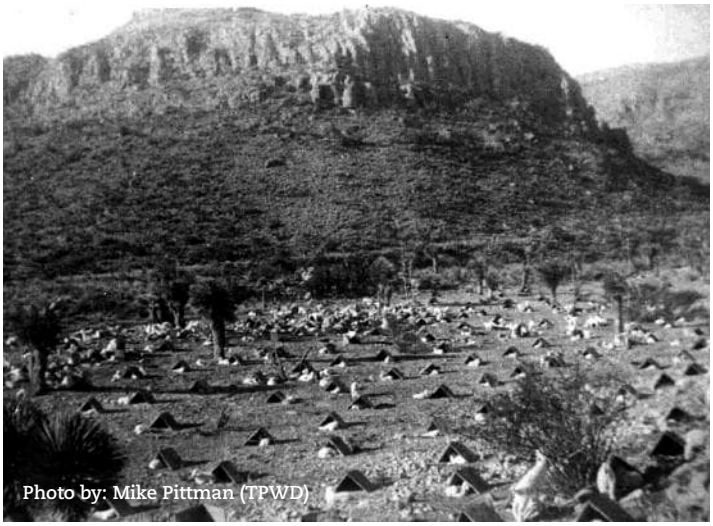


Photo by: Mike Pittman (TPWD)



Photo by: Brett Wiedmann (NDGFD)

Background

Throughout substantial portions of their range, bighorn sheep (*Ovis canadensis*) experience periods when populations are depressed; those episodes generally are associated with epizootics of respiratory disease (Ryder et al.1994). Diseases have contributed to the decline of bighorn sheep populations in much of western North America (Beecham et al. 2007, CAST 2008) and many native herds declined to less than 10% of historical size. According to historical accounts, such declines coincided with the advent of domestic livestock grazing on ranges occupied by bighorn sheep (Warren 1910, Grinnell 1928, Schillinger 1937, Honess and Frost 1942, CAST 2008). Epizootics among native bighorn herds were reported in various locations following European settlement and establishment of domestic livestock grazing throughout the central and southern Rocky Mountains. These observations may reflect the introduction of novel bacterial pathogens (including some strains of *Pasteurella [Mannheimia]* spp.) to naïve bighorn populations beginning in the late 1800s (Grinnell 1928, Skinner 1928, Marsh 1938, Honess and Frost 1942, Miller 2001).

Over the past 30 years, increasing evidence has underscored the potential risk of disease transmission from domestic sheep or goats to wild sheep (McQuivey 1978, Hunt 1980, Jessup 1982, Foreyt and Jessup 1982, Goodson 1982, Onderka and Wishart 1984, Jessup 1985, Black et al.1988, Coggins 1988, Festa-Bianchet 1988, Onderka and Wishart 1988, Onderka et al.1988, Schwantje 1988, Callan et al.1991, Coggins and Matthews 1992, Foreyt 1994, Foreyt et al. 1994, Cassirer et al.1996, Foreyt and Lagerquist 1996, Martin et al. 1996, Coggins 2002, Rudolph et al. 2003, Jenkins et al. 2007, Rudolph et al. 2007, George et al. 2008, Jeffress 2008, Lawrence et al. 2010). Moreover, a number of recent risk assessments and reviews (Beecham et al. 2007, CAST 2008, Baumer et al. 2009, USAHA 2009, WAFWA 2009, Croft et al. 2010, USDA Forest Service 2010a, b; Wehausen et al. 2011), conservation management strategies or plans (Colorado Division of Wildlife 2009, Montana Department of Fish, Wildlife, and Parks 2009), modeling exercises (Clifford et al. 2009, Cahn et al. 2011), and many wildlife biologists and wildlife veterinarians (Gross et al. 2000, Singer et al. 2000, Dubay et al. 2002, Epps et al. 2004, Garde et al. 2005, Jansen et al. 2006, Foreyt et al. 2009) have focused on risks associated with contact between wild sheep and domestic sheep or goats. Many of the aforementioned investigators and participants in workshops conducted throughout the western US (California, Arizona, Utah, and Idaho),

have recommended temporal or spatial separation of domestic sheep or goats from wild sheep to reduce the potential for disease in the latter.

Disease Transmission

Although domestic animals have been selected for their ability to live at high densities and for their resilience to infectious diseases (Diamond 1997), two-way transmission of certain diseases (e.g., paratuberculosis, some enteric pathogens and parasites) between wild sheep and domestic sheep or goats in shared habitats can occur (Garde et al. 2005). However, the most important and ecologically significant transmission in this context is from domestic sheep or goats to wild sheep.

Winter 2009-2010 bighorn sheep pneumonia die-offs (totaling an estimated 880 bighorns) in Montana, Nevada, Washington, Utah, and Wyoming have reduced bighorn numbers in at least 9 herds, either through direct mortality or agency removal (i.e., "culling") of bighorn sheep exhibiting symptoms of respiratory infections (Edwards et al. 2010, WAFWA 2010b). Domestic sheep and goats were known to occur within or near occupied bighorn sheep ranges and within normal bighorn movement zones, and association between wild sheep and domestic sheep or goats is known to have preceded at least one of these die-offs, was likely in 2 others, and was possible in 4 more (WAFWA 2010b).


Photo by: Donny Martorello (WDFW)

Die-offs of wild sheep populations and individual animals have occurred in the absence of reported association with domestic sheep or goats (Aune et al. 1998, UC-Davis 2007). However, when contact between wild sheep and domestic sheep or goats has been documented, the pattern and severity of die-off is typically greater than when otherwise is the case (Onderka and Wishart 1984, Martin et al. 1996, Aune et al. 1998, George et al. 2008).

It is generally acknowledged (Garde et al. 2005, CAST 2008) that thinhorn sheep (*Ovis dalli* spp.) in Alaska and northwestern Canada are likely naïve to exposure to many organisms commonly carried by domestic species, compared to wild sheep occurring in southern Canada and the continental U.S. Until this is confirmed and the effects of exposure to infectious organisms are clearly understood, it is essential that no association occurs between thinhorn sheep and domestic sheep or goats.


Photo by: Ernie Finch



Photo by: John Kanta (SDGFP)



Photo by: Ted Borda (Borda Land & Sheep Company)



Photo by: Ted Borda (Borda Land & Sheep Company)

Effective Separation

WAFWA defines "Effective Separation" as spatial or temporal separation between wild sheep and domestic sheep or goats to minimize the potential for association and the probability of transmission of diseases between species. WAFWA advocates that effective separation should be a primary management goal of state, provincial, territorial and federal agencies responsible for the conservation of wild sheep, based on evidence that domestic sheep or goats can transfer pathogens to wild sheep. Literature (reviewed by Wehausen et al. 2011) and experimental evidence (Lawrence et al. 2010) support the goal that domestic sheep or goats should not concurrently occupy areas where conservation of wild sheep is a clearly stated management goal.

Effective separation does not necessarily require removal of domestic sheep or goats in all situations. However, the option of removing domestic sheep or goats should be included in an array of alternatives available to address this issue. In fact, some collaborative working groups (USAHA 2009) have recommended domestic goats not be allowed to graze in occupied bighorn sheep habitat because of their gregarious nature and tendency to wander. We are aware of the continuing debate and discussion (CAST 2008, USAHA 2009) between wildlife advocates and some domestic sheep or goat industry proponents and resource managers regarding the credibility or scientific merit of past findings; that debate is founded largely on criticisms of experimental design or rigor, and limitations of drawing inferences about natural disease events when compared to controlled experiments in confined settings. However, it is WAFWA's collective opinion that enough is known about potential pathogen transmission from domestic sheep or goats to wild sheep that efforts toward achieving effective separation are necessary and warranted.

Reducing risk of disease transmission on the landscape by minimizing or preventing association between wild and domestic sheep or goats is a key management strategy for WAFWA agencies (e.g., Colorado Division of Wildlife 2009, Montana Department of Fish, Wildlife and Parks 2009). Legislation in Utah (House Bill 240 Supplement, 2009), Wyoming (Senate Enrolled Act No. 30, 2009) and Idaho (Senate Bill 1232 amended, 2009) provides direction, authority and responsibilities for addressing feral or stray livestock that pose a disease transmission risk. Further, recent court rulings (e.g., U.S. District Court, Idaho Case 09-0507-BLW) have mandated separation between domestic sheep or goats and bighorn sheep, including mandatory non-use of grazing allotments where effective separation could not be assured.



Effective Separation

Principal federal land management agencies in the western U.S., BLM and USFS, continue to review, revise, and update policies on the management of domestic sheep or goats in wild sheep habitat (USDI BLM 1992, 1998, 2010; USDA Forest Service 2009). Additionally, several administrative units of the USFS (Northern Region, Rocky Mountain Region, Southwest Region, Intermountain Region, and the Pacific Southwest Region) have designated bighorn sheep as a "Sensitive Species," thereby mandating special management emphasis. This includes: thorough reviews and analyses of management actions that could affect populations of bighorn sheep or their habitat to ensure their viability and to preclude demographic trends that would result in the need for Federal listing.

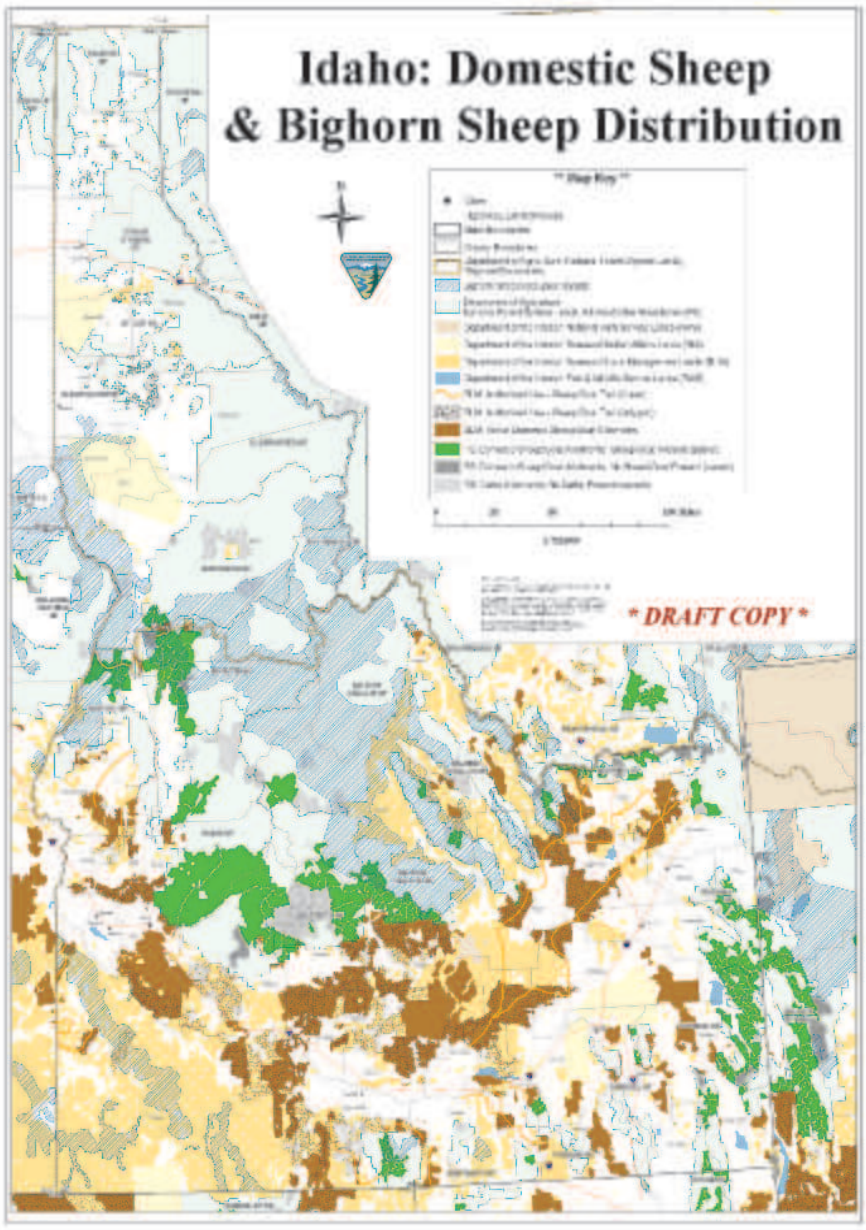
An interagency GIS-based decision-support tool and GIS coverage maps that overlay current bighorn sheep distribution with vacant and active domestic sheep or goat grazing allotments and trailing routes were finalized for 14 western states (WAFWA 2010a). These maps identify areas where association between domestic sheep or goats and bighorn sheep could occur on, or adjacent to, lands managed by BLM or USFS, and also identify areas that could provide spatial separation. The maps further provide a context for national policy development, and help identify situations where proactive management is necessary to minimize risk of association. Although risk of disease transmission from domestic sheep or goats to wild sheep is widely acknowledged by wildlife and land management agencies, a unified set of management guidelines for minimizing this risk has not yet been adopted.

In some cases, results of contact between domestic sheep or goats and wild sheep have been severe enough to endanger entire populations of the latter. In Idaho, legislation (Senate Bill 1232 amended, May 2009) mandated collaboration between the Idaho Department of Fish and Game and domestic sheep grazing permittees that identified BMPs to achieve effective separation between domestic sheep and wild sheep on both public and private lands. In specific situations, implementation of BMPs could lead to a reduced risk of association. In particular, BMPs implemented in open, gentle terrain where domestic sheep or goats can be easily controlled and monitored can reduce risk of association (Schommer 2009). Nevertheless, BMPs that work in one situation may not work in other situations (Schommer 2009).

Consequently, we recommend that managers take appropriate steps to minimize opportunities for association and, thereby, the potential for disease transmission in all situations.



Photo by: Bighorn Institute



Provided by: Chans O'Brien (USFS)



Photo by: Rebecca Barboza (CDFG)



Photo by: Larry Kruckenberg

Management Recommendations

The recommendations that follow can be applied to state, provincial, and territorial wildlife agencies, federal/crown land management agencies, wild sheep conservation organizations, domestic sheep or goat producers or permittees, and private landowners, and have been strategically assigned to logical categories. It is imperative, however, that readers recognize these recommendations typically apply to multiple parties, and that they further recognize that a multi-disciplinary and collaborative approach will produce the best outcomes, both for wild sheep and for producers or permittees. Definitions of various terms used throughout this document are provided in Appendix A.

Although these recommendations have been developed by a working group largely comprised of wildlife agency personnel, cooperation between numerous concerned parties is critically important to deriving on-the-ground solutions (USAHA 2009, Wild Sheep Foundation 2011). Among these are state, provincial, and territorial wildlife agencies; federal/crown land management agencies; First Nation or tribal representatives; domestic sheep or goat producers or grazing permittees; agricultural industry representatives; wild sheep conservation organizations; environmental groups; academic institutions; and interested individuals. As a result of information contained herein, it is our hope that collaborative discussions will occur and that those discussions yield results in the form of innovative and collaborative site-specific delivery of programs such as the British Columbia Wild/Domestic Sheep Separation Program and the Wyoming Statewide Domestic Sheep/Bighorn Sheep Interaction Working Group.

Many anthropogenic and environmental factors (CAST 2008) influence the demographics and viability of wild sheep populations. Some factors affecting wild sheep population performance can be managed while others cannot. Nevertheless, the guiding principle of our effort has been "to seek effective separation" between wild sheep and domestic sheep or goats. There is no "one size fits all" risk assessment of respiratory disease transmission between wild sheep and domestic sheep or goats. However, a comprehensive risk assessment (qualitative and quantitative) is a critically important component for managing the potential for disease transmission.

We recommend that wild sheep managers design and implement management strategies by taking the first step of assessing and prioritizing conservation value and relative importance of wild sheep populations. The greater the conservation value and the greater the risk of association with domestic sheep or goats, the more aggressive and comprehensive a strategy to ensure effective separation should be. To ensure that is the case, we offer the following:



Management Recommendations

RECOMMENDATIONS TO WAFWA AGENCIES

■ Historic and suitable but currently unoccupied wild sheep range should be identified, evaluated, and compared against currently-occupied wild sheep distribution and existing or potential areas where domestic sheep or goats may occur.

■ Risk assessments should be completed at least once per decade (more often if warranted) for existing and potential wild sheep habitat. These assessments should specifically identify where and to what extent wild sheep could interface with domestic sheep or goats, and the level of risk within those areas.

■ Following completion of site or herd-specific risk assessments, any translocations, population augmentations, or other restoration and management strategies for wild sheep should minimize the likelihood of association between wild sheep and domestic sheep or goats. Agencies should:

- Avoid translocations of wild sheep into areas with no reasonable likelihood of effective separation from domestic sheep or goats.
- Re-evaluate planned translocations of wild sheep to historical ranges as potential conflicts, landscape conditions, and habitat suitability change.
- Recognize that augmentation of a wild sheep herd from discrete source populations poses a risk of pathogen transfer (CAST 2008) and thus, only use source stock verified as healthy through a proper health assessment (WAFWA 2009) for translocations. Source herds should have extensive health histories and be regularly monitored to evaluate herd health. Wild sheep managers should evaluate tradeoffs between anticipated benefits such as demographic, behavioral and genetic interchange, and the potential consequences of mixing wild sheep from various source herds.
- Develop and employ mapping or modeling technology as well as ground based land use reviews prior to translocations to compare wild sheep distribution and movements with distribution of domestic sheep or goats. If a translocation is implemented and association with domestic sheep or goats occurs, or is likely to occur beyond an identified timeframe or pre-determined geographic area, domestic sheep or goat producers should be held harmless.

■ The higher the risk of association between wild sheep and domestic sheep or goats, the more intensively wild sheep herds should be monitored and managed. This is particularly important when considering "new" vs. "augmented" wild sheep populations.

- Site-specific protocols should be developed when association with domestic sheep or goats is probable. For example, decisions concerning percentage of translocated wild sheep that must be radio-collared



Photo by: Mike Cox (NDOW)



Photo by: Chase Fountain (TPWD)



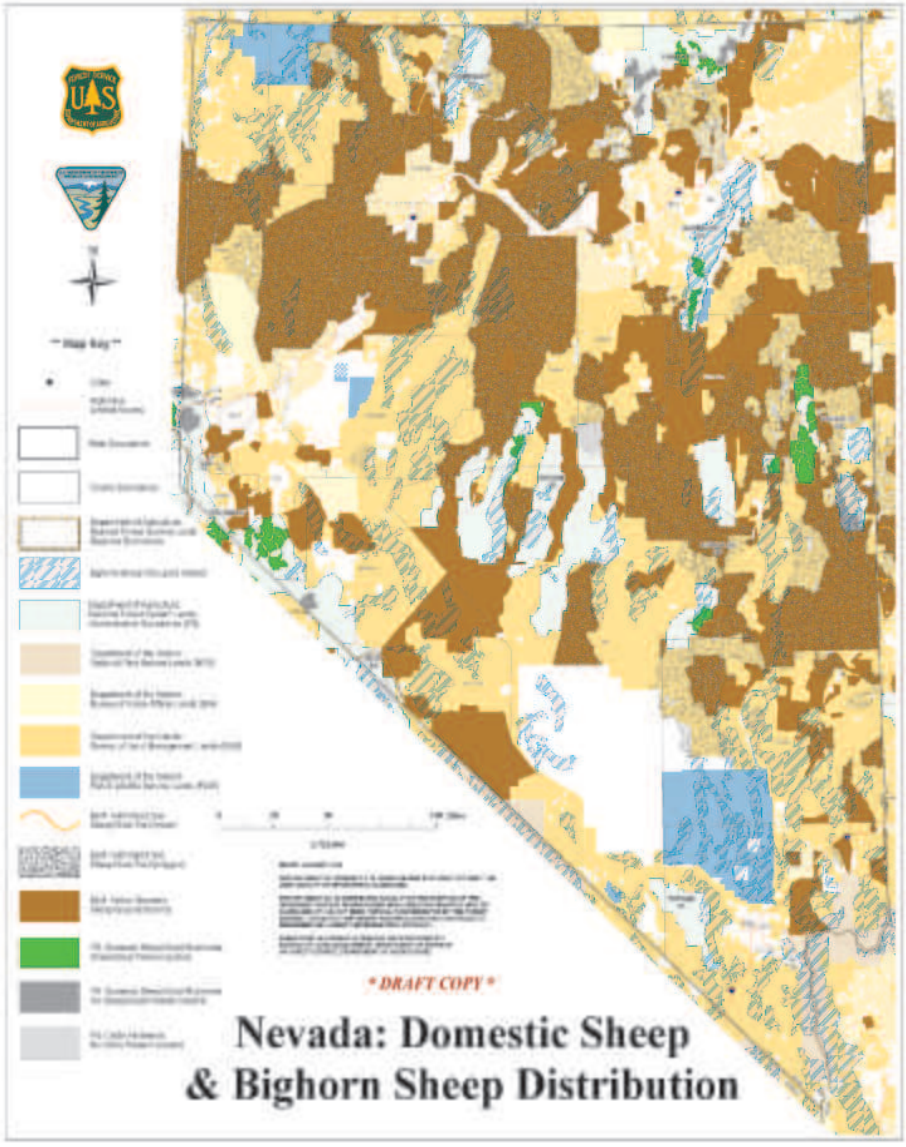
Management Recommendations

for achieving desired monitoring intensities should in part, be based upon the subsequent level of risk of association with domestic sheep or goats.

- Intensive monitoring provides a mechanism for determining proximity of wild sheep to domestic sheep or goats and for evaluating post-release habitat use and movements.
- Budgets for wild sheep translocation projects should include adequate funding for long-term monitoring.

■ Wild sheep managers should identify, analyze, and evaluate the implications of connectivity and movement corridors between largely insular herds comprising a meta-population against opportunities for increased association with domestic sheep or goats. Analyses should include distribution and continuity (Mack 2008) among populations of wild sheep and the anticipated frequency of movement among or within wild sheep range. In doing so, the benefits of genetic interchange and its resultant implications for population viability, must be weighed against the risks of disease transmission (Bleich et al. 1990), especially if dispersing or wandering wild sheep could travel across domestic sheep or goat grazing allotments or trailing routes, private land holdings or other areas where the potential transfer of endemic pathogens from an infected wild herd to a naïve herd could occur.

■ Removal of wild sheep known, or suspected to have closely associated with domestic sheep or goats is considered to be an effective management tool. Atypical movements by wild sheep can heighten risk of association with domestic sheep or goats. Additional measures to achieve effective separation should be implemented if such association occurs. However, removal of wild sheep from occupied, normally-anticipated wild sheep range is not always the best management option. Continuous risk of association exists during active grazing seasons when domestic sheep or goats are grazed within normally-anticipated wild sheep range. Thus, removal of individual wild sheep is an ineffective method for maintaining separation, and has potentially negative consequences for population viability. Removal of wild sheep should occur only after critical evaluation and further implementation of measures designed to minimize association and enhance effective separation.



Provided by: Chans O'Brien (USFS)

■ Wild sheep populations should have pre-determined population objectives, and should be managed at agreed-upon densities to minimize the potential for dispersal. Because some dispersal occurs regardless of population density, some risk of association is always present if domestic sheep or goats are within range of dispersing wild sheep.

■ Agencies should develop a written protocol to be implemented when association between wild sheep and domestic sheep or goats is confirmed. Notification requirements, appropriate response and post-contact monitoring options for both domestic sheep and goats and dispersing or wandering wild sheep should be included. Moreover, wildlife agencies should collaborate with agricultural agencies, land management agencies, producers and permittees, grazing industry representatives,



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and wild sheep advocates to develop an effective, efficient, and legal protocol to be implemented when feral or abandoned domestic sheep or goats threaten to associate with wild sheep but for which no owner can be identified. Written protocol examples are provided in Appendix B (British Columbia Fish, Wildlife and Habitat Management Branch) and Appendix C (Wyoming Game and Fish Department).

■ Wildlife agencies should develop databases as a system to report, record, and summarize association between wild sheep and domestic sheep or goats and its outcome; the WAFWA WSWG website (http://www.wafwa.org/html/wswg.shtml) would be a logical host. Further, wildlife managers and federal/crown land managers should encourage prompt reporting by the public of observed proximity between wild sheep and domestic sheep or goats.

■ Wild sheep managers should coordinate with local weed or pest management districts, or other applicable agencies or organizations involved with weed or vegetation management, to preclude the use of domestic sheep or goats for noxious weed or vegetation control in areas where association with wild sheep is likely to occur. Agencies should provide educational information and offer assistance to such districts regarding disease risks associated with domestic sheep or goats. Specific guidelines (Pybus et al. 1994) have already been developed and implemented in British Columbia, and are available at: http://www.for.gov.bc.ca/hfp/publications/00006/.

■ Specific protocols for sampling, testing prior to translocation, and responding to disease outbreaks should be developed and standardized to the extent practical across state and federal jurisdictions. Several capture and disease-testing protocols have been developed and are available to wild sheep managers (Foster 2004, UC-Davis 2007, WAFWA 2009). Protocols should be reviewed and updated as necessary by the WAFWA Wildlife Health Committee (WHC) and presented to WAFWA Directors for endorsement. Once endorsed, agencies should implement the protocols, and the WHC should lead an effort to further refine and ensure implementation of said protocols.

■ Agencies should coordinate and pool resources to support the ongoing laboratory detection and interpretation of important diseases of wild sheep. Furthermore, wild sheep managers should support data sharing and development and use of standardized protocols (WAFWA 2009). Interagency communication between wildlife disease experts such as the WAFWA Wildlife Health Committee (WHC) should be encouraged to enhance strategies for monitoring, managing and improving health of wild sheep populations through cooperative efforts.

■ Wild sheep management agencies should develop educational materials and outreach programs to identify and interpret the risk of association between wild sheep and domestic sheep or goats for producer groups, owners of small and large farm flocks, animals used for packing and 4-H animals. In some cases, regulation may be necessary to maintain separation.

RECOMMENDATIONS TO BLM, USFS, PARKS, PROTECTED AREAS AND OTHER APPLICABLE LAND MANAGEMENT AGENCIES

■ Joint federal land management agency guidelines on management of domestic sheep or goats in wild sheep habitat should be developed and included in broad agency policy documents. Guidelines should be based on the need to minimize risk of association and provide effective separation between domestic sheep or goats and wild sheep.



Photo by: Todd Nordeen (NGPC)



Photo by: Debra Hamilton (CDFG)



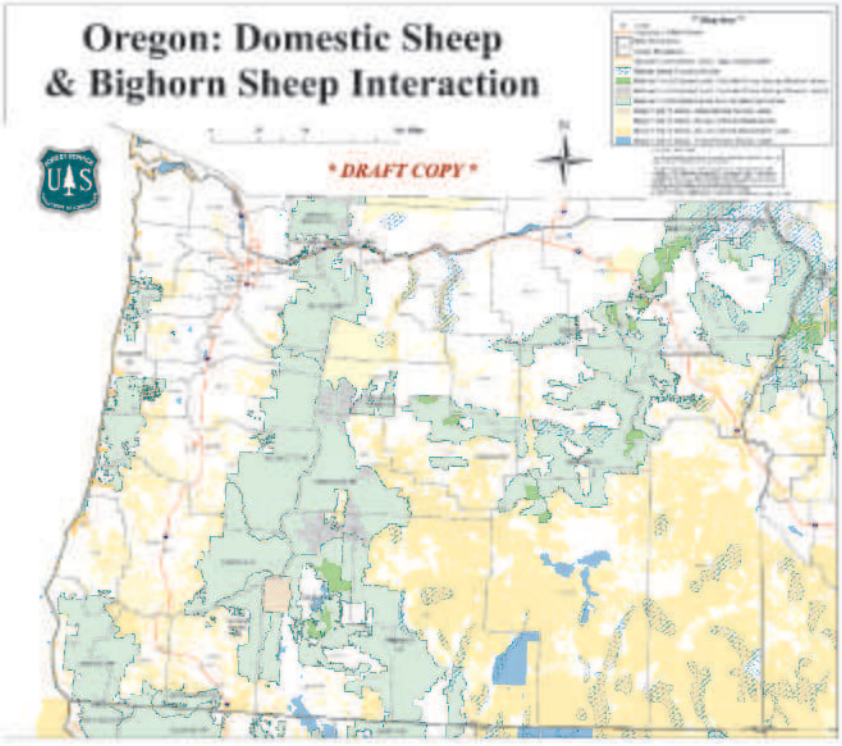
Management Recommendations

Approved guidelines should not include an automatic "sunset" provision or expiration date but, if there is a maximum longevity (i.e., a "sunset clause") specified by federal policy and if appropriate and timely review cannot be completed, guidelines should remain in effect, rather than becoming obsolete, until any mandated review can be completed.

■ The use of domestic sheep or goats as pack animals by persons that travel in identified wild sheep habitat should be prohibited by the appropriate management agency (e.g., USDA Forest Service 2011). Where legislation or regulations are not already in place, an outreach program to inform potential users of the risks associated with that activity should be implemented to discourage use of domestic sheep or goats as pack animals.



Photo by: Ted Borda (Borda Land & Sheep Company)



Provided by: Chans O'Brien (USFS)

■ Land management agencies that regulate or are responsible for domestic sheep or goat grazing allotments, trailing routes, vegetation management, use as pack stock, or any other uses involving domestic sheep or goats should only authorize such use(s) outside of occupied wild sheep range.

■ Land management agencies should require immediate notification by permittees and their herders of association between wild sheep and domestic sheep or goats and in no case should it be more than within 24 hours of any such event. Notification procedures, including phone numbers and contact information for permittees and use of satellite phones in backcountry settings, should be outlined in Annual Operating Instructions for grazing allotments and trailing permits, and should include consequences for failure to report.

■ Land management agencies should map active and inactive domestic sheep or goat grazing allotments and trailing routes, including information on dates of use and contact information for responsible grazing or trailing permittees.

■ Land management agencies must ensure that advance written instructions (such as USFS Annual Operating Instructions) exist, and that they address management, retrieval, and disposition of domestic sheep or goats present on public lands prior to or after permitted grazing or trailing dates.

■ Land management agencies should work collaboratively with state, provincial, and territorial wildlife and agricultural interests to develop written agreements that address management, retrieval, and disposition of domestic sheep or goats occupying public lands where there is no permitted use. Such agreements should also address the presence of feral sheep or goats and other exotic ungulates, especially ovines such as aoudad, red sheep, urial, or argali that are detected on public lands.

■ Land management agencies should review domestic sheep allotment boundaries or other use areas, such as trailing routes, and reconfigure boundaries or routes to avoid or minimize overlap with occupied wild sheep habitat. Techniques available to accomplish this include the use of geographic or topographic



Management Recommendations

barriers that enhance species separation, and temporal or spatial separation resulting from implementation of novel domestic sheep or goat grazing management strategies.

■ Land management agencies should undertake habitat enhancements that improve wild sheep habitat outside allotment boundaries in an effort to attract wild sheep away from domestic sheep allotments.

■ Land management agencies should undertake water developments to divert wild sheep away from domestic sheep allotments or domestic sheep or goats away from areas used by wild sheep.

■ Land management agencies should ensure that Annual Operating Instructions require careful management and vigilant herding to minimize potential association between wild sheep and stray domestic sheep or goats. A count-on, count-off inventory of domestic sheep or goats must be required as a condition of operation with follow-up provisions to account for missing livestock.

■ In areas of high risk of association, trucking should be required to minimize risks associated with trailing. Trucking of domestic sheep or goats is preferred to trailing because there is less chance of straying and, thereby, less likelihood of association with wild sheep, particularly when domestic sheep are in estrus.

■ Land management agencies should require marking of all permitted domestic sheep and goats to provide for rapid ownership identification of stray animals.

■ In the event of trailing, on-site compliance monitoring to minimize strays must be conducted by the permittee or the land management agency.

■ Land use or resource management plans should explicitly address the potential for domestic sheep or goats to associate with wild sheep. Land use plans should evaluate the suitability of permitting activities involving domestic sheep or goats, and determine the best course of action with respect to wild sheep conservation. Plans should also identify general areas of public land where domestic sheep or goats cannot be permitted for weed control, commercial grazing, recreational packing, vegetation management, or other uses.

■ Land management agencies should coordinate with appropriate entities involved in weed control programs that use domestic sheep or goats on public or Crown lands (Pybus et al. 1994), adjoining private lands, or state, provincial, and territorial wildlife habitat management areas to minimize risk of association between domestic sheep or goats and wild sheep.

■ Within occupied or suitable wild sheep habitat, where topography, vegetation, and other parameters allow, conversions of allotments from domestic sheep or goats to types of domestic livestock that pose a lower risk of disease transmission to wild sheep should be implemented.

■ Within suitable, historic wild sheep habitat not currently occupied by wild sheep, agencies should not convert cattle grazing allotments to domestic sheep or goat grazing, or allow trailing if restoration of wild sheep populations is an agency goal.



Photo by: AZGFD



Photo by: Justin Binfet (WGFD)

Management Recommendations

■ Under emergency conditions, stocking of allotments not currently under permit to domestic sheep or goats should be permitted only after an adequate risk assessment has been completed. Any such assessment must include appropriate documentation and the conclusion that effective separation can be assured, and can be accomplished via project-level NEPA analysis.

■ Land management agencies should incorporate state, provincial, or territorial wild sheep management plans either in, or as supplements to, federal resource or land use management plans, and collaborate with wildlife agencies to ensure comprehensive risk assessments (Clifford et al. 2009, USDA Forest Service 2010a, b) of domestic sheep or goat grazing allotments or trailing routes in wild sheep habitat are thorough and complete. To accomplish this objective, training adequate to allow the preparation of such assessments must be provided.



Photo by: Mike Cox (NDOW)



Photo by: Todd Nordeen (NGPC)

■ Where mandatory buffer zones (frequently cited as a minimum of 9 airline miles [14.5 km]) between domestic sheep or goats and wild sheep have been used to minimize association, it should be recognized that buffer zones apply to herds or populations of wild sheep, rather than individual wandering wild sheep. In some cases, buffer zones have been effective in reducing association between wild sheep and domestic sheep or goats. However, in contiguous wild sheep habitat where movements by wild sheep have the potential to exceed *a priori* expectations, buffer zones may not be effective or practical (Schommer and Woolever 2001).

■ Topographic features or other natural or man-made barriers (e.g., fenced, interstate highways) can be effective in minimizing association between wild sheep and domestic sheep or goats. Site-specific risk assessments should be completed to evaluate the efficacy of using natural barriers, defined buffer zones, or other actions to minimize risk of contact. Given the wide range of circumstances that exists across jurisdictions, buffer zones may not be needed in all situations. Conversely, buffer zones should not be precluded as an effective method to address potential association between wild sheep and domestic sheep or goats.

■ Land management agencies, in collaboration with jurisdictional domestic sheep or goat health agencies, should work with producers and permittees to prevent turnout or use of sick or diseased domestic sheep or goats on grazing allotments and trailing routes. Sick or diseased domestic sheep or goats can increase risk of association with wild sheep because they likely are less able to keep up with their bands and are more prone to straying. Sick or diseased animals observed on the range should be reported to land management agency personnel immediately, and inter-agency coordination to address the situation should promptly occur. Further, responsible agencies must require that domestic sheep or goats are in good health before being turned out. For example, Alberta and British Columbia have developed health certification protocols (Pybus et al. 1994) that must be complied with before domestic sheep are turned out for vegetation management in conifer regeneration efforts (available at: http://www.for.gov.bc.ca/hfp/publications/00006/). We emphasize that the higher the risk of association between domestic sheep or goats with wild sheep, the higher the certainty of domestic animal health should be. Further, it must be recognized that even clinically healthy domestic sheep or goats can still carry pathogens that are transmissible to wild sheep, and thus, pose a significant risk to wild sheep.



Management Recommendations

■ Proportional to risk of association between domestic sheep or goats and wild sheep, land management agencies should work with stakeholders to implement a variety of management practices. Examples include: herders, dogs or other guarding animals trained to repel animals foreign to domestic sheep bands or goat flocks (wandering wild sheep or various predators), regular counts, removal of sick animals, confinement of domestic sheep or goats at night, adequate fencing configurations, covenants, allotment retirements, conversion of class of livestock, trucking versus trailing, and others. Effectiveness of management practices designed to reduce risk of association are not proven (Baumer et al. 2009, Schommer 2009) and therefore should not be solely relied upon to achieve effective separation. Such practices could however, help achieve separation when applied outside of occupied wild sheep range or connected and potentially mitigate impacts associated with straying domestic sheep or goats, or wandering wild sheep.

■ Land management agencies and wildlife agencies should cooperatively manage for quality wild sheep habitat and routinely monitor habitat to detect changes in condition.

■ In areas where association between wild sheep and domestic sheep or goats is likely, land management agencies should post advisory signs at trailheads, campgrounds, and other high-use areas that are designed to educate visitors about the issue of interaction and to encourage prompt reporting of association of wild sheep with domestic sheep or goats. Agencies should also ensure that individuals keep dogs under immediate voice control or on leash to prevent scattering of domestic sheep or goats in permitted areas, or disturbances to wild sheep.

■ Land management agencies should clearly define the processes, protocols, and timelines for short-term or emergency management actions when intervention is needed to minimize risk of association between wild sheep and domestic sheep or goats.

■ Land management agencies should develop programs to foster and recognize the benefits of compliance, cooperation, and cost-sharing in efforts to prevent commingling of wild sheep and domestic sheep or goats on shared ranges.

■ In collaboration with wild sheep management agencies, land management agencies should investigate and implement an option to allow the permittee or producer, or appropriate agency representatives, to remove commingling wild sheep and, where not already established, develop or clarify legal authority for removing stray domestic sheep from public lands by lethal means.

■ Risk assessment should be conducted on an appropriate geographic scale regardless of jurisdictional boundaries. Recognizing the limits of regulatory authority, land management agencies should consider private in-holdings and adjacent private lands when conducting risk assessments.

■ Land management agencies should closely evaluate timing of permitted domestic sheep or goat grazing or trailing activities to reduce risk of disease transmission. For example, grazing estrous domestic females heightens



Photo by: Robin Fehlau (BLM)


Photo by: Stephanie Steinhoff (CPW)



Management Recommendations

attraction and increases the probability of association between wild sheep and domestic sheep, and should be eliminated where benefits can be accrued.

■ In areas of high risk of association between wild sheep and domestic sheep or goats, agencies and permittees should ensure enhanced monitoring of grazing and trailing patterns using global positioning system (GPS) collars or other technology that provide detailed data on movements and grazing patterns. While enhanced monitoring will not reduce risk of association, it is vital for development of meaningful risk assessments and to ensure appropriate management recommendations are taken to achieve effective separation.



Photo by: Mike Cox (NDOW)



Photo by: Helen Schwantje (BC FLNRO)

RECOMMENDATIONS TO WILD SHEEP AND OTHER CONSERVATION ORGANIZATIONS

■ Recognize and support efforts of wild sheep management agencies and industry leaders in maintaining effective separation.

■ Assist wildlife and land management agencies with development of informational brochures and other materials that identify and explain risk of association between wild sheep and domestic sheep or goats.

■ Assist wildlife and land management agencies with educational efforts regarding risks associated with the use of domestic sheep or goats as pack animals in wild sheep habitat. If use is authorized, encourage participants to closely control, tether, and night-pen their pack stock. Encourage prompt reporting of association between wild sheep and domestic sheep or goats, and promote a reporting system for monitoring association between wild sheep and domestic sheep or goats.

■ Maintain or establish open lines of communication with domestic sheep or goat producers and industry organizations to reduce polarization. Jointly organized and cooperatively-funded workshops on risk assessment, identification of practical strategies to achieve effective separation, development and distribution of pamphlets or brochures, and public speaking opportunities are tangible examples of collaborative, multi-disciplinary approaches to address potential disease transmission.

■ Continue to negotiate alternatives or incentives for domestic sheep or goat permittees to shift their operations to grazing allotments outside of wild sheep habitat. Advocate that permittees convert to a different class of livestock with lower risk of disease transmission or waive permitted domestic sheep or goat use in areas where risk assessment indicates high potential for association with wild sheep.

■ Encourage and support development and funding of cooperative research, and encourage agencies and conservation groups to commit resources necessary to maintain wild sheep populations.

SUGGESTED MANAGEMENT PRACTICES FOR DOMESTIC SHEEP AND GOAT PERMITTEES

The following suggestions are based largely on recommendations provided by CAST (2008), Baumer et al. (2009), or USAHA (2009), and are intended to provide a responsible and common-sense approach for reducing risk of association. However, there is no science-based evidence or evaluation that assesses the effectiveness of these actions to reduce risk or enhance separation (Schommer 2009).



Management Recommendations

■ Implement the following reporting and record keeping procedures or use an existing standard such as the BC (Appendix B) or Wyoming (Appendix C) models:

- Require prompt, accurate reporting by herders working on domestic sheep or goat grazing allotments where association of wild sheep with domestic sheep or goats is possible.
- Support fluency in English or translators for foreign herders in order to facilitate accurate reporting.
- Require sheepherders to use cellular or satellite phones or two-way radios, and location equipment such as GPS receivers to report and record grazing movements and encounters with wild sheep. Seek cost-sharing partnerships for providing communications equipment when an operator changes grazing management practices for the sole purpose of minimizing domestic sheep association with wild sheep. Partnerships could include wildlife management agencies, federal land managers, or private organizations.
- Require herders to record GPS locations, counts, losses and other information in a log book.

■ Place only experienced, informed and responsible sheepherders on allotments located near wild sheep habitat.

■ Ensure that all domestics are individually marked and traceable to source flocks.

■ Conduct full counts when trailing, immediately any time scattering occurs and regularly during general grazing.

■ Develop agreements between permittees and wildlife agencies that provide for locating and reacquiring all stray domestic sheep, either dead or alive. In the event of missing domestic sheep, a comprehensive search should be initiated immediately and the land manager and state wildlife agency must be notified of missing and subsequent recovery of animals.

■ Develop a detection and response protocol that includes:

- Reporting of wild sheep and domestic sheep associations (animal counts and GPS location) to the appropriate wildlife agency.
- Reporting of stray or missing domestic sheep to the land management agency who will, in turn, report that information to the wildlife agency.
- Removal of stray domestic sheep by the permittee, land manager or wildlife agency personnel.
- Removal of individual commingling wild sheep by wildlife agency personnel.
- Collection of standardized diagnostic samples from stray domestic sheep or commingling wild sheep.

■ Utilize the following trailing procedures:

- Conduct full counts when moving on and off each allotment/grazing site.
- Truck domestic sheep through "driveway" areas that pass through occupied wild sheep habitat.
- Truck in water (if needed) to reduce straying.
- Immediately remove animals unable to stay with the flock/herd and move them to a base property.
- Avoid trailing more than 5 miles per day and stop trailing when sheep or lambs show signs of fatigue. Provide for a "babysitter" or removal of lagging sheep when trailing.
- In the event that all animals cannot be accounted for, the permittee must advise the responsible agency and initiate efforts to locate missing animals and implement removal protocol as necessary.

■ Sick domestic sheep should be removed from allotments immediately and must never be abandoned.



Photo by: Mike Pittman (TPWD)



Photo by: Aaron Reid (BC FLNRO)



Management Recommendations

■ Select herder's camp, nighttime bedding ground, and midday bedding ground locations that maintain communication between guard dogs and herding dogs by smell, sound (barking) and sight, and to take advantage of differences in the sleep cycles of guard dog and herding dogs. Place mature and effective guard dogs and herding dogs with domestic sheep (at least 2 of each per 1000 animals) and do not use female dogs in heat.

■ If grazing on federal lands, comply with established "bed ground" standards. Where conditions permit, construct temporary electric or boundary fences to ensure that domestic sheep remain within selected bedding grounds.

SUGGESTED MANAGEMENT PRACTICES ON PRIVATE LANDS

■ Recognize that domestic sheep or goat farming on private lands can influence wild sheep population viability on adjacent public or other private lands.

■ Report any observed association between wild sheep and domestic sheep or goats on or near private land to the appropriate wildlife conservation agency.

■ Cooperate with wildlife agencies in reporting and removing feral sheep or goats and other exotic bovine ungulates such as aoudad, red sheep, urial, or argali that are detected within or near wild sheep habitat.

■ Participate in cooperative educational efforts to enhance understanding of the issues of disease transmission between domestic sheep or goats and wild sheep.

■ Do not release or leave unattended domestic sheep or goats in areas where they may seek, or be sought, by wild sheep.

■ Cooperate with appropriate agencies, agricultural and producer associations, conservation organizations, and other interested stakeholders to develop effective, comprehensive risk management approaches to help ensure effective separation between wild sheep and domestic sheep or goats, consistent with private property rights in and near wild sheep habitat.

- Possible approaches include, but are not limited to, changing species or class of livestock, purchase of land or the domestic sheep or goats, use of methods to ensure physical separation, or development of conservation incentives, bylaws, covenants, or legislation.

■ Consider partnerships with non-governmental organizations and wild sheep advocate groups for cost sharing on risk management/mitigation strategies such as fencing, or other domestic sheep or goat management actions that reduce risk of disease transmission from private flocks to wild sheep.

■ Support “effective separation” fencing standards that are designed to prevent nose-to-nose contact and aerosol transmission through adequate physical distance, in order to reduce transmission of respiratory disease agents. Examples include: electric outrigger fences (2 feet from page (woven) wire fencing) and double fencing (two page-wire fences with a minimum spacing of at least 10 feet). A combination of fencing methods with or without the use of effective livestock guardian dogs may be most effective to ensure that wild sheep do not physically contact domestic sheep or goats on private land.

■ Participate in or support cooperative research to enhance understanding and test mitigation protocols for disease risk management.

■ Carefully consider the consequences of using domestic sheep or goats for weed control on private lands where association with wild sheep could occur. Work with agencies to develop alternative weed management strategies to reduce risk of association, while adequately managing weed problems.



Photo by: David Wetzel (Texas Bighorn Society)



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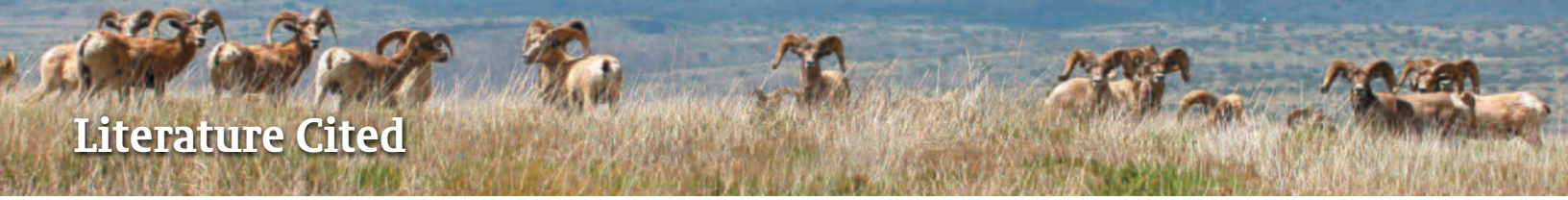
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Appendix A

Glossary of Terms

Allotment: A portion of a landscape where livestock grazing of a plant community is prescribed according to a specific land use plan or legally defined regulatory authority.

Annual Operating Instructions: Specific language included in a term grazing or trailing permit file; reviewed each year with the permittee, prior to turnout of livestock on a grazing allotment or trailing route.

Association: Close proximity between wild sheep and domestic sheep or goats, potentially leading to direct physical contact and potential disease transmission.

Augment: To intentionally introduce wild sheep from one or more source populations into another existing wild sheep population, to enhance the recipient population demographically or genetically.

Buffer zone: A defined and delineated space on a landscape established by wildlife managers to reduce association and the potential for disease transmission between wild and domestic sheep or goats across that geographic space.

Bighorn sheep: A member of the species *Ovis canadensis* found throughout the mountains of western North America from the Peace River in Canada to northern Mexico and east to the Badlands of the Dakotas.

Contact: Direct contact between body parts of two animals during which a disease might be transmitted from one to another. In this document, "contact" typically refers to nose-to-nose or face-to-face interactions that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with "Interaction."

Connectivity: Creating or maintaining networks of habitat that connect fragmented habitats, thus linking population segments of wildlife. Connectivity allows gene flow and enhances long-term species survival.

Conservation Incentives: In direct contrast to regulation-based conservation, incentive-based conservation provides economic, management or esthetic benefits to individuals or corporations to encourage them to conduct management activities that have positive conservation consequence to wildlife or wildlife habitat. Examples are: private land conservation easements, direct lease agreements for grazing rights for conservation purposes, or a trade/exchange of equal value grazing rights among various partners to minimize wildlife-domestic livestock conflict.

Die-off: A large-scale mortality event that impacts many animals from a population and may have significant demographic consequence for the long-term persistence of that population. In this report, such mortality events are usually caused by respiratory disease epidemics involving bacterial or other pathogens alone or in various combinations.

Disease: The word disease means literally "free of ease." Disease is any impairment that modifies or interferes with normal functions of an animal, including responses to environmental factors such as nutrition, toxicants, and climate. Typically, disease involves transmission of, and exposure to, some infectious agent but it may involve non-infectious causes such as congenital defects.

Dispersal: The process whereby individuals leave one habitat or landscape to seek another habitat or landscape in which to live.

Double fencing: Two fences running parallel around a landscape or pasture to prevent contact between animals across the fence line, designed to inhibit disease transmission.

Effective separation: Spatial or temporal separation between wild sheep and domestic sheep or goats, resulting in minimal risk of contact and subsequent transmission of respiratory disease between animal groups.

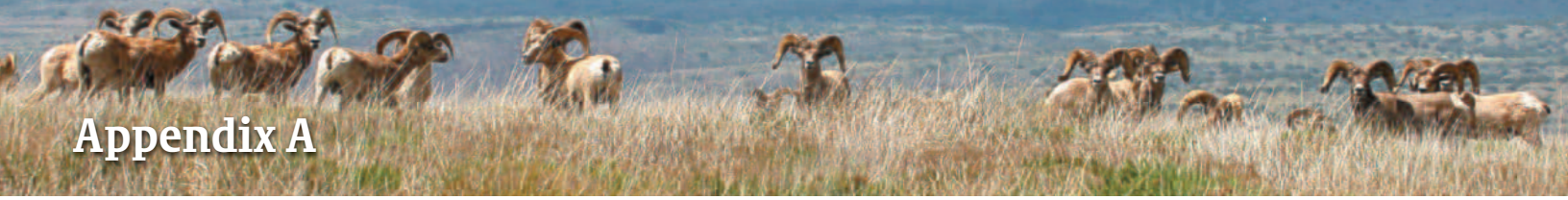
Feral: An animal of a domestic species that resides in a non-domestic setting and is not presently owned or controlled.

Historic habitat: Based on historic records, landscape that was previously occupied by bighorn sheep and thought to have provided necessary requirements to sustain a wild sheep population through time.

Interaction: Direct contact between body parts of two animals during which a pathogen might be transmitted from one to another. In this document, "interaction" typically refers to nose-to-nose or face-to-face interaction that may lead to the transmission of respiratory disease via secretions or aerosols. Synonymous with "Contact".

Metapopulation: An assemblage of populations, or a system of local populations (demes) connected by movement of individuals (dispersal) among various population segments.

Movement corridor: Routes that facilitate movement of animals between habitat fragments.



Appendix A

Occupied habitat/range: Suitable habitat in which a wild sheep population currently exists.

Preferred: A specific management action that *should* be chosen over another, whenever possible:
Radio collars: Transmitters fitted on neckband material to monitor animal locations.

Global Positioning System (GPS): A radio transmitter fitted on neckband material linked with orbiting satellites; animal locations can be precisely triangulated from space, with the location data then electronically stored in a memory chip or transmitted by various methods for data retrieval.

Very High Frequency (VHF): A radio transmitter fitted to neckband material transmitting in the Very High Frequency range that can be located from the ground or aircraft using a telemetry receiver.

Removal: Physical extraction of domestic sheep or goats, or wild sheep, to eliminate (permanently or temporarily) occupancy of that range or habitat.

Risk/Risk Assessment/Risk Management: In this context, evaluation of the probability that a wild sheep population could experience a disease event with subsequent demographic impacts. Identification of what factors might contribute to the probability of a disease event. Management actions taken to reduce the probability of exposure and/or infection among or between animals. Examples of risk management include separation of infected and non-infected animals, treatment of infected individuals, vaccination, manipulations of the host environment, or manipulations of the host population.

- Qualitative Risk Assessment: Interpretation and analysis of factors that cannot necessarily be measured.

- Quantitative Risk Assessment: Use of tangible data and measurements.

Spatial separation: A defined physical distance between animal populations.

Stray: A domestic sheep or goat physically separated from its flock or band.

Stressor: A specific action or condition that causes an animal to experience stress and the subsequent physiological results of that stress.

Suitable habitat: Landscape that has all necessary habitat requirements to sustain a wild sheep population through time.
Temporal separation: Segregating animal populations over time to prevent association, such that they may occupy the same physical space but at different times.

Thinhorn sheep: A member of the species *Ovis dalli* occurring in Alaska, Yukon Territory, Northwest Territories, and northern British Columbia.

Transmission: The physical transfer (direct or indirect mechanisms) of a disease agent from one animal to another, either within an animal population or between animal populations. In some instances, transmission can lead to full expression of disease in individuals or populations.

Transplant: An intentional movement of wild sheep from a source population to other suitable wild sheep habitat, either currently occupied or not. (Also called "translocation" in some documents.)

Trailing: The planned ambulatory movement of domestic sheep or goats across a landscape or within a corridor to reach a destination where grazing or use will be allowed.

Unoccupied habitat/range: Suitable habitat in which a wild sheep population does not currently exist.

Viability: The demographic and genetic status of an animal population whereby long-term persistence is likely.

Wandering Wild Sheep: Wild sheep, primarily but not always young, sexually-mature rams, occasionally traveling outside of normally anticipated or expected wild sheep range and adjacent habitat. Removal of wandering wild sheep typically does not have population-level implications for wild sheep. Conversely, failure to respond to wandering wild sheep may result in significant, adverse population-level impacts.



Appendix B

British Columbia Domestic-Wild Sheep Separation Project Contact Protocol

The following protocols outline ***the steps to be taken when reports of wild sheep contact with domestic sheep are received by the Ministry of Environment*** in one of several ways:

1. Regular report from public to regional office (Conservation Officer Service or Wildlife Section):

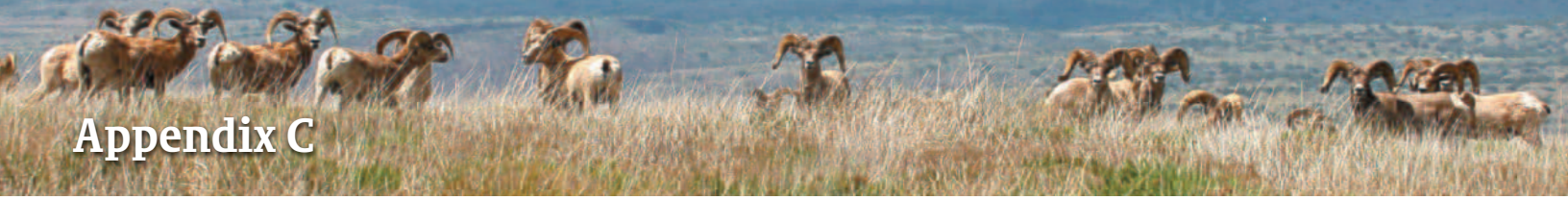
- Contact reported to Regional office.
- Assessment of situation by sheep biologist and COS, in consultation with wildlife veterinarian
- If close contact is confirmed and is considered a high risk situation, consider the following options:
    a. Kill bighorn and save carcass – sample bighorn and/or domestics in consultation with wildlife veterinarian
    b. Continue to monitor bighorn herd in area – observe and record general signs of health
    c. Do nothing – but keep records
- If contact is unsubstantiated/considered low risk, continue to monitor bighorn herd in area, alert and encourage mitigation measures with domestic producers in area to ensure separation.

2. Regular report from public to Call Line.

- Contact reported to Call Line; Call Line staff forwards to regional COS.
- Assessment of situation by COS and sheep biologist, in consultation with wildlife veterinarian
- If close contact is confirmed and is considered a high risk situation, consider the following options:
    a. Kill bighorn and save carcass – sample bighorn and/or domestics in consultation with wildlife veterinarian
    b. Continue to monitor bighorn herd in area – observe and record general signs of health
    c. Do nothing – but keep records
- If contact is unsubstantiated/considered low risk, continue to monitor bighorn herd in area, alert and encourage mitigation measures with domestic producers in area to ensure separation.

3. Out of hours call from public to Call Line.

- Contact reported to Call Line; Call Line staff forwards to regional COS officer-on-call.
- Assessment of situation by COS officer-on-call – contacts sheep biologist and wildlife veterinarian, if possible for consultation
- If sheep biologist and wildlife veterinarian cannot be contacted, biologist and veterinarian will support COS decision and action. COS will inform sheep biologist and wildlife veterinarian by email of the situation and action taken.
- If close contact is confirmed and is considered a high risk situation, consider the following options:
    a. Kill bighorn and save carcass – sample bighorn and/or domestics in consultation with wildlife veterinarian
    b. Continue to monitor bighorn herd in area – observe and record general signs of health
    c. Do nothing – but keep records
- If contact is unsubstantiated/considered low risk, continue to monitor bighorn herd in area, alert and encourage mitigation measures with domestic producers in area to ensure separation.



Appendix C

WYOMING GAME AND FISH DEPARTMENT

5400 Bishop Blvd. Cheyenne, WY 82006

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CLIFFORD KIRK
KERRY POWERS

MEMORANDUM

TO: Wildlife Division Employees

FROM: Jay Lawson, Chief, Wildlife Division

COPY TO: Terry Cleveland, Gregg Arthur, File

SUBJECT: **PROTOCOL FOR HANDLING THE COMMINGLING OF BIGHORN SHEEP AND DOMESTIC SHEEP/GOATS**

Due to the threat of disease transmission and subsequent bighorn sheep die-offs, the following protocol should be followed.

Wandering Bighorn Sheep:
Where there is known, suspected, or likely contact by a wandering bighorn sheep with domestic sheep/goats:

- If possible, that bighorn(s) should be live-captured and transported (one-way) to our Sybille Research Unit.
- If that bighorn(s) cannot be live-captured, that bighorn(s) should be lethally removed (per authority of Chapter 56) and, if possible, transported (either whole or samples) to our Sybille Unit or our WGFD Lab in Laramie.

Stray Domestic Sheep/Goat:
Where there is known, suspected, or likely contact by a stray domestic sheep/goat with bighorn sheep:

- The owner of such livestock should be notified and asked to remove the stray sheep/goat to eliminate the threat of disease transmission; however, it will be the owner's prerogative to determine what course of action should be taken.

Reporting:
All documented commingling and any actions taken must be reported to the employee's immediate supervisor, Wildlife Administration as well as the Bighorn Sheep Working Group Chairman, presently Kevin Hurley.

"Conserving Wildlife - Serving People"

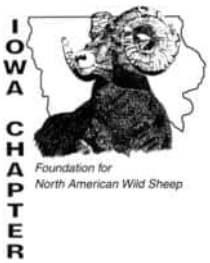
Financial assistance for this publication and other important work conducted by the Western Association of Fish and Wildlife Agencies Wild Sheep Working Group has been provided by:





























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EXHIBIT 8

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Population response of reintroduced bighorn sheep after observed commingling with domestic sheep

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Eur J Wildl Res (2014) 60:737–748
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ORIGINAL PAPER

Population response of reintroduced bighorn sheep after observed commingling with domestic sheep

Justin M. Shannon · Jericho C. Whiting · Randy T. Larsen · Daniel D. Olson · Jerran T. Flinders · Tom S. Smith · R. Terry Bowyer

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Abstract Bighorn sheep (*Ovis canadensis*) often die from respiratory disease after commingling with domestic sheep. From 2000 to 2009, we observed commingling between domestic and reintroduced bighorn sheep in 3 populations in UT, USA. We investigated how commingling affected survival of radio-collared female bighorns that were released initially (founder) and those that were subsequently released (augmented). We predicted that the proportion of young surviving to their first winter and population growth would be lower after observed commingling with domestic sheep. We observed groups of bighorns year-round on 2,712 occasions and commingling between domestic sheep and bighorns in 6 instances. On Mount Timpanogos, survival rates were best modeled as constant for females (n=57) before and after observed commingling with domestic sheep. Survival rates of female bighorns, however, decreased significantly in Rock Canyon (n=21) and on Mount Nebo (n=22) for founder, but not augmented bighorns after observed commingling with domestic sheep. Also, the proportion of young surviving to their first winter was almost 3 times lower and population growth was reduced for bighorns after observed commingling with domestic sheep in Rock Canyon and on Mount Nebo. Commingling between domestic and bighorn sheep reduced population parameters in 2 of 3 bighorn populations we studied; however, on Mount Timpanogos, interactions between those 2 species were not fatal for radio-collared female bighorns. Wildlife biologists should manage for spatial separation of these 2 species and consider the location of hobby farms and trailing operations of domestic sheep near release sites for bighorns.

Keywords Domestic sheep · *Ovis canadensis* · Reintroductions · Respiratory disease · Translocations

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Introduction

Bighorn sheep (*Ovis canadensis*) historically occupied much of the western USA (Buechner 1960; Valdez and Krausman 1999; Krausman and Bowyer 2003); however, populations of those mammals have declined drastically since the latter part of the nineteenth century (Geist 1971; Valdez and Krausman 1999). Historical declines have been attributed to overharvesting, habitat loss, competition with domestic livestock, and disease (Smith et al. 1988; Wehausen et al. 2011). Of those factors, pneumonia epizootics have plagued populations of bighorns for the past century (Grinnell 1928; Wehausen et al. 2011). Disease epizootics in bighorn populations appeared to follow the establishment of grazing by domestic livestock after European settlement (George et al.

2008; Wehausen et al. 2011). Respiratory disease may include multiple infectious agents, such as bacteria (primarily *Mycoplasma ovipneumoniae*, as well as *Pasteurella multocida*, *Mannheimia haemolytica*, and *Bibersteinia trehalosi*) (Dassanayake et al. 2010; Besser et al. 2012a, b, 2013), and potentially other stressors, such as drought and the proximity of the bighorn population to carrying capacity (Monello et al. 2001; George et al. 2008). Fatal respiratory disease poses 1 of the greatest threats to remaining populations of bighorn sheep in North America (McClintock and White 2007; Besser et al. 2012b).

Over the past 30 years, experimental research in enclosures has been extensive concerning the transmission of fatal respiratory disease when domestic sheep commingle with bighorn sheep (Foreyt and Jessup 1982; Onderka and Wishart 1988; Wehausen et al. 2011; Besser et al. 2012a). Additionally, die-offs in free-ranging herds of bighorns have been documented after suspected and observed contact with domestic sheep (Martin et al. 1996; Monello et al. 2001; Cassaigne et al. 2010); however, commingling between bighorns and domestic sheep has been difficult to observe in the wild prior to die-offs. Epizootics of respiratory disease can suppress populations of bighorn sheep by reducing survival of adult animals (Cassirer and Sinclair 2007; George et al. 2008) and decreasing survival of young, especially during summer (Monello et al. 2001; Cassirer and Sinclair 2007; George et al. 2008; Cassirer et al. 2013). Those factors produce lingering effects that can hinder population growth for many years after contact (Martin et al. 1996; Monello et al. 2001; Cassirer and Sinclair 2007). Although research has documented increased bighorn mortality shortly after exposure to domestic sheep in an experimental setting, the etiology of pneumonia epizootics in the wild is less certain (Besser et al. 2012b, 2013).

Reintroductions of bighorn sheep are an important management tool for conserving these unique mammals (Bleich et al. 1990; Whiting et al. 2010b), and this method often is used by biologists to reestablish populations (Bleich et al. 1990; Krausman 2000). Despite efforts to restore populations of bighorn sheep, many reintroductions have experienced low rates of success, because of predation (Rominger et al. 2004), habitat suitability (Smith et al. 1991), and disease (Singer et al. 2000a). Previous research indicates that reintroduced populations of bighorns may be more likely to experience problems with respiratory disease than native populations, especially when releases occur in areas of proximity to domestic sheep (Gross et al. 2000; Singer et al. 2000a; Monello et al. 2001). In some areas, disease may have been a major factor in limiting the establishment of populations of reintroduced bighorn sheep (Gross et al. 2000; Singer et al. 2000a; Shannon et al. 2008). Indeed, much remains to be learned about the implications of respiratory disease and its effects on the restoration and management of bighorn sheep (Monello et al. 2001; Wehausen et al. 2011; Plowright et al. 2013).

Mechanisms and causal agents leading to pneumonia epizootics in bighorn sheep after contact with domestic sheep are not completely understood (Wehausen et al. 2011; Besser et al. 2013). Much debate still exists about this controversial topic; therefore, long-term studies are needed documenting population dynamics of bighorns before and after such events occur to understand the implications of respiratory disease on the conservation of bighorn populations (George et al. 2008). We monitored 3 reintroduced populations of bighorns year-round in northern UT, USA from 2000 to 2009. During that time, we observed domestic sheep commingling with bighorns in each population. Those commingling events provided us with a rare, post hoc test in a natural setting regarding the effect of interactions of domestic sheep on population parameters of reintroduced bighorn sheep. We used Program MARK to test hypotheses (White and Burnham 1999) regarding survival of radio-collared female bighorns that were released initially (founder animals) and those that were subsequently released (augmented animals). Specifically, we evaluated the influence of augmentation and observed commingling with domestic sheep, as well as environmental, seasonal, and year effects on survival of radio-marked bighorns. We also predicted that the proportion of young surviving to their first winter and population growth for those bighorns would be substantially lower after observed commingling with domestic sheep. The results of our study provide a greater understanding of the implications of respiratory disease on the conservation, restoration, and management of populations of bighorn sheep in the western USA.

Materials and methods

Study area

We studied 3 populations (Mount Timpanogos, Rock Canyon, and Mount Nebo) of Rocky Mountain bighorn sheep (*O. canadensis canadensis*) that were reintroduced into UT, USA (Fig. 1). Those populations occupied the Uinta National Forest of the Wasatch Mountains, which are oriented north to south with a large urban interface (>500,000 people) to the west (Whiting et al. 2008). Elevation in those areas ranged from 1,388 to 3,636 m (Whiting et al. 2008). Mean summer temperature was 19 °C, and mean winter temperature was 3 °C (Whiting et al. 2011). Mean annual rainfall was 51 cm, and the mean yearly snowfall was 145 cm. Those areas were similar in environmental conditions, topography, and flora. Generalized vegetative zones descending in elevation were alpine, conifer, aspen (*Populus tremuloides*), maple (*Acer* spp.), juniper (*Juniperus* spp.), mountain brush, big sagebrush (*Artemisia tridentata* ssp.), forbs, and grasses (Whiting et al. 2008). Forage species used by bighorns in those areas



Fig. 1 Locations of study areas in which we observed commingling between domestic and bighorn sheep in UT, USA, from 2000 to 2009. *Dark lines* traversing the state are major highways

included bluebunch wheatgrass (*Elymus spicatus*), spike fescue (*Lecopoa kingii*), Sandberg's bluegrass (*Poa secunda*), shortstem buckwheat (*Eriogonum brevicaule*), and littlecup penstemon (*Penstemon sepalulus*) (Whiting et al. 2010b). In all of our study areas, grazing allotments for domestic sheep and goats were retired, or converted to cattle allotments, through the local United States Forest Service Office prior to bighorn sheep being released; therefore, no legal grazing by domestic sheep or goats occurred in our study areas.

Capture and observations of bighorn sheep

From 2000 to 2007, 157 bighorn sheep were captured and released into the 3 study areas (Fig. 1, Table 1). Ninety-four females were equipped with VHF radio collars at the time of release (Table 1), and 12 additional females were collared periodically throughout the study. To help identify groups (founder or augmented), bighorns released in all study areas in 2007 were marked with 2, colored ear tags. Wildlife biologists from the Utah Division of Wildlife Resources (UDWR) used care when capturing, handling, translocating, and attaching radio-transmitting collars and ear tags to bighorns (Sikes et al. 2011). We arbitrarily considered bighorn sheep released from 2000 to 2002 on Mount Timpanogos as founder animals and those released in 2007 as augmented bighorns (Table 1). After the release of bighorn sheep from Hinton, Alberta, Canada, on Mount Timpanogos in 2001, 3 of those 10 bighorns died within 5 months, and 5 individuals (1 male and 4 females) were removed by employees of the UDWR because of suspected disease, although we never observed those bighorns commingling with domestic sheep. We considered animals released in Rock Canyon (2001) and on Mount Nebo (2004) as founder animals and those released in 2007 as augmented bighorns (Table 1). Each release of augmented bighorns occurred in areas used by founder animals, and augmented and founder bighorns intermixed during 29 % of our sightings (n=1,401 observations) after January 2007.

Table 1 Locations, years of capture, source areas, and demographic information for populations of bighorn sheep released in northern UT, USA

Release site and date	Source area	Males	Females	Young	Total	% females collared
Mount Timpanogos						
January 2000[a]	Rattlesnake Canyon, UT	6	16	3	25	81
January 2001[a]	Hinton, Alberta, Canada	2	8	0	10	100
February 2002[a]	Sula, MT	2	6	1	9	67
January 2007	Sula, MT	0	20	0	20	70
March 2007	Alamosa, CO	1	17	0	18	100
Rock Canyon						
January 2001[a]	Hinton, Alberta, Canada	4	15	3	22	67
January 2007	Sula, MT	0	5	0	5	60
January 2007	Augusta, MT	0	5	0	5	60
Mount Nebo						
December 2004[a]	Augusta, MT	2	13	3	18	69
January 2007	Augusta, MT	3	22	0	25	59

[a] We considered bighorns from these releases as founder animals

We located bighorn sheep with transmitting radio collars using radiotelemetry equipment, binoculars, and spotting scopes year-round from 2000 to 2009. We observed groups of those ungulates an average of 24 occurrences each month. During that time, near Rock Canyon, we observed 1 domestic sheep along the urban interface 5 years before our first observed commingling between bighorn and domestic sheep. That domestic sheep was removed by wildlife biologists from the UDWR 12 days after being observed. We also observed 3 domestic sheep in an area near Rock Canyon 1 month before our observed first commingling between bighorn and domestic sheep. Those domestic animals were removed by wildlife biologists from the UDWR the day that they were observed. Additionally, in an area near Rock Canyon, we observed 6 domestic goats 1 month before our first observed commingling between bighorn and domestic sheep. All 6 of those goats were removed the day that they were observed. Because we did not observe commingling between domestic sheep or goats and bighorn sheep during all of those observations, it is tenuous to infer that transmission of pathogens occurred; therefore, for our analyses, we only used sightings of domestic sheep commingling with bighorns (i.e., the 2 species were within 20 m of each other and moved as a group) that were observed by at least 1 of the authors of this paper, wildlife biologists from the UDWR, or in 1 instance, a local law enforcement officer.

Survival analyses

We estimated monthly and annual survival rates (s) using known-fate models in Program MARK version 5.1 (White and Burnham 1999). We used model selection (Burnham and Anderson 2002) to evaluate support for survival models of radio-collared female bighorn sheep before and after the date of augmentations of bighorns and before and after the date of observed commingling with domestic sheep. We only tested for effects of source population of augmented bighorns on survival of collared females in 1 of our study areas (Mount Timpanogos). We were not able to test for the effects of source population of augmented bighorns in Rock Canyon, because there were too few collared females (3 from each release) to do such. We were not able to test for the effect of source population of augmented bighorns in models for Mount Nebo, because all bighorns in that area were from the same source population (Augusta, MT). We also tested for effect of group, which included founder or augmented individuals, on survival of females. To test for differences in survival of collared females in relation to weather (i.e., drought or inclement weather), we evaluated support for season—birthing (1 April to 31 July), summer and autumn (1 August to 30 September), and winter (1 October to 31 March) (Cassirer and Sinclair 2007; George et al. 2008)—and year effects. Some of those models included 4-, 8-, or 12-month linear or quadratic decreases in survival following commingling with domestic sheep (George et al. 2008). Those trend models allowed us to capture the possibility of acute, chronic, or recovery of survival rates following observed comingling with domestic sheep. We followed protocols for standard model selection and constructed a list of biological meaningful *a priori* candidate models for each population (Anderson and Burnham 2002; Burnham and Anderson 2002; Arnold 2010). Separate analyses for each population simplified our analyses and allowed us to evaluate support for models in relation to when augmentation of bighorn sheep occurred or when domestic sheep were observed comingling with bighorns in each population. We formatted encounter histories (live, dead, or censored) for each collared female bighorn by month. For our analyses, we only used collared females that were alive for

>1 month after release (Cassirer et al. 2013). We censored 9 bighorns on Mount Timpanogos (4 that were shot by wildlife biologists because of suspected disease in 2001 and 5 individuals because the battery on the radio collars failed) and 2 bighorns in Rock Canyon because of radio-collar failures.

We based model selection on the minimization of Akaike's information criterion (Akaike 1973) corrected for small sample size (AIC_c) (Lebreton et al. 1992) and AIC_c weights (w_i) (Buckland et al. 1997; Burnham and Anderson 2002). When model selection uncertainty occurred (competing models with >5 % AIC_c weight), we calculated model-averaged estimates (Burnham and Anderson 2002) of annual survival by adjusting time intervals to equal 1/12th of a year. To evaluate effect sizes, we examined overlap in 95 % confidence intervals (CI) associated with survival estimates. For survival analyses, we considered bighorn sheep released from 2000 to 2002 on Mount Timpanogos as founder animals and those released in 2007 as augmented bighorns (Table 1). We also considered animals released in Rock Canyon (2001) and on Mount Nebo (2004) as founder animals and those released in 2007 as augmented bighorns (Table 1).

We calculated an index of the survival of young bighorn sheep to their first winter for Rock Canyon and Mount Nebo and then compared that value before and after the first observed commingling event with domestic sheep. We could not compare that value on Mount Timpanogos, because our first observed commingling event between domestic and bighorn sheep occurred in August 2000, only 8 months after the first group of bighorns was released in that area (Table 1). That value included survival of young from collared and uncollared females, because we could not identify individual young. For this analysis, we first relocated collared and uncollared female bighorns throughout the birthing season to record birthdates and determine the number of young born in each population during that season. This method, which has been well established for these populations, provided a total number of young born in the sampling year. Data regarding the number of young born in all areas from 2000 to 2007 were adapted from Whiting et al. (2008, 2010b, 2011, 2012). Second, during winter (1 October to 31 March), bighorn sheep used areas of low elevation, which facilitated their relocation. We searched those areas and tallied the highest count of young observed across that season of the same year (Jorgenson 1992; Roy and Irby 1994). We then compared that value with the number of young born the previous spring to calculate an index of the proportion of neonates that survived to their first winter in each year (Clutton-Brock et al. 1987; Whiting et al. 2011). We did not partition data by year because of small sample sizes. Data concerning the number of young surviving to their first winter on Mount Timpanogos and in Rock Canyon from 2000 to 2006 were adapted from Whiting et al. (2010b, 2011). We used the two-sample Z test for proportions, which allows sampling with replacement (Remington and Schork 1970), to investigate the prediction that the proportion of young surviving to their first winter was reduced in Rock Canyon and on Mount Nebo after first observed commingling with domestic sheep. Others methods, such as age ratios, were considered more problematic than the method we used, because of the double variable nature of ratios (Bowyer et al. 2013).

To document an index of population growth before and after observed commingling between domestic and bighorn sheep from 2000 to 2009 in each area, we relocated bighorns during winter as described previously and tallied the highest population count of all bighorns observed during that season. Data from counts have been used as an index of population size (Slade and Blair 2000). We then calculated the annual growth rate (λ) (Monello et al. 2001) of bighorn sheep in Rock Canyon and on Mount Nebo for each year. We then averaged that value before and after the first observed commingling between domestic and bighorn sheep in those 2 areas. We could not compare annual growth rates of bighorn sheep on Mount Timpanogos, because our first observed commingling event between domestic and bighorn sheep occurred in August 2000, 8 months after the first group of bighorns was released in that area.

Results

From 2000 to 2009, we observed groups of bighorn sheep year-round on 2,712 occasions (Mount Timpanogos = 1,549, Rock Canyon = 797, and Mount Nebo = 366). On Mount Timpanogos, we observed 2 domestic sheep with 6 founder bighorns (2 females, 1 yearling, and 3 young) in August 2000 and 1 domestic sheep with 16 augmented bighorns (1 male, 13 females, and 2 young) in November 2008. In Rock Canyon, we sighted 1 domestic sheep with 4 bighorns (1 founder male, 2 founder females, and 1 augmented female) in November 2007. On Mount Nebo, we observed 1 domestic sheep with 3 founder bighorns (1 male, 1 female, and 1 young) in November 2006, 4 domestic sheep with 5 bighorns (females and young, most likely founders) in March 2007, and 4 domestic sheep with 2 founder females in February 2008. Observations of domestic sheep commingled with bighorns, in bighorn habitat, accounted for 0.2 % of all sightings of bighorn sheep, indicating that observing such events was rare. We observed no other commingling of bighorn sheep with any other domestic ungulates during our study.

Throughout the study, we calculated survival rates for 100 female bighorns that were radio-collared: 28 founder and 29 augmented bighorn sheep on Mount Timpanogos, 15 founder and 6 augmented individuals in Rock Canyon, and 9 founder

and 13 augmented bighorns on Mount Nebo. In Rock Canyon, all founder females that were radio-collared (n=6) died within 8 months after observed commingling with domestic sheep compared with 1 of 4 augmented females that were radio-collared. Similarly on Mount Nebo, 7 of 8 founder females that were radio-collared died within 8 months after commingling with domestic sheep in March 2007 compared with 2 of 13 augmented females that were radio-collared.

On Mount Timpanogos, the top model was the null model indicating constant monthly survival, but significant model selection uncertainty occurred with 5 other competing models receiving >5 % AIC_c weight (Table 2). Those models included group (difference in survivorship between founder and augmented bighorns), commingling events, season, and linear trend models for which survival varied in relation to commingling events (Table 2). Top models for Rock Canyon and Mount Nebo, however, indicated that variation in monthly survival rates was best modeled based on timing of observed commingling with domestic sheep, but with different estimated survival rates for augmented versus founder bighorns (Table 2). These top models were similar and accounted for almost all of the AIC_c weights, with no other models receiving >5 % model weight (Table 2).

Average annual survival (±95 % CI) for radio-collared female bighorns on Mount Timpanogos was estimated at 0.83 (0.68 to 0.92) before observed contact with domestic sheep in August 2000 and 0.83 (0.74 to 0.89) after that observed commingling (Fig. 2). Before commingling in November 2008, the estimated average annual survival rate of founder female bighorns was again 0.83 (0.74 to 0.89) compared with 0.81 (0.70 to 0.89) for augmented bighorns. Following commingling in November 2008, the estimated average annual survival rate for founder female bighorns on Mount Timpanogos was 0.82 (0.71 to 0.90) compared with 0.77 (0.59 to 0.89) for augmented bighorns (Fig. 2).

Average annual survival (±95 % CI) for all female bighorn sheep that were radio-collared in Rock Canyon was estimated at 0.84 (0.72 to 0.91) before observed contact with domestic sheep and 0.38 (0.17 to 0.64) after contact. For founder

Table 2 Results of model selection (AIC_c and ΔAIC_c), model weights (w_i), number of estimated parameters (K), and deviance for models (AIC_c weight >1 %) of bighorn sheep survival in relation to observed commingling with domestic sheep, as well as season, group (founder or augmented), and monthly trend effects in 3 populations in UT, USA, from 2000 to 2009

Model structure	AIC_c	ΔAIC_c	w_i	K	Deviance
Mount Timpanogos					
s(.)	315.32	0.00	0.20	1	125.36
s(group)	317.11	1.79	0.08	3	123.14
s(1st observed comingling)	317.13	1.82	0.08	2	125.17
s(group + 12-month linear trend, 1st observed comingling)	317.24	1.92	0.08	4	121.26
s(2nd observed comingling)	317.28	1.97	0.07	2	125.32
s(group + 4-month linear trend, 2nd observed comingling)	317.57	2.25	0.06	2	121.59
s(2nd observed comingling)	318.18	2.86	0.05	4	122.20
s(group + 8-month linear trend, 1st observed comingling)	318.40	3.08	0.04	4	122.42
s(group + 8-month linear trend, 2nd observed comingling)	318.54	3.22	0.04	4	122.56
s(group + 8-month quadratic trend, 1st observed comingling)	318.77	3.45	0.04	4	122.79
s(group + 4-month quadratic trend, 1st observed comingling)	318.84	3.52	0.03	4	122.86
s(group + 4-month linear trend, 1st observed comingling)	318.85	3.53	0.03	4	122.87
s(group + 4-month quadratic trend, 2nd observed comingling)	318.87	3.55	0.03	4	122.89
s(constant survival before 1st observed comingling, different survival by group post commingling)	318.97	3.65	0.03	4	122.99
s(group + 12-month linear trend, 2nd observed comingling)	319.00	3.69	0.03	4	123.03
s(season)	319.04	3.72	0.03	3	125.07
s(different survival by group before and after 1st comingling)	319.06	3.74	0.03	4	123.08
s(season*group)	320.25	4.94	0.02	9	114.20
Rock Canyon					
s(constant survival before commingling, different survival by group post commingling)	147.39	0.00	0.52	3	67.44
s(different survival by group before and after commingling)	147.74	0.35	0.44	4	65.77
Mount Nebo					
s(constant survival before 2nd commingling, different survival by group post commingling)	106.82	0.00	0.70	3	43.90
s(different survival by group before and after 2nd commingling)	108.62	1.80	0.28	4	43.68
s(constant survival before augmentation, different survival by group after augmentation)	114.47	7.65	0.02	3	51.56

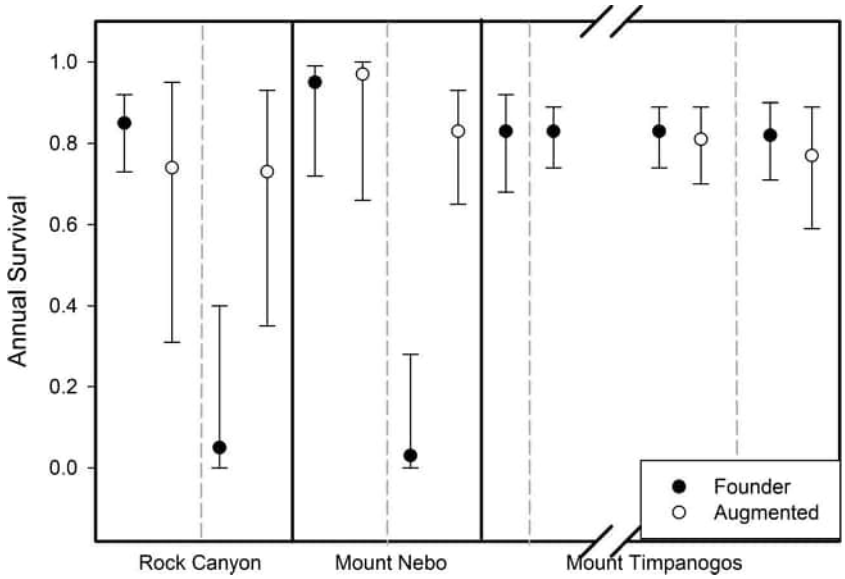


Fig. 2 Average annual survival rates of female bighorn sheep that were radio-collared in Rock Canyon, on Mount Nebo, and on Mount Timpanogos in UT, USA, from 2000 to 2009. *Dashed-vertical lines* represent observed commingling events between domestic and bighorn sheep during November 2007 in Rock Canyon and March 2007 (second commingling event) on Mount Nebo, as well as August 2000 (*left line*) and November 2008 (*right line*) on Mount Timpanogos

bighorns, an estimate of average annual survival in Rock Canyon was 0.85 (0.73 to 0.92) before observed contact with domestic sheep and 0.05 (0.00 to 0.40) after contact (Fig. 2). Annual survival rates for augmented female bighorns in Rock Canyon were 0.74 (0.31 to 0.95) before observed contact with domestic sheep and 0.73 (0.35 to 0.93) following observed commingling (Fig. 2). For Mount Nebo, supported models indicated that the second commingling event (March 2007) influenced survival rates of collared bighorn sheep (Table 2); therefore, we report annual survival rates of female bighorn sheep in relation to that event. On Mount Nebo, the average annual survival for all radio-collared female bighorns was estimated at 0.95 (0.73 to 0.99) before observed contact with domestic sheep and 0.64 (0.48 to 0.78) after contact. For founder bighorns, the estimated average annual survival rates on Mount Nebo were 0.95 (0.72 to 0.99) before observed commingling with domestic sheep and 0.03 (0.00 to 0.28) after commingling (Fig. 2). For augmented bighorns on Mount Nebo, the annual survival rates were estimated at 0.97 (0.66 to 1.00) before observed commingling with domestic sheep and 0.83 (0.65 to 0.93) afterward (Fig. 2).

We observed 1,313 groups of bighorn sheep during the birthing period on Mount Timpanogos (n=726), in Rock Canyon (n=398), and on Mount Nebo (n=189). Across all years and during the birthing season, we recorded 151 young born on Mount Timpanogos and 74 young born in Rock Canyon before and 26 young born after observed commingling between domestic and bighorn sheep; and on Mount Nebo, we recorded 10 young born before and 46 young born after observed commingling with domestic sheep. To assess survival of young to their first winter, we observed 964 groups of bighorn sheep on Mount Timpanogos (n=568), in Rock Canyon (n=277), and on Mount Nebo (n=119) during that season. Survivorship of young to their first winter was 34 % on Mount Timpanogos during the study. Survivorship of young to their first winter was almost 3 times higher in Rock Canyon (Z=5.01, P<0.001) and Mount Nebo (Z=3.62, P<0.001) before observed commingling with domestic sheep (Fig. 3).

Average annual growth rate (λ), indexed from changes in population size, of bighorns on Mount Timpanogos from 2000 to 2009 was estimated at 1.11 (Fig. 4), whereas the growth rate in Rock Canyon was estimated at 1.12 before observed contact with domestic sheep and 0.44 after commingling (Fig. 4). On Mount Nebo, λ for bighorns was estimated at 1.87 before and 0.73 after observed commingling with domestic sheep (Fig. 4).

Discussion

Effects of commingling

Long-term studies documenting population dynamics of bighorn sheep in the wild before and after epizootics of respiratory disease are difficult to conduct, but are needed to better understand implications of fatal pneumonia on the conservation of bighorns (George et al. 2008). We observed commingling between domestic and bighorn sheep in 3 populations of reintroduced bighorns. Although we were unable to collect immunological data or identify the etiological agent that caused die-offs, which is difficult to do in the wild (sensu Plowright et al. 2013), the best models indicated a decrease in survival rates of collared female bighorns in Rock Canyon and on Mount Nebo after observed commingling with domestic sheep. Similar outcomes have been documented in other studies (Cassirer and Sinclair 2007; George et al. 2008). Survival rates for collared female bighorns on Mount

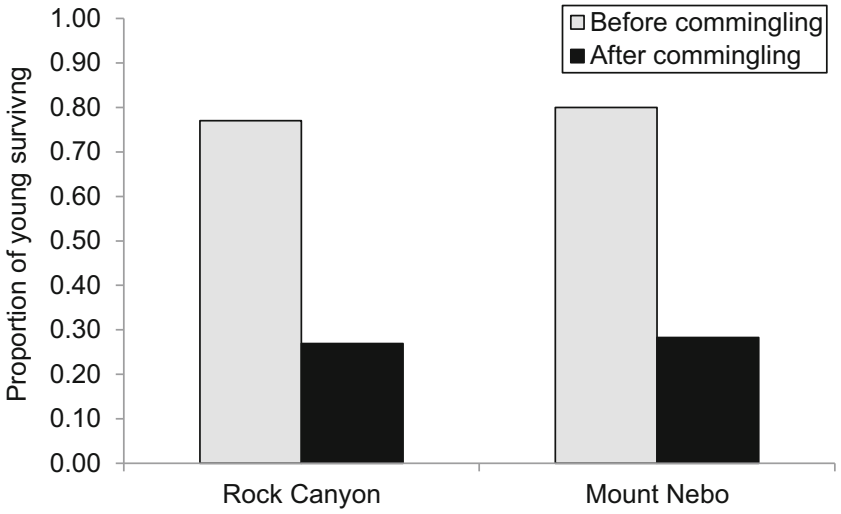


Fig. 3 Proportion of young surviving to their first winter in 2 populations of bighorn sheep before and after observed commingling with domestic sheep in UT, USA, from 2001 to 2009 in Rock Canyon and from 2005 to 2009 on Mount Nebo

Timpanogos were similar to survival rates of collared females in Rock Canyon and on Mount Nebo before observed commingling with domestic sheep. Additionally, on Mount Timpanogos, survival rates remained constant after 2 occasions of commingling with domestic sheep, indicating that not all interactions between domestic and bighorn sheep were detrimental to collared female bighorns in that population. We hypothesize that domestic sheep that interacted with bighorns on Mount Timpanogos were not carriers of pathogens that produced respiratory disease (Besser et al. 2012a), that pathogens were not transferred, or did not lead to fatal pneumonia in collared female bighorns (Wehausen et al. 2011).

Survival rates of founder versus augmented females

We also documented decreases in survival rates of female bighorn sheep that were considered founder (from original releases) in Rock Canyon and on Mount Nebo after observed commingling with domestic sheep. This outcome was noteworthy, because stress of translocation may increase the susceptibility of augmented bighorn sheep to disease (Weiser et al. 2009). The mechanisms leading to outbreaks of epizootic disease in bighorns after contact with domestic sheep in the wild are complex and may differ from the results of controlled pen studies (Wehausen et al. 2011). On Mount Nebo, all bighorns came from the same source herd and releases were separated by just over 2 years; however, survival rates of founder females in that population, as well as in Rock Canyon, were much lower than survival rates of augmented bighorns after observed commingling with domestic sheep. Additionally, on Mount Nebo, had we not evaluated for models including group (founder or augmented), the overall effect of observed commingling would have been difficult to detect, because of overlapping confidence intervals in survival rates of founder and augmented females in that population. We hypothesize that founder animals had a weaker innate immune response, that augmented bighorns had some level of resistance to pathogens, or that the transfer of pathogens or predisposing factors to disease differed between founder and augmented animals (Wehausen et al. 2011; Besser et al. 2012a; Plowright et al. 2013). Indeed, some female bighorn sheep may be chronic carriers of disease, but may not be infected by such maladies (Besser et al. 2013; Cassirer et al. 2013; Plowright et al. 2013). These ideas, however, deserve further experimental testing.

Augmentations of bighorn sheep have been a common management practice for this species for almost 100 years (Singer et al. 2000a). Reintroduced populations of bighorns, however, may be more likely to experience problems with respiratory disease than native populations, especially when releases occur in areas of proximity to domestic sheep (Gross et al. 2000; Singer et al. 2000a; Monello et al. 2001). Decreased survival rates of founder female bighorns in Rock Canyon and on Mount Nebo could have been caused by augmented bighorns that were carrying pathogens when they were released. Such an idea has been forwarded as a potential to spread disease to founder bighorn sheep (Wild Sheep Working Group 2012). Our models, however, did not support this idea. Indeed, no models that included variation in survival rates related to the timing of augmentation received >5 % AIC_c weight. Additionally, in Rock Canyon, survival rates of founder bighorns did not decrease until 11 months after augmentation and within 1 month following observed commingling with domestic sheep. If augmented bighorns were carriers of disease, we would have predicted that founder animals in Rock Canyon and on Mount Nebo would have died during the most stressful time of the year and when increased social interactions occur (i.e., winter to early spring following release) (Cassirer and Sinclair 2007; Cassirer et al. 2013).

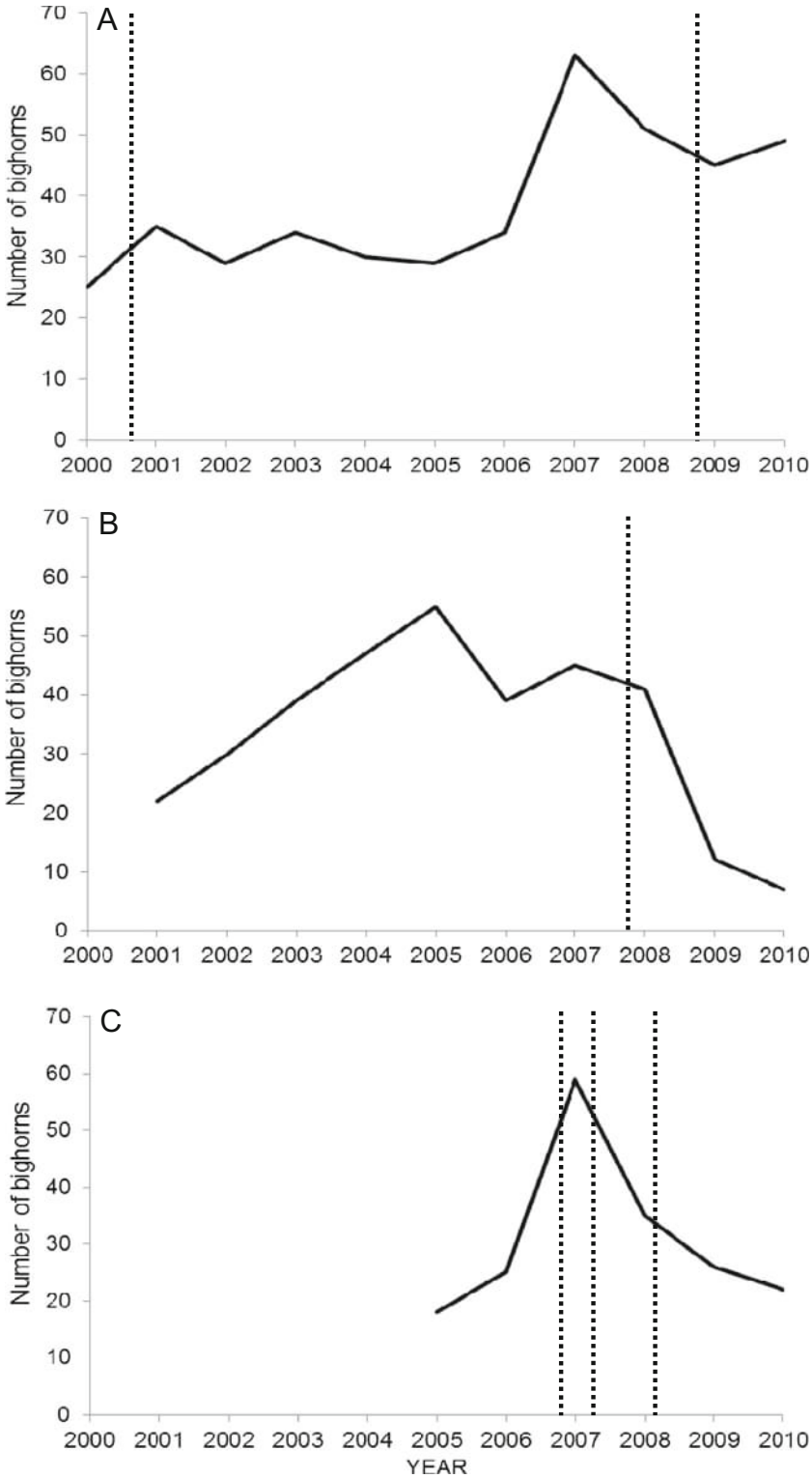


Fig. 4 Number of Rocky Mountain bighorn sheep counted on Mount Timpanogos (**a**), Rock Canyon (**b**), and Mount Nebo (**c**) during winter surveys in UT, USA. *Dashed-vertical lines* represent approximate dates of observed commingling events between domestic and bighorn sheep. Augmentations in all study areas in 2007 contributed to population growth (Table 1)

Survivorship of young

Quantifying survivorship of young bighorn sheep before and after contact with domestic sheep is a valuable way to document potential effects of commingling between those species (Monello et al. 2001; Cassirer and Sinclair 2007; George et al. 2008). In our study, we predicted that the proportion of young surviving to their first winter would be substantially lower after observed commingling with domestic sheep. This prediction was supported in areas (Rock Canyon and Mount

Nebo) in which we could compare survivorship of young before and after observed commingling between domestic and bighorn sheep. Those results were similar to other studies that documented a decrease in survival of young bighorns following suspected outbreaks of disease (Cassirer and Sinclair 2007; Cassirer et al. 2013; Plowright et al. 2013). Respiratory disease likely affected the survivorship of young for all female bighorns (founder and augmented) in Rock Canyon and Mount Nebo, even though survival rates of augmented females that were collared did not decrease in those populations. Indeed, young bighorns may die from the effects of respiratory disease even when adult females do not (Cassirer and Sinclair 2007; Cassirer et al. 2013; Plowright et al. 2013).

Although we could not compare survivorship of young before and after commingling on Mount Timpanogos, because those domestic and wild ungulates were first observed commingling 8 months after the initial release of bighorns, noteworthy patterns emerged in that population. Survivorship of young (n=93) was 40 % from 2000 to 2008. This low value, however, could have been partially attributed to young being born late in some of those years (Whiting et al. 2011), or potential effects of commingling with domestic sheep. After observed comingling with domestic sheep in November 2008 on Mount Timpanogos, survivorship of young (n=58) to their first winter was 26 %, similar to the survivorship values we observed in Rock Canyon and on Mount Nebo after observed commingling with domestic sheep. Once again, those young bighorns may have died from the effects of respiratory disease even when collared females did not (Cassirer and Sinclair 2007; Cassirer et al. 2013; Plowright et al. 2013). After observed die-offs, survivorship of young can be reduced for >5 years (Monello et al. 2001), which could have lingering effects on the establishment of reintroduced populations. We hypothesize that these lingering effects will continue to hinder population growth of bighorns in our study areas.

Population growth

Quantifying changes in population growth before and after commingling of domestic and bighorn sheep is a valuable way to detect the consequences of such interactions (Monello et al. 2001; Cassirer and Sinclair 2007). In Rock Canyon and on Mount Nebo, although not tested statistically, a general pattern emerged indicating decreases in estimated population growth rates after observed commingling of domestic and bighorn sheep, similar to the results reported in other studies (Monello et al. 2001; Cassirer and Sinclair 2007). Another study used information from at least 2 years prior and 2 years after die-offs to compare rates of population growth in bighorns (Monello et al. 2001). We documented long-term survival of collared females (almost 7 years in Rock Canyon) before observed commingling with domestic sheep, which provided a clear picture of the effects of such commingling on population growth of bighorns in that study area.

Density dependence

Density-dependent factors may predispose bighorn sheep to fatal respiratory disease (Monello et al. 2001). Across North America, almost 88 % of pneumonia epizootics in bighorns occurred within 3 years of peak population numbers (Monello et al. 2001). Our study populations were recently reintroduced and consisted of a low number of individuals in each population. Additionally, females in those populations exhibited high pregnancy rates (Whiting et al. 2008, 2010a, 2011) and high survival of young to first winter before contact with domestic sheep, which indicate that those populations were most likely not influenced strongly by density-dependent factors (Martin and Festa-Bianchet 2010).

Proximity of domestic sheep

Fatal respiratory disease can be transmitted to bighorn sheep by male bighorns wandering, contacting domestic sheep, and then returning and infecting other bighorn sheep (Besser et al. 2013), or by overlap of domestic sheep grazing allotments with areas used by bighorn sheep (Carpenter et al. 2014). Domestic sheep we observed most likely were stray animals from trailing operations or from hobby farms of residents who lived along a heavily populated urban interface. For example, in 2003, adjacent to our study areas along the Wasatch Front, we observed as many as 8 flocks of domestic sheep in small backyard pastures within 10 km of areas occupied by bighorns. Also, near Mount Nebo, road corridors that were within 6 km of areas occupied by bighorns were used to move domestic sheep from summer to wintering areas, much closer than the buffer of 20 km recommended to separate domestic and bighorn sheep (Smith et al. 1991; Singer et al. 2000a). The close proximity of bighorns to domestic sheep along the urban interface in our study areas may continue to be problematic, because of the behavioral attraction between these species (Etchberger et al. 1989; Turner et al. 2004; Wehausen et al. 2011). Indeed, in many areas where the urban interface encroaches on habitat of bighorn sheep, infectious diseases will become an increasingly important issue for the conservation of bighorns (Etchberger et al. 1989; Turner et al. 2004)—especially as the likelihood of interactions increases between wildlife and domestic species in those areas (Smith et al. 2009).

Management implications

The conservation of bighorn sheep populations remains an important issue across much of western North America

(Buechner 1960; Monello et al. 2001). Diseases of domestic sheep have long posed concerns for the conservation of bighorn sheep (Buechner 1960; Wehausen et al. 2011), especially for small, reintroduced populations (Gross et al. 2000; Singer et al. 2000b; Cassaigne et al. 2010). Additional information regarding the effects of respiratory disease on population growth in reintroduced bighorns is a pressing need for the conservation of these mammals (Monello et al. 2001), especially because much debate still exists about this controversial topic. In Rock Canyon and on Mount Nebo, we documented reductions in survival rates of founder female bighorns, survivorship of young, and population growth of bighorns after observed commingling with domestic sheep. Nonetheless, on Mount Timpanogos, survival rates remained constant for female bighorn sheep before and after observed commingling with domestic sheep, indicating that not all contact with domestic sheep resulted in die-offs of collared female bighorns. As well as understanding the proximity of release areas to domestic grazing allotments, we recommend that biologists consider hobby farms and trailing operations of domestic sheep in locations adjacent to translocation areas prior to releasing bighorn sheep. Also, if management of bighorn populations is the goal, we recommend spatial and temporal separation of bighorn and domestic sheep wherever possible (Martin et al. 1996; Schommer and Woolever 2008; Wehausen et al. 2011; Besser et al. 2013).

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EXHIBIT 9

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Plaintiffs,

v.

KRISTIN BAIL, Okanogan-Wenatchee National Forest, Forest Supervisor, and U.S. FOREST SERVICE,

Defendants,

S. MARTINEZ LIVESTOCK, a Washington Corporation,

Defendant-Intervenor.

No. 2:20-cv-00440-RMP

DECLARATION OF DR. THOMAS BESSER IN SUPPORT OF PLAINTIFFS' MOTION FOR PRELIMINARY INJUNCTION

I, Thomas Besser, with full knowledge of the penalties of perjury, declare as follows:

1. I have been a Professor and infectious disease researcher in the Department of Veterinary Microbiology and Pathology, College of Veterinary Medicine, and the Washington Animal Disease Diagnostic Laboratory at Washington State University, Pullman, Washington since 1986. Upon my retirement in September 2019, I became Professor Emeritus.

2. I have been asked by Plaintiffs in this litigation to provide my expert opinion on disease transmission from domestic sheep to bighorn sheep and scientific issues relevant for making management decisions where conflicts exist.

I. Professional Qualifications and Experience.

3. I have over thirty-five years of experience researching the epidemiology and ecology of infectious diseases caused by pathogens across host species. My CV is attached as Exhibit A.

4. I hold a Bachelor of Science degree in Zoology from the University of Wisconsin (1973), a Doctor of Veterinary Medicine degree from the University of Minnesota (1981), and a PhD in Veterinary Science from Washington State University (1986).

5. I have held appointments in the Washington Animal Disease Diagnostic Laboratory throughout my career at WSU: Bacteriology Section Supervisor (1986-2000, during which time I founded the Combined Diagnostic

Microbiology / Infectious Diseases PhD program), Director of Laboratory Services (2000-2004), Molecular Diagnostics Supervisor (2004-2008). Since 2008 I provided consultation on issues related to public health/food safety and wildlife diseases. I was Director of the WSU College of Veterinary Medicine's Immunology and Infectious Diseases graduate studies program (2013-2019). I was an adjunct professor in the Paul G. Allen School for Global Animal Health. In 2016, I was appointed to serve as the WSU/WSF Rocky Crate Endowed Chair in wild sheep disease research, which I held until my retirement.

6. I am a member of the American College of Veterinary Microbiologists and served on their Board of Governors from 2009 to 2012. I am also a member of the American Society for Microbiology, and served as a member of its Applied and Environmental Microbiology Editorial Board from 2008 to 2010.

7. I have received honors for my work from the University of Minnesota, Washington State University, the Washington State Academy of Sciences, and the American Association for the Advancement of Science, and I was a Fulbright Research Fellow at the University of Edinburgh in 2000-2001.

8. I have been conducting research in the fields of veterinary immunology, epidemiology, and microbiology since 1982. One of my primary research focus areas since 2005 has been epidemic pneumonia in bighorn sheep,

including the cause, prevention, and management of this disease through laboratory and field-based microbiological and epidemiological studies.

9. Specifically, my wild sheep research has focused on clarifying the cause of bighorn sheep epizootic pneumonia in order to improve the prevention and management of this disease. In 2009, I joined the Bighorn Sheep Disease Research Consortium, an association of experts studying many aspects of bighorn sheep pneumonia, including transmission, immunity, microbial etiology, connectivity and habitat modeling, pneumonia disease dynamics, and chronic carriage. As a member of this consortium and in my roles as a research microbiologist in the Department of Veterinary Microbiology and Pathology and a diagnostician at the Washington Animal Disease Diagnostic Laboratory, I studied the role of *M. ovipneumoniae* in causing the pneumonia outbreaks that follow its introduction into previously healthy bighorn sheep populations, the persistence of this agent (and the disease it causes) in bighorn sheep populations after it is introduced, and methods to clear the agent from infected bighorn sheep populations to improve their health and productivity. I have also worked on the health and productivity costs of *M. ovipneumoniae* in domestic sheep reservoir, and developed methods to eliminate this pathogen from domestic sheep operations.

10. I served as principal investigator of numerous individual and collaborative research projects looking at disease transmission to bighorn sheep

totaling over $700,000 since 2013. The funding sources for these projects included the U.S. Forest Service, the Idaho Wildlife Disease Research Oversight Committee, the Idaho Department of Fish and Game, the Washington Department of Fish and Wildlife, the Hells Canyon Initiative of Washington, Oregon, and Idaho, and both the national and numerous state chapters of the Wild Sheep Foundation.

11. I have published 361 research papers and 11 book chapters on various infectious disease, immunology, and diagnostic methods topics, including 25 papers on the diagnosis, pathophysiology, epidemiology, management, and control of bighorn sheep pneumonia. The bighorn sheep pneumonia papers where I served as first or senior author included[1]:

Association of Mycoplasma ovipneumoniae *infection with population limiting respiratory disease in free-ranging Rocky Mountain Bighorn Sheep* (Ovis canadensis canadensis) (2008).

Causes of Pneumonia Epizootics among Bighorn Sheep, Western United States, 2008-2010 (2012).

Survival of Bighorn Sheep Commingled with Domestic Sheep in the Absence of Mycoplasma ovipneumoniae (2012).

Bighorn sheep pneumonia: Sorting out the cause of a polymicrobial disease (2013).

Epizootic pneumonia of bighorn sheep following experimental exposure to Mycoplasma ovipneumoniae (2014).

[1] The full citations for these papers are found in my CV, attached to this declaration.

Immunogenicity of a Mycoplasma ovipneumoniae *bacteria for domestic sheep* (Ovis aries) (2014).

Comparison of two bacterial transport media for culture of tonsillar swab from bighorn sheep and mountain goats (2016).

Concordance in Diagnostic Testing for Respiratory Pathogens of Bighorn Sheep (2016).

Exposure of bighorn sheep to domestic goats colonized with Mycoplasma ovipneumoniae *induces sub-lethal pneumonia*. (2017).

Evidence for strain-specific immunity to pneumonia in bighorn sheep (2017).

Pneumonia in bighorn sheep: Risk and resilience. (2018).

A pilot study of the effects of Mycoplasma ovipneumoniae *exposure on domestic lamb growth and performance* (2019).

Risk factors and productivity losses associated with Mycoplasma ovipneumoniae *infection in United States domestic sheep operations* (2019).

Comparison of three methods of enumeration for Mycoplasma ovipneumoniae (2019).

Genetic structure of Mycoplasma ovipneumoniae *informs pathogen spillover dynamics between domestic and wild Caprinae in the western United States* (2019).

12. In addition, I contributed to other papers on bighorn sheep pneumonia as a co-author, which included:

Mycoplasma ovipneumoniae *can predispose bighorn sheep to fatal* Mannheimia haemolytica *pneumonia* (2010).

Use of exposure history to identify patterns of immunity to pneumonia in bighorn sheep (Ovis canadensis) (2013).

Pneumonia in Bighorn Sheep: Testing the Super-Spreader Hypothesis. (2015).

Age-specific infectious period shapes dynamics of pneumonia in bighorn sheep. (2017).

Detection of Mycoplasma ovipneumoniae *in Pneumonic Mountain Goat (*Oreamnos americanus*) Kids*. (2018).

Epidemic growth rates and host movement patterns shape management performance for pathogen spillover at the wildlife-livestock interface (2019).

Removal of chronic Mycoplasma ovipneumoniae *carrier ewes eliminates pneumonia in a bighorn sheep population.* (2020).

Restoration of a bighorn sheep population impeded by Mycoplasma ovipneumoniae *exposure.* (2020).

Previously Unrecognized Exposure of Desert Bighorn Sheep (Ovis canadensis nelsoni) to Mycoplasma ovipneumoniae *in the California Mojave Desert.* (2021).

13. I have given numerous presentations on bighorn sheep pneumonia and *Mycoplasma ovipneumoniae* at conferences, institutions of higher education, symposiums, colloquiums, workshops, and consortia both nationally and internationally. These include addresses presented at the following:

University of California (Davis CA, 2007).

Research Symposium: "Respiratory Disease in Wild and Domestic Sheep" hosted by the Association of State Wildlife Agencies (Salt Lake City, 2008).

Idaho collaborative working group on bighorn – domestic sheep (Boise, 2009).

WA/OR/ID Bighorn Sheep Disease Consortium (various, 2010, 2016, 2019).

Association for Veterinary Epidemiology and Preventive Medicine (Chicago, 2011).

Northern Wild Sheep and Goat Council (various, 2012, 2016, 2018, 2020).

Wild Sheep Working Group of the Western Association of Fish & Wildlife Agencies (Reno, 2013, 2015, 2019, 2020).

Wild Sheep Society of British Columbia (Cranbrook, 2013).

The Wildlife Society symposium on wildlife diseases (Charlotte, 2015).

Wallowa Whitman National Forest (Pendleton, 2015).

Okanagan Wenatchee National Forest (Ellensburg, 2016).

Oregon State University College of Veterinary Medicine (Corvallis, 2016).

Challis Sheep Producers (Challis, 2016, 2019).

University of Idaho Sheep Center Industry Advisory Board (Moscow, 2016).

Desert Bighorn Council (Borrego Springs, 2017).

American Society for Microbiology (New Orleans, 2017).

Midwest Wild Sheep Foundation chapter meeting (Minneapolis, 2017).

Wild Sheep Foundation Chapters and Affiliates (2017, 2018).

Ellensburg Sheep Producers (Ellensburg, 2018).

Desert Tortoise Council (Las Vegas, 2018).

Colorado Collaborative (Denver, 2019).

Montana WSF/DS collaborative meeting (Helena MT, February 2017).

Future Farmers of America state meetings in Washington and Idaho (Pullman WA and Moscow ID, 2018).

Hells Canyon area sheep and goat producers (Asotin, 2019).

NAPGA/WSF meeting on the Shoshone National Forest pack goat access issue (Spokane, August 2018).

14. I have also provided scientific opinions to the U.S. Forest Service in its development of management plans to reduce the risk of disease transmission from domestic sheep to bighorn sheep. These included a 2009 presentation to the agency that discussed transmission of pneumonia from domestic sheep to bighorn sheep, and a 2010 letter to the Payette National Forest explaining recent scientific research showing transmission of respiratory pathogens from domestic sheep to bighorn sheep.

II. Relevant Scientific Studies on Bighorn Sheep Disease.

15. My work on bighorn sheep pneumonia first addressed the question: What infection(s) cause bighorn sheep pneumonia outbreaks? Earlier work had identified many candidate pathogens that were found in bighorn sheep with pneumonia but had not clarified which infections caused the disease. My work targeting the cause of bighorn pneumonia resulted in two key papers.

16. First, in the paper, "Causes of pneumonia epizootics among bighorn sheep, Western United States, 2008-2010", we showed that the bacterium *Mycoplasma ovipneumoniae* was detected in nearly all bighorn sheep tested from eight different herds affected by pneumonia outbreaks but not found in the bighorn

sheep from the control healthy herds studied. No other pathogens had similarly high infection rates in pneumonic herds. Furthermore, our work identified single genetic strain types of *M. ovipneumoniae* involved within each outbreak. Many bacterial species exhibit minor changes in their DNA sequence as they evolve, and *M. ovipneumoniae* is more variable than most. This high variability provides a tool to researchers studying *M. ovipneumoniae* infections, because when it is directly transmitted from animal to animal, there is insufficient time for it to evolve and the DNA strain types match exactly, whereas when acquired from different sources differences in DNA sequences are expected. Therefore, the single strain types detected within outbreaks provide direct evidence that *M. ovipneumoniae* had spread directly from animal to animal as expected for the 'primary' pathogen driving the disease; none of the other candidate bacterial pathogen species showed this definite pattern of animal-to-animal spread.

17. Second, in the paper "Bighorn sheep pneumonia: sorting out the cause of a polymicrobial disease", we compared all the major candidate bighorn sheep pneumonia pathogens for how well they fit widely accepted epidemiological 'causal criteria', a powerful method to clarify complex questions of disease causality. The data summarized in this paper provided very strong support for *M. ovipneumoniae* as the causal agent of bighorn sheep epizootic pneumonia, while providing weak or no support for a causal role for all other candidate pathogens.

We now know that *M. ovipneumoniae* is the pathogen that triggers fatal bighorn sheep epizootic pneumonia outbreaks across the range of the species.

18. The genetic (DNA sequence-based) strain typing method described earlier also provided an explanation for a very important pattern that occurs repeatedly in bighorn sheep pneumonia: When previously healthy bighorn sheep herds first experience a pneumonia outbreak, the disease typically affects all age classes from lambs through adult animals. After these 'all-ages outbreaks' have waned, the surviving adults appear to recover to good health and have relatively normal life expectancies. However, for a period of years to decades afterwards, a different pattern of disease emerges, in which most or all lambs annually develop pneumonia, a pattern referred to as 'lamb pneumonia'.

19. Strain typing revealed that lamb pneumonia cases were infected by the same *M. ovipneumoniae* strain that had been introduced to trigger the earlier all-ages outbreak: A subset of the surviving, apparently healthy ewes continue to carry the outbreak strain in their noses and these chronic nasal carrier ewes serve as a source of the infection to lambs each year. The lamb infection quickly spreads to all lambs in the population, often triggering near 100% mortality before they reach 6 months of age. Herds affected by the lamb pneumonia pattern stagnate or decline in population numbers due to the lack of recruitment (sufficient lambs surviving the first year of life to replace normal adult death rates).

20. Another important aspect of bighorn sheep pneumonia is the spread of disease across metapopulations (groups of populations that are largely independent, but that are connected by occasional animal movements). A metapopulation structure generally adds greatly to the resilience of species like bighorn sheep, since local adverse events affecting one population are countered by animal movements from the other populations within the metapopulation. However, diseases like bighorn sheep pneumonia illustrate the downside of the metapopulation structure: if the animal moving between populations happens to be a chronic carrier of *M. ovipneumoniae,* it can trigger additional outbreaks across the metapopulation.

21. This pattern was clearly documented in the Hells Canyon metapopulation across the borders of Idaho, Washington, and Oregon: after the initial introduction of *M. ovipneumoniae* into northern Hells Canyon in 1995, 14 other populations in the metapopulation experienced disease from the same *M. ovipneumoniae* strain type between 1996 and 2013, due to movements of infected bighorn sheep through the canyon. From this and other examples, it is now clear that introduction of *M. ovipneumoniae* into one bighorn sheep population can trigger disease events in many other populations across long time periods.

22. Once the key role of *M. ovipneumoniae* in bighorn sheep pneumonia was clarified, the logical next question to address was: What is the source of *M.*

ovipneumoniae that infect bighorn sheep to trigger pneumonia outbreaks? We had previously shown that healthy bighorn herds (that is, those with no evidence of pneumonia) were free of this pathogen, based on both highly sensitive nasal swab PCR tests and on blood tests that indicated lack of previous exposure or infection. When some of those healthy, *M. ovipneumoniae*-negative herds subsequently experienced fatal pneumonia outbreaks, *M. ovipneumoniae* were invariably present, showing that the herd had recently become infected.

23. Using genetic strain typing of *M. ovipneumoniae*, we were able to demonstrate that some of those outbreaks were caused by *M. ovipneumoniae* known to be carried by other bighorn sheep herds within the metapopulation, and we concluded that those outbreaks resulted from infections carried by infected bighorn sheep from the source infected herd. However, most new bighorn sheep pneumonia outbreaks were caused by *M. ovipneumoniae* strains that were not carried by any bighorn herds within the region, and we concluded that these outbreaks resulted from contacts with other infected animal sources.

24. The most frequent and widespread *M. ovipneumoniae* infected animal sources are domestic sheep and domestic goats. *M. ovipneumoniae* was first discovered and characterized in domestic sheep, and subsequently it has been recognized as infecting and causing respiratory disease in both sheep and goats globally. *M. ovipneumoniae* is extremely common in domestic sheep: the USDA

National Animal Health Monitoring Service Sheep 2011 project, a national survey of domestic sheep operations, detected *M. ovipneumoniae* infections in approximately 90% of domestic sheep operations sampled, including in all operations larger than 500 head involved in the study.

25. We investigated the ability of *M. ovipneumoniae* carried by domestic sheep to cause bighorn sheep disease in the paper "Epizootic pneumonia of bighorn sheep following experimental exposure to *Mycoplasma ovipneumoniae"*, where we showed that *M. ovipneumoniae* carried by apparently healthy domestic sheep can infect and induce severe pneumonia in previously healthy bighorn sheep. These experiments also showed that domestic and bighorn sheep in proximity interacted readily, for example at feedbunks, water supplies, and bedding areas, including nose-to-nose contacts, such that direct contact transmission would be possible.

26. While *M. ovipneumoniae* has recently been reported in species other than sheep and goats (Caprinae), neither its ability to persist in these hosts for long periods of time, nor the ability of these non-Caprinae hosts to transmit the pathogen to bighorn sheep has been demonstrated, and the low carriage prevalence and the low genetic diversity of *M. ovipneumoniae* in non-Caprinae hosts are not consistent with them representing a separate reservoir for bighorn sheep infection. Together, these data show that domestic sheep, if present on the landscape

occupied by bighorn sheep, carry *M. ovipneumoniae* that represents a large risk for bighorn sheep infection and resulting pneumonia outbreaks. Domestic goats also pose a definite risk to bighorn sheep due to their *M. ovipneumoniae* reservoir status, although limited current data shows that goat sources tend to cause less severe and less persistent bighorn disease. In contrast, non-Caprinae species have not yet been shown to present any risk of transmitting *M. ovipneumoniae* to bighorn sheep.

27. *M. ovipneumoniae* infections from different sources can be identified and distinguished based on variation within their DNA sequences, as mentioned earlier. The DNA sequence-based molecular strain typing method (Multi-Locus Strain Typing, MLST) we developed for *M. ovipneumoniae* can be used to track spread of specific strains within and between bighorn sheep populations, and to identify potential sources of strains responsible for new bighorn pneumonia epizootics.

28. This method was first published in the paper entitled "Evidence for strain-specific immunity to pneumonia in bighorn sheep", which determined "…that introduction of a new genotype (strain) of *M. ovipneumoniae* into a chronically infected bighorn sheep population in the Hells Canyon region of Washington and Oregon was accompanied by adult morbidity (100%) and pneumonia-induced mortality (33%) similar to that reported in epizootics

following exposure of naïve bighorn sheep. This suggests an immune mismatch occurred that led to ineffective cross-strain protection." In this example, more than ten years after a severe pneumonia outbreak, the Black Butte bighorn herd exhibited the common 'lamb pneumonia' pattern where the ewes that survived the outbreak had recovered to apparent good health and a normal life expectancy, but included chronic nasal carriers of the original outbreak strain that when transmitted to lambs resulted in annual high lamb pneumonia mortality.

29. In this paper we documented introduction of a new *M. ovipneumoniae* strain that triggered a dramatic change in the pattern of disease: all adult ewes developed signs of pneumonia (morbidity) and 30% died (mortality). The lambs again experienced a fatal pneumonia outbreak, primarily triggered by lung infections with the newly introduced *M. ovipneumoniae* strain. The finding of lack of cross-strain immunity has since been repeated elsewhere, confirming that the limited immunity that bighorn sheep may develop to a strain of *M. ovipneumoniae* with which they have been infected for years fails to consistently protect them from genetically novel strains that they may encounter.

30. The MLST method was subsequently used for a much larger study of *M. ovipneumoniae* strain types that was published in the paper entitled "Genetic structure of Mycoplasma ovipneumoniae informs pathogen spillover dynamics between domestic and wild Caprinae in the western United States". That paper

concluded: "The genetic data identify domestic sheep as an infection reservoir with multiple and ongoing spillovers to bighorn sheep. Domestic goats are also a source of infection to bighorn sheep, but dynamics of spillover appear to differ from domestic sheep. Strain-sharing across bighorn sheep populations and between wild hosts suggests that, following spillover, pathogen persistence and host movements also contribute to pathogen spread. The ability for *M. ovipneumoniae* to persist and maintain virulence in the absence of spillover is unclear." In this context, 'spillover' refers to infections acquired by a susceptible host species (here, bighorn sheep) from an infected source of a different species (here, domestic sheep or goats).

31. The domestic sheep sampled in this study carried a very large diversity of *M. ovipneumoniae* strains, whereas the infected bighorn sheep herds typically carried only one or two strains. This diversity of strains within domestic sheep likely adds considerably to the risk posed by domestic sheep-bighorn sheep contacts due to the high likelihood that a genetic strain to which the bighorn sheep are not immune will be encountered. A final interesting finding from this study was that strains of *M. ovipneumoniae* carried by domestic sheep were clearly distinguishable from strains carried by domestic goats, indicating that the strain type analysis could indicate the likely source host of this pathogen.

III. Scientific Explanation of Risks to Bighorn Sheep from Domestic Sheep.

32. Bighorn sheep pneumonia occurs when *M. ovipneumoniae* infection is acquired by a susceptible bighorn sheep host following direct or close contact with another animal infected with viable *M. ovipneumoniae*. *M. ovipneumoniae* is unable to survive in the environment for more than a few minutes, so to become infected a susceptible animal must either directly contact the infected host (nose-to-nose contact) or be contacted by respiratory droplets within seconds after they are shed by the infected host (for example, immediately after the host coughs or sneezes).

33. Pathogen transmission is not visible, and its detection requires use of specific diagnostic tests; newly infected animals don't exhibit signs of the disease until after the incubation period. For *M. ovipneumoniae*, transmission is detectable by realtime PCR tests as soon as 24 hours after infection, but its relatively long incubation period means that a week or more must elapse before the newly infected animal begins exhibiting disease signs (nasal discharge, coughing, etc.). Death from pneumonia may occur from a few weeks to several months after pathogen transmission.

34. The delays between infection and disease onset, and between disease onset and death, make it impossible to identify the specific moment of transmission or the specific animals involved in a *M. ovipneumoniae* transmission event.

However, the MLST strain typing method that we have developed for *M. ovipneumoniae* offers an alternative method to determine the source when this pathogen is newly introduced into bighorn sheep, since finding that MLST strain in a host within or near the bighorn sheep range strongly suggests that the strain was transmitted from that source.

35. For example, given a new pneumonia outbreak in which *M. ovipneumoniae* is detected, the strain can be compared to *M. ovipneumoniae* strains found in potential sources in the region. If no regional bighorn herds carry the strain, then the source must be an infected individual of some other animal host. Potential source animals/herds can then be systematically screened for the outbreak strain. Using these methods, we have successfully identified the sources of *M. ovipneumoniae* strains that were transmitted from domestic sheep and domestic goats, under range conditions, that resulted in bighorn sheep pneumonia outbreaks. This approach offers good potential to clarify the pathogen sources that cause bighorn sheep pneumonia outbreaks; however, it is laborious, time-consuming, and expensive, and dependent on the willingness of the owners of potential pathogen sources to permit sampling and typing of the strains of *M. ovipneumoniae* carried by their animals.

36. *M. ovipneumoniae* induces disease indirectly; the infection damages the muco-ciliary clearance defense mechanisms that normally clears small numbers

of inhaled bacteria from the mouth and throat. In the presence of *M. ovipneumoniae* infection, these inhaled bacteria are not cleared but instead infect and multiply in the lung tissues and airways, and it is these multiple secondary infections that cause severe disease or death. The severity and course of the disease within an individual infected bighorn sheep result from the extent, diversity, and virulence of the secondary infections that occur, and these vary from animal to animal.

37. As discussed above, bighorn sheep that do not die during a pneumonia outbreak return to apparent good health over the subsequent months but may carry *M. ovipneumoniae* for long periods in their nasal passages. In some herds these persistently shedding individuals serve as a source of infection to lambs born in subsequent years, triggering annual pneumonia outbreaks that may kill a high percentage of the lambs for years or even decades after the initial outbreak. It is now clear that such recurrent lamb pneumonia outbreaks may threaten extirpation of the affected bighorn sheep herds, as the herds are unable to produce enough offspring to recover from the disease event. In addition, carriers of *M. ovipneumoniae* may infect other bighorn herds during movements within metapopulations.

38. After decades of research to clarify this complex disease, the risk posed by pneumonia outbreaks to bighorn sheep populations is now recognized to

flow directly from the infection of the bighorn sheep population with *M. ovipneumoniae* from another animal host. Such infections are relatively infrequent, as a series of uncommon events must occur for pathogen spillover to occur. However, if sources of infection are prevalent within or near the bighorn home ranges, the risk of infection is cumulative across years. When I began studying bighorn sheep pneumonia, the three bighorn herds in the Yakima WA area (Umtanum, Tieton, and Cleman Mountain) were all free of *M. ovipneumoniae* and lacked evidence of significant respiratory disease. Since then, Umtanum was infected with *M. ovipneumoniae* in 2009, Tieton in 2013, and Cleman Mountain in 2020.

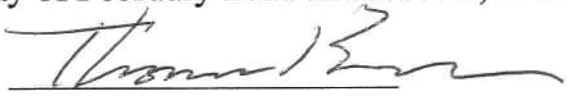
39. These outbreaks differed in their severity, and each was associated with a different genetic strain type of *M. ovipneumoniae*. All three of the outbreak-associated strain types belonged to the group of strain types typically detected in domestic sheep, rather than domestic goats. None of the *M. ovipneumoniae* genetic strain types associated with these outbreaks had previously been detected in any bighorn sheep population anywhere in western North America, ruling out bighorn sheep to bighorn sheep transmission as the source of infection of these herds. Together, these three outbreaks indicate a high regional risk of spillover *M. ovipneumoniae* transmission to bighorn sheep, suggesting that increased efforts to

remove sources of this pathogen will be required to permit recovery of these regional bighorn sheep populations.

40. In conclusion, over the last decade the science around pneumonia infections of bighorn sheep has evolved significantly. It has established that *M. ovipneumoniae* is the agent that causes respiratory disease episodes in bighorn populations, and that many strains of *M. ovipneumoniae* exist such that infection with one strain will not prevent future infection by another strain. Domestic sheep carry many strains of *M. ovipneumoniae* and together with domestic goats are the most likely source of transmission to bighorn sheep. Because of the potential for a significant die-off within an infected bighorn herd, spread of disease to other herds, and long-lasting impacts on lamb recruitment within infected populations, the consequences of *M. ovipneumoniae* transmission from a domestic sheep to a bighorn sheep are severe. Such consequences are evident in the three Yakima area bighorn herds, which all have experienced infection of *M. ovipneumoniae* from domestic sheep and could experience further disease impacts from future transmission from domestic sheep or goats within or near their home ranges.

Pursuant to 28 U.S.C. § 1746, I declare under penalty of perjury that the foregoing is true and correct.

Signed this 26th day of February 2021 in Moscow, Idaho.



Thomas Besser

EXHIBIT 10

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Evidence for strain-specific immunity to pneumonia in bighorn sheep: Immunity in Bighorn Sheep

Article *in* Journal of Wildlife Management · September 2016

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Research Article

Evidence for Strain-Specific Immunity to Pneumonia in Bighorn Sheep

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ABSTRACT Transmission of pathogens commonly carried by domestic sheep and goats poses a serious threat to bighorn sheep (*Ovis canadensis*) populations. All-age pneumonia die-offs usually ensue, followed by asymptomatic carriage of *Mycoplasma ovipneumoniae* by some of the survivors. Lambs born into these chronically infected populations often succumb to pneumonia, but adults are usually healthy. Surprisingly, we found that introduction of a new genotype (strain) of *M. ovipneumoniae* into a chronically infected bighorn sheep population in the Hells Canyon region of Washington and Oregon was accompanied by adult morbidity (100%) and pneumonia-induced mortality (33%) similar to that reported in epizootics following exposure of naïve bighorn sheep. This suggests an immune mismatch occurred that led to ineffective cross-strain protection. To understand the broader context surrounding this event, we conducted a retrospective analysis of *M. ovipneumoniae* strains detected in 14 interconnected populations in Hells Canyon over nearly 3 decades. We used multi-locus sequence typing of DNA extracts from 123 upper respiratory tract and fresh, frozen, and formalin-fixed lung samples to identify 5 distinct strains of *M. ovipneumoniae* associated with all-age disease outbreaks between 1986 and 2014, a pattern consistent with repeated transmission events (spillover) from reservoir hosts. Phylogenetic analysis showed that the strain associated with the outbreak observed in this study was likely of domestic goat origin, whereas strains from other recent disease outbreaks probably originated in domestic sheep. Some strains persisted and spread across populations, whereas others faded out or were replaced. Lack of cross-strain immunity in the face of recurrent spillovers from reservoir hosts may account for a significant proportion of the disease outbreaks in bighorn sheep that continue to happen regularly despite a century of exposure to domestic sheep and goats. Strain-specific immunity could also complicate efforts to develop vaccines. The results of our study support existing management direction to prevent contacts that could lead to pathogen transmission from domestic small ruminants to wild sheep, even if the wild sheep have previously been exposed. Our data also show that under current management, spillover is continuing to occur, suggesting that enhanced efforts are indicated to avoid introducing new strains of *M. ovipneumoniae* into wild sheep populations. We recommend looking for new management approaches, such as clearing *M. ovipneumoniae* infection from domestic animal reservoirs in bighorn sheep range, and placing greater emphasis on existing strategies to elicit more active cooperation by the public and to increase vigilance on the part of resource managers. © 2016 The Wildlife Society.

KEY WORDS bighorn sheep, disease ecology, Hells Canyon, livestock-wildlife interface, molecular epidemiology, multi-locus sequence typing, *Mycoplasma ovipneumoniae*, *Ovis canadensis*.

Pneumonia in bighorn sheep (*Ovis canadensis*) is a population-limiting disease associated with transmission of pathogens from domestic sheep and goats (Foreyt and Jessup 1982, Besser et al. 2013, Cassirer et al. 2013). As with many other wildlife diseases, a lack of comprehensive, system-specific information hampers disease management (Besser et al. 2013, Joseph et al. 2013). Limiting contact with domestic sheep and goats is the primary strategy for preventing disease emergence in bighorn sheep (Western Association of Fish and Wildife Agencies Wild Sheep Working Group 2012, The Wildlife Society 2015). Although currently the best management option available, implementation is politically and logistically difficult because of the natural movements of wild animals, unregulated presence of domestic sheep and goats on private lands, and concerns by the livestock industry about losing access to public grazing allotments. Reliable knowledge about health

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threats and potential solutions will help wildlife and land managers make appropriate risk management decisions that will succeed in resolving the problem of pneumonia in bighorn sheep.

Based on the hypothesis that *Mannheimia haemolytica* expressing leukotoxin is the key causal pathogen, researchers have tested numerous vaccines to boost immunity to disease in bighorn sheep. However, so far no vaccine has protected wild sheep commingled with domestic sheep or goats in captive settings or shown potential for efficacy in free-ranging animals (Callan et al. 1991, Kraabel et al. 1998, Cassirer et al. 2001, Subramaniam et al. 2011, Sirochman et al. 2012). There may be several reasons for the elusiveness of an effective vaccine. First, there is a basic question as to the role of *M. haemolytica* in the disease (Besser et al. 2013) and second there are significant technical difficulties associated with vaccine development and application. Experimental challenge with leukotoxin-positive *M. haemolytica*, a well-described respiratory pathogen in domestic ruminants, is lethal to bighorn sheep in captivity (Foreyt et al. 1994, Dassanayake et al. 2009). However, *M. haemolytica* is only weakly associated with pneumonia epizootics in free-ranging bighorn sheep populations (Besser et al. 2012*b*). The pathology, microbiology, and the course of disease experimentally induced with *M. haemolytica* also do not match observations from the field (Besser et al. 2014). Recently, application of sensitive molecular diagnostic techniques on high quality samples led to identification of *Mycoplasma ovipneumoniae*, a previously overlooked bacterium, as the pathogen most strongly supported as a primary causal agent of pneumonia in bighorn sheep (Besser et al. 2008, 2012*a*, *b*).

M. ovipneumoniae is host-specific to Caprinae, and is frequently carried asymptomatically by domestic sheep and goats (Martin and Aitken 2000). When introduced into naïve bighorn sheep populations, outbreaks of polymicrobial pneumonia ensue, sometimes resulting in high mortality in all age classes (Besser et al. 2008, 2014). After all-age pneumonia outbreaks, surviving adults usually maintain good health and normal life spans, although some individuals chronically carry *M. ovipneumoniae* in their upper respiratory tract (Besser et al. 2013). Both carriers and non-carriers are resistant to disease although this protection fails to prevent epizootics in lambs (Plowright et al. 2013, Manlove et al. 2016).

M. ovipneumoniae is also associated with mild and transient respiratory disease, usually in juveniles, in its normal domestic sheep and goat hosts (DaMassa et al. 1992, Martin and Aitken 2000). However, several investigators have reported that *M. ovipneumoniae* infections in domestic sheep and goats can cause severe pneumonia, particularly when multiple strains are present (Parham et al. 2006, Rifatbegović et al. 2011). This could be linked to a strain-specific immune response that fails to provide universal protection. Many pathogens are able to evade host immune responses by expressing a diversity of surface-exposed targets for neutralizing antibodies. From influenza virus to *Mycoplasma* spp., antigenic variation within and across strains enables immune escape by pathogens and also complicates development of vaccines (Citti et al. 2010, Vink et al. 2012, Quiñones-Parra et al. 2014).

We documented the effects of invasion of a novel strain of *M. ovipneumoniae* into a group of free-ranging bighorn sheep that had harbored adult carriers for nearly 20 years following an all-age pneumonia outbreak (Cassirer et al. 1996, Plowright et al. 2013). Our expectation was that these adults were immune to the pathogen and that invasion of a new strain would not cause disease.

STUDY AREA

We conducted this study near Heller Bar at the mouth of the Grande Ronde River in Asotin County, Washington, USA (46.079° N, −116.986° W). The area was located in low elevation (250–1,250 m) canyon grasslands and cliffs along the breaks of the Grande Ronde and Snake Rivers on the northern edge of Hells Canyon. Summers were hot ($\bar{x}$ highs in Jul and Aug = 26–32° C) and winters were mild ($\bar{x}$ lows in Dec and Jan = −2 to 2° C). Average annual precipitation was 31 cm. July and August were the driest months and peak precipitation occurred in May. Plant associations were dominated by perennial bunchgrass (*Pseudoroegneria spicata* and *Festuca idahoensis*) communities, with deciduous riparian shrub stringers and upland shrub-fields. Douglas-fir (*Pseudotsuga menziesii*) and ponderosa pine (*Pinus ponderosa*) stands occurred on northerly aspects. In addition to bighorn sheep, common ungulates in the study area included mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), and elk (*Cervus elaphus*). Potential predators of bighorn sheep included cougars (*Felis concolor*), bobcats (*Lynx rufus*), coyotes (*Canis latrans*), wolves (*C. lupus*), and black bears (*Ursus americanus*). Over 50% of the area was publicly owned and managed by federal and state agencies chiefly for wildlife, recreation, and seasonal (spring) cattle grazing. A low density, unincorporated rural community was scattered on adjoining private rangelands at the mouth of the Grande Ronde River and along the adjacent Snake River.

Following extirpation in the early 1900s, the Washington Department of Fish and Wildlife reintroduced bighorn sheep to the Joseph Creek Wildlife Area near Heller Bar. Between 1977 and 1989, 39 sheep were translocated from Washington, Oregon, and Montana to establish the Black Butte population (Johnson 1995). This became one of 16 interconnected populations that comprise the Hells Canyon bighorn sheep metapopulation. The Black Butte population increased to approximately 215 animals before a pneumonia outbreak occurred in 1995; 70% of the sheep died or were transferred to captivity in an attempt to stop the epidemic (Cassirer et al. 1996). The source of the outbreak was thought to be domestic sheep or goats on private lands within the Black Butte bighorn sheep population range (Rudolph et al. 2003). The population never recovered because of chronically low recruitment due to pneumonia-induced mortality in lambs (Plowright et al. 2013). By 2013, only 36 bighorn sheep were observed in surveys, and the population was estimated at 45 (Cassirer et al. 2013, Washington Department of Fish and Wildlife, unpublished data). Three

spatially distinct female groups occur in the population: Heller Bar, Shumaker, and Joseph Canyon. The groups are connected by movements of males, but we observed no female interactions across groups during this study. The Heller Bar female group was most accessible from the road and was the subject of this investigation.

METHODS

Observations

We monitored the Heller Bar female group during 2013 and 2014 as part of a study of contact patterns and lamb survival. We could individually identify 4 (31%) and 11 (85%) of the 13 adult females in 2013 and 2014, respectively, by numbered ear tags and color-coded and numbered very high frequency (VHF) radio-collars. One unmarked female was missing a horn, so all 13 sheep were individually identifiable in 2014. We located marked animals from the ground by radio-telemetry and then observed them through binoculars and a spotting scope. We conducted frequent and intensive observations between 1 May and 16 July to document productivity and neonatal survival (2013 median observation interval = 4 days, median duration of each observation = 3 hr; 2014 median observation interval = 1.5 days, median duration = 2 hr). Frequency of observation from 17 July through 26 August was every 10 days in 2013 and every 5 days in 2014, and from 26 August through the first week in October we observed the sheep once a month in 2013 and every 10 days in 2014. Median duration of observations from 17 July through October was 1 hour in both years. At each observation we recorded female and lamb health and behavior. Animals observed with nasal discharge, droopy ears, head shaking, or lethargy received a clinical score of 1, and animals observed coughing received a clinical score of 2. Sheep with no evidence of disease received a clinical score of 0.

Radio-collars on adults were equipped with a switch that triggered a fast pulse mortality signal if no movement was detected for 4 hours. We conducted site investigations, and where possible, retrieved carcasses whole when mortalities were detected. Where this was not possible, we conducted field necropsies and collected the head, the respiratory tract, and grossly abnormal tissues when available. We detected lamb mortalities through observation and retrieved whole dead lambs when autolysis was not too advanced for diagnostic testing (Cassirer and Sinclair 2007). We assigned lamb mortality dates as the midpoint between the last live observation and either the date when the carcass was found, or the date when the dam was first observed without a lamb if no carcass was located. We assumed a female had lost her lamb when it was found dead or when the number of lambs declined and she was never again observed with a lamb that year. All cadavers and tissues were submitted to the Washington Animal Disease and Diagnostic Laboratory (WADDL; Pullman, WA, USA) for analysis.

Health Sampling

We captured and sampled females in February ($n = 11$ of 13) and July ($n = 2$ of 11) 2014. In October 2014, we resampled all 8 remaining sheep when we transferred them to captivity. We conducted captures via helicopter netgun and by darting from the ground with chemical immobilizing agents. All capture and handling followed animal care protocols approved by the Washington Department of Fish and Wildlife. Sampling entailed collecting throat swabs and placing them in buffered glycerol or Port-a-cul transport media (Becton, Dickinson, and Company, Franklin Lakes, NJ, USA, #220144, #221606) for aerobic culture to detect Pasteurellaceae, swabbing nasal passages and placing swabs in mycoplasma broth (#102, Hardy Diagnostics, Santa Maria, CA, USA) for culture enrichment and polymerase chain reaction (PCR) detection of *M. ovipneumoniae* (Ziegler et al. 2014), and collection of serum for detection of antibodies to *M. ovipneumoniae* (competitive enzyme-linked immunosorbent assay [ELISA]), bovine respiratory syncytial virus (virus neutralization [VN]), bovine virus diarrhea (VN), infectious bovine rhinotracheitis (VN), and bovine parainfluenza-3 (PI-3, VN). Diagnostic testing on the above samples was conducted by WADDL.

We also collected upper respiratory washes by flushing nasal passages with 50 ml of phosphate-buffered saline and swabbed the oropharynx. We kept samples cool and processed them within 48 hours of collection, or stored them at -20° C. We extracted DNA (DNeasy, Qiagen, Redwood City, CA, USA) from swabs, from 10-ml aliquots of nasal wash, and from lung tissues of animals that died during the study as well as 2 pneumonic lambs that died in adjacent populations in 2013 to test for presence of pneumonia agents. We used a multiplex PCR to detect Pasteurellaceae including *Bibersteinia trehalosi*, *Pasteurella multocida*, and *Mannheimia* spp. (Besser et al. 2012*b*) and performed PCR for *lktA*, the gene encoding leukotoxin A, the major virulence factor of *Mannheimia* spp. and *B. trehalosi* (Walsh et al. 2016). If an agent was detected by either PCR or culture on any sample, we classified the animal as positive for that agent.

Strain Typing

Health of the Hells Canyon bighorn sheep metapopulation has been intensively monitored since the 1995 pneumonia outbreak in the Black Butte population, and intermittently prior to this. Therefore, we had access to fixed, frozen, and fresh lung tissue and swab samples collected from 1995–2015 in the Heller Bar female group and from 1986–2015 in adjacent female groups and populations. We extracted DNA from a subset of these sources to detect and strain type *M. ovipneumoniae* within the study population and the metapopulation through time. Detection was based on conventional (McAuliffe et al. 2003) and realtime (Ziegler et al. 2014) PCR.

We used multi-locus sequence typing (MLST) to characterize strains using partial DNA sequences of the 16S-23S intergenic spacer region (IGS), the small ribosomal subunit (16S), and the genes encoding RNA polymerase B (*rpoB*) and gyrase B (*gyrB*). We amplified these targets with PCR using a suite of existing and newly developed primers (Table 1). Because of the high degree of DNA sequence

Table 1. Oligonucleotide primers for polymerase chain reactions (PCR) used to amplify *Mycoplasma ovipneumoniae* multi-locus sequence typing (MLST) targets. Nesting refers to external and internal primer sets used for nested PCR reactions for amplification of the MLST loci, IGS, *rpoB*, and *gyrB,* when amplification from the default (internal) primers produced insufficient DNA template for sequencing.

Target[a]	Nesting	Oligonucleotide primer sequence	Reference
LM-F		TGAACGGAATATGTTAGCTT	McAuliffe et al. (2003)
LM-R		GACTTCATCCTGCACTCTGT	McAuliffe et al. (2003)
Ex-IGS-F	External	GTTAACCTCGGAGACCATTG	This paper
Ex-IGS-R	External	GTTTGCTAGGTTGGGTTTCC	This paper
IGS-F	Internal	GGAACACCTCCTTTCTACGG	Besser et al. (2012*b*)
IGS-R	Internal	CCAAGGCATCCACCAAATAC	Besser et al. (2012*b*)
Ex- *rpoB* −F	External	AGTTATCACAATTTATGGATCAAA	This paper
Ex- *rpoB* −R	External	GCTCAAAGTTCCATTTCNCCGAA	This paper
rpoB −F	Internal	TCGGCTTCAGCAATTCCTTTCTT	This paper
rpoB −R	Internal	TCGGCTGTTGGGTTGTCTTCTC	This paper
Ex- *gyrB* −F	External	AAAACGWCCAGGKATGTATATTGG	This paper
Ex- *gyrB* −R	External	GGATCCATTGTTGTTTCTCATAATTG	This paper
gyrB −F	Internal	GGGTCAAACAAAAGCAAAACTAAA	This paper
gyrB −R	Internal	ACGGAATAAAAATGTCAAAAGTAA	This paper

[a] LM = small ribosomal subunit (16S) gene, IGS = 16S-23S intergenic spacer, *rpoB* = β subunit of RNA polymerase gene, *gyrB* = gyrase B gene, F = Forward, R = Reverse.

variation in *M. ovipneumoniae*, the biggest challenge in developing this ensemble of loci was identification of targets with sufficiently conserved primer binding site sequences to enable consistent PCR amplification for subsequent sequencing. The loci selected for this study each exhibited extensive sequence polymorphism and together provide a highly discriminatory test. We typed the concatenated sequences using multi-locus sequence analysis because of the large numbers and diversity of the alleles detected at each target locus. We aligned sequences using Clustal Omega (http://www.ebi.ac.uk/Tools/msa/clustalo/, accessed 06 Sep 2016). We report sequence divergence as the percentage non-identity.

All PCR protocols included a preliminary dissociation phase (95° C, 15 min), amplification, and a final extension phase (72° C, 7 min). We amplified the 16S target using 35 cycles of 30 seconds each of dissociation (95° C), annealing (58° C), and extension (72° C). We amplified the IGS target using 35 cycles of dissociation (95° C, 1 min), annealing (52° C, 2 min), and extension (72° C, 2 min). For nested IGS amplification, the parameters for the external primers were identical except that the annealing temperature was 54° C. For *rpoB* and *gyrB*, we used inner and nested reactions with identical amplification conditions: dissociation (95° C, 1 min), annealing (50° C, 1 min), and extension (72° C, 2 min). We treated the extracts with alkaline phosphatase and exonuclease I (FastAP and ExoI, ThermoFisher Scientific, Waltham, MA, USA) according to the manufacturer's instructions. We submitted extracts to Amplicon Express (Pullman, WA, USA) to determine forward and reverse DNA sequences using the same primers used for PCR amplification. Representative sequences of all 4 target loci for the gentoypes herein are available in Genbank: strain 393 (KU986495, KU986500, KU986503, KU986506, representing IGS, 16S, *rpoB*, and *gyrB*), strain 404 (KU986496, KU986501, KU986504, KU986507), strain 415 (KU986494, KU986499, KU986502, KU986505), strain 402 (KU986493, KU986498, representing IGS and 16S), and strain 419 (KU986492, KU986497).

Statistical Analysis

We used a Kaplan–Meier staggered entry estimator and a Cox proportional hazard model to analyze survival of females and lambs. We fit trend lines to 7-day moving averages of clinical scores using a lowess smoothing factor derived from locally weighted moving mean scores spanning 25% of the full dataset (2–3 weeks). We used a Fisher's exact test to analyze prevalence of pneumonia agents before, during, and after the outbreak and to compare agents present in adult and lamb mortalities. We used a Kruskal–Wallis rank-sum test to determine whether neutralizing titers to PI-3 differed before, during, and after the outbreak. We used a 1-way analysis of variance (ANOVA) and Tukey contrasts to test for differences in serologic antibody titers to *M. ovipneumoniae* over the course of the outbreak and a 2-sided *t*-test to compare pre-outbreak antibody titers to *M. ovipneumoniae* in animals that died and those that survived. We used a Wilcoxon rank sum test with continuity correction to analyze duration of clinical signs. We conducted analyses with package survival (Therneau 2015), and stats and base packages in R (R Core Team 2015).

RESULTS

Survival and Clinical Signs of Disease

In 2013, we observed all marked females with lambs, and median parturition date was 18 May (range = 5–20 May). In 2014, we observed 10 of 13 females with live lambs and median parturition date was 8 May (range = 27 Apr–17 May). One marked female and her lamb died, presumably of dystocia, on 16 May 2014 (e5 and L5, Fig. 1a), 1 marked female was observed with a dead 2-day old lamb (e10, Fig. 1a), and 1 unmarked female appeared to be pregnant but was never observed with a lamb (e22, Fig. 1a).

We observed clinical signs of pneumonia in lambs starting 1 June in 2013 and 26 May in 2014. Symptoms continued until the day the last lamb died, which was 30 June in 2013, and 2 July in 2014 (Fig. 1). Median lamb mortality date was 28 June in 2013 and 24 June in 2014, at a median age

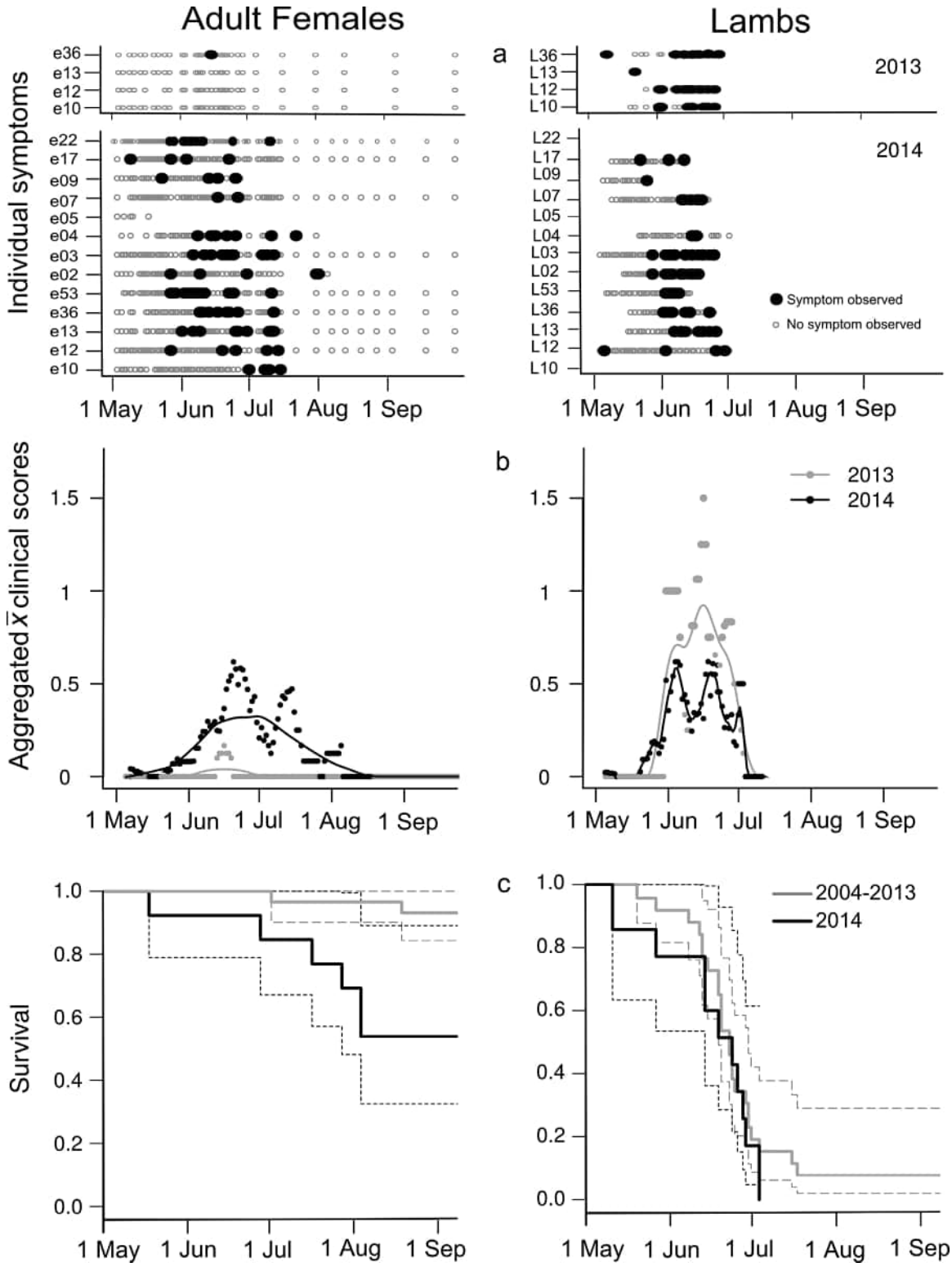


Figure 1. Clinical signs of pneumonia and survival of bighorn sheep in the Black Butte, Washington population during summers 2013 ($n = 4$ adult F and 4 lambs) and 2014 ($n = 13$ adult F and 10 lambs). (a) Time series of field observations of pneumonia symptoms in adult females (e) and their lambs (L). Observations ending prior to September indicate individual died. (b) Smoothed average daily clinical scores for adult females and lambs. (c) Adult female and lamb survival between May and October 2014 and survival between May and October during the 10 previous years, 2004–2013 (Kaplan–Meier curves and 90% CIs).

of 40 and 44 days, respectively. All lambs died both years and there were no differences in lamb survival curves between years (log $\text{rank}_1 = 0.01$, $P = 0.92$) or between 2014 and the previous 10 years (Fig. 1c). We submitted 11 lambs for necropsy (6 in 2013 and 5 in 2014). With the exception of 1 lamb that died at approximately 2 days of age in 2014 (L10, Fig. 1a), all lambs presented characteristic lesions of bighorn lamb respiratory disease, including moderate to

Table 2. Prevalence of *Mannheimia* spp. (Mh), *Bibersteinia trehalosi* (Bt), *Pasteurella multocida* (Pm), Pasteurellaceae leukotoxin encoding gene (*Lkt*A), and *Mycoplasma ovipneumoniae* (*Movi*) in asymptomatic bighorn sheep females (F) sampled before and after a pneumonia outbreak, symptomatic females during the outbreak, and in the lungs of pneumonic females that died in the Black Butte population and pneumonic lambs that died in Black Butte, (10) and adjacent populations (2), Washington and Oregon, USA.

Agent	F before ($n = 11$)	F during (symptomatic) ($n = 2$)	F pneumonia mortalities ($n = 3$)	Lamb pneumonia mortalities ($n = 12$)	F after ($n = 8$)
Mh	0.91	1.00	0.00	0.70	0.75
Bt	0.82	1.00	1.00	0.80	1.00
Pm	0.73	1.00	1.00	0.10	1.00
*Lkt*A	0.27	0.50	0.33	0.50	0.38
Movi	0.09	1.00	1.00	1.00	0.13

severe, subacute to chronic bronchopneumonia and otitis media.

Median age at first observation of clinical signs in lambs was 20 days (range: 7–35), median duration of clinical signs was 22 days (range: 1–59), and median age at death was 42 days (range: 22–66). Assuming that lambs were infected by 4 days of age and lung lesions were present by 10 days of age (Besser et al. 2008), we estimated a median latent period of 16 days (range: 3–31) between infection and first observation of disease symptoms in lambs and a median infection period of 38 days (range: 18–62) prior to death.

In adults, the only evidence of possible respiratory disease in 2013 was a single observation of coughing on 14 June, and all adults survived. In 2014, we observed clinical signs of pneumonia in adults starting in May. By June, all adults exhibited symptoms of pneumonia including severe prolonged coughing (Fig. 1a and b). Five adult females (38%) died between May and August 2014 (difference between summers, log $\text{rank}_1 = 5.98$, $P = 0.01$) and the hazard of an adult female dying in the summer of 2014 was 6.83 times higher (SE = 0.83, $P = 0.02$) than in any of the previous 10 summers (2004–2013, Fig. 1c). We did not observe pneumonia symptoms prior to the first adult death on 16 May 2014. Subsequent mortalities followed observation of clinical signs of pneumonia and occurred on 26 June, 18 July, 27 July, and 3 August (Fig. 1a). Median duration of clinical signs was 36 days (range = 18–81 days), which was longer than observed in lambs (median = 22 days, range = 1–59, W = 136.5, $P < 0.001$). Duration of clinical signs did not differ between adults that died and those that survived (Fig. 1a, Wilcoxon rank sum W = 20, $P = 1.0$). We submitted samples to WADDL from all (4 of 5) mortalities where sufficient tissues were available for diagnosis. No gross or histological evidence of respiratory disease was found in the female that died on 16 May, although evaluation of tissues at WADDL was limited because of autolysis. The 3 adult females submitted for necropsy between late June and early August were diagnosed with chronic, moderate to severe bronchopneumonia. The survivors appeared to make a full recovery with no evidence of ongoing disease.

Microbiology and Immune Responses

M. ovipneumoniae was the only pneumonia agent detected more frequently in the lungs of adults that died of pneumonia than in the upper respiratory tract of healthy adults before and after the outbreak ($\chi_1^2 = 26.66$, $P < 0.001$; Table 2). Prevalence of other suspected pneumonia agents in the upper respiratory tract of symptomatic adults sampled during the outbreak was similar to that detected in the lungs of adults that died of pneumonia except that *Mannheimia* spp. were detected in the upper respiratory tract of live adults but not in the lungs of adults that died. We found no differences in prevalence of pneumonia agents present in upper respiratory tract samples collected before and after the outbreak ($\chi_1^2 < 2.6$, $P > 0.2$) or in the lungs of lambs that died in 2013 and 2014 ($\chi_1^2 < 0.39$, $P > 0.5$). Detection of *Mannheimia* spp. was more common in lamb mortalities than in adult mortalities ($\chi_1^2 = 4.55$, $P = 0.07$), and *P. multocida* was more frequently detected in the lungs of dead adults than lambs ($\chi_1^2 = 8.78$, $P = 0.01$; Table 2).

We detected serologic evidence of exposure to PI-3 (VN titer ≥ 4) and *M. ovipneumoniae* (ELISA inhibition > 50%) in adults before, during, and after the 2014 pneumonia outbreak. We did not detect evidence of exposure to other respiratory viruses during the study. Average *M. ovipneumoniae* ELISA percent inhibition (%I) values prior to the outbreak (69%) increased significantly to 89%I and 82%I during and after the disease event, respectively ($F_{2,18} = 4.811$, $P = 0.02$; Fig. 2a). Individuals that died during the outbreak had higher *M. ovipneumoniae* ELISA % I values prior to the outbreak ($\bar{x} = 79\%$) than those that survived ($\bar{x} = 59\%$, $t_{7.5} = 3.02$, $P = 0.02$; Fig. 2b). Median PI-3 titers of 256 ($\log_2 7.7$) did not change significantly over the course of the outbreak ($\chi^2_2 = 4.55$, $P = 0.23$).

Strain Typing

We genotyped *M. ovipneumoniae* from all Heller Bar bighorn sheep where it was detected in 2013 ($n = 7$) and 2014 ($n = 11$). We found a single strain in 2013 based on identical DNA sequences of each of the 4 MLST loci, and that strain was also detected in the first lamb to die of pneumonia in 2014. All subsequent detections of *M. ovipneumoniae* differed from the 2013 strain at 3 MLST loci. The IGS sequences differed by 32 single nucleotide polymorphisms (SNP) and 3 base insertions or deletions (indels, 8.7% divergent), *rpoB* by 16 SNP (2.8% divergent) and *gyrB* by 16 SNP (4% divergent). The 16S sequences did not differ between strains.

We report strain differences by IGS sequences because we were unable to amplify *rpoB* and *gyrB* from DNA extracted

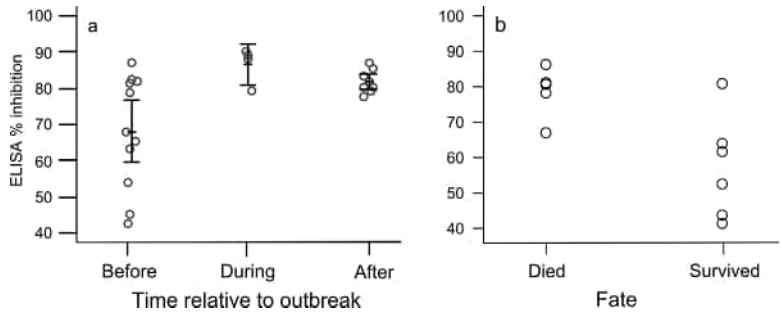


Figure 2. Serologic titers (competitive enzyme-linked immunosorbent assay [ELISA]) to *Mycoplasma ovipneumoniae* in bighorn sheep in Black Butte, Washington, February–October 2014. (a) Mean and 90% confidence intervals before, during, and after a pneumonia outbreak. (b) Antibody titer levels before the outbreak in adults that survived ($\bar{x} = 59\%$) and those that died ($\bar{x} = 79\%$).

from formalin-fixed, paraffin-embedded lung tissues, the only specimens available prior to 2006. Because each of these strains differed by indels in IGS, the strains are conveniently designated by their differing IGS lengths. The 2013 Black Butte strain, IGS 404, has been detected in this population since the 1995 pneumonia outbreak (Fig. 3b). The 2014 strain, IGS 393, had never previously been detected in this population or any other bighorn sheep population in Hells Canyon or elsewhere in the western United States (among >700 other isolates that have been IGS typed).

In October 2014, we removed survivors from the Heller Bar female group in an attempt to prevent further spread of this strain. Nonetheless, 1 month after the removal, we detected the IGS 393 strain type in an adult male removed from the town of Asotin, Washington and we detected it again 4 months later in a 9-month-old lamb in the Shumaker female group, located between the Joseph and Heller Bar

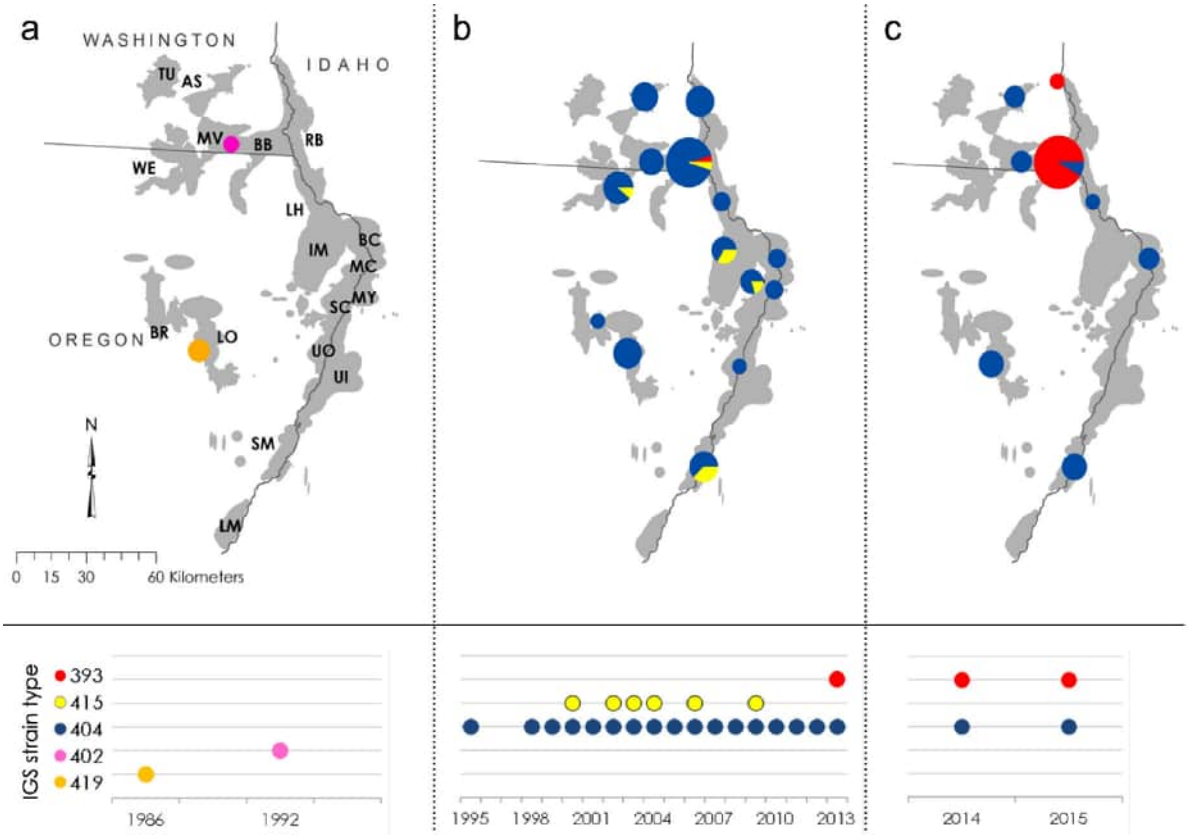


Figure 3. Spatiotemporal distribution of the 16S-23S intergenic spacer (IGS) genotypes of *Mycoplasma ovipneumoniae* in the Hells Canyon bighorn sheep metapopulation in Washington, Oregon, and Idaho, USA in (a) 1986 and 1992 (b) 1995–2013; and (c) 2014–2015. Each colored marker represents one strain type, pie charts display strain types within populations and are scaled by sample size. Pie charts containing >1 color indicate that 2 strain types were present in a population during that time interval but not necessarily detected in the same year. Gray shaded polygons denote bighorn sheep populations: AS = Asotin, BB = Black Butte, BC = Big Canyon, BR = Bear Creek, IM = Imnaha, LH = Lower Hells Canyon, LM = Lookout Mountain, MU = Muir, MV = Mountain View, MY = Myers Creek, RB = Redbird, SM = Sheep Mountain, TU = Tucannon, UO = Upper Hells Canyon, Oregon, UI = Upper Hells Canyon Idaho.

groups in the Black Butte population. Retrospective analysis revealed that this strain was present in the lungs of a male that died of pneumonia in the Joseph Creek group in December 2013, representing the index case of disease associated with the IGS 393 strain type. The IGS 393 strain has not been detected in any surrounding populations, which remain carriers of the original IGS 404 strain (Fig. 3c).

Two other strains were detected in specimens obtained during or after disease outbreaks in other Hells Canyon populations (Coggins 1988, Foreyt et al. 1990), and have not been detected since. These samples were from the Lostine population in 1986–1987 (IGS 419) and the Mountain View population in 1992 (IGS 402; Fig. 3a). A third strain (IGS 415) associated with a pneumonia outbreak in the Sheep Mountain population in 2000 was apparently replaced by the IGS 404 strain by 2006 based on samples typed from 2006 and 2015 in that population. The IGS 415 strain was subsequently infrequently detected in 4 other populations between 2003 and 2009 and has not been found since then (Fig. 3b).

Sequence divergence among the 3 recently detected strains where all 4 genes could be analyzed (i.e., IGS 393, 404, and 415) was between 9% and 10%. These strains were well dispersed across 20 genotypes of *M. ovipneumoniae* collected from 9 domestic sheep flocks in the western United States and Australia and 10 domestic goat flocks in the western United States and China. The IGS 404 and 415 types, first identified in the Black Butte and Sheep Mountain populations, respectively, were more closely related to the domestic sheep lineage, whereas the IGS 393 type detected in the Black Butte population in 2013 and 2014 clustered with the domestic goat clade (Fig. 4).

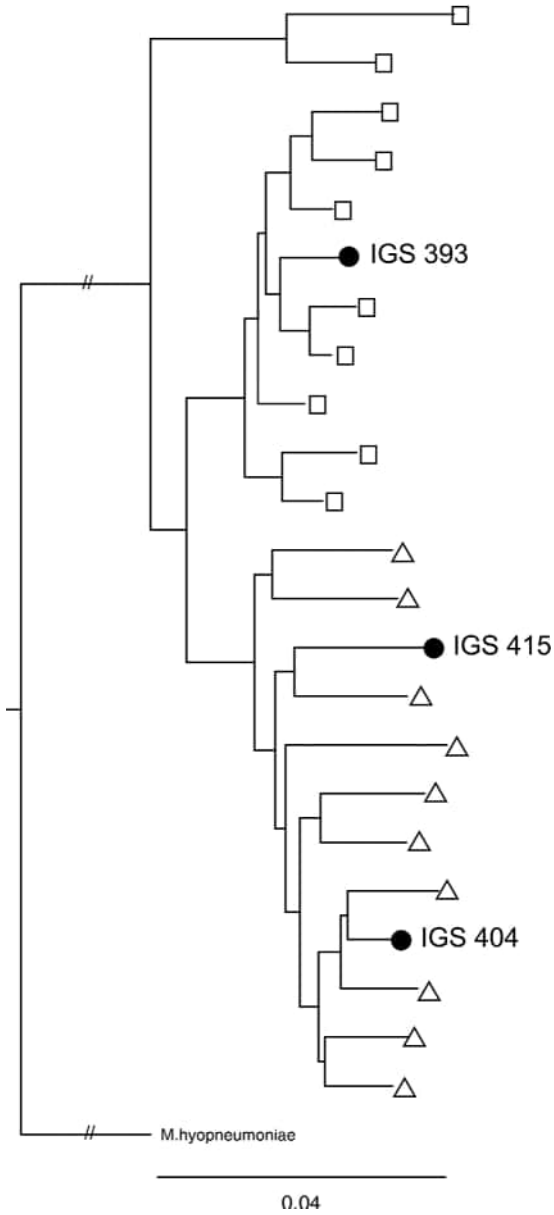


Figure 4. Phylogeny of 3 bighorn sheep strains of *Mycoplasma ovipneumoniae*, Hells Canyon, Washington, Oregon, and Idaho, USA, and randomly selected strains from domestic sheep (triangles) and domestic goats (squares), 1975–2015. Domestic sheep and goats appear to host divergent lineages of *M. ovipneumoniae* and the samples from bighorn sheep clustered with either the domestic sheep or domestic goat lineages. Neighbor-joining tree of concatenated partial 16S, 16S-23S intergenic spacer region (IGS), *rpoB*, and *gyrB* DNA sequences is rooted with homologous sequences from *M. hyopneumoniae*. Branch lengths are scaled by proportion non-identity (scale bar). Domestic sheep samples are from Washington, Oregon, Idaho, Nevada, Colorado, California, and an ATCC type strain from Australia. Domestic goat samples are from Washington, Idaho, California, and China (Yang et al. 2011, 2014).

DISCUSSION

This is the first study to report on an all-age pneumonia outbreak in an intensively sampled population of free-ranging bighorn sheep with health, survival, and observational data collected before, during, and after the disease event. The collection and analysis of this information, employing recently developed molecular methods for pathogen detection and genotyping, allowed us to attribute severe disease in a bighorn sheep population with long-standing *M. ovipneumoniae* carriage to introduction of a novel strain of *M. ovipneumoniae*. This conclusion is supported by the detection of the never before recorded IGS 393 strain in the pneumonic lungs of adults that died, and in the upper respiratory tract of adults with clinical signs during the outbreak. We also observed a significant increase in antibody titers to *M. ovipneumoniae* during the outbreak denoting an active immune challenge and we documented that previous exposure and ongoing carriage of the *M. ovipneumoniae* IGS 404 strain was not protective against disease. To the contrary, lower survival of adults with higher serologic titers prior to the disease outbreak could reflect a harmful autoimmune reaction associated with antibody response to *M. ovipneumoniae* in bighorn sheep as has been suggested for domestic sheep (Niang et al. 1998*a*). Strain-specific immunity, as measured by serologic antibody inhibition of *M. ovipneumoniae*, was similarly reported by Alley et al. (1999) for domestic sheep.

Adult mortality associated with this strain introduction was within the range previously observed during pneumonia outbreaks in naïve animals in this metapopulation (28–42%; Cassirer et al. 2013). Lamb mortality followed an identical time course regardless of strain, consistent with a lack of

protective immunity in neonates. The timing of the onset of clinical signs following infection in lambs (latent period) was similar to that reported in experimental challenge of adults (Besser et al. 2014). However, disease progression in lambs was more rapid and severe than observed in free-ranging adults in this study or in experimental exposure of naïve adults in captivity (Besser et al. 2014).

Although pneumonia in bighorn sheep is a polymicrobial disease, pathogens other than *M. ovipneumoniae*, including *lkt*A positive *Pasteurellaceae* and respiratory viruses, were either not detected or showed no association with disease. Whereas *M. ovipneumoniae* was present in all pneumonic adults and lambs, prevalence of *Pasteurellaceae* varied between age classes. This could be due to conditions associated with growth of an opportunistic pathogen or to other factors. Sample sizes were too small to draw broader inference. Anaerobic bacteria, not tested in this study, are a large component of the microbiome in pneumonic bighorn sheep lung tissue and may also play a larger role as secondary pathogens than previously suspected (Besser et al. 2008).

The novel strain of *M. ovipneumoniae* detected in this study differed from the resident strain by 52 independent genetic mutations on 4 loci. This unique strain was not a variant of a resident strain and had never before been detected in over 700 samples strain-typed from Hells Canyon and other bighorn sheep populations. Therefore, the most likely source of this Caprinae-specific pathogen was a domestic sheep or goat. Phlyogenetic analysis indicated that this strain was most likely of domestic goat origin.

This strain introduction likely occurred from a domestic goat on or from private lands within bighorn sheep range despite substantial efforts by wildlife managers and nongovernmental organizations to prevent contact. Management strategies included distributing educational material to flock owners and the general public, purchasing and removing a domestic sheep flock, and removing individual bighorn or domestic sheep and goats when they were at risk of contact. Our retrospective analysis showed that unique strains of *M. ovipneumoniae* were associated with 4 other epidemiologically unrelated all-age pneumonia outbreaks in Hells Canyon, as would be expected from similar spillover events. Two of these historical strains (IGS 402 and 419) apparently remained localized, one spread and subsequently disappeared (IGS 415), whereas the fourth (IGS 404) has persisted and proliferated over a span of $\geq$20 years. It is not clear why some strains of *M. ovipneumoniae* persist and others apparently do not. The IGS 404 strain may have driven fade-out of other extant strains when it spread, as introduction of the IGS 393 strain did in this study. Strain replacement might occur when the carrier host immune response is cross-reactive but protection is strain-specific. Under these conditions a new strain could have a competitive advantage and exclude the original strain.

Although evidence suggests that this epizootic was caused by introduction of a novel *M. ovipneumoniae* strain, it is also possible that pneumonia outbreaks could be precipitated in carrier bighorn sheep populations if appropriate mutations occur in strains to which resistance has previously been acquired. Mutations in key virulence genes or in genes coding for the *M. ovipneumoniae* capsule, which likely plays a role in adherence to host cells and in evading antibody recognition (Niang et al. 1998*b*, Razin et al. 1998), could cause disease and are unlikely to be detected by our strain-typing method. Another plausible mechanism of pneumonia resurgence would be reintroduction of the same strain of *M. ovipneumoniae* into a population following either pathogen fade-out and waning immunity (Sydenstricker et al. 2005) or recruitment of unexposed susceptible individuals. Finally, other factors may play a role in triggering outbreaks such as pathogen dose, host contact patterns, immunocompetence, and invasion of secondary pathogens. Identifying the conditions most frequently associated with pneumonia outbreaks in previously exposed populations and a wider investigation of the genetic diversity and host-specificity of *M. ovipneumoniae* strains would provide valuable insights into the adaptive immune response in bighorn sheep and the ecology of this disease.

MANAGEMENT IMPLICATIONS

Lack of cross-strain immunity to *M. ovipneumoniae* could be one explanation for the regular occurrence of pneumonia epizootics in bighorn sheep populations over a century after initial contact with domestic sheep. Single strain infection in bighorn sheep populations contrasts with *M. ovipneumoniae* carriage in domestic sheep where numerous strains typically coexist within a flock (Alley et al. 1999, Harvey et al. 2007). In the absence of cross-strain immunity, these flocks may serve as a constant source of novel strains capable of causing disease in bighorn sheep. Although vaccination could potentially reduce pathogen burden or prevalence within bighorn sheep populations, it is not clear that a vaccine would protect bighorn sheep from severe disease if exposed to new strains. Our results instead support preventing spillover as a primary strategy for managing disease in bighorn sheep. This could be accomplished by maintaining separation between bighorn sheep and domestic sheep and goats, by clearing *M. ovipneumoniae* infection from domestic hosts, and by exercising caution to avoid mixing *M. ovipneumoniae* strains among bighorn sheep populations during translocations. The management strategies implemented near the bighorn sheep in this study were apparently unsuccessful in preventing transmission, underscoring the difficulty of maintaining separation. New approaches, more active cooperation by the public, and greater vigilance on the part of resource managers may be key to preventing pneumonia outbreaks in bighorn sheep.

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ATTACHMENT 2

August 05, 2019

David Whittekiend
Uinta-Wasatch-Cache Forest Supervisor
857 West South Jordan Parkway
South Jordan, UT 84095

Re: Comments on the High Uintas Domestic Sheep Analysis Project

Dear David,

The undersigned conservation organizations are providing these comments in response to the June 25, 2019 Notice of Release of the Draft Environmental Impact Statement (DEIS) for the High Uintas Wilderness Domestic Sheep Analysis Project. These parties have previously submitted scoping comments in response to the May 2014, December, 2015 and February 2016 Scoping Notices. A relevant subset of these scoping comments are included as an attachment to these comments, since we have come to the conclusion that our scoping comments were more-or-less ignored by the USFS in this NEPA process. As such, we are noting this and including them here again to make sure this problem is noted in the project record.

Below we detail some concerns we have with the analysis of the proposed action. Our chief comments are organized into the following categories:

I. The USFS has generally failed to address domestic sheep grazing in the Hugh Uintas wilderness in the context of pending climate change

II. Issues relating to Bighorn sheep and risk of contact with domestic sheep

III. Issues relating to wilderness qualities and values

IV. Appropriateness of sheep grazing within important lynx habitat

V. Overgrazing of domestic sheep in the wilderness

I. The USFS has generally failed to address domestic sheep grazing in the Hugh Uintas wilderness in the context of pending climate change

The DEIS makes only a single mention of climate change and this is in relation to conifer encroachment in willow communities (DEIS p71). Thus acknowledging that climate change is real, the DEIS never mentions it again or in connection with Forest Management, in this case grazing of domestic livestock in the Ashley and Uinta Wasatch Cache National Forests and in the allotments in question along with the other allowed or permitted activities cumulatively

affect wildlife, habitats, watersheds, soils and carbon sequestration. Domestic sheep grazing in these and other allotments in these Forests remove vegetation and its associated stored carbon, generate greenhouse gases, accelerate soil erosion and thereby the accelerated loss of carbon from the soils.

The livestock industry's contribution to greenhouse gases also includes CO_2 released by conversion of forests to grasslands for the purpose of grazing.[1] Worldwide, livestock production accounts for about 37 percent of global anthropogenic methane emissions and 65 percent of anthropogenic nitrous oxide emissions with as much as 18% of current global greenhouse gas emissions (CO_2 equivalent) generated from the livestock industry.[2] Nitrous oxide, 300 times more potent than methane in trapping greenhouse gases, is also produced and released with livestock production.[3] It is estimated that livestock production, byproducts, and other externalities account for 29.5 billion metric tons of CO_2 per year or 51 percent of annual worldwide greenhouse gas emissions from agriculture.[4] Gerber, et al., 2013 state, "Livestock producers, which include meat and dairy farming, account for about 15 percent of greenhouse gas emissions around the world. That's more than all the world's exhaust-belching cars, buses, boats, and trains combined."[5] Saunois et al. (2016a) note "the recent rapid rise in global methane concentrations is predominantly biogenic—most likely from agriculture—with smaller contributions from fossil fuel use and possibly wetlands. …Methane mitigation offers rapid climate benefits and economic, health and agricultural co-benefits that are highly complementary to CO_2 mitigation."[6]

It is estimated that three times as much carbon resides in soil organic matter as in the atmosphere[7], while grasslands and shrublands have been estimated to store 30 percent of the world's soil carbon with additional amounts stored in the associated vegetation.[8] Long term intensive agriculture can significantly deplete soil organic carbon[9] and past livestock grazing in the United States has led to such losses[10, 11]. Livestock grazing was also found to significantly

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reduce carbon storage on Australian grazed lands while destocking currently grazed shrublands resulted in net carbon storage.[12] Livestock-grazed sites in Canyonlands National Park, Utah, had 20% less plant cover and 100% less soil carbon and nitrogen than areas grazed only by native herbivores.[13] Declines in soil carbon and nitrogen were found in grazed areas compared to ungrazed areas in sage steppe habitats in northeastern Utah. As grazing intensity increased, mycorrhizal fungi at the litter/soil interface were destroyed by trampling, while ground cover, plant litter, and soil organic carbon and nitrogen decreased. [14] A review by Beschta et al. determined that livestock grazing and trampling in the western USA led to a reduction in the ability of vegetation and soils to sequester carbon and also led to losses in stored carbon.[15]

A landmark report from the United Nations' scientific panel on climate change paints a much darker picture of the immediate consequences of climate change than previously thought and says that avoiding the damage requires transforming the world economy at a speed and scale that has "no documented historic precedent." [16] The report, issued late last year by the Intergovernmental Panel on Climate Change, a group of scientists convened by the United Nations to guide world leaders, describes a world of worsening food shortages and wildfires, and a mass die-off of coral reefs as soon as 2040—a period well within the lifetime of much of the global population.

The report "is quite a shock, and quite concerning," said Bill Hare, an author of previous I.P.C.C. reports and a physicist with Climate Analytics, a nonprofit organization. "We were not aware of this just a few years ago." The report was the first to be commissioned by world leaders under the Paris agreement, the 2015 pact by nations to fight global warming. The authors found that if greenhouse gas emissions continue at the current rate, the atmosphere will warm by as much as 2.7 degrees Fahrenheit (1.5 degrees Celsius) above preindustrial levels by 2040, inundating coastlines and intensifying droughts and poverty. Previous work had focused on estimating the damage if average temperatures were to rise by a larger number, 3.6 degrees Fahrenheit (2 degrees Celsius), because that was the threshold scientists previously considered for the most severe effects of climate change. The new report, however, shows that many of those effects will come much sooner, at the 2.7- degree mark.

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In its DEIS, the Forest Service totally ignores the potential impacts of this change, including but not limited to, the effects and consequences of permitting livestock grazing. Timber harvests, road density and off-road vehicle use being allowed in the Forests and other management actions such as oil and gas, pipelines and so on also are integral to this problem.

The USDA, in its Committee of Scientists Report recognize the importance of forests for their contribution to sustainability and contributing to global carbon cycles and that preservation of plants, animals and habitats should be the first priority in managing Forest Service natural resources.[17] The 2011 draft NFMA regulations recognize that forests provide "Benefits… including… Regulating services, such as long term storage of carbon; climate regulation…"

How can this national forest be considered "suitable" for activities that contribute to—rather than reduce—the greatest threat to the Earth's biosphere? The present level of CO_2 in Earth's atmosphere is already dangerous and not sustainable under any definition of the word. Typical of FS NEPA documents, the DEIS has no analysis of the project's carbon budget. It is clear that the management of the planet's forests is a nexus for addressing this huge crisis of our times. Yet the DEIS fails to even disclose the amount of CO_2 emissions created by Forest Plan or project implementation, or consider the best available science on the topic. This is immensely unethical.

The FS has never analyzed and disclosed the cumulative effects of overall agency management contributions to the reduction in stored carbon and thus, to climate change. The DEIS fails to provide comprehensive estimates of the total amount of CO_2 or other greenhouse gas emissions caused by FS management actions and policies—forestwide, regionally, or nationally. The DEIS fails to quantify CO_2 and other greenhouse gas emissions from several other common human activities related to forest management and recreational uses. These include emissions associated with machines used for logging and associated activities, removal of carbon stored in trees and vegetation by logging and so-called "vegetation treatments", vehicle use for administrative actions, recreational motor vehicles, and most emissions associated with livestock grazing, including loss of carbon stored in vegetation as it is consumed, and soils as they erode. The Forest Service is simply ignoring the impacts of these management and other authorized activities.

An analysis[18] of the carbon footprint of off-road vehicles in California determined that:

- Off-road vehicles in California currently emit more than 230,000 metric tons — or 5000 million pounds — of carbon dioxide into the atmosphere each year. This is equivalent to the emissions created by burning 500,000 barrels of oil. The 26 million gallons of gasoline consumed by off-road vehicles each year in California is equivalent to the amount of gasoline used by 1.5 million car trips from San Francisco to Los Angeles.
- Off-road vehicles emit considerably more pollution than automobiles. According to the

[17] USDA. 1999. Sustaining the People's Lands. Recommendations for Stewardship of the National Forests and Grasslands into the Next Century. Committee of Scientists March 15, 1999. Accessed on July 28, 2019. https://www.fs.fed.us/emc/nfma/includes/cosreport/Committee%20of%20Scientists%20Report.htm

[18] Kassar, Chris and Paul Spitler, 2008. Fuel to Burn: The Climate and Public Health Implications of Off-road Vehicle Pollution in California. A Center for Biological Diversity report, May 2008.

California Air Resources Board, off-road motorcycles and all-terrain vehicles produce 118 times as much smog-forming pollutants as do modern automobiles on a per-mile basis.

- Emissions from current off-road vehicle use statewide are equivalent to the carbon dioxide emissions from 42,000 passenger vehicles driven for an entire year or the electricity used to power 30,500 homes for one year.

Another study[19] provides data on the amount of fossil fuel being consumed by snowmobiles in Montana, from which one can calculate the carbon footprint. The study finds that resident snowmobilers burn 3.3 million gallons of gas in their snowmobiles each year and a similar amount of fuel to transport themselves and their snowmobiles to and from their destination. Non-residents annually burn one million gallons of gas in snowmobiles and about twice that in related transportation. So that adds up to 9.6 million gallons of fuel consumed in the pursuit of snowmobiling each year in Montana alone. Multiply that by 20 pounds of carbon dioxide per gallon of gas (diesel pickups emit 22 pounds per gallon) and snowmobiling releases 192 million pounds (96 thousand tons) of climate-warming CO_2 per year into the atmosphere.

Kutsch et al., 2010[20] provide an integrated view of the current and emerging methods and concepts applied in soil carbon research. They use a standardized protocol for measuring soil CO_2 efflux, designed to improve future assessments of regional and global patterns of soil carbon dynamics. The authors state:

> *Excluding carbonate rocks, soils represent the largest terrestrial stock of carbon, holding approximately 1,500 Pg C in the top metre. This is approximately twice the amount held in the atmosphere and thrice the amount held in terrestrial vegetation. Soils, and soil organic carbon in particular, currently receive much attention in terms of the role they can play in mitigating the effects of elevated atmospheric carbon dioxide (CO_2) and associated global warming. Protecting soil carbon stocks and the process of soil carbon sequestration, or flux of carbon into the soil, have become integral parts of managing the global carbon balance. This has been mainly because many of the factors affecting the flow of carbon into and out of the soil are affected directly by* ***land-management practices****. (Emphasis added.)*

Rather than allow continued grazing by up to 40,000 domestic sheep in the sensitive watersheds and soils of the Uinta Wilderness, the Forest Service should be engaged in reversing soil erosion, restoring plant productivity to potential and restoring damaged watershed function. This can best be accomplished by terminating grazing these domestic sheep in these and adjacent allotments such as West Fork Blacks Fork.

A further, and normally overlooked aspect has to do with the Forest Services' obligation to consider other factors such as connectivity of habitats. Grazing of domestic sheep and other

[19] Sylvester, James T., 2014. Montana Recreational Off-Highway Vehicles Fuel-Use and Spending Patterns 2013. Prepared for Montana State Parks by Bureau of Business and Economic Research, University of Montana. July 2014.

[20] Kutsch, Werner L. Michael Bahn and Andreas Heinemeyer, Editors, 2010. Soil Carbon Dynamics: An Integrated Methodology. Cambridge University Press.

Forest management actions described above fragment already fragmented habitats and corridors for lynx, wolverine, deer, elk, grizzly bears and other wildlife. It is necessary to provide analysis, standards, mitigations and other on-ground measures such as road crossings, overpasses, road closures, closure of areas to ohvs/snowmobiles, livestock grazing, trapping and limiting noise levels to enable these and other animals that rely on migration, habitat security and capability to be allowed to do so. For example, since climate change is such a central part of these species fate as evidenced in the cited court ruling and papers in another section of these comments related to wolverine, the Forest Service should address its own Roadmap to address climate change. Recognizing the current and coming changes to climate with longer, drier periods and drought, the Forest Service has implemented a Roadmap to address climate change[21]. This roadmap provides guidance to the agency, including, but not limited to:

- Assess vulnerability of species and ecosystems to climate change
- Restore resilience
- Promote carbon sequestration
- Connect habitats, restore important corridors for fish and wildlife, decrease fragmentation and remove impediments to species migration.

To date, in project after project, we have not seen the Forest Service cite or adhere to these principles in any project EA or EIS. This project is no exception.

In addition, the National Fish, Wildlife and Plants Climate Adaptation Strategy proposed by the Fish and Wildlife Service, NOAA Fisheries and the American Fish and Wildlife Association describes climate change effects and emphasizes conservation of habitats and reduction of non-climate stressors to help fish and wildlife adapt.[22] The Forest Service must address conservation of habitats and reduction of non-climate stressors such as the habitat degradation from livestock grazing, including soil loss, plant communities shifting to increasers or weeds to help fish and wildlife adapt in accordance with the National Fish, Wildlife and Plants Climate Adaptation Strategy. Instead, the Forest Service announces and approves project after project that further destroys habitat and connectivity with no complete analysis of cumulative effects and no actions to recover lost habitats and connectivity.

II. Issues relating to Bighorn sheep and risk of contact with domestic sheep

The Forest Service May Not Abdicate its Responsibility to Comply With Agency Policy

The Forest Service acknowledges that the proposed alternative would include the authorization of grazing on allotments that pose a significant risk to bighorn sheep, a Region 4 Sensitive Species, but the Forest Service contends that authorized grazing on BLM lands and domestic sheep grazed on private lands likewise puts bighorn sheep at risk, so the additional risk posed by

[21] USDA. 2010. National Roadmap for Responding to Climate Change. 30p. www.fs.fed.us/climatechange/pdf/roadmap.pdf
[22] https://www.wildlifeadaptationstrategy.gov/

grazing on Forest Service lands is inconsequential. This argument is logically inconsistent, and inconsistent with Forest Service policy, Forest Plan direction, and the National Forest Management Act. Further, this argument was thoroughly addressed during litigation relating to the Payette National Forest's Bighorn Sheep Viability Plan Amendment.

The Forest Service is required to coordinate the conservation of Sensitive Species with other agencies (FSM 2670.22). The Forest Service is not authorized to coordinate the destruction of populations of native species where commercial interests would benefit from such destruction, and the Forest Service cannot abdicate the agency's responsibilities to other federal or state agencies, or to private landowners, even in the event that coordination done with the goal of Sensitive Species conservation fails to mitigate risks from other sources. As such, instead of dismissing the risks posed to bighorn sheep by Forest Service allotments due to those posed by BLM allotments and private lands, the Forest Service should be coordinating with BLM and with state wildlife agencies in Utah and Wyoming to address risks posed by domestic sheep outside of the Forests. In the absence of such coordination, the Forest Service must nevertheless comply with NFMA, NEPA, and Forest Service policy.

The Forest Service's flawed argument that it need not mitigate risks on Forest Service lands because risks occur on BLM lands would enable BLM to adopt a similar position, where BLM officials could dismiss their own obligations to protect bighorn sheep, contrary to BLM policy, and authorize high risk grazing due to the risks posed by Forest Service grazing and private lands. The circular logic presented by the Forest Service, wherein federal agencies may collude to avoid following agency policies requiring the conservation of species on their respective lands, is unreasonable.

The Forest Service's dismissal of the risks posed to bighorn sheep populations from Forest Service authorized activities due to the presence of domestic sheep on private lands incentivizes the decimation of native species by livestock producers, timber companies, and others. Following this logic to its natural conclusion, anywhere domestic livestock allotments would be subject to scrutiny and potential mitigation actions due to the presence of species listed as Sensitive, a domestic livestock producer need only create a high risk situation on private lands to ensure the availability of public lands grazing. This would also mean that the Forest Service would never act to protect Sensitive wildlife populations where any other source of risk exists for that species, or where the presence of risks is unknown but cannot be decisively asserted to be zero. Taken together, these factors would lead to the rapid decline and local extirpation of species the Forest Service is mandated to protect, precisely because the Forest Service has identified their viability as of concern. This is likewise unreasonable.

The argument regarding the presence of risk from other sources was settled within the Payette National Forest Plan Amendment for Bighorn Sheep Viability NEPA assessment and subsequent litigation. Because bighorn sheep already exposed to domestic sheep pathogens respond to new strains of those pathogens just as naive sheep would, and because the pathogen strains rapidly evolve, risk from each pathogen source compounds the overall risk to bighorn sheep populations. Mitigation of one source of risk, even where others remain, nevertheless reduces overall risk to a population. The Forest Service is required to mitigate known risks originating from Forest Service activities, regardless of other potential sources of risk.

From the Payette National Forest Plan Amendment for Bighorn Sheep Viability FSEIS at 3-14:

> *"Additional arguments state that since disease pathogens have already been transferred to domestic sheep, separation at this point is moot, or that private lands provide risks to bighorn sheep that cannot be offset, regardless of actions taken on Federal lands. These contentions claim that management on Federal lands to provide separation will not be effective due to changed conditions that cannot be offset. The uncertainty in these contentions poses all of the risk to be borne by bighorn sheep. They do not consider that pathogens likely evolve as they move within and between species, or existing or new diseases that are virulent to bighorn sheep (e.g., mycoplasms) may still be transferred between domestic and bighorn sheep. Recent serological research (Dassanayake et al. 2009) demonstrates that pathogens, in this case Mannheimia haemolytica serotype A1, which are not lethal to domestic sheep, are transferrable to bighorn sheep and highly lethal to them. In another recent experiment, pathogens were tagged and followed as they passed from domestic to bighorn sheep and resulted in bighorn sheep mortality (Lawrence et al. Forthcoming)."*

The Forest Supervisor further explained the rationale in the ROD:

> *"In making my decision, I considered cumulative effects. During the public comment period, I received letters that stated, "Given the probabilities of contact from off-forest private lands sources, excluding domestic sheep on Federal lands is futile." Activities that occur on private lands are outside my control. By implementing Alternative 70 modified, I believe we can successfully manage the low level of foray contact risk with this alternative. The Forest Plan Standards and Guidelines will allow the Forest Service to manage the risk of Alternative 70 modified so it will not add to the greater risks left on the landscape that are outside the control of the Payette National Forest. I have the responsibility to analyze cumulative effects on Forest Service administered lands, and disclose them to the public. The analysis conducted recognizes these uncertainties but clearly focuses on the Forest Service's responsibility to provide adequate habitat to support viable populations of bighorn sheep, particularly given the risks that the species currently faces relative to potential impacts from disease. I believe that given the cumulative effects, Alternative 70 modified meets the needs of bighorn sheep as a sensitive species by not further contributing to a downward trend in the population numbers. The regulations implementing NFMA require that I select an alternative that provides habitat to support at least a minimum number of reproductive bighorn sheep and the habitat is well distributed so that those bighorns can interact with others in the planning area. For this document, the definition of planning area is lands administered by the Payette National Forest."*

Plaintiffs in a case challenging the Payette decision asserted this argument was flawed. The courts, however, upheld the rationale, summarizing:

> *"[The Forest Service] responded, in effect, that one risk (endemic disease cycling) does not take away from other risks (transmission from domestic sheep). FS006134. So "[e]ven though other events may lead to die-offs of bighorn sheep, the Forest Service still ha[d] a responsibility to address the risk of disease posed by its management decisions relating to domestic sheep grazing." Id.; see also FS006137*

(noting the need to manage the risk of disease from domestic sheep even if some bighorn populations carry disease endemically); FS006225 (same); FS006234 (same). Defendants further concluded that there was insufficient information on endemic disease transmission to model the possibility accurately. FS005447. And they cited research showing that "pathogens evolve as they move within and between species" and that certain domestic sheep carry pathogens that are lethal to bighorn sheep but not domestic sheep – suggesting that there are still pathogen strains capable of transfer, even if domestic sheep have already transferred one lethal strain. FS005095 [FSEIS at 3-14]

Defendants' response is reasoned and reasonable. NEPA does not require that agencies eliminate all risks contributing to a problem before they can address one of those risks. Cf. Lands Council, 537 F.3d at 1001 (explaining that agencies need not even "present every uncertainty in its EIS" because "such a requirement might inadvertently prevent [agencies] from acting due to the burden it would impose" (emphasis added)).

Whatever the risks from endemic disease transmission, there is still a risk from domestic sheep that is within Defendants' control, even if domestic sheep have already transmitted one lethal pathogen strain. Plaintiffs' studies also show the possibility of endemic disease transmission, but they do not show the fact of it or the irrelevance of taking any other protective action. Cf. id. (Idaho Wool Growers Association et al v. Vilsack et al, No. 1:2012cv00469 (D. Idaho 2013))

The Forest Service May Not Rely on Other Agencies and Hypothetical Future Actions To Meet Agency Requirements

The Biological Evaluation for bighorn sheep repeatedly refers to the 'cyclic nature' of the High Uintas bighorn herds, as though this is the natural condition of bighorn sheep occurring in the area. This is misleading. Repeated declines followed by slight recovery over time is the signature of repeated exposure to pathogens originating in domestic livestock. The assertion that bighorn sheep herds in the area are resilient to disease is likewise misleading, and is contradicted by Best available science and by the herd histories of the Forestwide population. Bighorn sheep have been previously extirpated from the High Uintas, and were only restored through artificial restocking. Die-offs have occurred multiple times since then, and the current population has only been sustained through extensive management intervention. Bighorn sheep remain below the landscape carrying capacity, and large segments of the total population have been eliminated for the protection of the remainder of the population. Any significant recovery followed artificial supplementation from other populations. The populations have been restricted from interacting with others in the planning area for their own protection, and the populations are not self-sustaining. All of these conditions originate from the domestic sheep grazing analyzed under the proposed action. There is nothing natural about the population history of the High Uintas bighorn sheep, and nothing to indicate the population is unusually resilient.

The loss of more than one third of the Forestwide population of bighorn sheep in 2009 following an outbreak of respiratory disease in the supplemented Goslin herd illustrates the potential consequences of pathogen exposure: In order to protect the animals that were not yet exposed to disease, UDWR enlisted Wildlife Services to kill a large portion of the Forestwide population. Had they not, a greater proportion of the population may have been lost. It is clear from the Goslin herd history that supplementation of existing herds and reintroduction of new herds into

the habitat of extirpated populations has not led to viable and self sustaining populations over the last few decades, and may not be relied upon for attainment of goals and adherence to policies regarding Sensitive Species. The failed augmentation and subsequent removal of the Goslin herd is a stark example of why bighorn sheep researchers, state wildlife agencies across the West, and WAFWA strongly discourage transplants to new habitat or augmentations of existing bighorn sheep herds where pathogens or the risk of pathogen exposure remains on the landscape.

Here, the Forest Service proposes to continue to authorize grazing despite agency policies because the state of Utah has committed to augmenting bighorn sheep herds in the High Uintas. However, the Forest Service cannot create an obligation for a state agency to mitigate harm caused by Forest Service authorized activities to protected resources, and the Forest Service cannot waive its own obligations by relying on the hypothetical future actions of another agency. The Forest Service cannot diminish a population of a Sensitive Species through avoidable actions, and cannot allow the total extirpation of a subset of the forestwide population, regardless of any promise by UDWR to undertake future augmentations.

The Forest Service's argument here was dismissed by the courts in the order granting a TRO enjoining sheep grazing on the Caribou-Targhee National Forest:

> *"[The Forest Service] argues that, because the South Beaverhead population is not viable, it does not matter, under the Forest Plan, if it is extirpated—i.e. the risk of extirpation does not violate the Forest Plan. In other words, the Forest Service asks the court to the measure the Forest Plan's maintenance requirement not herd-by-herd, but by considering the sum of all of the individual bighorn populations Forest-wide. The sum would necessarily include the South Bighorn population—unless or until they are extirpated. This circular logic is untenable.*
>
> *The meaning of "maintain" underscores the Court's point. The Oxford English Dictionary contains numerous definitions for maintain, including: "to sustain (life) by nourishment," "to keep up, preserve, cause to continue in being (a state of things, a condition, an activity, etc.); to keep vigorous, effective, or unimpaired; to guard from loss or deterioration."22 Thus, in no way do the common definitions and understandings support neglect or deterioration of a population of animals (taken as a whole, or in part) that the Forest Service is mandated to maintain.*
>
> *Layered on top of the mandate of maintaining viable populations of all desired native or non-native wildlife, are the requirements related to sensitive species. Bighorn sheep are currently designated as a sensitive species in National Forests in the Intermountain region, including the Caribou-Targhee National Forest. (Dkt. 19-5 at 3.) With regard to sensitive species, the Forest Plan directs the Forest Service to "develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions." (Forest plan, Sensitive Species, 2670.22, Dkt. 19-8.)*
>
> *By authorizing domestic sheep grazing on the allotments, the Forest Service risks extirpation of a herd, albeit small, of sensitive species. This is an action that threatens the herd, and to the Forest Service's point, potentially will diminish the overall population of bighorn sheep throughout the Forest."* [Case No. 1:17-CV-434-CWD]

Forest Service Sensitive Species policy states that the Forest Service must "avoid or minimize impacts to species whose viability has been identified as a concern," and that the Forest Service must "analyze the significance of impacts that cannot be avoided on the population and on the species as a whole. Impacts may not result in a loss of viability or create a significant trend toward federal listing as T&E" (FSM 2670.32). The Forest Service cannot reasonably assert that avoidable exposure of bighorn sheep to domestic sheep pathogens complies with Sensitive Species policy, and that such exposure, which is occurring on Forest Service lands throughout the West, will not contribute to a trend toward ESA listing for the species.

The Proposed Action Does Not Comply with Forest Plan Direction

Forest Plans implementing NFMA provide guidance for meeting the viability and distribution requirements for native species. Ashley National Forest Plan direction includes "Ecosystems on the Forest provide and maintain viable and well-distributed populations of flora and fauna. New listings of threatened, endangered, and sensitive species as a result of Forest Service management activities are avoided. Population objectives developed cooperatively with the Utah Division of Wildlife Resources and U.S. Fish and Wildlife Service are achieved. To contribute to species stabilization and full recovery, habitats across all levels or scales for endangered, threatened, and proposed flora and fauna species listed in accordance with the Endangered Species Act are protected and recovered, and sensitive species appearing on the Forest Service Intermountain Region's Sensitive Species list are protected. Newly-developed management direction from recovery plans and conservation strategies to which the Forest Service is a signatory is incorporated as applicable to facilitate protection and/or recovery of threatened, endangered, or sensitive species." The Forest Service acknowledges that bighorn sheep will be neither maintained nor enhanced by the proposed action. The proposed action should therefore be disallowed on the Ashley National Forest.

The Uinta Forest Plan includes the goal: "sensitive species appearing on the Forest Service Intermountain Region's Sensitive Species list are protected" and stipulates that "[n]ewly-developed management direction from recovery plans and conservation strategies to which the Forest Service is a signatory is incorporated as applicable to facilitate protection and/or recovery of threatened, endangered, or sensitive species." Management direction from states and counties, even where the Forest Service is a signatory, should not be integrated into projects where it will fail to facilitate the protection and recovery of Sensitive Species, and management actions which would fail to protect sensitive species should not be permitted on the Uinta National Forest. The Uinta Plan further states "If consistent with ecosystem health and integrity, and threatened, endangered, and sensitive species management, forage for livestock grazing on lands identified as suited for this use is provided to support social and economic community stability." Forage shall not be provided where it is inconsistent with the needs of Sensitive Species. The proposed action does not comply with Forest Plan direction on either Forest, and does not comply with NFMA.

The Forest Service's Biological Evaluation is Flawed

The 2013 Utah Bighorn Management Plan is not a peer reviewed document, and does not constitute Best available science. The state's definition of a Minimum Viable Population is

therefore not only inaccurate, it is not applicable to the current project. The MVP estimate of 125 has been perpetuated for decades despite being unsupported by the literature, and despite fundamental flaws resulting from the lack of any consideration of bighorn sheep exposure to domestic sheep pathogens in the single study upon which it was originally based.

Region 4 Forest Service officials have presented conflicting numbers for a Minimum Viable Population, with John Shivik, Region 4 Wildlife Program leader, asserting the number is 188. The total population distributed across both forests has recently risen from below 150 to 192, or from below a number considered viable for a single planning unit to a number that just meets Region 4's minimum threshold for viability. The cause of the most recent drop below the viability threshold was pneumonia, which likely originated as a result of the domestic sheep authorizations proposed here. Past pneumonia events have resulted in declines that, if they occurred in equal proportion today, would leave the total population below 125. It is clear that the proposed action can, has, and will lead to a loss of viability, and will not facilitate the continued existence of self sustaining populations of bighorn sheep well distributed across the forests. The risk to bighorn sheep from the proposed action is replicated on public lands Westwide, where many bighorn herds remain at risk from Forest Service authorized domestic sheep grazing a decade or more after being added to Regional Forest Service Sensitive Species lists. The Forest Service's determination that the proposed action "may impact individuals, but would not cause a trend toward the federal listing or cause a loss of viability" is inaccurate and unjustifiable.

The spatial and temporal bounds of the cumulative effects analysis described in the Biological Evaluation are too limited, and thus do not capture either the total area described in the risk assessment or the time period over which direct and reasonably foreseeable effects will occur. It likewise fails to describe in detail the reasonably foreseeable future condition of bighorn sheep populations under all possible alternatives.

The project risk assessment considers risks from private and BLM lands, outside of the Biological Evaluation's stated range. Past impacts to bighorn sheep in the High Uintas date back more than a century, and this is acknowledged throughout the evaluation, yet the BE sets the prior impact date at just 3 years. Several bighorn populations carry pathogens contracted greater than 3 years ago, and several demonstrate the population-wide impacts of that pathogen exposure. There is therefore no basis for a 3-year baseline for historic impacts. Bighorn sheep exposure to pathogens is likely to result in population impacts lasting greater than ten years, and bighorn sheep exposed near the end of the ten year period of the permit will certainly be affected at the time the permit expires and beyond. Further, the Forest Service's poor record of NEPA completion on permits means the permit is not guaranteed to undergo a thorough NEPA assessment at the end of a 10 year period, and is instead likely to be renewed without changes to the permit Terms and Conditions. The minimum timeline for determining reasonably foreseeable future effects should be the average period bighorn sheep populations are affected by pathogens added to the average number of years between NEPA assessment completion for allotments.

The Forest Service Should Not Have Dismissed a Reduced Grazing Alternative, and Should Have Analyzed an Alternative Wherein BLM Grazing was Discontinued

The effect of exposure to multiple strains of domestic sheep pathogens from multiple sources is not redundant, but additive. As such, the Forest Service has unreasonably dismissed an alternative wherein reduced grazing on Forest Service lands would be analyzed in detail and given fair consideration throughout the process. Further, the Forest Service has failed to analyze an alternative in which BLM grazing is likewise discontinued (40 C.F.R. §1502.14(c)).

NEPA's alternatives requirement serves to inform the public of "reasonable alternatives that would avoid or minimize impacts," (40 C.F.R. § 1502.1). Here the Forest Service's preferred alternative would offer no solution to the problem of disease transmission, so its rejection of a reduced or no grazing alternative for not fully alleviating risk to bighorn sheep is irrational.

The Forest Service has Failed to Prepare an Updated Capability and Suitability Assessment

Guidance on the completion of Suitability assessments is contained in the Forest Service's *Rangeland Suitability For Livestock Grazing At the Forest Plan Level and Standards for NEPA Display*, including:

- Subtract areas where decisions have been made that specific TES habitats, including habitat for Forest Service sensitive species, need to be excluded from livestock grazing due to an established incompatibility.
- Have IDT specialists on the planning team identify any additional areas where conflicts occur between livestock grazing and other resources to the extent that the conflicts cannot be resolved or satisfactorily mitigated, and where the other resource values are proposed in the alternative to take precedence over livestock use. If the planning recommendation is that livestock use in these areas is incompatible, or the conflicts are incapable of being resolved in a satisfactory manner, these lands will be designated as other than suitable for the specific alternative for this planning cycle. Clearly document the reason for the other than suitable determination.

Bighorn sheep were designated as a Forest Service Sensitive Species in 2009. There is a clear, established incompatibility with bighorn sheep in the allotments proposed for domestic sheep grazing, and these conflicts cannot be mitigated or resolved through allotment management practices alone. The suitability analysis is therefore outdated, not based on Best available science or agency direction, and is not an appropriate document on which to make wildlife management decisions. An accurate suitability analysis must produced prior to the release of the FEIS.

III. Issues relating to wilderness qualities and values

According to Forest Service data[23] obtained recently, the High Uintas Wilderness is the most

[23] This is from a FOIA response to Wilderness Watch from Region IV of the Forest Service. This DEIS includes some new information that corrects the earlier FOIA data but does not change the general conclusions therein.

heavily grazed Wilderness in the entire National Wilderness Preservation System (NWPS). This fact alone suggests why the Uintas, perhaps the best habitat for Rocky Mountain Bighorn Sheep in the entire NWPS, has struggling populations of that species, which were mainly if not entirely reintroduced.

Nowhere in the DEIS does it explicitly state that domestic livestock grazing in Wilderness is a nonconforming use that detracts and denigrates wilderness character. For example, we provided citations in our scoping comments detailing agency guidance on wilderness character monitoring, which explicitly states the negative impacts of livestock grazing on wilderness character. Rather than look at impacts or honestly compare the non-grazed areas with those which are grazed, the agency dissembles the public through statements like, "The proposed action in this analysis does not change this and does not create new, additional, or amplified impacts to the wilderness resource." DEIS at 192. If the Fall Creek allotment is grazed as per the proposed action, it would create new, additional and amplified impacts to the wilderness resource. Again, the failure to recognize grazing as a nonconforming use that harms wilderness character severely biases the NEPA analysis.[24]

In 1964, Congress passed the Wilderness Act "to secure for the American people of present and future generations the benefits of an enduring resource of wilderness."[25] The law provided statutory protections for wilderness areas and established the National Wilderness Preservation System. The Act, among other things, mandated that wilderness areas be administered in a manner that will leave them "unimpaired for future use and enjoyment as wilderness" and provide for "the protection of these areas" and "the preservation of their wilderness character."[26]

The Wilderness Act defines wilderness: "A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are *untrammeled by man*, where man himself is a visitor who does not remain."[27] Wilderness is "land retaining its *primeval character and influence*, without permanent improvements or human habitation, which is protected and managed so as to *preserve its natural conditions*...."[28] In addition, wilderness should be "*affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable*."[29]

The provision allowing grazing in the Wilderness Act is an exception to the general premise of the Act, which directs agencies to manage wilderness areas to preserve their wilderness character and natural conditions. The language concerning livestock grazing in wilderness is a mere forty words long: "Within wilderness areas in the national forests designated by this Act...the grazing of livestock, where established prior to September 3, 1964, shall be permitted to continue subject to such reasonable regulations as are deemed necessary by the Secretary of Agriculture." Thus,

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[24] Our earlier comments raised the issue of the monitoring protocol. Since that time, *Keeping It Wild 2, An Updated Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System* (Landres et al, 201has come out. GTR-217. Regardless of the many shortcomings with this document, it does recognize the impacts of livestock grazing on Wilderness.

[25] 16 U.S.C. § 1131(a).

[26] *Id*.

[27] 16 U.S.C. § 1131(c) (emphasis added).

[28] *Id*. (emphasis added).

[29] *Id*. (emphasis added).

grazing which existed in wilderness areas when the Wilderness Act was enacted may continue. In other words, grazing is an exception to normal wilderness protections. It is a use that, by definition and practice, degrades Wilderness.

By leading the reader to conclude the proposed action would not harm Wilderness, the DEIS also fails to recognize existing agency policy regarding Wilderness:

> *Each designated wilderness is affected by a variety of human influences that vary in intensity. In one area, human influence may be very limited; in another area, major disturbances occur. The number and intensity of these influences cause a gap between the attainable legislative wilderness and the conditions that exist on a wilderness ("X"). The goal of wilderness management is to identify these influences, define their causes,* ***remedy them, and close the gap ("A") between the attainable level of purity and the level that exists on each wilderness ("X").***

Forest Service Manual (FSM) at 2320.6, emphasis added. See also FSM 2310.6 – Exhibit01. The impacts on wildlife, recreation, soils, fisheries and watersheds, all independent of wilderness analysis, are reason enough to end grazing in the High Uintas Wilderness. By primarily addressing grazing impacts on these other important aspects, the agency would also improve wilderness character as per manual direction.

The DEIS premises much of its analysis on the condition classes established in the 1997 wilderness management plan for the High Uintas Wilderness. However, as the DEIS explains regarding the wildest condition class, "Generally, Class I areas are defined outside permitted livestock allotments." DEIS at 192. Thus, the agency has biased the NEPA analysis by premising the analysis on the described condition classes established in an earlier plan. In essence, the agency is telling the public there is no real need to objectively analyze the no-grazing alternative. The DEIS as a whole bears out this bias as demonstrated elsewhere in these comments.[30]

The DEIS also refers to documents (specialists reports) which are not available on the web. Allegations are made without the public being able to review the source material. For example:

> *The majority of wilderness visitors stay on Forest system trails and visit and camp at popular destination sites such as lakes (containing fish), and scenic meadows with meandering streams. Wilderness visitors typically utilize approximately 35,251 acres (Appendix E-Table D of the Wilderness/Recreation Resource Report [project record]) within the analysis area or about 24 percent of the analysis area.*

DEIS at 194. Indeed, the entire analysis on primitive recreation refers to the project record on pages 195 to 197 of the DEIS. What the DEIS fails to recognize is that those seeking a true primitive recreation experience and avoiding popular sites would likely be most harmed by domestic livestock grazing, assuming the DEIS is accurate regarding location of sheep and the popular recreation sites. The DEIS on pages 201 and 202 makes a similar mistake regarding the percentage of visitors who registered a negative comment.

Furthermore, it would appear that most visitors register at the trailhead, the beginning of the trip, before encountering any sheep in the Wilderness. As such, reliance on these registers is wrong.

[30] The one exception is a tiny portion of the Fall Creek Allotment which has been in a nonuse status since before the Wilderness was designated.

In any case, breaking down the wilderness analysis, citing Landres et al 2008, into the following factors--untrammeled, naturalness, undeveloped, and solitude/primitive/unconfined recreation—misses what is important about wilderness character.

The apparent adoption of the Keeping it Wild 2 (KIW2) in the DEIS is a misuse of that protocol. It is simply a monitoring protocol. Attachment H is a critique by wilderness professional of how KIW2 has downplayed the essence of Wilderness and how KIW2 has been used to justify trammeling actions in Wilderness.

Regardless, even if we were to assume that the analysis of these four factors is either appropriate or sufficient to analyze impacts to Wilderness and wilderness character, the DEIS analysis of these four factors is serious flawed. For example, the DEIS makes some incredible comments regarding so-called naturalness.[31] For example:

> *Wilderness ecological systems are fairly free from the effects of modern civilization. A herd of domestic sheep displaces some of the native wildlife from that site the herd occupies at that moment in time. Once the sheep herd passes, the wildlife will typically move back in within a few days.*

DEIS at 201. In no way is sheep grazing, including the forage consumed, the watershed degradation, potential disease organisms left in feces, and the like natural. Further, there are no site-specific citations that wildlife move in after a few days or that wildlife numbers approximate those of a natural condition. This is particularly true of bighorn sheep, whose numbers are far below what they once were before domestic sheep grazing.

Regarding structures and the undeveloped attribute analyzed in the DEIS, the DEIS states:

> *Permanent structures are limited to trail features (boardwalks, bridges, water bars, and signs) necessary for resource protection and are confined to the prism of the trails. There is one small (5' x 6') log structure in the Henry's Fork Lake vicinity that is used for salt storage, which was there prior to the area being designated Wilderness. There are also 43 temporary structures associated with sheep herder camps. A typical herder camp consists of a skeletal tent frame, fire ring, and one to two horse tie rails; camps are simple and temporary in design. Other than these features, the area is free of human-made structures.*

Ibid. However, the FSM states, "Permanent improvements include such items as trails, toilet buildings, cabins, fences, *tent frames, fire grills,* and instrumentation stations. Emphasis added FSM at 2320.5 5. Additionally, there is no indication that the permanent log structure is necessary for grazing operations (presumably salt storage) rather than temporary structures.[32]

There is no mention of predator control and its impacts on Wilderness. The FSM states, "Predacious mammals and birds play a critical role in maintaining the integrity of natural

[31] This too, is in error. The Wilderness Act refers to natural conditions and never uses the word naturalness.

[32] Oddly, the DEIS at 203 states regarding the log structure under the no grazing alternative, "The one small log structure in the vicinity of Henry's Fork Lake in the Hessie Lake-Henry's Fork Allotment may remain for salt storage." Salt would not be needed if no grazing were taking place. Further, the DEIS inconsistently states on page 208 "no permanent structures" exist except those associated with trails and for visitor use.

ecosystems." FSM at 2323.33c. A wolverine was found in 2014 and the area is within lynx habitat. Also, there is no mention in the DEIS about bears or coyotes. The only mention of mountain lions is in conjunction with bighorn sheep.

We raised the issue of sheep driveways in our scoping comments. These have become sacrifice zones, depauperate of plant diversity and severely eroded. This affects the Wilderness as well as surrounding lands, roadless and roaded. Similarly, the analysis evades the history of the Fall Creek allotment. The following statement is misleading:

> *The reissuance of grazing permits is a continuance of practices already in place prior to and since wilderness designation and would not change the quality of the wilderness character found at that time since no changes in general operations are being proposed. The implementation of this alternative, therefore, would not change the existing wilderness character.*

DEIS at 208. The DEIS itself admits that there ahs been no grazing since 1977 on the Fall Creek Allotment. The High Uintas Wilderness was designated in 1984. Thus, at the time of designation, there had not been any use on the allotment for seven years. The DEIS does not detail any impacts from grazing this allotment in terms of establishing a sheep driveway.

Given the impacts addressed elsewhere in this comment and the errors found in the wilderness analysis, it is wrong to suggest the gain in quality of wilderness characteristics would only be "slight" for Alternative 1. See DEIS at 208.

The High Uintas could be one of the most outstanding Wildernesses in the entire NWPS. The grazing of domestic sheep severely hampers the recovery of native wildlife, native predators, and watersheds.

IV. Issues relating to Canada Lynx in the High Uintas

The Canada lynx (*Lynx canadensis*) is listed as a threatened species under the Endangered Species Act. However, the U.S. Fish and Wildlife Service has determined that Utah does not contain critical lynx habitat, i.e., habitat essential to the survival of the species. While there does not appear to be a resident population of lynxes in Utah today, Utah nevertheless contains vast expanses of lynx habitat where lynxes were historically present.

Having been previously extirpated from Colorado, the Canada lynx was reintroduced into the San Juan Mountains beginning in 1999. Lynxes have since proliferated and spread out over the landscape. Several lynxes have made forays into Utah, with the Uinta Mountains and surrounding forestlands being most visited.[33] In addition, the greater Yellowstone ecoregion, including the Salt River and Wyoming ranges, which are located just to the north of the Uintas, supports a naturally occurring Canada lynx population and is classified as critical habitat for the Canada lynx.[34]

[33] Colorado Department of Wildlife Report, 2006-7, page 29.
[34] https://www.fws.gov/mountain-prairie/es/species/mammals/lynx/criticalhabitat_files/20081016_noa_yellowstone_map.pdf

The Uinta Mountains are recognized as a regionally significant wildlife corridor.[35] This corridor connects to the greater Yellowstone ecoregion through the Bear River Mountains of northern Utah and southern Idaho, and through the Crawford Mountains of southwest Wyoming.

Given that there are resident lynx populations in Colorado and Wyoming today, and given that the Uinta Mountains are recognized as a regionally significant wildlife corridor, it is no surprise that lynxes still use the Uintas. Indeed, telemetry records confirm that there is a "hot spot" of lynx occurrences at the western end of the Uinta Mountains, where collared lynxes from Colorado remain for a time before moving on, presumably unable to find mates. As of 2009, at least 22 individuals had made at least 27 visits to the state of Utah, recorded by air telemetry and satellite.[36] The highest concentration of lynx locations in Utah, as identified by telemetry, is in the Uinta Mountains. "The use-density surface for lynx use in Utah indicates the primary area of use being located in the Uinta Mountains."[37]

The Uinta Mountains are core lynx habitat

Sophisticated, peer-reviewed modeling identifies the Uintas as core lynx habitat. Here is an excerpt from the study[38].

"Using 90m-cell resolution, we used ArcGIS to conduct a habitat suitability analysis to identify best core areas for lynx in the study area. Inputs were vegetation community types (National Land Cover Database 2001), and weighted road density (Census 2000 TIGER/Line data). Each cell was attributed a score based on the dominant vegetation community type from the reclass values in table 1. Vegetation types (Figure 2) were assigned scores from 1 to 10 based on known lynx affinities for various land cover types, and re-classified in a binary raster where scores of 8 to 10 were considered to contain suitable vegetation types for lynx. Suitable vegetation types for lynx were defined by the current literature (Ruediger et al. 2000, Singleton et al. 2001, Singleton et al. 2002, USFS 2002, Bunnell et al. 2005, Wasatch-Cache National Forest 2005, Southwest ReGAP model, 2006, Shenk 2008). Suitable road density (Figure 3) for lynx was similarly calculated in ArcGIS using a kernel line density function, and assessed in a binary manner, with values below a 6.4-km/0.9-km radius circle (or <4-mi/mi^2) threshold considered acceptable as core (Singleton et al. 2001). After all cells that surpassed both the vegetation suitability and road density suitability thresholds were identified, habitat patches were formed using ArcGIS REGIONGROUP, 8-neighbor. For the purposes of this model, we considered large enough core patches for lynx to be those that are at least 1,600 km^2, the approximate area of eight average home range sizes for male lynx in the American Rockies (Ruggiero et al. 1999, Squires 2005, Shenk 2006, personal communication John Squires, personal communication Tanya Shenk). This generated nine individual core habitat areas within the study area (Figure 4).

We assumed that areas identified as core patches in our model would: (1) be of sufficient area to support more than two mated-pairs of lynx to reside year round, for multiple years; (2)

[35] Wasatch-Cache National Forest March 2003 Revised Forest Plan 4-21.
[36] Colorado Department of Wildlife (CDOW) Report, 2006-7, Tables 4 and 6, pages 23 and 24.
[37] Ibid. page 10; see also Figure 2, page 29.
[38] Jones, A.L. and W. Bates. 2007. Least-Cost Corridor Analysis for Evaluation of Lynx Habitat Connectivity in the Middle Rockies.

provide necessary land cover types for denning and hunting; (3) contain necessary prey to support lynx year-round; and (4) sufficient safety from human persecution.
Our model indicated that there are nine clusters of relatively well-connected blocks of suitable landscapes of sufficient size to be considered core lynx habitat (Figure 4). These habitat concentration areas include the High Uintas Wilderness (plus adjacent forested lands), a core patch in the Bear River Range, and many core patches in close proximity to one another in both the west slope of the Colorado Rockies and the greater Yellowstone region."

Given that the Uinta Mountains are core lynx habitat and a regionally significant wildlife corridor, it is perhaps surprising that there does not appear to be a resident population of lynxes in the Uintas today.[39] No doubt this is true, but why? Have researchers simply failed to detect them? Not likely. Lack of evidence of lynxes in this case is evidence of lack of lynxes. The most obvious and most probable explanation is that, following an initial extirpation due to trapping, hunting, poisoning, logging and livestock grazing, natural recolonization of the Uintas by Canada lynx is prevented by ongoing anthropogenic disturbances. One major continuous disturbance to consider is the domestic sheep trailing and grazing in the Uintas that has gone on every year for over 100 years.

Why is there not a resident lynx population in the Uintas?

The Forest Service relies on two dubious hypotheses to explain the absence of a resident lynx population in the Uintas today. Unsurprisingly, neither one involves sheep grazing.

> H1: There was never a resident population of lynxes in the Uintas to begin with—the occasional visiting lynx has always been a disperser, or at best a temporary resident.[40]

> H2: The intersection of vegetation cover types used by sheep and delineated by lynx habitat is of insignificant size and is discountable when compared to the acres of the entire lynx analysis unit (LAU); and the percentage of overlap would not likely result in lynx/hare habitat/food loss.[41]

Neither hypothesis is plausible. In both cases the underlying premises are much too weak to support the hypothesis even when their truth is granted. Consequently, they provide no support for the conclusion that Alternative 2 "is not likely to adversely affect the Canada lynx."[42] Let's examine these two hypotheses and their underlying premises.

H1. Based on a number of lynx surveys conducted by state and federal agencies between 1999 and 2017, which found no solid evidence of lynx presence, the FS concludes that there is not a resident lynx population in the Uinta Mountains today. The FS further concludes that there never was a resident lynx population in the Uintas—only occasional transients. According to this

[39] Draft Environmental Impact Statement High Uintas Wilderness Domestic Sheep Analysis (DEIS), June 2019, page 27.
[40] Ibid. page 129.
[41] Ibid. page 132.
[42] Ibid. page 133.

hypothesis, the Uintas are not good lynx habitat, which explains why lynxes have not been detected and leads to the conclusion that the Uintas will probably never host a resident lynx population regardless of the livestock grazing. Here is what the FS states in an earlier document: "We conclude that lynx that occur in Utah are dispersers rather than residents."[43]

Additionally, the Forest Service states that there were only 10 verified records of lynx in Utah in the 20th century, most of them in or near the Uintas, and that four of the 10 verified lynx occurrences in the Uintas correlate to the cyclic [lynx] highs of the 1960s and 1970s.[44]

To conclude from these premises that there has never been a resident population of lynxes in the Uintas commits the fallacy of "begging the question" by presupposing what is to be proved. (For simplicity, we'll narrow "never" to "since 1800".) Obviously, the explanation for why there is not a resident population of lynxes in the Uintas today, and no detectable reproduction, could just as easily be that human uses of the forest—for example, ongoing domestic sheep grazing—have resulted in the extirpation of lynxes from the Uintas and are preventing their natural recovery. What does the evidence actually show? Let's examine each premise carefully.

A: lynx sightings. There may have only been 10 verified records of lynx occurrence in the Uintas in the 20th century, but there have been an additional 17 reliable reports of lynx in Utah in the 20th century, based on physical remains (including photographs), visual sightings and track identifications, plus another 10 of unknown reliability. [45] The total number of records is 37. Most of these lynx occurrences were on the north slope of the Uintas, in or near the West Fork of Blacks Fork. Even if we discount the 10 reports of unknown reliability, we still have 17 reliable reports and 10 verified records of lynx, for a total of 27, most of which located the lynx in the Uintas! In other words, the historical evidence indicates a minimum of 10-37 lynxes in the Uinta Mountains over the last 103 years (not counting dispersers from Colorado). Thus, there can be little doubt that the actual number "sightings" was greater than 10. 30 would be much more probable.

Why arbitrarily exclude the "reliable" sightings? What does "reliable" mean if you can't rely on what is reliable? Yet the FS chooses not to rely on them for the purpose of the DEIS—a decision that would seem to be based not so much on a desire for accuracy as a desire to minimize the presence of lynx in Utah in order to make room for Alternative 2.

At this point we should ask ourselves how many records—verified records, if you like—it would take to establish that there was a resident population of lynxes in the Uintas during some part of the 20th century. Does anyone have even the slightest clue? Of course not. And the reason is that there are no empirical data for establishing a baseline on which to base a prediction. Surely all we can reliably say is that the more records (verified + reliable), the higher the probability. Thus, this premise commits the fallacy of begging the question, by presupposing what is to be proved.

[43] West Fork Blacks Fork Grazing FEIS (WFBF FEIS), 2006, page 48.
[44] DEIS page 129.
[45] Ruggiero, et al., Ecology and Conservation of Lynx in the United States, University Press of Colorado, (1999.) p. 210

B: lynx cyclic highs. The fact that four of the verified records of lynx occurrence correlate with cyclic highs in the lynx metapopulation does nothing to support the hypothesis that lynx in the Uintas were transient dispersers rather than members of a resident population. This premise also begs the question.

First, the cyclic high explanation is inconsistent with the predominant snowshoe hare story: "The predominant snowshoe hare story in this century has been that snowshoe hares are strongly cyclic in the north but show reduced or no cycles in their southern distribution."[46]

Second, the Uinta lynx population, assuming there was one, would most likely have also been undergoing a cyclic high, since cyclic highs occur throughout the metapopulation.[47]

Third, the fact that only four of 27-37 lynx occurrences—one in seven—correlated with a lynx population cyclic high is statistically irrelevant to the question of where those four lynxes came from. The conclusion insinuated by the FS is that they probably immigrated to the Uintas from a distant population when the habitat for that distant population became saturated—but, significantly, no evidence is given for this conclusion. It is to be expected that some of the records and reports would correlate with a lynx population cyclic high, since cyclic highs, which occur one or two years out of 10 or 11,[48] exhibit about the same frequency as the proportion of lynx records during the purported cyclic highs to the proportion of lynx records plus reliable reports (= 1 in 7).

C: no evidence of lynx reproduction in Utah. What does this show beyond what no one denies, namely that there may not be a resident population of lynxes in the Uintas now? This has no bearing whatsoever on whether there was ever a resident lynx population in the Uintas or whether one could exist there today if domestic sheep grazing were eliminated. Put another way, this premise again begs the question, for it doesn't tell us why biologists have obtained no evidence of recent lynx reproduction in Utah or the Uintas. And absent this knowledge, all we are entitled to conclude is that there is probably not a resident lynx population in the Uintas today.

Conclusion: Premises A, B & C carry no water. Each begs the question and so does nothing to move the evidence needle in either direction with respect to whether the Uinta Mountains and surrounding forests ever hosted a resident lynx population. From an evidentiary point of view, they are each a 0. And 3x0 = 0. So much for H1.

H2. Since the principal prey species of the Canada lynx throughout its range is the snowshoe hare, a dearth of snowshoe hare habitat in the Uintas would be evidence for a low or nonexistent population of hares, and hence a low or nonexistent population of lynxes. Furthermore, if it can be shown that sheep grazing will impact only a very small amount of lynx habitat—e.g., hare food resources—and that the impact will be insignificant and non-cumulative, then we may conclude that sheep grazing will probably not be detrimental to any lynxes there might actually be.

[46] Ruggiero, et al. p. 191.
[47] Ruggiero, et al. p. 438.
[48] Ruggiero, et al. p. 271,2.

The West Fork Blacks Fork watershed (WFBF) is exemplary of lynx habitat in the Uintas. The WFBF grazing allotment lies within a lynx analysis unit (LAU 34). In stark contrast to what the Forest Service claims in the DEIS, in the West Fork Blacks Fork Grazing Allotment FEIS, 2006, the Forest Service estimates the allotment to include 7,625 acres of primary lynx habitat and 27 acres of secondary lynx habitat on the national forest system land, for a total of 7,652 acres, or 42% of the allotment acreage).[49] The allotment as a whole is estimated to contain 36,640 acres of lynx habitat on Forest Service lands, and roughly another 10,000 acres of lynx habitat on private lands.[50]

According to the FS's own analysis, the quantity of lynx habitat within the grazing allotment in LAU 34, as stated in the 2006 WFBF Grazing FEIS, is enough to accommodate at least one male lynx home range and one or more female lynx home ranges. ("Home ranges of lynx are generally 6-8 square miles...")[51] These estimates would be five times higher for LAU 34 as a whole = ~ 5 male home ranges and ~ 10 female home ranges. When you consider the entire Uinta Mountain range and associated forest lands, this would obviously allow for many breeding pairs and thus for a persistent resident population. So, why isn't there a resident lynx population in the Uintas today? Is it because the stated amount of lynx habitat is incorrect?

In contrast to what the FS states in the 2006 WFBF Grazing FEIS, the DEIS revises the earlier estimate by stating that there are only 574 acres of primary lynx habitat in LAU 34![52] The DEIS similarly reduces the amount of primary lynx habitat throughout the Project Area by identifying it with vegetation types that provide food for snowshoe hares, namely "aspen, mixed aspen, sagebrush, and willow vegetation cover types"[53]

The DEIS states:

> *The total acres of intersection between vegetation cover types (likely used by sheep) and delineated lynx habitat are insignificant (size of impact is minute and would never reach the scale that take would occur) and discountable (based on a person's best judgement effects would not be able to be meaningfully measured, detected, or evaluated) when compared to the acres of the entire LAU (Table 24 and Table 25 above). The acres of lynx habitat that could possibly be affected by sheep grazing in this project area is 0.60 percent on the UWCNF and 0.09 percent on the ANF. This percentage of overlap would unlikely result in lynx/hare habitat loss. It is also unlikely that sheep grazing would significantly impact the overall hare food resources to the point of decreasing the hare population because grazing would not cause the vegetation cover types to change and the allotments are currently in satisfactory condition (Cameron 2017 and Huber 2016). A significant impact would be where a person could show that sheep grazing results in an adverse effect and take of an individual lynx. The take for*

[49] West Fork Blacks Fork Grazing FEIS, 2006.
[50] Ibid.
[51] Ibid.
[52] DEIS p. 126-133.
[53] Ibid.

this project would result from an indirect effect to lynx where snowshoe hare populations were decreased resulting in prey reduction.[54]

To summarize: In the DEIS, the FS claims that the Uinta sheep grazing allotments contain less than .1% of primary lynx habitat. This bit of legerdemain was accomplished by adopting an "indicator" as a proxy: "In order to compare and contrast effects to Canada lynx, an indicator was chosen to evaluate."[55] This indicator is the number of acres of aspen, mixed aspen, sagebrush, and willow vegetation cover types within the (PA): "The domestic sheep diet consists of forbs, grasses, and some woody vegetation such as young aspen sprouts (DeByle 1985 and Jensen et al. 1972). Sheep primarily consume forbs, grasses to a lesser extent, and incidentally use willows and aspens as forage (Cameron and Huber 2017). Snowshoe hare, lynx's main prey item, may compete with sheep for these food items in certain habitats such as aspen, mixed aspen, sagebrush, and willow vegetation types within the Project Area."[56]

This is quite a revelation. The FS must have made a tremendous error in the 2006 WFBF Grazing FEIS! The "correction" presented in the DEIS identifies a mere 1,995 acres of primary lynx habitat in all the Uinta LAUs combined, which isn't enough to support a single lynx home range! Secondary lynx habitat isn't even quantified. No wonder sheep trailing and grazing can't have a negative impact on lynxes. As an indicator of lynx abundance and of impacts to the Canada lynx and its habitats from annual sheep trailing and grazing for more than a century, this is simply ludicrous—as if there is no other possible way in which the grazing activities can affect lynxes or a lynx population. Nothing else is even considered.

What about the abundance of lynx prey species in the Uintas? The primary prey species of the lynx throughout its range is snowshoe hare, secondarily red squirrel.[57] Is it the case that there just aren't very many of these animals in the Uintas?

To the contrary, research indicates that the Uintas support a fairly robust hare population with densities comparable to those in other western states and Canadian provinces where Canada lynx are present.[58] Snowshoe hare surveys were conducted in the forest on the north slope of the Uintas, in the same general area that many historic lynx sightings were made, and they have shown "…an average of 0.34 hares per hectare over the three year period within mature vegetation types."[59]

This density also compares favorably with what similar studies have shown in Colorado and Washington—states that have resident lynx populations. For example, a Colorado study

[54] Ibid.
[55] Ibid.
[56] Ibid.
[57] Bunnell, Kevin D., Doctoral Dissertation: Factors Potentially Limiting Canada Lynx Conservation in the Uinta Mountains and the Intermountain West, 2005.
[58] WFBF Grazing FEIS, p. 3-42; Ruggiero, et al. *Ecology and Conservation of Lynx in the United States*, University of Colorado Press (2000), Chapter 7, p. 185)
[59] Bunnell, Kevin D., Doctoral Dissertation: Factors Potentially Limiting Canada Lynx Conservation in the Uinta Mountains and the Intermountain West, 2005.

conducted in 1998 indicated an average of 0.29 hares per hectare.[60] Thus, the evidence indicates that the principal prey species of Canada lynx is fairly abundant in the Uintas. The researchers also surveyed for red squirrels with similar results.

Using WFBF as an example once again, in a previous publication the FS estimated that "Potential habitat for snowshoe hare within the WFBF Allotment based on cover types is approximately 7,354 acres"—approximately equal to the quantity of lynx habitat on the allotment.[61] Apparently snowshoe hare and hare habitat are both moderately abundant on grazing allotments in the Uintas, as well as within the LAUs.

Conclusion: The FS is able to conclude that there is less than .1% primary lynx habitat within the PA by equating primary lynx habitat with aspen, mixed aspen, sagebrush, and willow vegetation. This despite the fact that throughout North America lynx prefer boreal forest consisting primarily of spruce and fir! In addition, the proxy was only measured within the PA, which excludes most of the national forest. If this proxy is adequate for identifying primary lynx habitat, then surely it is adequate for identifying snowshoe hare habitat within the forest as well. And from this one would be warranted in concluding that there are very few snowshoe hares in the Uinta Mountains and surrounding forests. Yet, of course, this is not true, as is shown by the work of Bunnell et al. There is no reason to suppose that snowshoe hare abundance in the Uinta Mountains and surrounding forests is too low to support a residence lynx population. Quite the opposite in fact! So much for H2.

The DEIS fails to consider likely negative impacts to lynxes from sheep grazing

There are many thousands of acres of snowshoe hare habitat and Canada lynx habitat in the PA. H1 and H2 were apparently designed to spare the FS from having to analyze the probable impacts of annual domestic sheep trailing and grazing on Canada lynxes within the PA. The analysis provided by the FS not only minimizes the amount of primary lynx habitat within the PA to a ridiculously low percentage of the total area, it doesn't address probable impacts to the totality of lynx habitat—primary and secondary—within the PA, and hence doesn't adequately address the probable negative effects on the Canada lynx. If the DEIS is correct, the only possible negative impact to lynxes in the Uintas from sheep grazing, albeit an indirect impact, would be restricted to less than 2,000 acres total and would be minimal at worst. This is so obviously untenable as to verge on absurdity. Lynxes rely on a variety of vegetation types. Primary lynx habitat is habitat that provides for a number of needs, not just food for snowshoe hares. The FS acknowledges as much in the DEIS:

> *"Primary habitat consists of Engelmann spruce, subalpine fir, and lodgepole pine on spruce-fir habitat types that supports foraging, denning, and rearing of young. Secondary habitat includes other vegetation types (cool/moist Douglas-fir) when interspersed within subalpine forests and immediately adjacent to primary habitat. Non-habitat are dry forest types such as ponderosa pine and climax lodgepole pine (Ruediger et al. 2000)."*[62]

[60] Species Status Assessment for the CANADA LYNX *(Lynx canadensis)* Contiguous United States Distinct Population Segment, October 2017, page 28.
[61] West Fork Blacks Fork Grazing FEIS, 2006.
[62] DEIS page 129, emphasis added.

It is not incumbent upon citizen reviewers to show that, or how, sheep trailing and grazing, ongoing every year for more than a century, might negatively affect the Canada lynx. It is incumbent on the Forest Service to demonstrate convincingly that the activity will not have a significant negative effect on the Canada lynx. In this regard, the FS is in default and has failed utterly to make a case for its preferred alternative, Alternative 2, so far as Canada lynx conservation is concerned.

Applicable Law.

Marble Mountain Audubon v. Rice[63] interprets NEPA to require the Forest Service to consider biological corridors and to ensure their functionality. The standard for such a review is the same "hard look" NEPA requires of other environmental effects. This means those corridors within the analysis area and linkages with areas adjacent to the analysis area need to be examined, plus the value of the entire analysis area, as part of a larger corridor within or between ecosystems. Friends of the Bitterroot, Inc. v. USFS[64], and Oregon Natural Resources Council v. John Lowe[65] also highlight the importance of including corridors as an element of consideration for an agency decision. Therefore, the Forest is required to address how the grazing and other management activities in the Uinta Mountains affect the Uinta corridor—a corridor that would normally function to promote genetic diversity and population stability 0f lynxes among far flung populations in the Rocky Mountains.

(G18) In Lynx Analysis Units design all management activities to maintain, restore, or protect desired lynx and lynx prey habitats including foraging, denning and movement.[66]

V. Grazing Impacts on the Uinta Wilderness Ecosystem

This section of comments on the Uinta Domestic Sheep DEIS was written by Dr. John Carter, Yellowstone to Uintas Connection. Emanuel Vasquez with the Wild Utah Project conducted mapping and GIS analysis. Darlene Voerner, Ashley NF Soil Scientist - Retired, provided photographs and comments on the sensitivity and characteristics of alpine soils in relation to domestic sheep grazing. Jonathan Ratner of Western Watersheds Project determined ground cover using Sample Point software.

Other than a section of trail here, or a spot there, the DEIS is devoid of any admittance of impacts on soils, vegetation, streams or watersheds by grazing tens of thousands of domestic sheep in this sensitive, steep and erodible landscape. It conflates gophers with areas with low ground cover and claims that areas with high ground cover lack gophers, stating, *"Where sheep graze in the absence of pocket gophers, ground cover is often greater than 85 percent. Where pocket gophers are more abundant, ground cover is reduced."* The DEIS and Forest Specialists avoid the obvious. That is tens of thousands of sheep are grazing these sensitive areas and avoiding the adjacent wet meadows. They graze them before the plants have begun growth as

[63] No. 90-15389, D.C. No. CV89-170-EJG, Sept. 13, 1990
[64] 900 F. Supp. 1368, 1372 (D. Mont 1994)
[65] 109 F.3d 521, 526 (9th Cir. 1997)
[66] Revised Forest Plan Wasatch-Cache National Forest 2003, page 4-42, emphasis added

snowmelt continues until near the end August in many years. The Forest Service concludes that sheep trampling the wet soils on slopes and eating plants that have barely begun growth don't do damage, but gophers do. The DEIS ignores the ecology of gophers which we have previously summarized along with a study of grazed and ungrazed snow bank and meadow areas showing the soil compaction and forage removal by livestock create a situation wherein gophers, when present, have to forage further, repair and rebuild tunnels that have suffered damage from compaction, thus more visible activity. (See comments dated July 13, 2014).

Then the DEIS (p52) states, *"Other areas with low percent ground cover can be divided into two groups. The first group includes snowbeds, Red Pine Shale barrens, and scoured drainage-ways. Sheep have equal access to these areas that have high percent ground cover as they do to areas that have low percent ground cover."* (DEIS p52). The DEIS (p52) also notes that sheep do not prefer riparian areas and use there is light. This applies to wet meadows as well. In many instances these side by side comparisons of the sensitive areas, i.e. red shale or steep slopes with an adjacent wetland or wet meadow area (avoided by sheep) are used to make this claim that since sheep have equal access to both areas, it cannot be sheep causing the destabilization or bare soil in the shale area. As will be seen below, the Forest Service, by limiting its monitoring to areas less sensitive to damage by sheep grazing also makes the claim that conditions are "satisfactory".

A review of the "studies" provided by the Forest Service on July 10, 2019 in response to our data request shows that the dominant focus of Forest Service monitoring has been in meadows, wetlands and riparian areas, i.e. "climax communities" according to Darlene Voerner a former soil scientist with the Ashley NF. These have higher resistance to sheep grazing impacts, and receive less use by sheep, while little focus has been on areas described above such as the snowbeds, Red Pine Shale barrens and scoured drainage-ways that are not capable and subject to high erosion rates. Steep slopes are rarely monitored. The relationship of sheep grazing in these alpine capable and non-capable areas to watershed dynamics and flood forces is ignored. Scoured streams are "natural", bare soils in these sensitive areas are "natural". But, basic hydrology would acknowledge that sheep grazing removes vegetation and compacts soils, while creating bare ground. These factors as represented in the Universal Soil Loss equation and even in Forest Service research by such notables as Paul Packer in the 1950's, would say that grazing increases runoff and decreases infiltration, and as slope angle increases so do erosion and runoff. The increased flood forces scour streams, and particularly in areas where livestock grazing has removed vegetation or trampled banks.

The entire database of studies provided in our FOIA response dated July 10, 2019 is devoid of reference to the role of domestic sheep in accelerating loss of soil cover and erosion. All bare soil is natural, a result of gophers, snowbeds, talus slope runoff, frost boils and so on. Bedding, salting, watering spots, trailing and camps are claimed to only damage small areas. (DEIS p53). For example, sheep bedding is claimed to be less than 1% of the Project Area. Salt grounds are moved around, and account for less than 1% of the Project Area. Trail damage is acknowledged as less than 1% of the Project Area (160,000) acres. For bedding, this amounts to 1,600 acres in a single year, but sheep have grazed these allotments for decades, nearly a century. In ten years, the damage would be 10% or 16,000 acres. In a century, the entire project area has been subjected to bedding, salting, and trailing with the associated damage to soils and plant

communities. Trailing is not limited to a narrow band, as high passes and slopes on both sides are grazed and denuded.

A huge problem is present in this DEIS and the monitoring studies conducted by the Forest Service. This is to deflect around damage by domestic sheep. This appears in the record after Mont Lewis, who worked in these areas in the 1960's, applied ecological principles driven by the R4 Range Analysis Handbook. It was a logical, science-based document, but has been abandoned as have the basic principles of Range Science. Such things as setting stocking rates based on desirable forage present in capable areas, these are areas that are not on steep slopes, are not moderately to highly erodible, are not in dense forest and do not risk accelerated erosion. Stocking rates were to be based on the amount of forage consumed[67] by the permitted livestock in those capable acres, which the Forest Service states now must produce more than 200 lbs/acre of forage, but doesn't account for that and these other factors in its own capability and suitability determinations. Utilization rates supported by science are currently 30%, not the 50 - 60% allowed on most public lands. In addition, grazing periods should be adjusted to allow sensitive native plants to maintain vigor, i.e. productive and producing seed or propagules, and not be grazed during early growth. Destocking during drought[68] is vital, and rest is vital for recovery of plant vigor following grazing.[69] None of these principles were observed in the DEIS or the "studies" provided by the Forest Service. The DEIS is devoid of Range or Ecological Science.

We are not surprised at this obfuscation around conditions on the ground or the abandonment of science. During meetings with various Forest Service staff we have been told these allotments are "hammered", that they fear the wrath of the permittees and their political allies and that if they do anything to change the status quo, the Region comes down on them. Recent books and articles that provide interviews with retired agency employees paint a picture of failed management, lying and then relying on environmental groups to sue so the agencies can claim to their permittees and associated political allies within and without the agencies that they had no choice in the matter. See Daily Beast Article by Christopher Ketcham[70], "Western Turf Wars" by Mike Hudak[71] and most recently the "This Land: How Cowboys, Corruption and Capitalism are Ruining the American West"[72]. The Forest Service is entrusted with managing these lands as part of its public trust duty and represents the public, not extractive interests.

We note that in his 2018 State of the Union on January 30, President Trump invoked the public trust responsibilities of the agencies.

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[67] Carter, J. 2016. Updating the Animal Unit Month. Yellowstone to Uintas Connection. https://app.box.com/s/zx4xjekrfuht2aq12soruw0qfil8hogk

[68] Holechek et al. 2004. Range Management Principles and Practices. 5th Ed. Prentice-Hall, NJ.

[69] Carter, J. 2013. Utilization, Rest and Grazing Systems - A Review. Yellowstone to Uintas Connection. https://app.box.com/s/ngw6723dx52quxw2rd8u

[70] Ketcham, C. 2017. Help Wanted: Biologists to Save the West From Trump. https://www.thedailybeast.com/help-wanted-biologists-to-save-the-west-from-trump

[71] Hudak, M. 2007. Western Turf Wars: The Politics of Public Lands Ranching. http://westernturfwars.com/

[72] Ketcham, C. 2019. This Land: How Cowboys, Capitalism, and Corruption are Ruining the American West. https://www.kingsenglish.com/event/christopher-ketcham-land-how-cowboys-capitalism-and-corruption-are-ruining-american-west

All Americans deserve accountability and respect -- and that is what we are giving them. So tonight, I call on the Congress to empower every Cabinet Secretary with the authority to reward good workers -- and to remove Federal employees who undermine the public trust or fail the American people.

The "Standards of Conduct for Employees of the Executive Branch" states principles such as:

- *Public service is a public trust, requiring employees to place loyalty to the Constitution, the laws and ethical principles above private gain.*
- *Employees shall put forth honest effort in the performance of their duties.*
- *Employees shall act impartially and not give preferential treatment to any private organization or individual.*

This indicates that the public trust is elevated above politics or turning a blind eye (willful blindness) to the damage. Making decisions without full disclosure of the facts and best available science is an abdication of the public trust.

In his 1970 Report, *"Alpine Rangelands of the Uinta Mountains - Ashley and Wasatch National Forests"*, Mont Lewis addresses the sensitive nature of these alpine areas and applies these principles to management.[73] He identifies the areas that should not be grazed due to erosion susceptibility, he identifies the mechanisms of sheep damage to soils and plant communities. He explains that potential ground cover in most areas is near 100%. Mont was apparently the last objective Range Professional on these Forests.

Summary of Mont Lewis report

- Soil development
    - Glacial moraines - shallow and rocky, less than a foot of soil, 50% rock
    - Fellfields - very shallow, poorly developed
    - Boulder fields and talus - soil becomes deep, up to 30", eventually covering most of the boulders
    - Alluvial outwash - terraces and fans found at the foot of boulder fields and talus, soils formed from fines flushed out by snowmelt and storms, soils up to 30" deep
    - Slopes below seeps and snowdrifts - on steep slopes where moisture present, plants occupy most of the soil strip, similar to boulder field and meadow
    - Meadows and bottomlands - sediment deposited, well developed and deep, soils with high organic content

Photographs in the report depict vegetation cover is high when sites are in good to excellent condition.

- Alpine soils are sandy to silt loams with surface aggregates that are "rather weak and poorly defined" while a high percentage of rocks and gravel counteract this and result in medium erosion hazard. Shale derived soils are unstable with moderately high to high erosion hazard and rapid erosion occurs wherever ground

[73] Lewis, M. 1970. Alpine Rangelands of the Uinta Mountains, Ashley and Wasatch National Forests. US Forest Service.

cover is lacking. Any grazing use that damages plant cover may have serious consequences.
    - Ground cover on stable sites is nearly complete, on rocky areas very little soil is exposed, most communities have a very tough sod which gives it its stability.
    - Frost action breaks down soil stability in some areas, which is accelerated by grazing animals. "If a site is naturally unstable, it would be folly to add the burden of grazing use to it." (p21) "Trampling by sheep was observed to increase the size of the sod breaks and thus contribute to the instability." (p23) Example of dry meadow in poor condition due to frost and heavy grazing breaking up the sod. (p25). Ashley NF Range studies called this an "interrupted turf community" (covered in a later section). "Sheep walking across solifluction terraces, tend to break the sod and thus weaken its stabilizing power on the face of the terrace. (p27, 29).
    - Concentration of runoff at the base of boulder fields can gouge the turf and create headcuts.[74]
- Plant Communities
    - Cites reference of *Deschampsia caespitosa* sites being classified as snowbed vegetation, with *Geum* turf characterizing exposed sites where wind removes much of the snow. Water accumulation resulted in bog vegetation such as *Carex scopulorum*. Lists dominant species characteristic of wet and dry meadows, drier exposed sites.
    - *Geum rossii* a dominant in boulder fields and dry meadow, deep roots compared to shallower rooted grasses and sedges. Associates with *Deschampsia caespitosa* in dry meadows.
    - Sedge-grass community occurs on the most stable portions of high ridges and slopes with deep soils.
    - Wet meadow and bog communities are too wet for sheep grazing and can include *Carex aquatilus, Carex saxatilis, Deschampsia caespitosa*.
    - Dry meadow or *Deschampsia* and *Geum* community grades from wet and semiwet meadows to dryland comunities and are positioned in the basins and at the foot of slopes. Dry meadows are common on the Uinta Alpine areas and is a favorite of grazing animals, and heavy use and damage to the plant cover have occurred in many areas.
    - Alpine shrub community are the willow, dryad and heath. Hedged and dead willow clumps are common on heavily grazed sheep ranges.
    - Conifer community are characterized by scattered trees and open parks. It extends to the head of drainages, along terraces and benches. The drier sites within this area are generally in poor condition due to heavy grazing. The conifer community is one of the heaviest grazed portions of the high elevation types.
- The report (p50) discusses the rate of change in succession with removal of livestock based on the Kidney Lakes exclosure. After eleven years of exclusion vigor improved, and desirable plants increased in composition, while non-forage species were reduced. The vegetation changes resulted in condition changing from fair to good.

[74] John Carter note - this is counterintuitive as the turf formed in the same position under the same climate/water regime, so an external force such as sheep grazing and trampling has to break the sod. Once the sod is broken, then wind and water erosion can take place.

- Range condition guides were based on results of site analysis on areas that had little or no past grazing use. Most of the areas studied had ground cover approaching 100 percent. Studies on areas that had deteriorated from past grazing use had reduced ground cover and a decline in plant vigor. This results in lowered soil stability.
- Determination of suitability
    - Suitability determined by accessibility, animal preference, soil erodibility, slope and ground cover
    - Wet meadows not preferred by sheep were not considered suitable.
    - Soils with high or moderately high erosion index are very susceptible to erosion. "If a protective ground cover of vegetation and litter cannot be maintained under grazing use, the area should be classed as unsuitable and closed to livestock." (p57). Soil on shale areas are in this classification. Slopes over 20% should be heavily sodded before they are considered as suitable for grazing.
    - Observations show sheep grazing to be a most important factor in sod breaking and reduced ground cover. Serious erosion problems develop when about 30% of the soil becomes bare.
- Grazing capacity
    - Should be based only on suitable range. Suitable and non-suitable areas are intermixed on much of the alpine area and grazing use must consider the damage of the unsuitable areas while suitable areas are grazed. Damage will be based on the stability of the unsuitable range.
    - Unsuitable areas on steeper slopes and shale outcrops must be given full protection from grazing

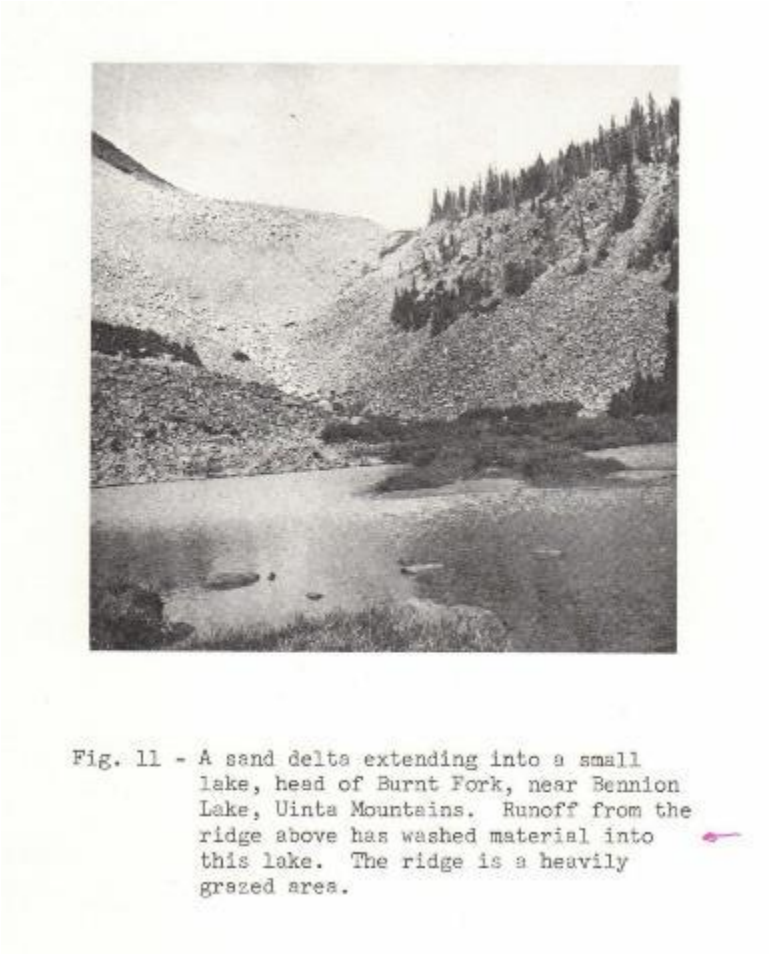


Fig. 11 - A sand delta extending into a small lake, head of Burnt Fork, near Bennion Lake, Uinta Mountains. Runoff from the ridge above has washed material into this lake. The ridge is a heavily grazed area.

Lewis provided photographs typifying communities in good to excellent condition, not recently grazed. He also provided photographs showing typical sheep damage. The DEIS cites Brown (2006)[75] as the authority on these communities. We have protested the use of this document as biased and down-grading potential

[75] Brown, Garry D. 2006. 2006. An Alpine Plant Community Classification for the Uinta Mountains, Utah. USDA Forest Service Intermountain Region, Ashley and Wasatch-Cache National Forests.

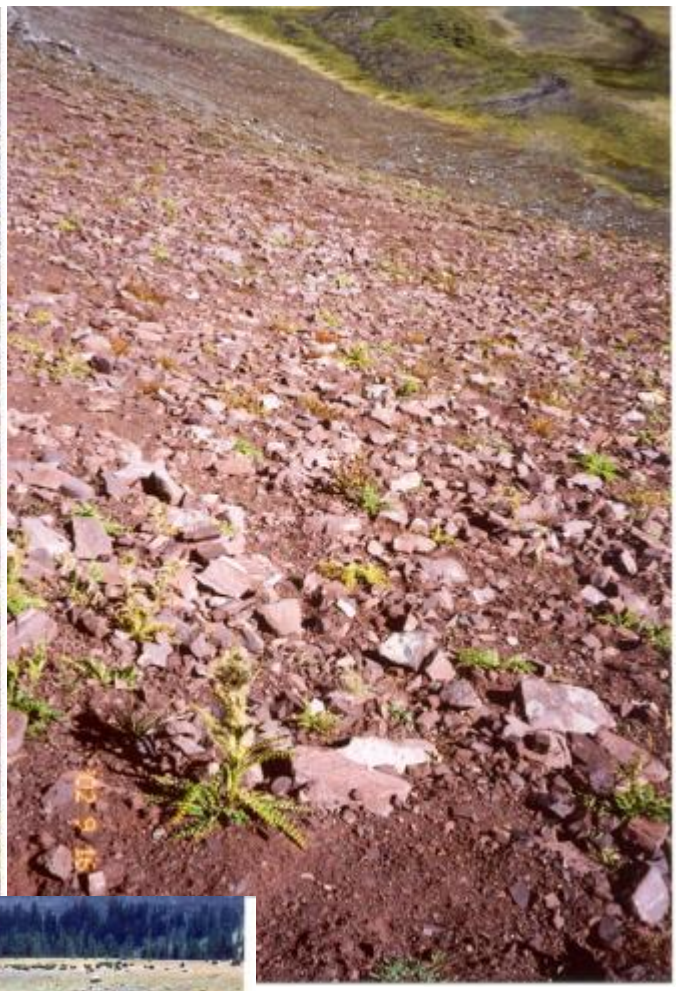
plant and soil communities to claim current degraded conditions are natural, Brown's work was done in heavily grazed sheep allotments. Brown was associated with Sheryl Goodrich, one of the sheep damage deniers that have worked for the Forest Service since the early 1990's. Our letter (attached) requested that this study be withdrawn and a more honest characterization produced that uses ungrazed watersheds as references.

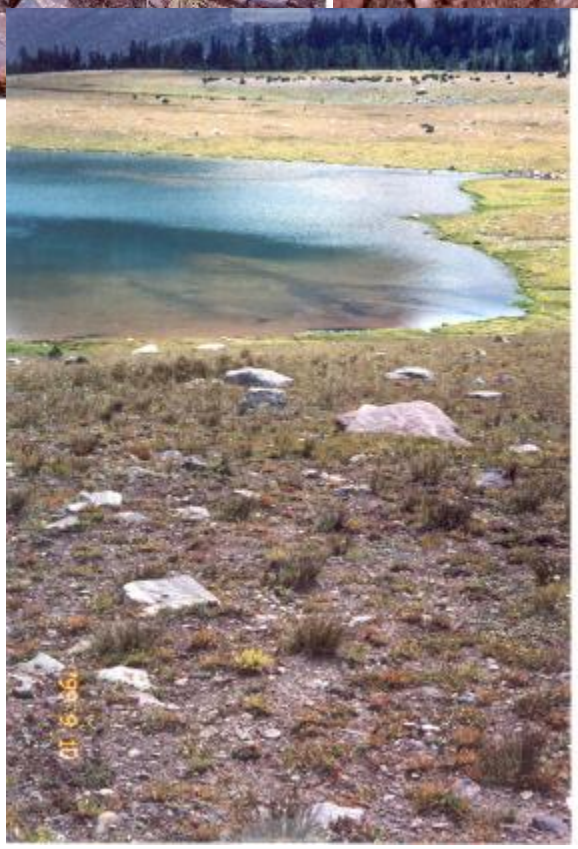
Above is a Figure from Lewis' report showing consequences of sheep grazing on steep slopes and ridges, which due to harsh growing conditions and erosion hazard should not be grazed. In this case the lake is being filled with sediment from the accelerated erosion generated by sheep grazing in this sensitive, steep area. Today, these areas are still grazed by sheep as the photos and ground cover data in the 2006 report (Carter 2006) by Dr. Carter on behalf of WWP demonstrates in numerous photographs. [76] Two examples are provided in the following photos.

The left photo below was taken in East Fork Blacks Fork and shows the steep slope with near 100% bare soil, but with residual thistles that are deep rooted, illustrating that the soil can support a high percent ground cover if not grazed. The right photo shows the slope leading into Lake Fork Basin from Red Knob Pass along the sheep trail, but the entire slope, not just the trail, is denuded by grazing sheep. Lewis also reported that lakes in the Uintas were being filled with sediment from sheep grazing slopes and erodible soils in their watersheds. An example from the West Fork Blacks Fork's Lake EJOD was provided in (Carter 2006) and is shown in the following photo. Note the bare soil in the foreground which is typical of all the uplands surrounding the lake. This occurs throughout the grazed areas of the Uintas and is ignored by the Forest Service.

[76] Carter, J. 2006. Watershed Conditions Uinta Wilderness. Western Watersheds Project. https://app.box.com/s/944957604b8618539585







Another example of an area that should not be grazed is the shale type. Lewis provides the photo below (left) of this type in very poor condition that should not be grazed. The photo at right is from Carter (2006), showing a similar area grazed by sheep in East Fork Black's Fork. It is mostly bare soil, but with trees and plants present showing it has potential for plant occupancy. The Forest Service today claims these conditions are natural and have no relation to domestic sheep grazing. The agency makes this claim by relying on flawed information such as Brown (2006), biased interpretations by Forest Service staff, ignoring that sheep use these areas, and by not using ungrazed reference areas.

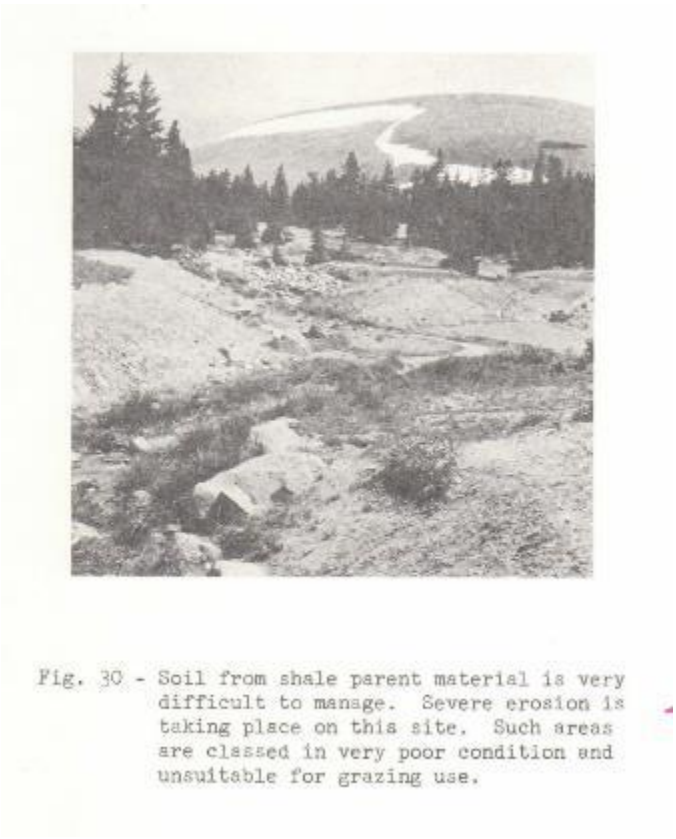
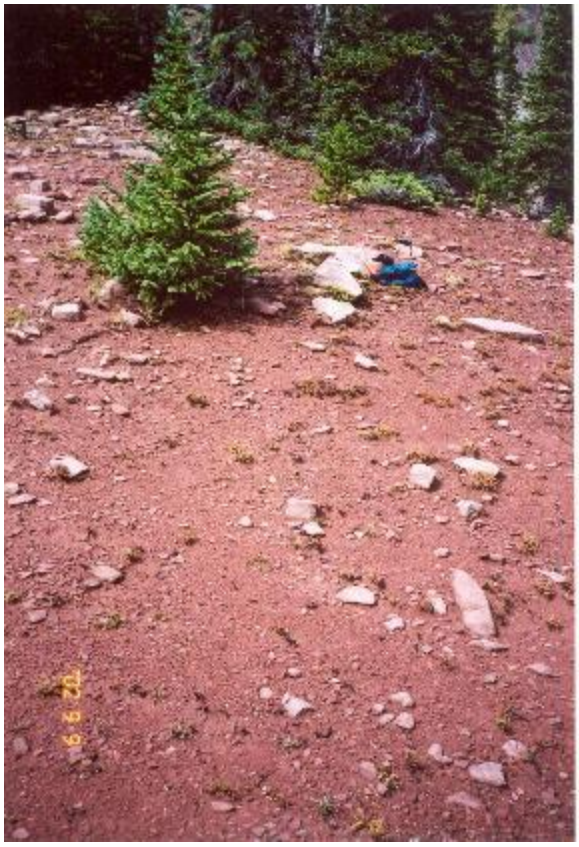


Fig. 30 - Soil from shale parent material is very difficult to manage. Severe erosion is taking place on this site. Such areas are classed in very poor condition and unsuitable for grazing use.



Lewis (1970) provides other examples of sheep damage in photos below. The photo at right is termed alpine turf. It is an area that should have near 100% ground cover but has a large amount of bare soil due to sheep grazing. The left photo is shown in very poor condition reflecting high percent bare soil. Here, Lewis is objectively reporting on sheep damage to areas that have high potential ground cover. Whereas, the current Forest Service would report these conditions as naturally occurring. For example, Sheryl Goodrich, in a photo of a meadow with bare soil and soil pedestals calls it an "interrupted turf community". See later section for photos and comments.



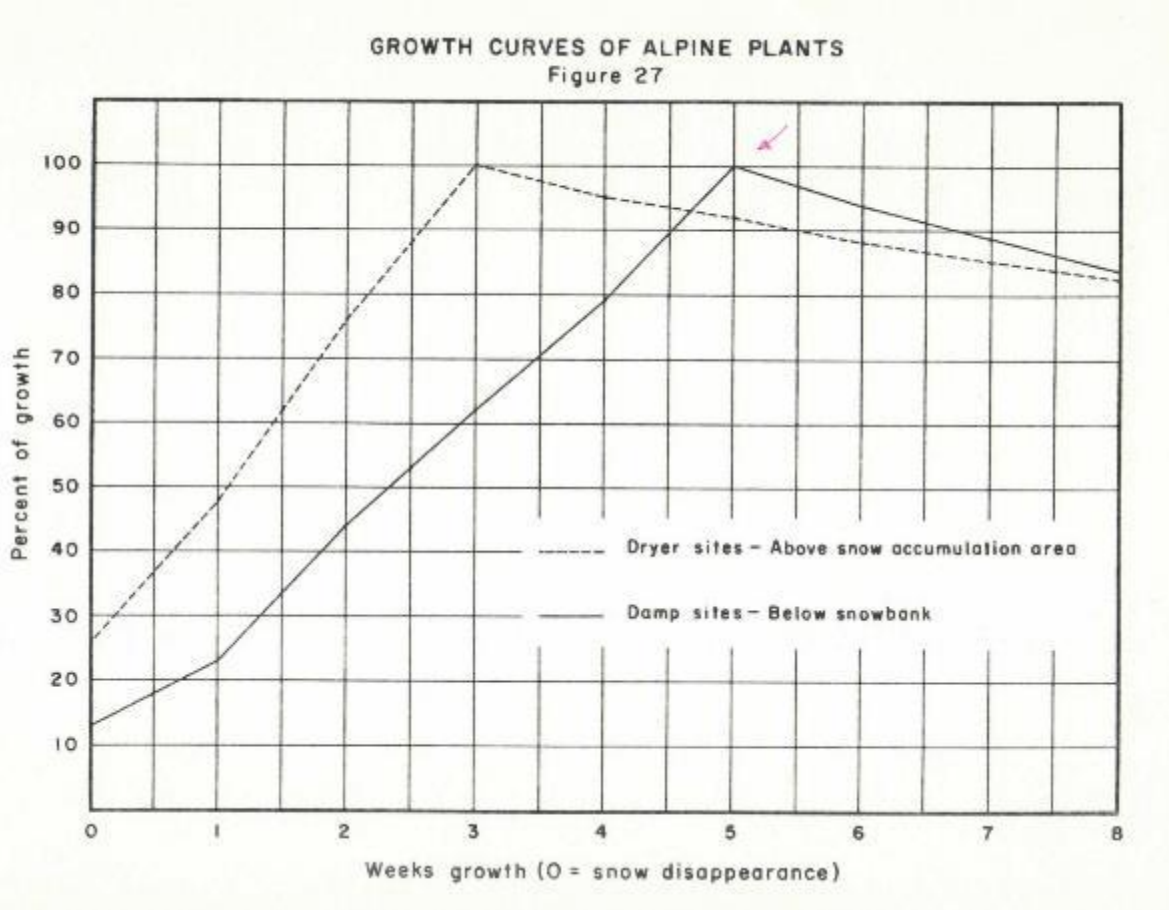
Fig. 29 - Geum-sedge community in very poor condition and unsuitable for livestock grazing. The soils on this 40 percent slope are very unstable.



Fig. 28 - Alpine turf in very poor condition. This site has approximately 35 percent bare soil. It is a concentration area with a long history of heavy use. Lack of soil stability places it in the very poor condition class.

Regarding Range Science principles, Lewis (1970) provides growth curves for alpine plants in two settings. One curve is for well drained locations above snowbanks, the other a less well drained site below snowbanks. Inspection of these curves reveals that after snowmelt, plants in the "above" position reach growth peak in three weeks following snowmelt. Those in the lower position take five weeks to reach peak growth. Sheep grazing in these allotments occurs between late July to early September. Snow melts from the higher elevations and snowbank areas as late as August (see photos in the next section from Forest Service studies). This means that sheep will be grazing and trampling areas such as snowbank or snowbed areas before plants have a chance to grow and while soils are still wet. As Range Science has shown, this is a recipe to eliminate those plants. See Holechek et al (2004)[68]. While ignoring this basic plant physiological fact, the Forest Service allows sheep to graze these areas too early and destroys the plant community, then attributes bare soil to snowbeds or gophers or claim it is in a natural state.

As noted above, we reviewed the ecology of gophers in our comments previously submitted, and while there can be more activity in areas of long-lasting snowbanks, this is due to soil compaction and reduced forage productivity. When sheep are added, more compaction occurs and less production is present. This has the effect of forcing the gopher population to forage more, dig more and eat a larger proportion of the plant roots present. In a normal situation, gophers live in stable tunnel systems and there is little evidence of their presence. Add livestock and, all of a sudden, more gopher activity is evident.



Plant and Soil Interpretations for Alpine Soils by Darlene Voerner, Ashley NF Soil Scientist - Retired

The following writeup and photographs illustrate some of the characteristics and effects of domestic sheep grazing in the Uinta alpine area. We have also requested the report by Christie Oprandy, Soil Scientist-Retired Ashley NF, for the West Fork Black's Fork allotment management plan EIS so that the soil interpretations for that allotment can be applied to this project.

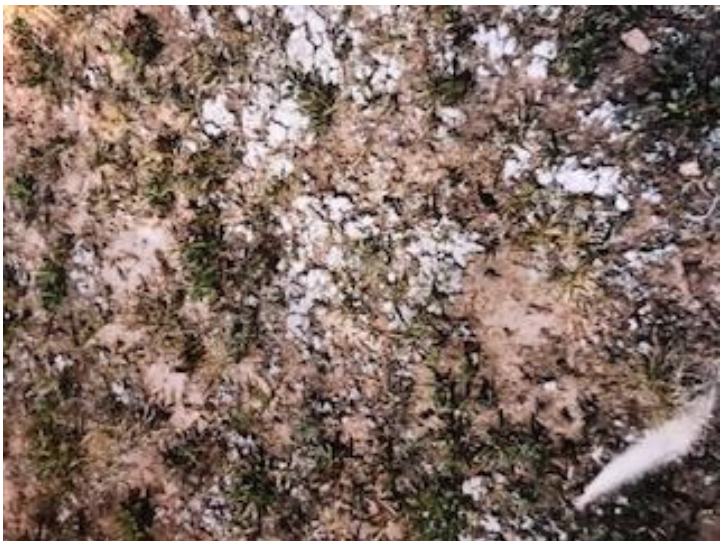
Alpine soils in the cirque basins of the Uintas are formed in till and are generally shallow, sandy and very erosive. Ground moraine has deeper soils but no less erosive. Many components of these systems, whether natural or not, exhibit conditions under which disturbance should be enough to remove them from the suitable grazing designation the Forest has given them. Climate change, gophers, short growing season, shallow erodible soils, lack of lichen in many allotments containing alpine soils should be looked at closer in terms of how much erosion has taken place and continues to erode. It is necessary to know how much eroded phase of soils there is and not just vegetation points that generally are done in climax plant communities. There should be an analysis of the amount of eroded phases of soils in the alpine basins.



Late Snowbanks in alpine areas reduce growing seasons in years where The snowpack lasts into the summer.



Sheep Allotment with broken turf. Soils are shallow with a 1-2 inch A Horizon. Once the turf breaks and erosion starts, the vegetation continues To peel back reducing productivity and increasing loss of soil.



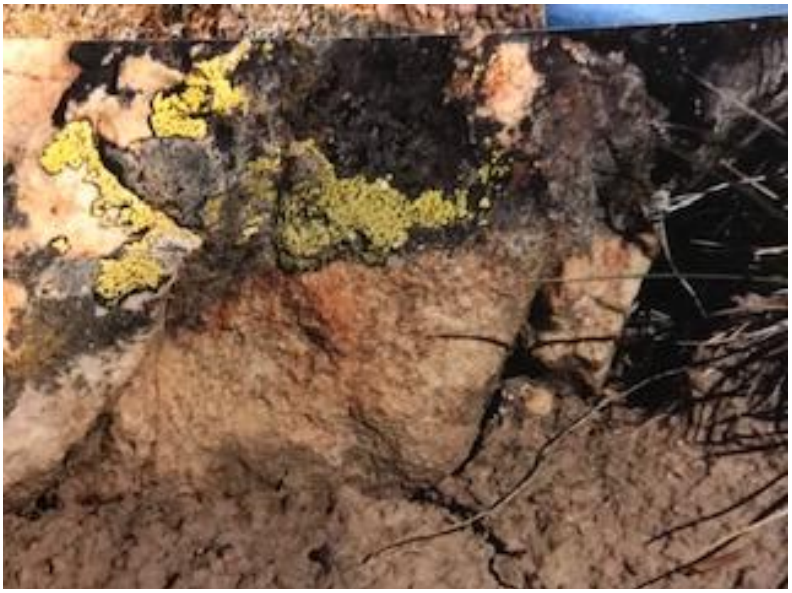
Lichen are an important component of alpine areas. They help stabilize the Soil. Chepeta Lake Area. Grazing has been discontinued and lichens are coming back in to stabilize the soils.



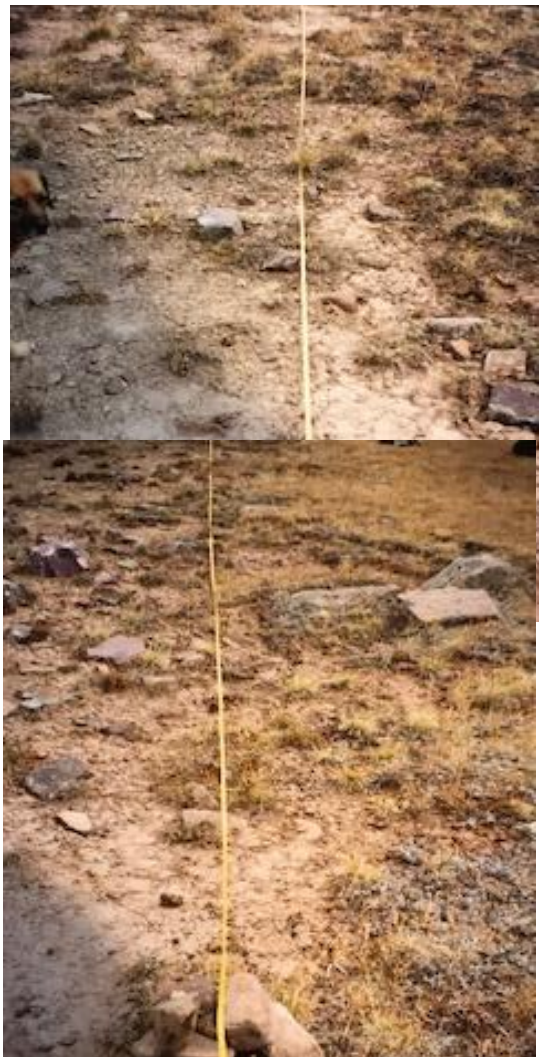
Areas called barren or rock are oftentimes the result of a thin layer of soil that has been eroded exposing what becomes barrens and bedrock. Once these plant communities start breaking and soil erodes it continues to exfoliate and move back.



A lichen line from soil erosion. The lower section of this rock is level with soil and vegetation to the right. The lichen covered area sticks above the past soil line. West Fork Blacks Fork.



A soil/lichen line with erosion of the soil below the lichen. Vey common to see erosion leaving lichens growing to where the soil at one time was. West Fork Blacks Fork.



Eroded phases of soil in alpine showing the breaking of the sod and the continued removal leaving pedestaled vegetation behind. It is not known what percent of the alpine basins are In an eroded phase and a level 2 soil survey should be done to identify the extent of this erosion

Comments on Forest Service "Studies"

In response to our request, we received a file from the Forest Service titled, "03-Studies". In that file, there are field photos and some data sheets for each of the ten allotments in question. Due to lack of time, we have only reviewed the Ashley NF allotment files and cannot do a complete analysis since our request for a 30-day extension was denied stating that *"Forest Service specialists have already summarized this information as part of their analyses…as part of the DEIS."*[77] This is a problem in that the DEIS is general in nature and, for example, while the DEIS mentions utilization standards it applies, there is no data. There was no presentation of actual utilization measurements for each allotment and there was no utilization data provided in the files we obtained. So, utilization standards are meaningless as there is no data and therefore no enforcement. It is all deflection around the situation on the ground. For the Ashley NF allotments we reviewed all the data files and photos. There were 1565 study sites in the Ashley NF spreadsheet titled "**07092019ANFStudyPlotCoordinates**" provided by the Forest Service. Many of these had no location coordinates. But, of 1565 sites listed only 69 reported ground cover data from either line intercept or ocular estimates in the past 20 years, and location data was missing for some of those. In the following pages, we make reference to the page, folder and file in which photographs or data forms are located.

[77] Forest Service response to request for extension of time dated July 30, 2019.

Examples of Topography, Snow Cover Time Period

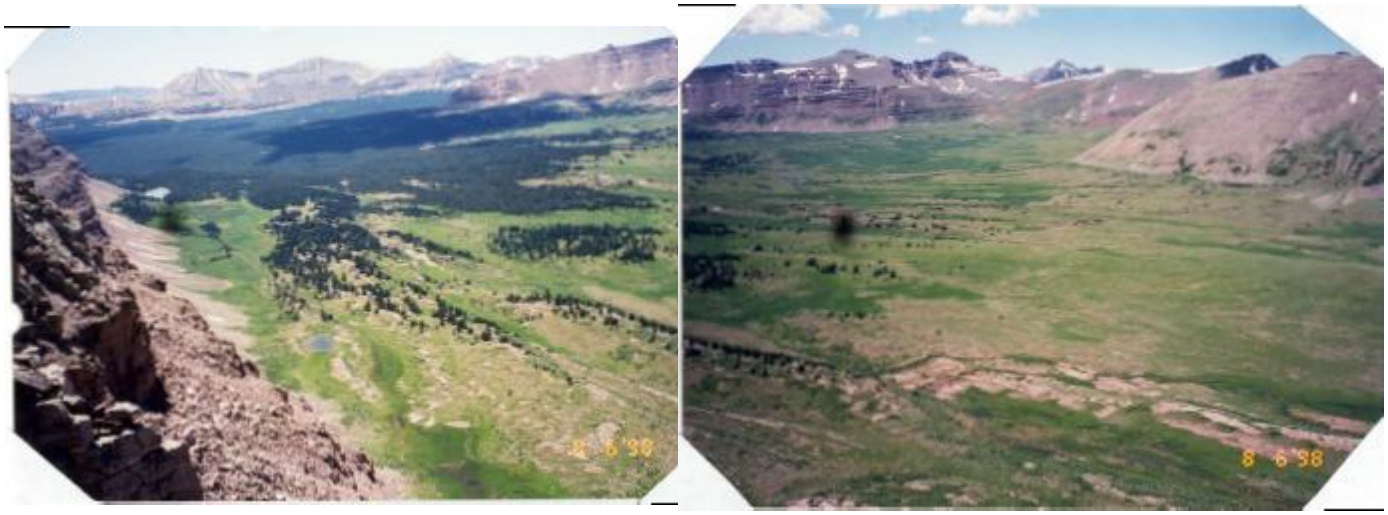
The head of Yellowstone Drainage M Muir 2009 (P193 Tungsten 24-002 to 24-035) shows basin with wet meadow and willow habitat in the valley floor (habitat avoided by sheep), leaving the knolls, rocky slopes and a few dry sites subjected to sheep grazing scattered around these wet sites that are not preferred.



The head of Yellowstone 29 July 2008 (p163 Tungsten 11-002 to 11-013) showing valley bottom, heavily forested areas, wetland and willow areas, all areas either not capable for sheep grazing or not preferred and avoided in preference to drier upland sites..which in this photo are the ones along the base of ridges and talus slopes, in sensitive soils.



Lower Oweep Basin and head of Lake Fork drainage (p403 Tungsten 11-002 to 11-013). Similar to the Yellowstone photos above, showing non capable, wet, forested areas with capable areas in the drier uplands. Lewis in his report indicates only a small amount of the land in the alpine is "suitable", which in his day meant capable.



Tungsten photo showing snow present 29 July 2008 (p92 Tungsten 11-002 to 11-013). Snow still laying in slopes at the end of July. The allotments in this project are grazed by sheep from mid-July to early September. The growth of plants in these areas will have barely begun when sheep are allowed to graze them, yet it is the snow or gophers that cause bare soil and erosion.



Snow still present Head of Yellowstone August 1967 (p123 Tungsten 11-002 to 11-013). Similar to the photo above, but showing snow still present in these "snowbeds" until sometime in August. Plant growth will not be far along in these areas even at the end of the grazing season. Again, is it any wonder there is low production and high bare soil when a stressed environment such as this is not allowed to complete its growth before thousands of sheep graze and trample it?



Fall Creek allotment ungrazed since the 1970 time period.

Phinney Lake August 2009 (p10 Fall Creek 22-007 to 22-021) showing conifer and dry meadow looking lush and green after decades of rest from grazing by sheep. This site had 100% ground cover.



Phinney Southwest August 2009 (p31, 32 22-007 to 22-021). The next two photos showing old trail with erosion healing after decades of rest from sheep grazing. Adjacent dry meadow fully vegetated head cuts healing





Phinney Southwest August 2009 (p33, 36, 38 22-007 to 22-021). Next three photos show wet meadow and adjacent dry upland moraines appearing fully vegetated after decades of rest from sheep grazing. Evidence of bank scouring from high runoff events appears to be absent and in the third photo an area of bank trampling is healing as sedges stabilize it.







Photos below taken from Carter (2006). Upper shows headcuts in a meadow in the Middle Fork Beaver Creek watershed. They are healing after decades of rest from sheep grazing. The bottom photo is of active headcuts in the East Fork Black's Fork where sheep grazing continues.





Phinney North 2009 (p39 22-007 to 22-021). Dry meadow with Deschampsia and Danthonia common. Ground cover 99% after decades of rest from sheep grazing.



Fall Creek Basin 2009 (p113 22-007 to 22-021). Shows trail barely visible in absence of sheep and herders' horses. This is in the presence of recreation.



Fall Creek Ledge Lake Trail 2004 (p115 22-007 to 22-021). Shows trail with headcuts healing and vegetation returning to bare areas after two or more decades of no sheep trailing.



Fall Creek trail braiding shown 2009 (p137 22-007 to 22-021) note vegetation growing in bare areas as it recovers in the absence of sheep grazing and trailing.



Fall Creek snowbed site 2004 (p232, 233 22-007 to 22-021). This shows cover of plants such as pussytoes, sibbaldia and soil lichens. A note with photos states, *"Close-up of an area with an abundance of a gray lichen that grows on the soil. Abundance of this lichen indicates absence or low presence of pocket gophers. It does not seem to be able to persist in abundance in areas where pocket gophers are highly active."* As pointed out in St. Clair et al (2007) who studied lichens in the Uinta mountains, lichen cover is reduced in the presence of sheep grazing.[78] In these photos, it is the absence of sheep that have allowed lichens to grow. In addition, without sheep, there is no evidence of gophers in the photos.





[78] St. Clair, L, Johansen, J, St. Clair, S, and Knight, K. 2007. The influence of grazing and other environmental factors on lichen community structure along an alpine tundra ridge in the Uinta Mountains, Utah, USA. Arctic, Antarctic, and Alpine Research: 39 p 603-613.

Other photos in the Fall Creek folder show areas of bare soil remain, head cuts and bank scours and bank trampled areas remain, but these appear to be healing after two to three decades of rest as sedges, willows and other plants move in, so recovery is clearly a long-term process. It took a century for the degradation to take place, it likely will take that long or longer for full recovery.

Ottoson Sheep Grazing 2009 (p33 09-001 to 22-013). Here sheep are seen grazing on the dry areas and completely avoiding the wet areas. The removal of vegetation and trampling of these uplands leads to accelerated runoff and flood forces that lead to scouring of stream banks.



Ottoson Severe erosion 2009 (p38 (p33 09-001 to 22-013) as accelerated runoff scours out channels. These do not show signs of healing as the ones in Fall Creek with decades of rest do.



Ottoson Little Basin snowbed (p 42, 43 09-001 to 22-013) shows a snowbed adjacent to willows. Sheep graze these slopes that are described as "barren" and where *"The growing season is so short for plants to colonize much of the site."* Here Goodrich & Co recognize the growing season is short, but say nothing of the contribution of sheep to the loss of plant cover or lichens by grazing these steep slopes as plants have barely begun growth and soils are wet.





Ottoson Little Basin Discontinuous Sod Community 2001 (p97 09-001 to 22-013). Here Goodrich & Co call this broken up meadow a "discontinuous sod community". As Mont Lewis demonstrated in his report (Figure 28), this is alpine turf in very poor condition due to heavy sheep grazing. Goodrich & Co claim it is not sheep because the area with high cover is not broken up. What they don't address is the characteristics of what they call a "turf community" which may be a wetter site with greater resistance to damage. Inset is also a copy from Lewis (1970) showing the same situation but acknowledging the role of sheep.

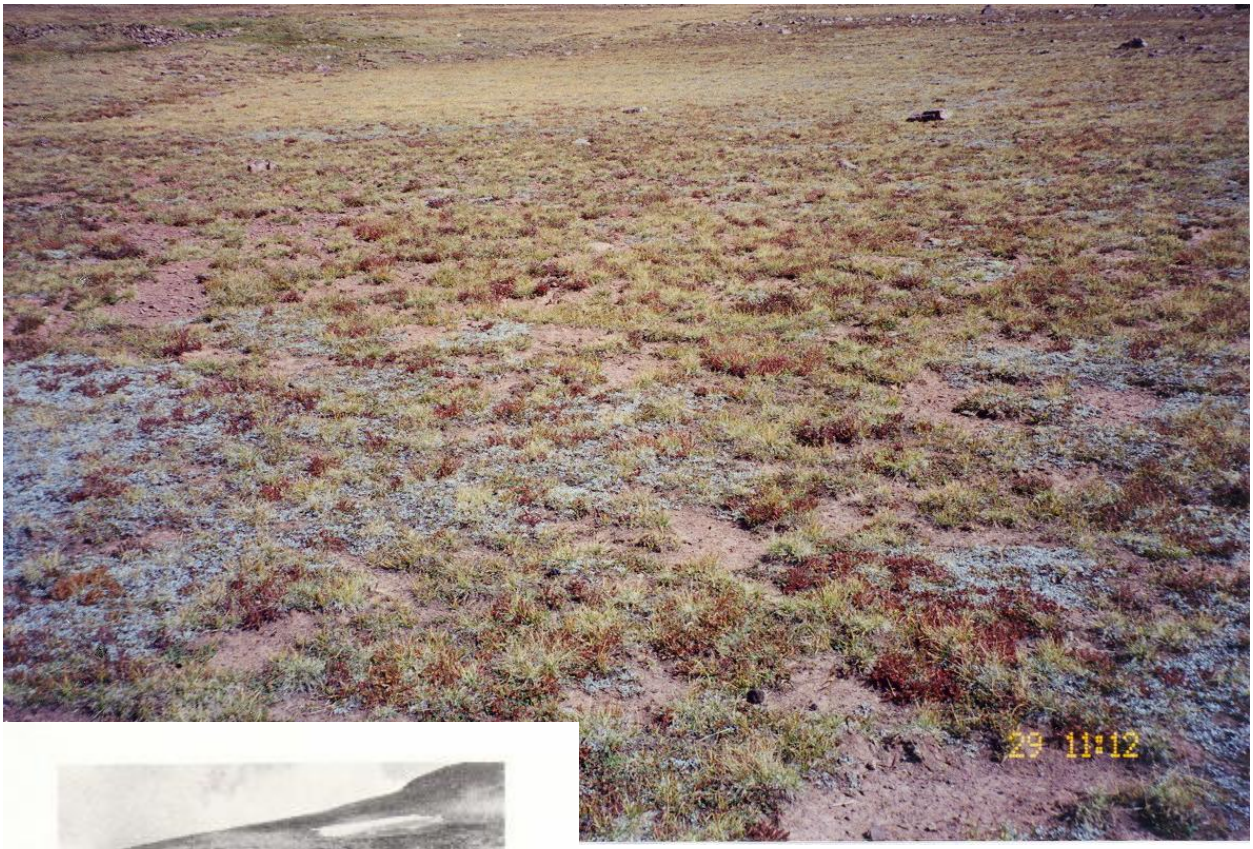




Fig. 28 - Alpine turf in very poor condition. This site has approximately 35 percent bare soil. It is a concentration area with a long history of heavy use. Lack of soil stability places it in the very poor condition class.

Ottoson wet meadow 1994 (p167 09-001 to 22-013). Note with photo by Goodrich states, *"Sheep are very reluctant to use these wet meadows."* He acknowledges this fact, but ignores it when convenient to claim barren areas are natural when they are situated adjacent to these sites.



Ottoson sheep being driven 1982 (p292 22-014 to 23-027). Sheep being driven into dense timber and thru boulders. Non capable areas that are purposefully exposed to sheep.



Rorripa Snowbed 29 August 2001. (p298, 301 22-014 to 23-027). Note with photos states, *"2001 was a relatively light snow-pack year. Snow release date was prior to 29 August this year."* The Forest Service knows these sensitive locations are snow covered until near the end of the permitted grazing season, yet they are grazed and trampled while plants barely begin to grow and soil is wet. No evidence of gophers in these photos, yet high percent bare.



Ottoson Lake Fork gopher activity 1993 (p307 22-014 to 23-027). Note with photos states, *"Pocket gopher eskers indicate a site highly selected by gophers"*. This is also a site selected by sheep if one notes that it is an upland adjacent to an extensive wet meadow or wetland area. This is an example of the Forest Service deflecting around the fact that sheep will concentrate in the area where gopher activity is seen, while avoiding the area across the creek.



Oweep sheep trail 2001. (p60 10-002 to 23-002). Note with photo states, *"A Sheep trailing is evident by the narrow band of vegetation of slightly different color indicated by the blue arrows. This trailing intercepts a headcut shown in the lower photo. At this point the trailing combined with the head cut presents an obvious disturbance. The degree of contribution of sheep trailing to the headcut is unknown. However, it likely contributes to the cutting if not the cause of the cut."* It appears the steeper slope to the left provides surface flow that cuts thru an area where sheep trail, creating this erosion feature. These are common throughout grazed areas in the Uintas and for once the Forest Service admits sheep contribute to the failure of the headcut to heal.



Painter Basin 2003 (p304 12-022 to 12-052. Note with photo states, *"This shows the vivid contrast in vegetation cover on the near side of the stream in quartzitic materials and the relative sparse cover on the far side of the stream where shale materials are abundant. Had livestock grazing been so intense as to cause the conditions on the far side of the stream, similar conditions could be expected on the near side of the stream. Site specific factors and not the more or less ubiquitous factor of livestock grazing are strongly indicated to be the cause of the sharp contrast between the 2 sides of the stream."* Here Goodrich & Co fail to note that wet meadow/willow habitat is on the right side in a more level site. They have admitted sheep avoid these areas, yet here in their zeal to forgive any sheep impacts, they fail to connect the dots to acknowledge the area used by sheep is the less stable shale on the left. Sheep bedding, grazing, trailing, loss of ground cover all are happening on the left. This area should not be grazed, but is.



Ottoson Basin 2001 (p144 22-014 to 23-027) Ground cover data sheet on page 147 reports 2% bare soil at this former exclosure site. This photo was scanned by Sample Point and determined to be 40% bare soil. Forest Service data does not agree with the plot photo.



Bald Mountain Study

St. Clair et al (2007) report on research to determine lichen distribution and other factors in relation to sheep grazing and snow duration in the Uinta Mountains. Their literature review of effects of grazing in alpine areas summarizes by saying, *"These studies and others (Andreev, 1975; Utkin, 1974) show conclusively that when grazing animals are herded extensively, there are significant changes in both the lichen and vascular plant communities; specifically, the total lichen cover was reduced, some sensitive species were completely eliminated, and there was a proliferation of grass species (Olofsson, 2006; Polezhaev, 1980)."* Fruticose and foliose species were more susceptible to grazing impacts while the crustose and squamulose species with lower growth form are not as impacted. (References in quotes not footnoted).

They studied a location at Bald Mountain in the Uintas to determine physical and biological differences as determined by differences in accessibility to sheep and along an elevational gradient. Their results are shown in the chart (Figure 4) extracted from their paper as seen below. The lower elevation sites were in snow longer than the upper sites which were windswept. In the figure 4 from their paper below, sites 1 - 9 are the lower elevation higher snow sites, or meadow location also used as a sheep bedding area. Sites 10 - 18 were higher elevation and more windswept, rocky areas less used by sheep. The Figure shows the sites with more snow and accessible to sheep had total ground cover of about 50%, while the rocky sites with less snow and less sheep access had total ground cover ranging from about 50% to near 100% and an average of about 75%. Bare ground was much higher in the meadow locations than in the more rocky locations. The grazed site had fewer lichen species and was dominated by crustose forms. It also had two vagrant species brought in from lower elevations by the sheep. The conclude by saying, *"Data from this project demonstrated that lichen community distribution and structure are directly influenced by several factors, including domestic sheep grazing, degree of rockiness, nature of the vascular plant community, and snowmelt patterns. Grazing activity had a double impact on lichen community structure at the lower transect sites by 'adding' new species while eliminating species sensitive to trampling."*

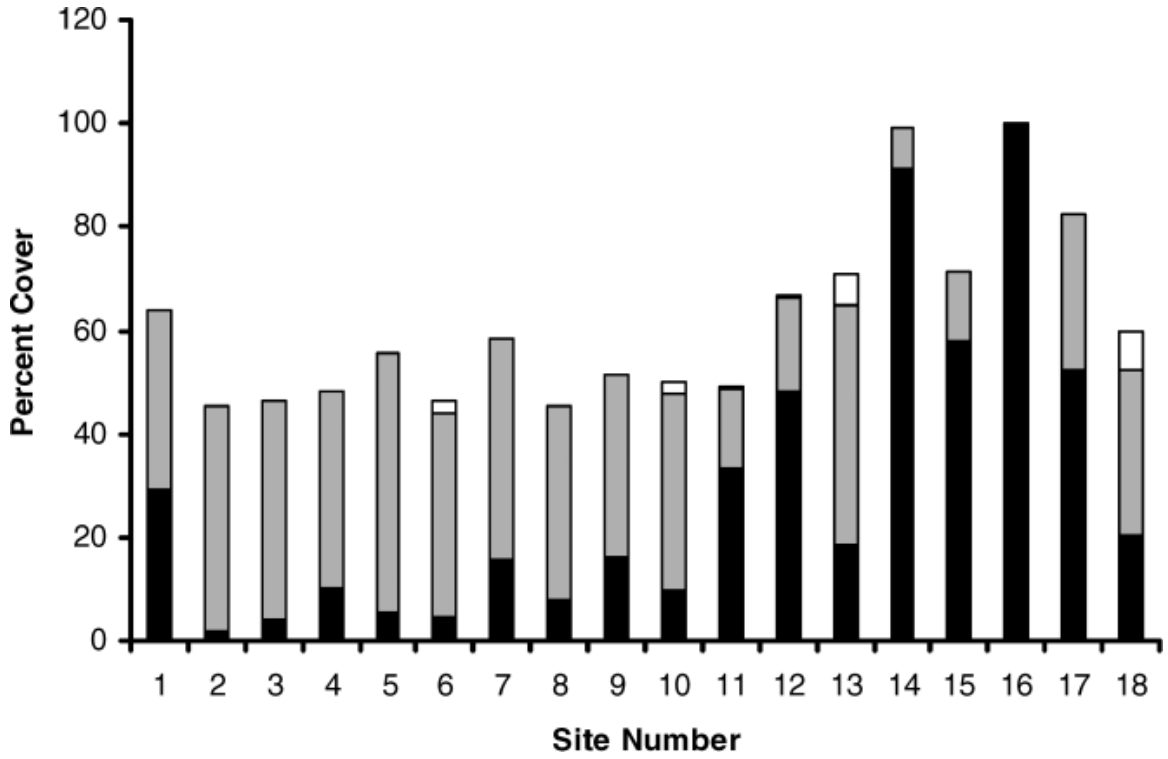


FIGURE 4. Rock cover (black), angiosperm cover (gray), and *Selaginella densa* cover (white) for all 18 sites. Remaining cover was in the categories of bare ground, plant litter, lichens, and mosses. Percent sum cover could exceed 100% in the instances where rocks were overtopped by lichens or angiosperms.

More on Bald Mountain

On July 8, 2019 Dr. Carter received an email with the following photos from a couple who backpacked into the Uintas Wilderness the previous weekend. The email stated, *"I spent the long weekend in the Uintas, my husband and I climbed to the top of Bald Mountain in the Red Castle allotment. There was so much sheep sh.. we couldn't put our packs down. In most places the ground was so saturated the melt was creating overland flow, so the feces was in standing water that was running off into the creeks. We hiked all the way back down without water, because gross. I trust my filter but that was just disgusting."* Many years ago, Dr. Carter and a friend were backpacking in the same area. His friend drank water running off these ridges and contracted giardia. Dr. Carter did not drink the water and did not contract giardia. From a recreation and human health standpoint alone, this water pollution issue should be sufficient to terminate sheep grazing in the Uinta Wilderness.

The photos provided with the email depict Bald Mountain with snowpack melting and melt water running off with sheep manure in the water, polluting everything downstream. The photos show the condition left at the end of the season last year with little residual vegetation in the areas where melt is ongoing. In order for sheep to graze these high elevation ridges, they travel and graze up the steep slopes beneath. Steve Ryberg, former District Ranger of the Evanston Mtn View District told Dr. Carter they were not supposed to graze in these places. But in the years

Dr. Carter backpacked these ridges and valleys, they were laden with sheep manure as evidence they had been grazing and trailing in non-capable areas. Photos follow.















Analysis of Forest Service Monitoring Site Selection

In our FOIA response (July 10, 2019) the Forest Service provided some data. Some of this is difficult to figure out given our request for a 30-day extension was denied by the Forest Service. In the file for study site locations (**07092019ANFStudyPlotCoordinates**) there were 1565 locations listed in the spreadsheet for the Ashley NF, none for the UWCNF. Of those, 517 had no location information, leaving 1048 with location coordinates. This was indicated to be for the Ashley NF allotments. Inspection of the attribute table for the Ashley NF in the GIS data provided (**GISData Folder**), we found 714 records for monitoring locations for the Ashley NF and 284 records for the UWCNF. Of the 714 records for the Ashley NF, 211 had no location information, leaving 503 monitoring points with location data. The UWCNF had 284 points listed in its attribute table with none lacking coordinates. It appears the Ashley NF data has some gaps with the spreadsheet referenced giving 1048 coordinate locations, but the attribute table giving only 503 with location data, so 545 sites appear to be missing. It is also important to remember that the vast majority of these study sites consisted of photographs, not actual data collection.

We did an analysis of some of this. The lack of a vegetation coverage for the UWCNF prevented analysis of that component in the UWCNF. We were attempting to look at the distribution of Forest Service monitoring locations by vegetation, soils and slope attributes. We also went through the Ashley NF data file (**01-Ashley Studies**) for the Fall Creek, Ottoson, Oweep, Painter, and Tungsten folders to locate ground cover data to determine where and in what habitat areas ground cover data was collected either by line-point intercept or other estimates. We found 69 locations with some form of ground cover data for the past two decades. Of these, 54 sites had location coordinates.

Due to lack of time, our review of the "Studies" folder was limited to the Ashley NF. That review generated many of the photographs and observations reported in previous paragraphs of this section. We were unable to review plant species data for any trend comparison in the time allowed, but that should be the Forest Service's job anyway.

GIS analysis to determine the distribution of Forest Service monitoring sites in both Forests determined that 587 of 783 sites (75%) were in capable areas as defined by the Forest Service in generating their Forest Plan map of capability. Capable acres did not include consideration of soil erosion hazard, forested areas, forage production, so this is a very conservative analysis. Omission of these factors shows the Forest Service capability map is inaccurate as it does not reflect the complete set of Forest Service criteria defining capability.

When we looked at the distribution of monitoring sites for both Forests by slope increments, the vast majority (465/789 or 59%) of sites were located in areas of <10% slope, or areas likely to be more stable and less sensitive to impacts of sheep grazing. See **Chart 1** below. We also calculated the number of sites based on area. See **Table 1** below. This points out that the more sensitive erodible and/or steep slope areas were monitored less while the less sensitive sites were monitored more.

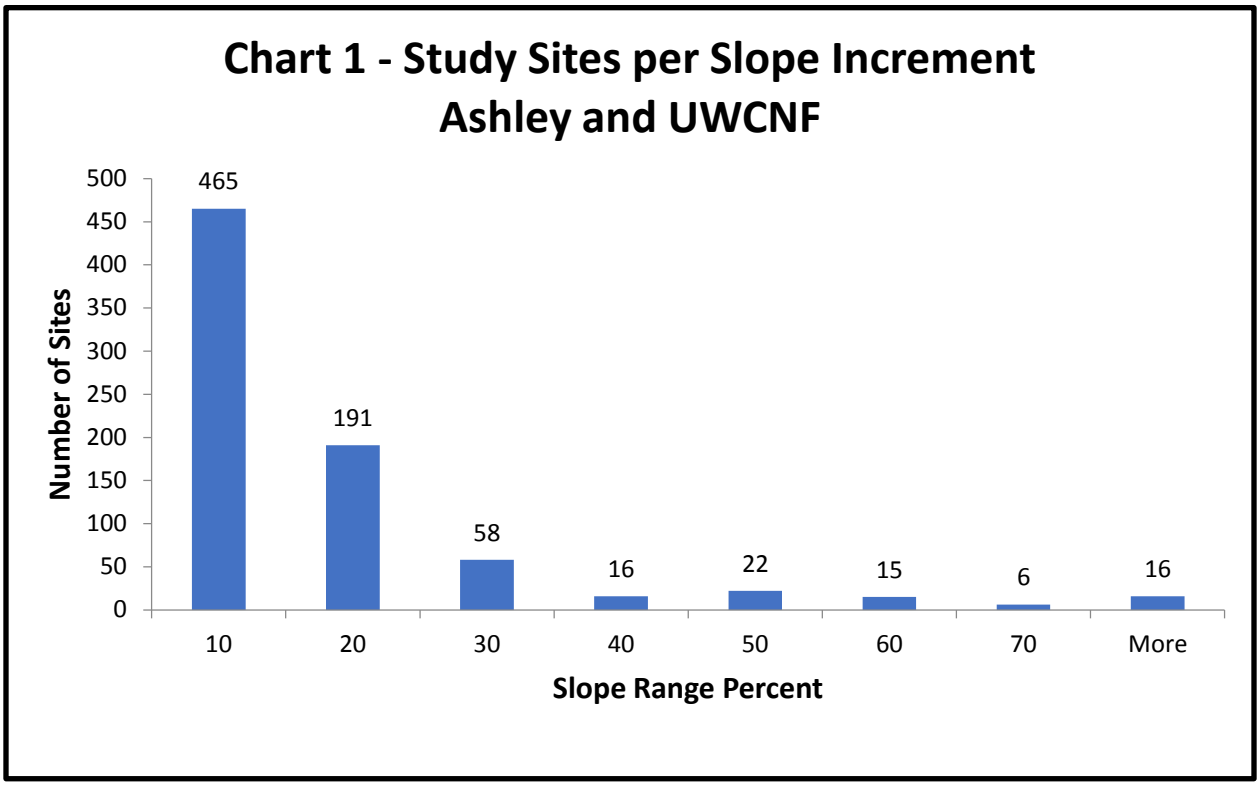
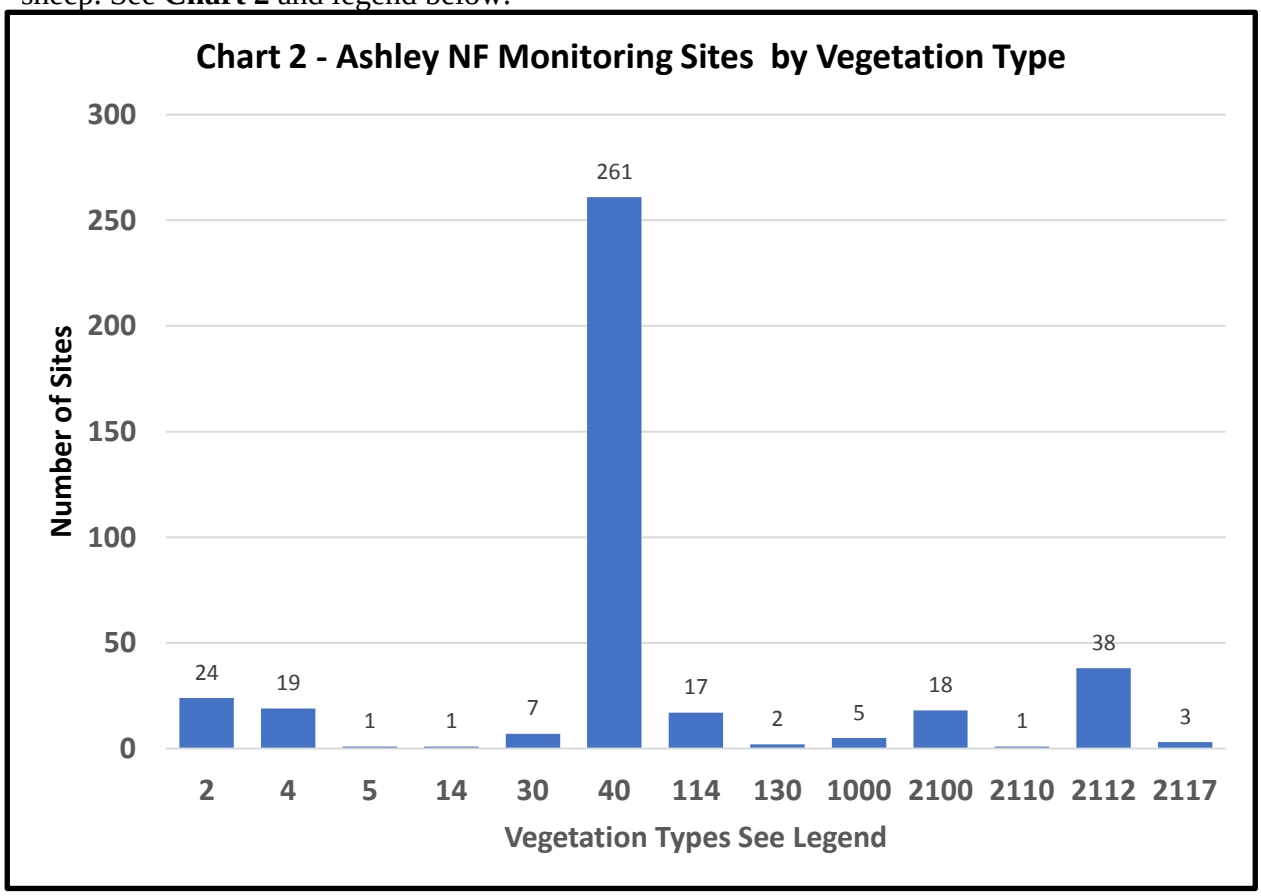


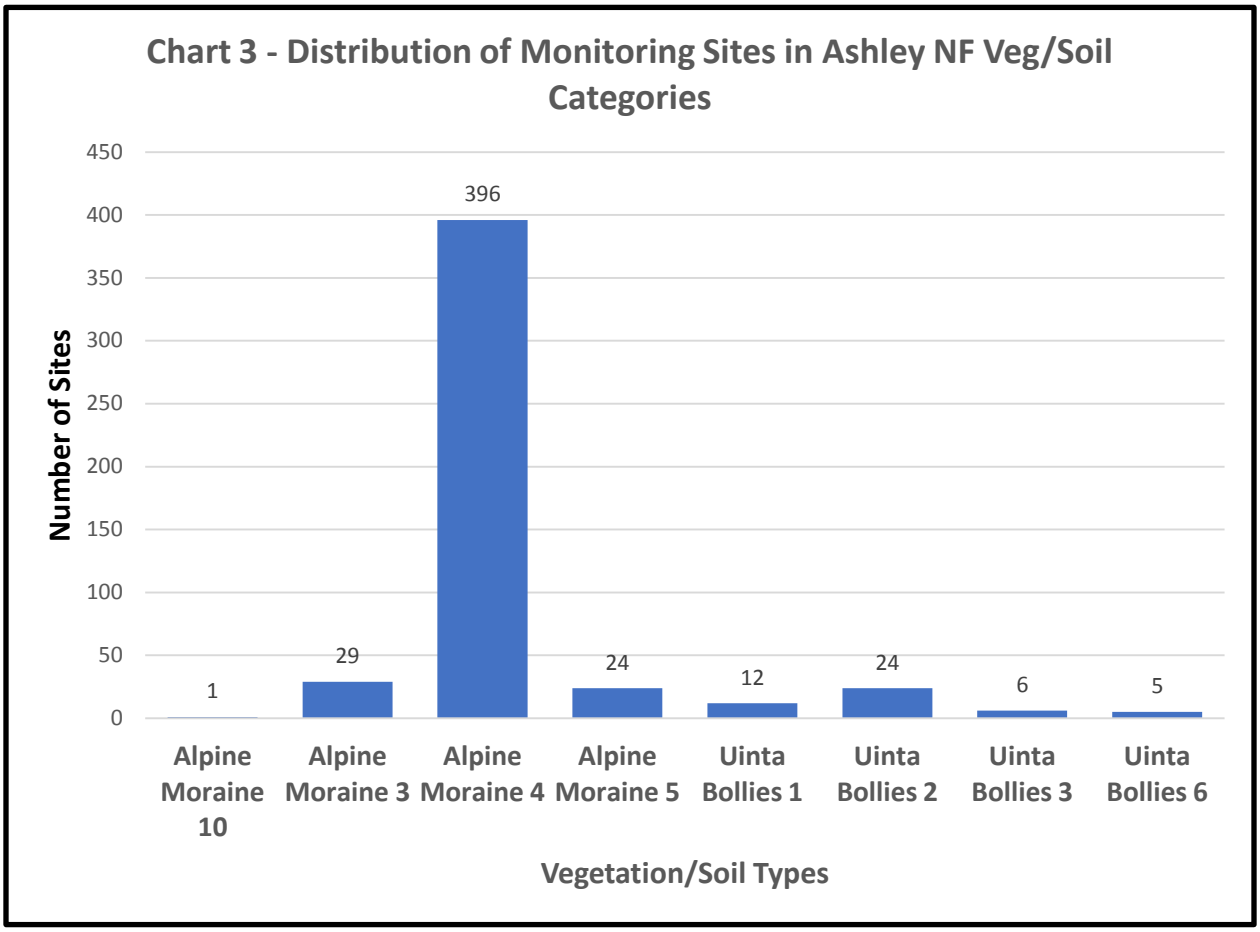
Table 1. Monitoring Sites Per Acre by Slope Class			
Slope Classes Percent	**Acres**	**No of Sites**	**Acres/Site**
0-10	43320	465	93
10-20	42399	191	222
20-30	21501	58	371
30-40	13443	16	840
40-50	9996	22	454
50-60	8576	15	572
60-70	7492	6	1249
Greater than 70	14199	16	887

The analysis of the number of monitoring sites by vegetation type for the Ashley NF (no coverage for UWCNF) determined that 261 of 397 sites (66%) were in Alpine/Wet and dry meadows, willow and graminoid complex, or the less sensitive areas or areas not preferred by sheep. See **Chart 2** and legend below.



VEGTYPE	DESCRIPTION
2	Alpine/Low forb/grass/sedge undifferentiated
4	Alpine/Geum/sedge and sedge/geum
5	Alpine/Kobresia
14	Alpine/Carex nigricans
30	Alpine/Upland willow field undifferentiated
40	Alpine/Wet and dry meadows, willow and graminoid complex
114	Coniferous forest/PIEN/wet and dry meadow complex
130	Coniferous forest/MC/meadow matrix too mixed for delineation
1000	Riparian/RIPARIAN
2100	Riparian/LOW WILLOW
2110	Riparian/Planeleaf willow (Salix planifolia -SAPL2)
2112	Riparian/SAPL2/Carex aquatilis
2117	Riparian/SAPL2/Carex scirpoideae

Analysis of the number of monitoring sites for each Veg/Soil or Landtype Category determined that 396 of 497 sites (80%) were in AM4 moraine category.

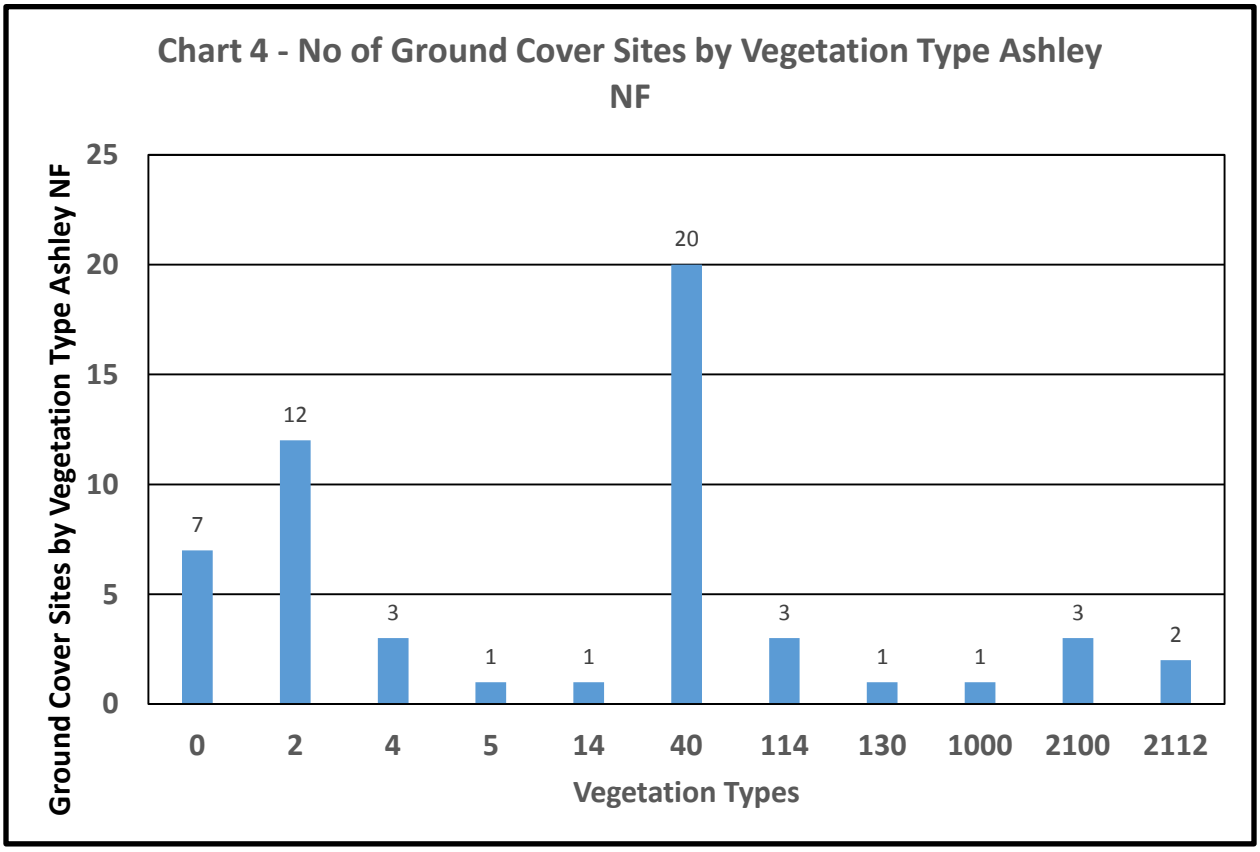


Symbol	Name	Description
AM10	Alpine Moraine 10	Glacial canyon bottoms below AM6 having wet meadows, springs and seeps, and thin hummocky ground moraines and outwash with some inner gorges cut deep in the underlying quartzite bedrock.
AM3	Alpine Moraine 3	Hummocky ground moraine containing lakes, meadows, and streams located in glacial valley bottoms just below the cirques.
AM4	Alpine Moraine 4	Rounded glacially, topography mantled by a thin, veneer of till. Bedrock ledges and areas of scoured bedrock are common.
AM5	Alpine Moraine 5	Lateral morainic lands in cirque basins. Includes a few small lakes and narrow wet meadows.
UB1	Uinta Bollies 1	Lower Bollie side slopes with currently active solifluction feature with an elevation ranging from 11,000 to 12,000 feet and gradients that are typically 5 to 30 percent but range up to 50 percent.

UB2	Uinta Bollies 2	Generally steep to extremely steep mountain side slopes above timberline. Included are cirque headwalls and sides. The elevation is above timberline and ranges from 11,000 to 12,500 feet with gradients of 50 to 80 percent.
UB3	Uinta Bollies 3	Gently to moderate rolling upland surfaces that form the crest of the Uinta Range with an elevation ranging from 11,000 to 13,000 and gradients of 5 to 15 percent.
UB6	Uinta Bollies 6	Flat to gently rounded tree covered surfaces of the bollies at slightly lower elevations that UB3 and UB5. The elevation of this unit ranges from 10,000 to 11,000 feet. Gradients are typically 5 to 30 percent.

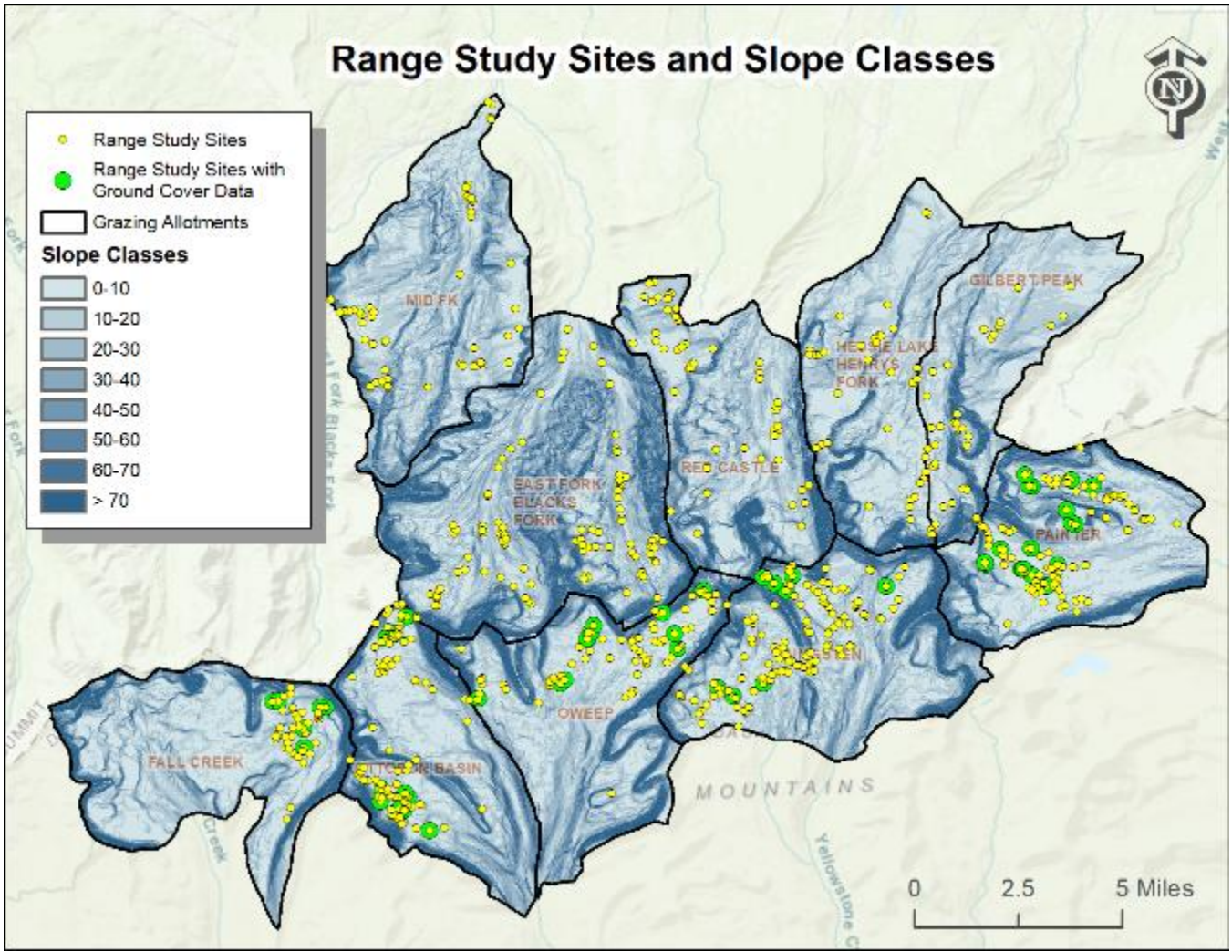
Ground Cover Sites

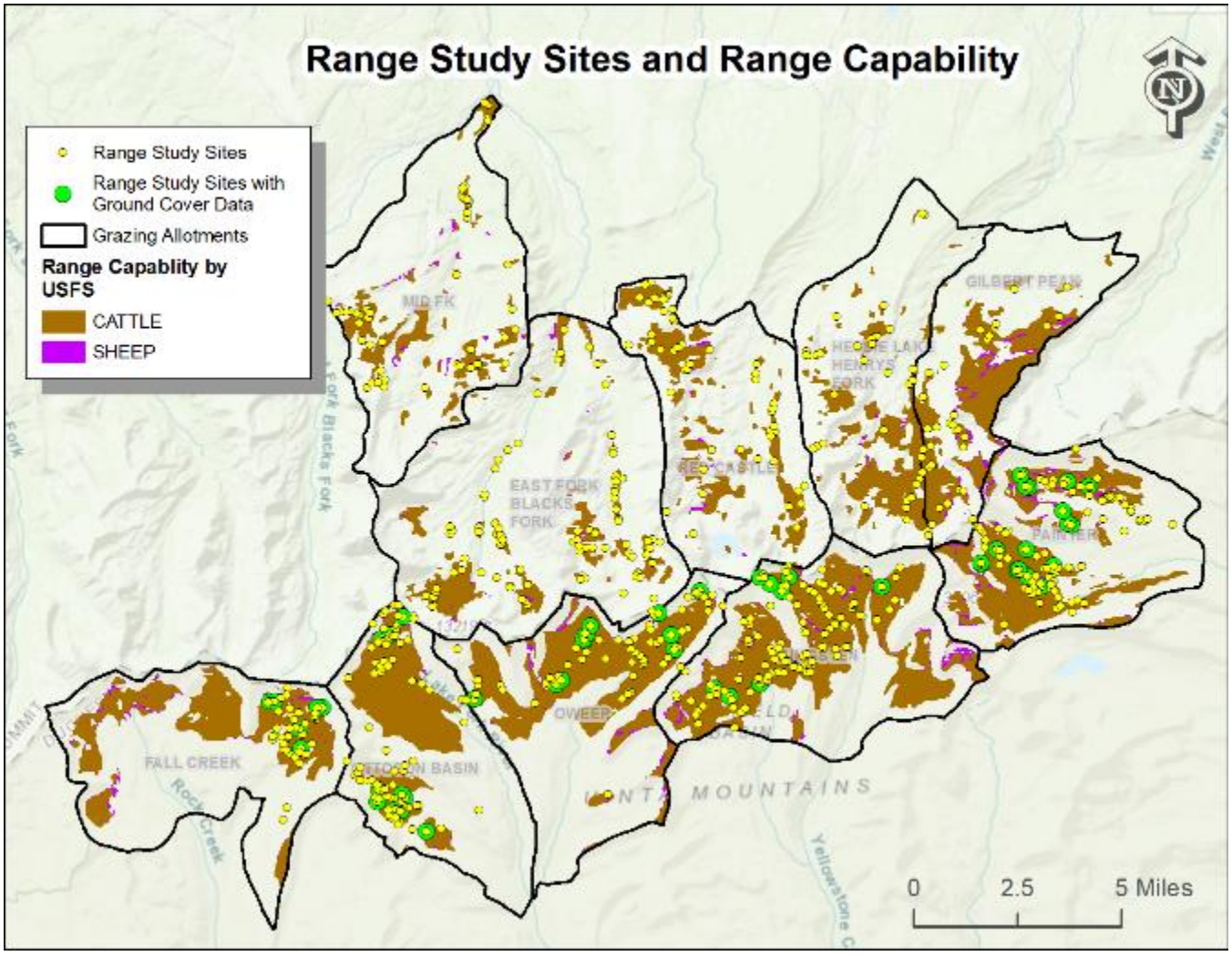
For the sites that had recent ground cover data or observations (Since 2000), 46 of 54, or 85% were in capable areas (as described above). The sites were distributed unevenly with veg/soil or landtype with 47 sites in AM4, 3 each in Uinta Bollies 2 and 3, respectively and 1 in Alpine Moraine 3. No sites with ground cover data were located in AM10, AM3, AM5, UB1, or UB6. The number of ground cover monitoring sites in the Ashley NF by Vegetation Type is shown in **Chart 4** below with its associated legend showing most sites in less sensitive, more stable areas.

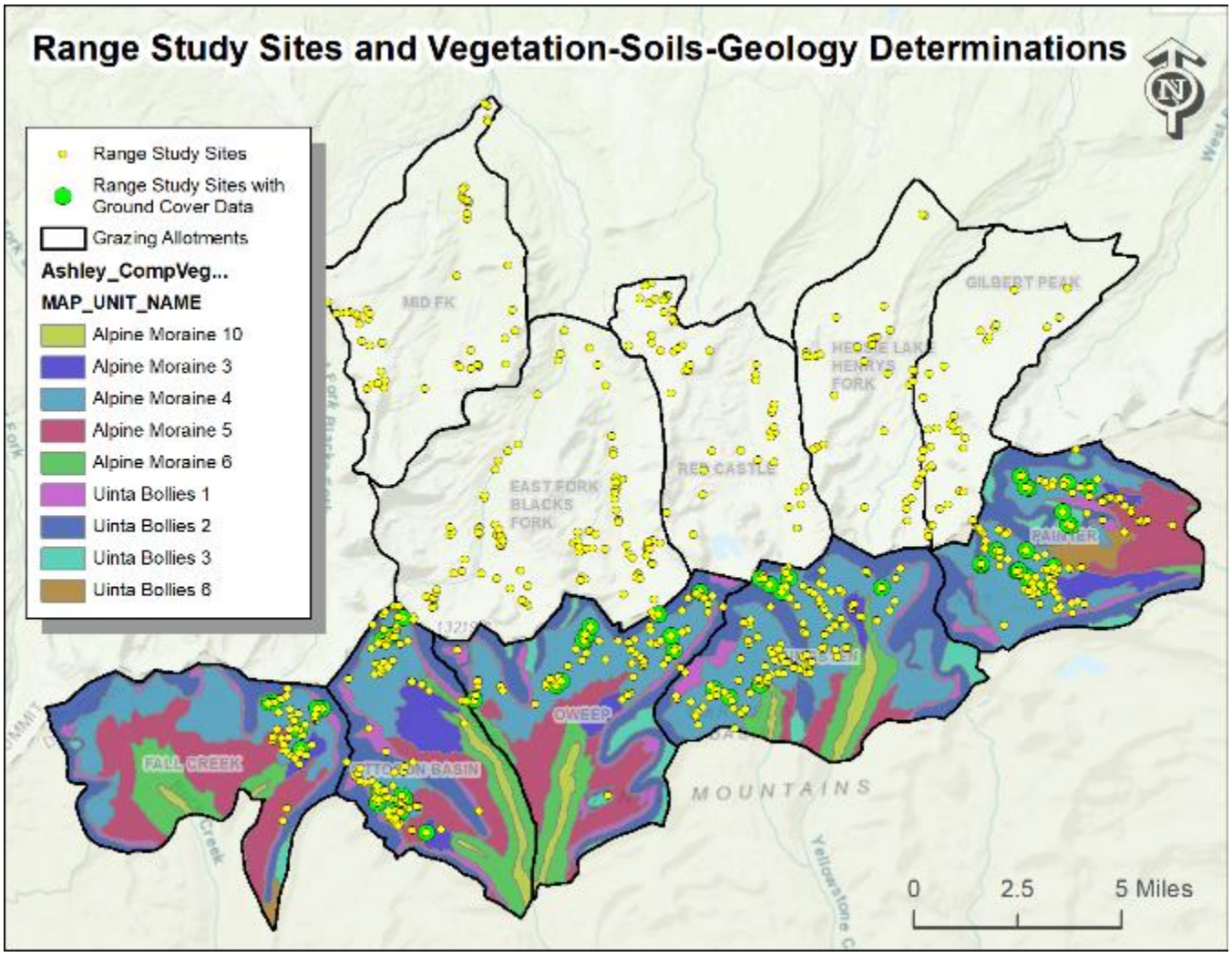


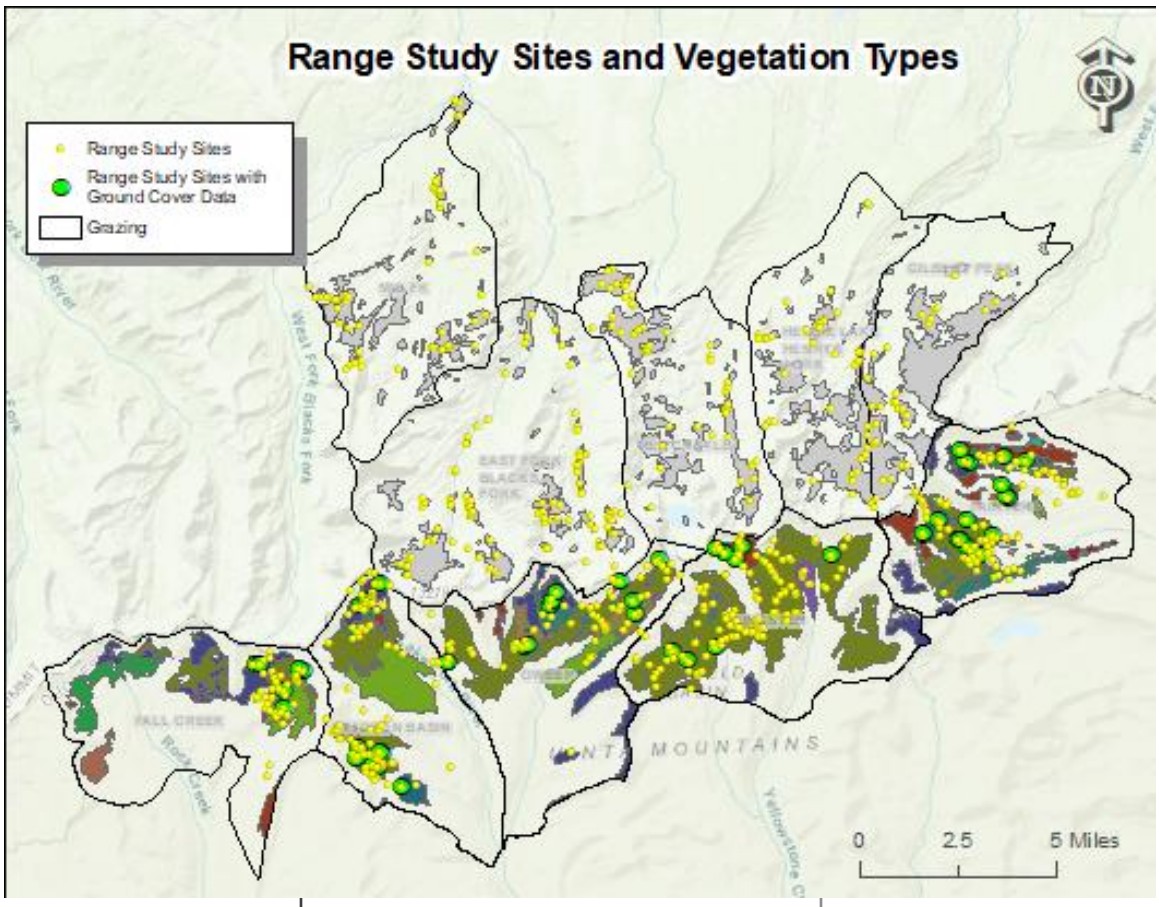
NUMBER OF SITES	VEGTYPE	DESCRIPTION
7	0	Not Determined
12	2	Alpine/Low forb/grass/sedge undifferentiated
3	4	Alpine/Geum/sedge and sedge/geum
1	5	Alpine/Kobresia
1	14	Alpine/Carex nigricans
20	40	Alpine/Wet and dry meadows, willow and graminoid complex
3	114	Coniferous forest/PIEN/wet and dry meadow complex
1	130	Coniferous forest/MC/meadow matrix too mixed for delineation
1	1000	Riparian/RIPARIAN
3	2100	Riparian/LOW WILLOW
2	2112	Riparian/SAPL2/Carex aquatilis

Maps were generated to illustrate the monitoring site distributions. These follow and clearly show the vast amount of land not monitored. These would be the steep slopes and other non-capable areas.




Range Study Sites and Range Capability
Range Study Sites
Range Study Sites with Ground Cover Data
Grazing Allotments
Range Capablity by USFS
CATTLE
SHEEP
MID FK
EAST FORK BLACKS FORK
FALL CREEK
MOUNTAINS
0
2.5
5 Miles


Range Study Sites and Vegetation-Soils-Geology Determinations
Range Study Sites
Range Study Sites with Ground Cover Data
Grazing Allotments
Ashley_CompVeg...
MAP_UNIT_NAME
Alpine Moraine 10
Alpine Moraine 3
Alpine Moraine 4
Alpine Moraine 5
Alpine Moraine 6
Uinta Bollies 1
Uinta Bollies 2
Uinta Bollies 3
Uinta Bollies 6
MID FK
EAST FORK BLACKS FORK
RED CASTLE
HENRYS FORK
GILBERT PEAK
PAINTER
OWEEP
FALL CREEK
MOUNTAINS
0
2.5
5 Miles



Vegetation Types

- Vegetation type data not available
- Alpine/Carex nigricans
- Alpine/Carex rupestris/cushion plant
- Alpine/Danthonia intermedia
- Alpine/Dryas octopetala
- Alpine/Geum/sedge and sedge/geum
- Alpine/Kobresia
- Alpine/Low forb/grass/sedge undifferentiated
- Alpine/Salix glauca
- Alpine/Salix glauca trending to conifer
- Alpine/Upland willow field undifferentiated
- Alpine/Wet and dry meadows, willow and graminoid complex
- Alpine/with conifer displacement
- Coniferous forest/Krummholz PIEN/SAGL/Meadow complex
- Coniferous forest/MC/Wet or moist understory (CALE, CACA)
- Coniferous forest/MC/meadow matrix too mixed for delineation
- Coniferous forest/PIEN/low forb parklands
- Coniferous forest/PIEN/wet and dry meadow complex
- Riparian/Carex aquatilis
- Riparian/LOW WILLOW
- Riparian/Mixed dry and wet meadow complex
- Riparian/Planifolia willow (Salix planifolia -SAPL2)
- Riparian/RIPARIAN
- Riparian/SAPL2/Carex aquatilis
- Riparian/SAPL2/Carex scirpoideae
- Riparian/with conifer displacement

Conclusion – Grazing impacts in the High Uintas

Neither the DEIS nor the Range Studies we received accurately depict the situation on the ground in which sensitive areas are proactively grazed by domestic sheep as they avoid the less sensitive wet locations. Steep, erodible slopes are grazed, and grazed during and immediately after snowmelt before plant growth is at a stage that prevents loss of the plants for basic physiological reasons the Forest Service should know and manage to avoid. This loss of plant and crust cover combined with trampling and displacement by sheep creates accelerated erosion and runoff. Streams are scoured, headcuts are created and these persist in open allotments. Whereas, in closed allotments, these erosion features are recovering along with ground cover. Sheep are bedded, trailed, salted across the entire landscape, even on tops of high ridges and mountains.

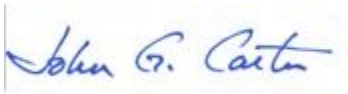
Forest Service monitoring and interpretation is heavily biased in favor of the sheep industry and its permittees. This bias fails to document and explain what is really happening as monitoring is focused on the less sensitive areas of lesser slope, higher soil moisture and a resistant turf. Mont Lewis' 1970 report depicted the effects of domestic sheep grazing on this ecosystem and reinforced the need for not grazing sensitive areas, in today's terms, areas that are not capable. Instead, the Forest Service allows permittees to graze to the tops of mountains, on steep slopes and passes and ignores the effects on these areas. It does not compare these areas in grazed allotments to long term ungrazed allotments and make an honest determination. Instead, it deflects and uses the highly flawed Brown (2006) characterization of alpine plant communities to claim conditions are "satisfactory". There is no explanation of what "satisfactory" means in terms of the potential of these soils/plant communities and what their current condition is.

Alpine soils in the Uintas are a critical component of the watersheds that provide water to a large portion of Utah's population. The loss of integrity of these soils and their plant communities threatens this water supply. The effects of degradation by domestic sheep are visible nearly everywhere and result in accelerated runoff and lowered water storage. This is evident in the eroded uplands, depleted plant communities and scoured streams

The public is left without representation as bias and deflection is used to maintain the status quo. Meanwhile watersheds are degraded, water pollution is created by thousands of domestic sheep that affect downstream users and those who come to the Uintas to see and enjoy this rare place.

In Conclusion…

We are disappointed as to the weaknesses and general failings of multiple aspects of the NEPA anlaysis undertaken in this DEIS. We look forward to working with the Forest Service in fulfilling the intent of NEPA, NFMA and the other statutes and regulations the Forest Service works within, through a complete and accurate analysis of the impacts of the plan, prior to the issuance of a ROD.



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ATTACHMENT 3

Erosion Prediction (USLE)
Used for HEL, NRI, and other Designated Programs
THIS IS NOT CURRENT EROSION PREDICTION TECHNOLOGY

Index Section I - (USLE) Erosion Prediction

Page	Subjects - Figures - Tables
2	Estimating Soil Loss Resulting from Water Erosion (Sheet and Rill). Universal Soil Loss Equation
3	Instructions for Determining Soil Loss by Water Erosion
4	Figure a & b - Slope Length description
9	Table I. – "RKLS" factors
15	Table II. – "LS" Factors
16	Table IIIa – "C" Factors for Cropland
16	Table IIIb - "P" Factors for Buffer strips
17	Table IIIc - "P" Factor for Stripcropping
17	Table IIId - "P" Factor for Terrace
18	Table IIIe – 10 year EI – 80 "P" Factor
18	Table IIIe – 10 year EI – 100 "P" Factor
22	Table IVa-f - "C" Factors for Cropland
27	Table IVg - "C" Factor for permanent Pasture, Idle Land, or Grazed Woodland
28	Table IVh – Slope Length Limits for Contouring
29	Table V – Percent of the annual EI Curve
30	Figure 1 – EI Values for P Factors
31	Figure 2 – Rainfall Factors

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Estimating Soil Loss Resulting From Water Erosion (Sheet and Rill)

The Universal Soil Loss Equation (USLE) enables planners to predict the average rate of soil erosion for each feasible alternative combination of crop system and management practices in association with a specific soil type, rainfall pattern, and topography. When these predicted losses are compared with given soil loss tolerances, the USLE provides specific guidelines for effecting erosion control. The equation is expressed as follows:

A = R K L S C P

A = is the computed soil loss per unit area, expressed in the units selected for K and for the period selected for R. In practice, these are usually so selected that they compute A in tons per acre per year.

R = the rainfall and runoff factor, is the number of rainfall erosion index units in an average year's rainfall. "R" values in Iowa are 150 and 175. See Rainfall "R" Factor map (Figure 2), Page 27.

K = the soil-erodibility factor is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as a 72.6 ft. length of uniform 9 percent slope continuously in clean tilled fallow. See Table VI.

L = the slope length factor is the ratio of soil loss from the field slope length to that from a 72.6 foot length under identical conditions.

S = the slope-gradient factor is the ratio of soil loss from the field slope gradient to that from a 9 percent slope under otherwise identical conditions. The slope length and steepness factors are combined into a common factor referred to as the LS factor when using this formula. Obtain "LS" factor from Table II, Page 13.

C = the cover and management factor is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow. See Table IV a-e, Pages 18-22.

P = the support practice factor P in USLE describes the effect of contour or cross-slope tillage practices on sheet and rill erosion. This factor also considers the effect of other supporting practices including buffer strips, stripcropping, and terracing. See Table III a-d, Pages 14-15.

T = the soil tolerance expressed in tons per acre per year.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Reference: Agriculture Handbook 537, TSC –Technical Note.

The USLE is designed to predict longtime-averages soil losses for specified conditions. To compute the average annual soil loss from a particular field slope, refer to the appropriate charts and tables and select the values of R, K, LS, C, and P that apply to the specific conditions.

The C factor can be obtained from Table IV a-e, Pages 18-22. The P factor can be calculated for contouring and cross-slope farming and modified for stripcropping, terraces, or contour buffer strips.

Table I is calculated to give the predicted average annual soil loss for a given soil, slope, and rainfall factor under a fallow condition. The product of the factors RKLS (C and P factor omitted) gives predicted soil loss without the effect of a growing crop, crop residues, or practice factor.

The predicted average annual soil loss is found by multiplying a CP factor by a fallow soil loss amount from Table I.

"T" is not a part of the Universal Soil Loss Equation. It is a limit of the average annual loss that an acre of the soil of defined characteristics can tolerate per year and still permit a high level of crop productivity to be sustained economically and indefinitely. T factors are listed in Table VI.

DETAILED INSTRUCTIONS – USLE FACTORS

I. RAINFALL AND RUNOFF FACTORS (R)

The numerical value used for R is the soil loss equation quantifies the raindrop impact effect and provides relative information on the amount and rate of runoff likely to be associated with the rain. This factor reflects long term averages over a period of 20 years. The local value of this index may be obtained directly from the map, Figure 2.

II. SOIL ERODIBILITY FACTOR (K)

The soil erodibility factor, K, in the USLE is a quantitative value experimentally determined. Table VI provides a county specific list of K factors.

III. SLOPE LENGTH (L)

Slope length is defined as the distance from the point of origin of overland flow to the point where either the slope gradient decreases enough that deposition begins, or the runoff water enters a ephemeral gully, classical gully, permanent or man made channel considered part of the drainage network. A change in land cover or a substantial change in gradient along a slope does not begin a new slope length for purposes of soil loss estimation.

IV. SLOPE STEEPNESS (S)

Determine the appropriate percent slope for the slope length being considered. Use this value in the equation. For push up grassed back slope terraces only, reduce the slope steepness by 25 percent. For push up narrow base terraces, reduce the slope steepness by 20 percent. <u>If the terrace is not constructed from borrow immediately below the terraces, do not use these reduction factors</u>.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

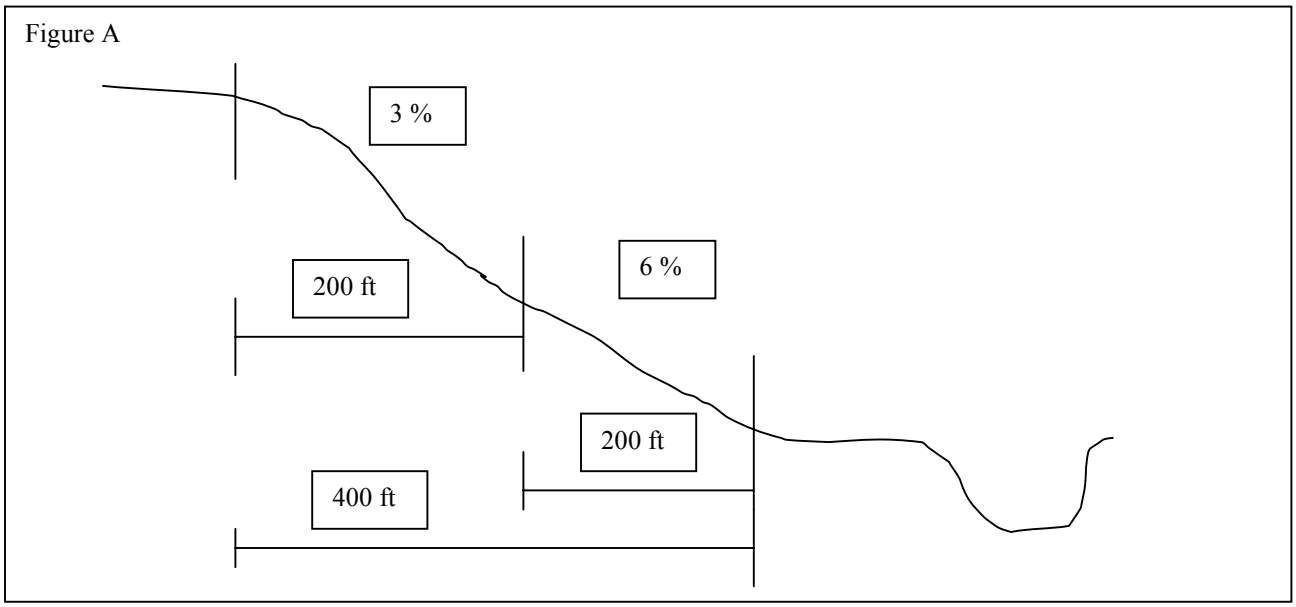
Determine Slope Length and Steepness

Not all measured slopes will have the same gradient, i.e., from point of origin to point of deposition.

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When the lower end of the slope is steeper than the upper end, the gradient of the steeper segment should be used with the overall slope length to plan and apply erosion control practices.

Figure A



In Figure A, the soil loss and treatment needed to reduce soil loss to the T-factor will be based on the entire length of 400 feet with a slope of 6 percent.

Figure B

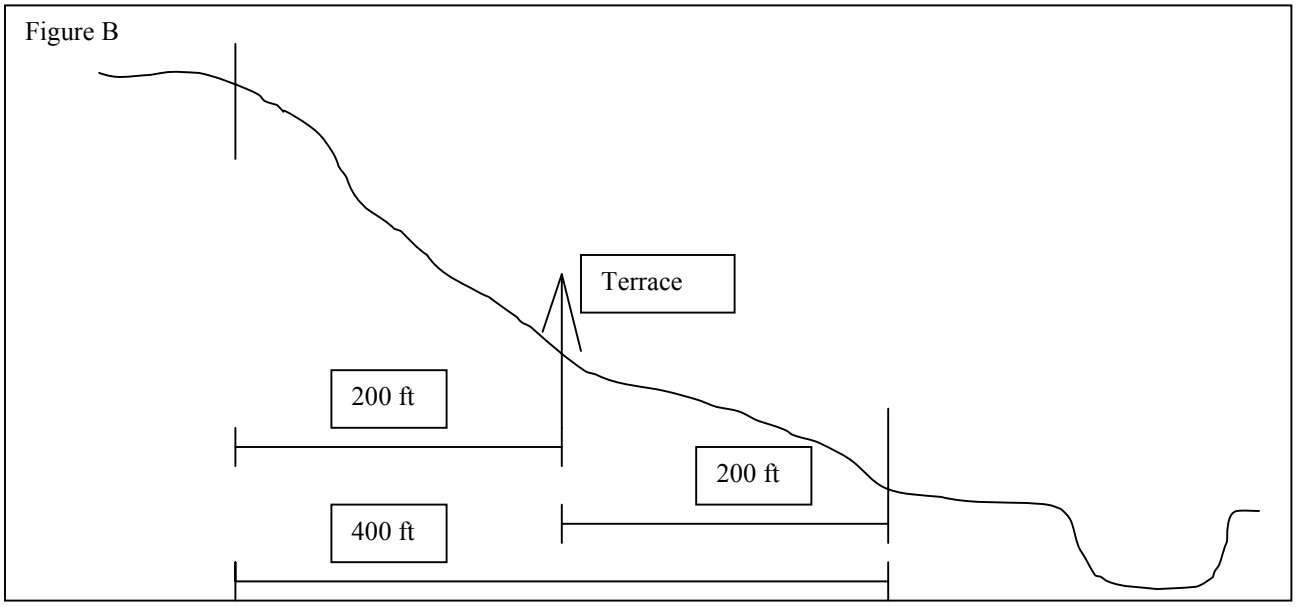


Figure B shows how long slope is reduced to shorter slopes by terracing. The point of origin for the lower 200 foot slope becomes the terrace ridge.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

To calculate soil loss on irregular slopes, and changes in soil types on slopes, see instructions on page 16 of Agricultural Handbook Number 537. Once the slope length and steepness have been determined for the area, refer to Table II for the LS ratio to be used in the equation.

V. SUPPORTING PRACTICES FACTOR (P)

The supporting Practice Factor (P) in USLE describes the effect of contour or cross-slope tillage practices on sheet and rill erosion. The factor is based on ridge height, row grade, field slope, and storm intensity (EI). Stripcropping, terraces, and buffer strips annual practice must be calculated by crop and averaged over the years of the rotation where a change in ridge height and row direction occurs.

CONTOURING AND CROSS-SLOPE FARMING

The following method for determining contour P factors can be applied to both contour farming and cross-slope farming. However, the use of the procedure with cross-slope farming should involve careful judgment. The planner should ensure that both the row grade and the downhill slope values accurately describe the predominant critical area used to plan the field or treatment unit.

The predominant critical area is that landscape unit which is the most erosive significant landscape area in the field. Areas in insignificant size, which are eroding at rates exceeding that of the predominant critical area, may be ignored. The planner management system is designed to treat the predominant critical area.

The contour P factor procedure should be used where a significant attempt has been made to contour the field or where a majority of the field is farmed at or near the contour. Where highly dissected slopes or complex topography occur, row grades may differ significantly resulting in a wide range of P values on the various USLE slopes in the field. In these situations, the P factor procedure should not be used, and a P value of 1.0 is appropriate.

A. A contour P Factor can be determined for contour farming as well as cross-slope farming using the following procedure:

1. Determine the 10-year storm EI value for the field location from Figure 1.

2. Using the Contour P Factor Table IIIe for that 10-year storm EI, select the appropriate ridge or oriented roughness height. Guidelines for this selection are:

   a. Low Ridge or Oriented Roughness – Roughness height is 1-3 inches created by tillage and planting equipment as with small grain crops, no-till planting, etc.
   b. Moderate Ridge or Oriented Roughness – Ridge height is 3-5 inches created by tillage, planting, and cultivation equipment as with some row crops.
   c. Ridge System – Ridge height is greater than 5 inches as with ridge-till systems for row crops.

3. Select an appropriate downhill slope L and S and row grade. Read the contour P Factor from Table IIIe.

4. In some crop production systems partial-year contouring credit may be applied for that portion of the year when ridges created by tillage, planting, and/or cultivation are contour or cross-slope.

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5. For crop rotation that include ridge or oriented roughness for different height develop a CP value for each crop, calculate the rotation average annual CP, and apply that value in USLE computations. (Example F)

6. Allowable slope length limits as shown in Table IIIa are applicable for contouring, stripcropping, and buffer strips.

Buffer strips, stripcropping, and terraces all modify the P factor. Use the appropriate subfactor listed in Tables IIIb, IIIc, and IIId and make appropriate modification.

BUFFER STRIPS

Buffer strips consist of narrow strips of perennial grasses and legumes. Buffer strips are generally considered permanent but may be moved or rotated when the vegetative stand deteriorates. Credit for buffer strips is accounted for by multiplying the Contour P Factor by the appropriate subfactor listed in Table IIIb. The following formula will be used to calculate buffer strips width:

$$SW = \frac{(\%\ SW)\ (CS)}{1 - \%\ SW}$$

Where SW = buffer strip width
% SW = Percent of slope in grass
and CS = cultivated strip width

STRIPCROPPING

Stripcropping consists of alternating near equal-width strips of row crops with strips of close grown crops or rotation hay. Credit for stripcropping is accounted for by multiplying the Contour P Factor by the appropriate subfactor listed in Table IIIc.

TERRACES

Credit for terraces is accounted for by multiplying the Contour P Factor by the appropriate subfactor listed in Table IIId. Credit for buffer strips or stripcropping may also be applied when these practices are applied within the cropped portion of the individual terrace interval. For stripcropping credit, at least two strips within the terrace interval must be present.

EXAMPLES:

A. Field is in continuous corn and on a contour system that meets 330 Standard. Field slope is 6%, row grade is 0%, and ridge height is moderate. From Table IIIe, Contour P Factor is 0.40.

   This field also has 25 ft. wide buffer strips every 100-ft. (20% of field in buffer strips). Obtain the buffer strip sub-factor from Table IIIb. The Contour P Factor is 0.40 X 0.8 = 0.32.

B. Field is in a corn-soybean-oats rotation. Field slope is 6%, row grade is 2%, and ridge height is moderate. From Table IIIe, P Factor is 0.75.

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C. Field is in a conventional tillage corn-soybean-oats rotation and contour system meets 330 Standard. Field slope is 10%, row grade is 0%, and ridge height is low for small grain and moderate for row crops. Contour CP factor for rotation is calculated as follows:

Crop	C	P	CP
Corn	0.36	0.50	0.18
Soybeans	0.27	0.50	0.135
Oats	0.15	0.75	0.1125
			0.5275/3 = 0.17

When the "P" factors varies depending on crop, a weighted CP must be calculated as in examples C and F.

D. Field is in a corn-soybean rotation on a ridge-till system. Field slope is 8% and row grade is 3%. Planting is on May 1 for corn and May 15 for soybeans reducing ridge height to 3 inches. A ridge in excess of 5 inches is rebuilt with cultivation by June 15 for corn and July 1 for soybeans and is maintained until planting the next crop. Refer to Table V for the Percent of Annual Erosion Index Value for EI area #14. P Factor is calculated as follows:

Crop	Dates	Ridge Ht.	Season P	% Annual EI	P x EI
Corn	5/1-6/15	3 inches	0.80	0.17	0.14
	6/15-5/15	6 inches	0.65	0.83	0.54
Soybeans	5/15-7/1	3 inches	0.80	0.26	0.21
	7/1-5/1	5 inches	0.65	0.74	0.48
					1.38/2 = 0.69

E. Field with 10% slope is in continuous corn. Field is fall chisel plowed and spring disked up and down hill. Field is planted May 1st cross slope with 1% row grade. P Factor is calculated as follows:

Crop	Dates	Ridge Ht.	Season P	% Annual EI	P x EI
Corn	11/1-5/1	6 inches	1.0	0.12	0.12
	5/1-11/1	3 inches	0.65	0.88	0.57
					0.69

F. Field is in a Corn-Corn-Small Grain-Hay-Hay-Hay rotation. Field slope is 10%, row grade is 0%, and ridge height is low for small grain and moderate for row crop. Contour CP Factor for rotation is calculated as follows:

Crop	C	P	CP
Corn	0.17	0.50	0.85
Corn	0.30	0.50	0.15
Small Grain	0.10	0.75	0.075
Hay	0.02	1.00	0.02
Hay	0.02	1.00	0.02
Hay	0.02	1.00	0.02
			0.37/6 = 0.06

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If this field is contour stripcropping with 50% of the slope in alternate hay strips, Contour CP Factor is 0.06 x 0.5 = 0.03.

G. Field is in a continuous corn rotation and is terraced with broadbase, graded terraces with open outlets. Terrace interval is 120 feet and overall grade including 300 feet at outlet is 0.5%. Field slope is 4% and ridge height is moderate. Contour P Factor is 0.60 x 0.8 = 0.48

H. Field in a corn-soybean rotation is terraced with narrow-based closed outlet terraces. Terrace interval is 150 feet. Field slope is 8%, row grade is 0.5%, and ridge height is moderate. Contour P Factor is 0.60 x 0.7 = 0.42.

VI. COVER AND MANAGEMENT FACTOR (C)

The cover and management factor "C" measures the combined effect of all interrelated cover and management factors.

Tables IVa – IVe can be used to determine annual "C" values based on percent of residue cover, type of tillage, and crop.

Table IVf – IVh can be used to determine "C" values for permanent pasture, idle land, grazed woodland or undisturbed woodland.

Procedure for measuring ground cover and crop residue cover

1. Use any line equally divided and marked into 100 equal parts. Fifty-foot cable transects lines (CAM lines) have been supplied to all offices and are suggested for this purpose.
2. Stretch the line diagonally across the crop rows.
3. Count the number of points that have any residue under them when sighting from directly above one end of the mark. It is important that the same point on each mark be used to insure statistical accuracy. A flag wire may assist in uniform sighting where the soil is ridged.
4. The number of points counted with residue equals percent cover on that field.
5. The same procedure should be repeated at randomly selected spots within the field and data averaged to obtain a representative sample. At least three measurements should be taken.
6. When measuring ground cover on pastureland or woodland, place the line across slope or as nearly on the contour as possible and proceed as in cropland acres.

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TABLE 1
RKLS Values
Average Annual Soil Loss from Continuous Fallow
R = 150
Non – Contoured

Slope Length	Slope %	K Values								
		.10	.15	.17	.20	.24	.28	.32	.37	.43
100	2	3.0	4.5	5.1	6.0	7.2	8.4	9.6	11.1	12.9
	3	4.3	6.5	7.3	8.6	10.3	12.0	13.8	15.9	18.5
	4	6.0	9.0	10.2	12.0	14.4	16.8	19.2	22.2	25.8
	5	8.0	12.0	13.6	16.0	19.3	22.5	25.7	29.7	34.5
	6	10.1	15.1	17.1	20.2	24.2	28.2	32.3	37.3	43.4
	7	12.4	18.5	21.0	24.7	29.7	34.6	39.6	45.7	53.4
	8	14.9	22.3	25.3	29.7	35.7	41.6	47.6	55.0	63.9
	9	17.6	26.4	29.9	35.2	42.2	49.3	56.3	65.1	75.6
	10	20.5	30.8	34.9	41.1	49.3	57.5	65.7	76.0	88.3
	11	23.7	35.5	40.3	47.4	56.9	66.3	75.8	87.6	101.9
	12	27.1	40.6	46.0	54.1	64.9	75.8	86.6	100.1	116.3
	13	30.6	45.9	52.1	61.3	73.5	85.8	98.0	113.3	131.7
	14	34.4	51.6	58.5	68.8	82.6	96.3	110.1	127.3	148.0
	15	38.4	57.6	65.3	76.8	92.1	107.5	122.9	142.0	165.1
	16	42.6	63.9	72.4	85.1	102.2	119.2	136.2	157.5	183.1
	17	46.9	70.4	79.8	93.9	112.7	131.4	150.2	173.7	201.9
	18	51.5	77.3	87.6	103.0	123.6	144.2	164.8	190.6	221.5
	19	56.2	84.4	95.6	112.5	135.0	157.5	180.0	208.1	241.9
	20	61.2	91.8	104.0	122.4	146.8	171.3	195.8	226.4	263.1
150	2	3.4	5.1	5.8	6.8	8.2	9.5	10.9	12.6	14.6
	3	4.9	7.3	8.3	9.7	11.7	13.6	15.5	18.0	20.9
	4	7.1	10.6	12.0	14.1	16.9	19.7	22.6	26.1	30.3
	5	9.8	14.7	16.7	19.7	23.6	27.5	31.5	36.4	42.3
	6	12.3	18.5	21.0	24.7	29.6	34.6	39.5	45.7	53.1
	7	15.1	22.7	25.7	30.3	36.3	42.4	48.5	56.0	65.1
	8	18.2	27.3	31.0	36.4	43.7	51.0	58.3	67.4	78.3
	9	21.5	32.3	36.6	43.1	51.7	60.3	68.9	79.7	92.6
	10	25.1	37.7	42.8	50.3	60.4	70.4	80.5	93.0	108.1
	11	29.0	43.5	49.3	58.0	69.6	81.2	92.8	107.3	124.8
	12	33.1	49.7	56.3	66.3	79.5	92.8	106.0	122.6	142.5
	13	37.5	56.3	63.8	75.0	90.0	105.0	120.0	138.8	161.3
	14	42.1	63.2	71.6	84.3	101.1	118.0	134.9	155.9	181.2
	15	47.0	70.5	79.9	94.0	112.8	131.7	150.5	174.0	202.2
	16	52.1	78.2	88.6	104.3	125.1	146.0	166.8	192.9	224.2
	17	57.5	86.2	97.7	115.0	138.0	131.0	184.0	212.7	247.2
	18	63.1	94.6	107.2	126.2	151.4	176.6	201.9	233.4	271.2
	19	68.9	103.3	117.1	137.8	165.3	192.9	220.5	254.9	296.2
	20	74.9	112.4	127.4	149.9	179.8	209.8	239.8	277.2	322.2

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TABLE 1
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Non – Contoured

Slope Length	Slope %	K Values								
		.10	.15	.17	.20	.24	.28	.32	.37	.43
200	2	3.7	5.6	6.3	7.4	8.9	10.4	11.9	13.7	15.9
	3	5.3	7.9	9.0	10.6	12.7	14.8	16.9	19.6	22.8
	4	7.9	11.9	13.5	15.8	19.0	22.2	25.3	29.3	34.0
	5	11.3	17.0	19.3	22.7	27.2	31.8	36.3	42.0	48.8
	6	14.3	21.4	24.2	28.5	34.2	39.9	45.6	52.8	61.3
	7	17.5	26.2	29.7	35.0	42.0	49.0	56.0	64.7	75.2
	8	21.0	31.5	35.7	42.1	50.5	58.9	67.3	77.8	90.4
	9	24.9	37.3	42.3	49.8	59.7	69.7	79.6	92.1	107.0
	10	29.0	43.6	49.4	58.1	69.7	81.3	92.9	107.4	124.9
	11	33.5	50.3	57.0	67.0	80.4	93.8	107.2	124.0	144.1
	12	38.3	57.4	65.0	76.5	91.8	107.1	122.4	141.6	164.5
	13	43.3	65.0	73.6	86.6	104.0	121.3	138.6	160.3	186.3
	14	48.7	73.0	82.7	97.3	116.8	136.3	155.7	180.1	209.3
	15	54.3	81.4	92.3	108.6	130.3	152.0	173.7	200.9	233.5
	16	60.2	90.3	102.3	120.4	144.5	168.6	192.6	222.8	258.9
	17	66.4	99.6	112.9	132.8	159.3	185.9	212.4	245.6	285.5
	18	72.8	109.3	123.8	145.7	174.8	203.9	233.1	269.5	313.2
	19	79.5	119.3	135.2	159.1	190.9	2222.7	254.6	294.3	342.1
	20	86.5	129.8	147.1	173.0	207.6	242.2	276.9	320.1	372.0
250	2	4.0	5.9	6.7	7.9	9.5	11.1	12.7	14.7	17.0
	3	5.7	8.5	9.6	11.3	13.6	15.9	18.1	21.0	24.4
	4	8.7	13.0	14.7	17.3	20.8	24.2	27.7	32.0	37.2
	5	12.7	19.0	21.6	25.4	30.5	35.5	40.6	46.9	54.6
	6	15.9	23.9	27.1	31.9	38.3	44.6	51.0	59.0	68.6
	7	19.6	29.3	33.2	39.1	46.9	54.7	62.6	72.3	84.1
	8	23.5	35.3	40.0	47.0	56.4	65.8	75.2	87.0	101.1
	9	27.8	41.7	47.3	55.6	66.8	77.9	89.0	102.9	119.6
	10	32.5	48.7	55.2	64.9	77.9	90.9	103.9	120.1	139.6
	11	37.5	56.2	63.7	74.9	89.9	104.9	119.9	138.6	161.1
	12	42.8	64.2	72.7	85.6	102.7	119.8	136.9	158.3	183.9
	13	48.4	72.6	82.3	96.9	116.2	135.6	155.0	179.2	208.3
	14	54.4	81.6	92.5	108.8	130.6	152.3	174.1	201.3	234.0
	15	60.7	91.1	103.2	121.4	145.7	170.0	194.2	224.6	261.0
	16	67.3	101.0	114.4	134.6	161.5	188.5	215.4	249.0	289.4
	17	74.2	111.3	126.2	148.4	178.1	207.8	237.5	274.6	319.2
	18	81.4	122.2	138.4	162.9	195.4	228.0	260.6	301.3	350.2
	19	88.9	133.4	151.2	177.9	213.5	249.0	284.6	329.1	382.4
	20	96.7	145.1	164.4	193.5	232.1	270.8	309.5	357.9	415.9

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300	2	4.2	6.3	7.1	8.4	10.0	11.7	13.4	15.5	18.0
	3	6.0	9.0	10.2	12.0	14.4	16.7	19.1	22.1	25.7
	4	9.3	14.0	15.8	18.6	22.3	26.1	29.8	34.4	40.0
	5	13.9	20.8	23.6	27.8	33.4	38.9	44.5	51.4	59.8
	6	17.5	26.2	29.7	34.9	41.9	48.9	55.9	64.6	75.1
	7	21.4	32.1	26.4	42.8	51.4	60.0	68.5	79.2	92.1
	8	25.8	38.6	43.8	51.5	61.8	72.1	82.4	95.3	110.7
	9	30.5	45.7	51.8	60.9	73.1	85.3	97.5	112.7	131.0
	10	35.6	53.3	60.5	71.1	85.4	99.6	113.8	131.6	152.9
	11	41.0	61.5	69.8	82.1	98.5	114.9	131.3	151.8	176.4
	12	46.9	70.3	79.7	93.7	112.5	131.2	150.0	173.4	201.5
	13	53.1	79.6	90.2	106.1	127.3	148.5	169.8	196.3	228.1
	14	59.6	89.4	101.3	119.2	143.0	166.9	190.7	220.5	256.3
	15	66.5	99.7	113.0	133.0	159.6	186.2	212.8	246.0	285.9
	16	73.7	110.6	125.3	147.5	177.0	206.5	235.9	272.8	317.1
	17	81.3	122.0	138.2	162.6	195.1	227.7	260.2	300.8	349.6
	18	89.2	133.8	151.7	178.4	214.1	249.8	285.5	330.1	383.6
	19	97.4	146.1	135.6	194.9	233.8	272.8	311.8	360.5	418.9
	20	106.0	158.9	180.1	211.9	254.3	296.7	339.1	392.1	455.6
400	2	4.6	6.8	7.8	9.1	11.0	12.8	14.6	16.9	19.6
	3	6.5	9.8	11.1	13.0	15.7	18.3	20.9	24.1	28.0
	4	10.4	15.7	17.8	20.9	25.1	29.2	33.4	38.6	44.9
	5	16.0	24.1	27.3	32.1	38.5	44.9	51.4	59.4	69.0
	6	20.2	30.2	34.3	40.3	48.4	56.5	64.5	74.6	86.7
	7	24.7	37.1	42.0	49.5	59.4	69.2	79.1	91.5	106.3
	8	29.7	44.6	50.6	59.5	71.4	83.3	95.2	110.0	127.9
	9	35.2	52.8	59.8	70.4	84.4	98.5	112.6	130.2	151.3
	10	41.1	61.6	69.8	82.1	98.6	115.0	131.4	151.9	176.6
	11	47.4	71.1	80.5	94.8	113.7	132.7	151.6	175.3	203.7
	12	54.1	81.2	92.0	108.2	129.9	151.5	173.2	200.2	232.7
	13	61.3	91.9	104.1	122.5	147.0	171.5	196.0	226.7	263.4
	14	68.8	103.2	117.0	137.6	165.2	192.7	220.2	254.6	295.9
	15	76.8	115.2	130.5	153.6	184.3	215.0	245.7	284.1	330.2
	16	85.1	127.7	144.7	170.3	204.3	238.4	272.4	315.0	366.1
	17	93.9	140.8	159.6	187.8	225.3	262.9	300.4	347.4	403.7
	18	103.0	154.5	175.1	206.0	247.2	288.4	329.6	381.1	442.9
	19	112.5	168.7	191.2	225.0	270.0	315.0	360.0	416.2	483.7
	20	122.4	183.5	208.0	244.7	293.6	342.6	391.5	452.7	526.1

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TABLE 1
RKLS Values
Average Annual Soil Loss from Continuous Fallow
R = 175
Non – Contoured

Slope Length	Slope %	K Values								
		.10	.15	.17	.20	.24	.28	.32	.37	.43
100	2	3.5	5.3	6.0	7.0	8.4	9.8	11.2	13.0	15.1
	3	5.0	7.5	8.5	10.0	12.0	14.1	16.1	18.6	21.6
	4	7.0	10.5	11.9	14.0	16.8	19.6	22.4	25.9	30.1
	5	9.4	14.0	15.9	18.7	22.5	26.2	30.0	34.6	40.3
	6	11.8	17.6	20.0	23.5	28.2	32.9	37.6	43.5	50.6
	7	14.4	21.6	24.5	28.9	34.6	40.4	46.2	53.4	62.0
	8	17.3	26.0	29.5	34.7	41.6	48.6	55.5	64.2	74.6
	9	20.5	30.8	34.9	41.0	49.3	57.5	65.7	75.9	88.3
	10	24.0	35.9	40.7	47.9	57.5	67.1	76.7	88.6	103.0
	11	27.6	41.5	47.0	55.3	66.3	77.4	88.4	102.3	118.8
	12	31.6	47.3	53.7	63.1	75.8	88.4	101.0	116.8	135.7
	13	35.7	53.6	60.7	71.5	85.8	10.1	114.4	132.2	153.7
	14	40.1	60.2	68.2	80.3	96.3	112.4	128.5	148.5	172.6
	15	44.8	67.2	76.1	89.6	107.5	125.4	143.3	165.7	192.6
	16	49.7	74.5	84.4	99.3	119.2	139.1	158.9	183.8	213.6
	17	54.8	82.1	93.1	109.5	131.4	153.3	175.3	202.6	235.5
	18	60.1	90.1	102.1	120.2	144.2	168.2	192.3	2222.3	258.4
	19	65.6	98.4	111.6	131.2	157.5	183.7	210.0	242.8	282.2
	20	71.4	107.1	121.3	142.7	171.3	199.8	228.4	264.1	306.9
150	2	4.0	6.0	6.7	7.9	9.5	11.1	12.7	14.7	17.1
	3	5.7	8.5	9.6	11.3	13.6	15.9	18.1	21.0	24.4
	4	8.2	12.3	14.0	16.5	19.7	23.0	26.3	30.4	35.4
	5	11.5	17.2	19.5	22.9	27.5	32.1	36.7	42.4	49.3
	6	14.4	21.6	24.5	28.8	34.6	40.3	46.1	53.3	62.0
	7	17.7	26.5	30.0	35.3	42.4	49.5	56.5	65.4	76.0
	8	21.2	31.9	36.1	42.5	21.0	59.5	68.0	78.6	91.4
	9	25.1	37.7	42.7	50.3	60.3	70.4	80.4	93.0	108.1
	10	29.3	44.0	49.9	58.7	70.4	82.1	93.9	108.6	126.2
	11	33.8	50.8	57.5	67.7	81.2	94.8	108.3	125.2	145.5
	12	38.7	58.0	65.7	77.3	92.8	108.2	123.7	143.0	166.2
	13	43.8	65.6	74.4	87.5	105.0	122.5	140.1	161.9	188.2
	14	49.2	73.8	83.6	98.3	118.0	137.7	157.3	181.9	211.4
	15	54.9	82.3	93.3	109.7	131.7	153.6	175.5	203.0	235.9
	16	60.8	91.2	103.4	121.7	146.0	170.3	194.6	225.1	261.6
	17	67.1	100.6	114.0	134.1	161.0	187.8	214.6	248.2	288.4
	18	73.6	110.4	125.1	147.2	176.6	206.1	235.5	272.3	316.4
	19	80.4	120.6	136.6	160.7	192.9	225.0	257.2	297.4	345.6
	20	87.4	131.1	148.6	174.8	209.8	244.8	279.7	323.4	375.9

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TABLE 1
RKLS Values
Average Annual Soil Loss from Continuous Fallow
R = 175
Non – Contoured

Slope Length	Slope %	K Values								
		.10	.15	.17	.20	.24	.28	.32	.37	.43
200	2	4.3	6.5	7.4	8.6	10.4	12.1	13.8	16.0	18.6
	3	602	9.3	10.5	12.4	14.8	17.3	19.8	22.9	26.6
	4	9.2	13.8	15.7	18.5	22.2	25.8	29.5	34.2	39.7
	5	13.2	19.9	22.5	26.5	31.8	37.1	42.4	49.0	56.9
	6	16.6	25.0	28.3	33.3	39.9	46.6	53.2	61.6	71.5
	7	20.4	30.6	34.7	40.8	49.0	57.1	65.3	75.5	87.7
	8	34.5	36.8	41.7	49.1	58.9	68.7	78.5	90.8	105.5
	9	29.0	43.5	49.3	58.1	69.7	81.3	92.9	107.4	124.8
	10	33.9	50.8	57.6	67.8	81.3	94.9	108.4	125.3	145.7
	11	39.1	58.6	66.4	78.2	93.8	109.4	125.1	144.6	168.1
	12	44.6	67.0	75.9	89.3	107.1	125.0	142.8	165.2	191.9
	13	50.5	75.8	85.9	101.1	121.3	141.5	161.7	187.0	217.3
	14	56.8	85.2	96.5	113.5	136.3	159.0	181.7	210.1	244.1
	15	63.3	95.0	107.7	126.7	152.0	177.4	202.7	234.4	272.4
	16	70.2	105.4	119.4	140.5	168.6	196.7	224.8	259.9	302.0
	17	77.5	116.2	131.7	154.9	185.9	216.9	247.8	286.6	333.0
	18	85.0	127.5	144.5	170.0	203.9	237.9	271.9	314.4	365.4
	19	92.8	139.2	157.8	185.6	222.7	259.9	297.0	343.4	399.1
	20	100.9	151.4	171.6	201.9	242.2	282.6	323.0	373.5	434.0
250	2	4.6	6.9	7.9	9.2	11.1	12.9	14.8	17.1	19.9
	3	6.6	9.9	11.2	13.2	15.9	18.5	21.1	24.4	28.4
	4	10.1	15.1	17.2	20.2	24.2	28.3	32.3	37.3	43.4
	5	14.8	22.2	25.2	29.6	35.5	41.4	47.4	54.8	63.7
	6	18.6	27.9	31.6	37.2	44.6	52.1	59.5	68.6	80.0
	7	22.8	34.2	38.8	45.6	54.7	63.9	73.0	84.4	98.1
	8	27.4	41.1	46.6	54.9	65.8	76.8	87.8	101.5	117.9
	9	32.5	48.7	55.2	64.9	77.9	90.9	103.8	120.1	139.5
	10	37.9	56.8	64.4	75.8	90.9	106.1	121.2	140.1	162.9
	11	43.7	65.5	74.3	87.4	104.9	122.4	139.8	161.7	187.9
	12	49.9	74.9	94.8	99.8	119.8	139.7	159.7	184.7	214.6
	13	56.5	84.8	96.1	113.0	135.6	158.2	180.8	209.1	243.0
	14	63.5	95.2	107.9	127.0	152.3	177.7	203.1	234.9	272.9
	15	70.8	106.2	120.4	141.6	170.0	198.3	226.6	262.0	304.5
	16	78.5	117.8	133.5	157.1	188.5	219.9	251.3	290.6	337.7
	17	86.6	129.9	147.2	173.2	207.8	242.5	277.1	320.4	372.3
	18	95.0	142.5	161.5	190.0	228.0	266.0	304.0	351.5	408.5
	19	103.8	155.6	176.4	207.5	249.0	290.5	332.0	383.9	446.2
	20	112.9	169.3	191.8	225.7	270.8	316.0	361.1	417.5	485.3

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TABLE 1
RKLS Values
Average Annual Soil Loss from Continuous Fallow
R = 175
Non – Contoured

Slope Length	Slope %	K Values								
		.10	.15	.17	.20	.24	.28	.32	.37	.43
300	2	4.9	7.3	8.3	9.8	11.7	13.7	15.6	18.1	21.0
	3	7.0	10.5	11.9	14.0	16.7	19.5	22.3	25.8	30.0
	4	10.9	16.3	18.5	21.7	26.1	30.4	34.7	40.2	46.7
	5	16.2	24.3	27.6	32.4	38.9	45.4	51.9	60.0	69.7
	6	20.4	30.6	34.6	40.7	48.9	57.0	65.2	75.4	87.6
	7	25.0	37.5	42.5	50.0	60.0	70.0	80.0	92.4	107.4
	8	30.0	45.1	51.1	60.1	72.1	84.1	96.1	111.2	129.2
	9	35.5	53.3	60.4	71.1	85.3	99.5	113.8	131.5	152.9
	10	41.5	62.2	70.5	83.0	99.6	116.2	132.8	153.5	178.4
	11	47.9	71.8	81.4	95.7	114.9	134.0	153.2	177.1	205.8
	12	54.7	82.0	92.9	109.3	131.2	153.1	174.9	202.3	235.1
	13	61.9	92.8	105.2	123.8	148.5	173.3	198.1	229.0	266.1
	14	69.5	104.3	118.2	139.1	166.9	194.7	222.5	257.3	299.0
	15	77.6	116.4	131.9	155.2	186.2	217.2	248.3	287.0	333.6
	16	86.0	129.0	146.2	172.0	206.5	240.9	275.3	318.3	369.9
	17	94.9	142.3	161.3	189.7	227.7	265.6	303.5	351.0	407.9
	18	104.1	156.1	176.9	208.1	249.8	291.4	333.0	385.1	447.5
	19	113.7	170.5	193.2	227.3	272.8	318.3	363.7	420.6	488.8
	20	123.6	185.4	210.2	247.2	296.7	346.1	395.6	457.4	531.6
400	2	5.3	8.0	9.1	10.6	12.8	14.9	17.0	19.7	22.9
	3	7.6	11.4	12.9	15.2	18.3	21.3	24.3	28.1	32.7
	4	12.2	18.3	20.7	24.4	29.2	34.1	39.0	45.1	52.4
	5	18.7	28.1	31.8	37.4	44.9	52.4	59.9	69.3	80.5
	6	23.5	35.3	40.0	47.1	56.5	65.9	75.3	87.0	101.2
	7	28.9	43.3	49.0	57.7	69.2	80.8	92.3	106.7	124.1
	8	34.7	52.0	59.0	69.4	83.3	97.1	111.0	128.4	149.2
	9	41.0	61.6	69.8	82.1	98.5	114.9	131.4	151.9	176.5
	10	47.9	71.9	81.4	95.8	115.0	134.1	153.3	177.3	206.0
	11	55.3	82.9	94.0	110.5	132.7	154.8	176.9	204.5	237.7
	12	63.1	94.7	107.3	126.3	151.5	176.8	202.0	233.6	271.5
	13	71.5	107.2	121.5	142.9	171.5	200.1	228.7	264.4	307.3
	14	80.3	120.4	136.5	160.6	192.7	224.8	256.9	297.4	345.2
	15	89.6	134.4	152.3	179.2	215.0	250.8	286.7	331.4	385.2
	16	99.3	149.0	168.9	198.7	238.4	278.1	317.9	367.5	427.1
	17	109.5	164.3	186.2	219.1	262.9	306.7	350.5	405.3	471.0
	18	120.2	180.3	204.3	240.3	288.4	336.5	384.6	444.6	516.8
	19	131.2	196.9	223.1	262.5	315.0	367.5	420.0	485.6	564.4
	20	142.7	214.1	242.7	285.5	342.6	399.7	456.8	528.2	613.8

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Table II – Universal Soil Loss Equation
Values of the Topographic Factor, LS, for Specific Combinations of Slope Length and Steepness

Slope Length (Feet)	Percent of Slope																				
	.2	.5	.8	1.0	2.0	3	4	5	6	8	10	12	14	16	18	20	25	30	40	50	60
25	.06	.07	.09	.09	.13	.19	.23	.27	.34	.50	.68	.90	1.15	1.42	1.72	2.04	2.94	3.98	6.33	8.91	11.58
50	.07	.08	.10	.10	.16	.23	.30	.38	.48	.70	.97	1.28	1.62	2.01	2.43	2.88	4.16	5.62	8.95	12.60	16.37
75	.07	.09	.11	.12	.18	.26	.36	.46	.58	.86	1.19	1.56	1.99	2.46	2.97	3.53	5.10	6.89	10.96	15.44	20.05
100	.08	.10	.11	.13	.20	.29	.40	.53	.67	.99	1.37	1.80	2.29	2.84	3.43	4.08	5.89	7.95	12.65	17.82	23.15
125	.08	.10	.12	.14	.21	.31	.44	.60	.75	1.11	1.53	2.02	2.56	3.17	3.84	4.56	6.59	8.89	14.15	19.93	25.88
150	.09	.10	.12	.15	.23	.32	.47	.66	.82	1.21	1.68	2.21	2.81	3.48	4.21	5.00	7.21	9.74	15.50	21.83	28.35
175	.09	.11	.13	.15	.24	.34	.50	.71	.89	1.31	1.81	2.39	3.03	3.75	4.54	5.40	7.79	10.52	16.74	23.58	30.63
200	.09	.11	.13	.16	.25	.35	.53	.76	.95	1.40	1.94	2.55	3.24	4.01	4.86	5.77	8.33	11.25	17.89	25.21	32.74
225	.09	.11	.13	.16	.26	.37	.55	.80	1.01	1.49	2.05	2.71	3.44	4.26	5.15	6.12	8.83	11.93	18.98	26.73	34.73
250	.10	.11	.14	.17	.26	.38	.58	.85	1.06	1.57	2.16	2.85	3.63	4.49	5.43	6.45	9.31	12.57	20.01	28.18	36.60
275	.10	.12	.14	.17	.27	.39	.60	.89	1.11	1.64	2.27	2.99	3.80	4.71	5.69	6.76	9.77	13.19	20.98	29.56	38.39
300	.10	.12	.14	.18	.28	.40	.62	.93	1.16	1.72	2.37	3.12	3.97	4.92	5.95	7.06	10.20	13.77	21.91	30.87	40.10
350	.10	.12	.14	.19	.29	.42	.66	1.00	1.26	1.85	2.56	3.37	4.29	5.31	6.42	7.63	11.02	14.88	23.67	33.34	43.31
400	.10	.13	.15	.20	.30	.43	.70	1.07	1.34	1.98	2.74	3.61	4.59	5.68	6.87	8.16	11.78	15.91	25.30	35.65	46.30
500	.11	.13	.16	.21	.33	.46	.76	1.20	1.50	2.22	3.06	4.03	5.13	6.35	7.68	9.12	13.17	17.78	28.29	39.85	51.77
600	.11	.14	.16	.22	.34	.49	.82	1.31	1.65	2.43	3.35	4.42	5.62	6.95	8.41	9.99	14.43	19.48	30.99	43.66	56.71
700	.12	.14	.17	.23	.36	.51	.87	1.42	1.78	2.62	3.62	4.77	6.07	7.51	9.08	10.79	15.58	21.04	33.48	47.16	61.25
800	.12	.14	.17	.24	.37	.54	.92	1.51	1.90	2.80	3.87	5.10	6.49	8.03	9.71	11.54	16.66	22.49	35.79	50.41	65.48
900	.12	.15	.17	.25	.39	.55	.96	1.60	2.02	2.97	4.11	5.41	6.88	8.51	10.30	12.24	17.67	23.86	37.96	53.47	69.45
1000	.13	.15	.18	.26	.40	.57	1.00	1.69	2.13	3.13	4.33	5.70	7.25	8.97	10.86	12.90	18.63	25.15	40.01	56.36	73.21
1100	.13	.15	.18	.26	.41	.59	1.04	1.77	2.23	3.29	4.54	5.98	7.61	9.41	11.39	13.53	19.53	26.38	41.96	59.11	76.78
1200	.13	.16	.19	.27	.42	.60	1.08	1.85	2.33	3.43	4.74	6.25	7.95	9.83	11.89	14.13	20.40	27.55	43.83	61.74	80.20

1/ LS values for slopes greater than 20 percent and/or slopes exceeding 1000 feet are speculative.

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Table IIIa - Slope Length Limits

		Stripcropping and Buffer Strips	
% Slope	Contouring [1, 3]	Strip Width [2]	Total Land Slope [1, 3]
1 – 2 %	400 ft	130 ft	800 ft
3 - 5 %	300 ft	100 ft	600 ft
6 – 8 %	200 ft	100 ft	400 ft
9 – 12 %	120 ft	80 ft	240 ft
13 – 16 %	80 ft	80 ft	160 ft
17 – 20 %	60 ft	60 ft	120 ft
21 – 25 %	50 ft	50 ft	100 ft

[1/] Limit may be increased by 25% if residue cover after planting is 50% or greater.
[2/] Limits width of row cropped strip for stripcropping and buffer strips.
[3/] Where allowable slope length values are exceeded adjust the P factor as follows:

$$\text{Adjusted P} = \frac{(\text{allowable slope length} \times P) + (\text{slope length} > \text{allowable} \times 1)}{\text{Total Slope Length}}$$

Table IIIb – Buffer Strips P Subfactor

% of Slope in Grass	Subfactor
10	0.9
20	0.8
30	0.7
40	0.6
50	0.5

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IIIc – Stripcropping P Subfactors

% Rotation in Meadow	Subfactor
50%	0.50
33%	0.67
25%	0.75
0%	1.00

Table IIId – Terrace P Subfactors

		Open Outlets with Channel Grade [2/]		
Horizontal Interval in Feet	**Closed Outlet [1/]**	**0.1 – 0.3**	**0.4 – 0.7**	**0.8**
Less than 100	0.5	0.6	0.7	1.0
100 – 140	0.6	0.7	0.8	1.0
140 – 180	0.7	0.8	0.9	1.0
180 – 225	0.8	0.8	0.9	1.0
225 – 300	0.9	0.9	1.0	1.0
Over 300	1.0	1.0	1.0	1.0

[1/] Subfactor for closed outlet terraces also applies to terraces with underground outlets and level terraces with open outlets.

[2/] The channel grade is measured on the 300 feet of terrace or the one-third of total terrace length closest to the outlet, whichever distance is less.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

10 Year EI - 80 "P" Factor Tables IIIe

Table 1 **Contour P Factor Values** **Low (1-3") Ridge or oriented roughness height**

10 year EI = 80 Row Grade (Percent)

Downhill Slope	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
0	1.00																
2	0.85	0.90	0.95	0.95	1.00												
4	0.75	0.85	0.90	0.90	0.95	0.95	0.95	1.00									
6	0.70	0.80	0.85	0.85	0.90	0.90	0.90	0.95	0.95	0.95	1.00						
8	0.70	0.80	0.80	0.85	0.85	0.85	0.90	0.90	0.90	0.95	0.95	1.00					
10	0.75	0.80	0.80	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.95	0.95	0.95	1.00			
12	0.80	0.85	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	1.00		
14	0.85	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.00		
16	1.00																

Table 2 **Contour P Factor Values** **Moderate (3-5") Ridge or oriented roughness height**

10 year EI = 80 Row Grade (Percent)

Downhill Slope	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	5.00	6.00	7.00	8.00	9.00	10.00	12.00	14.00	18.00
0	1.00																	
2	0.50	0.75	0.85	0.95	1.00													
4	0.40	0.60	0.70	0.75	0.80	0.85	0.90	0.95	1.00									
6	0.40	0.55	0.65	0.70	0.75	0.80	0.80	0.85	0.90	0.95	1.00							
8	0.45	0.60	0.65	0.70	0.70	0.75	0.80	0.80	0.85	0.90	0.90	0.95	1.00					
10	0.50	0.60	0.65	0.70	0.70	0.75	0.75	0.80	0.80	0.85	0.90	0.90	0.95	0.95	1.00			
12	0.50	0.60	0.65	0.70	0.70	0.75	0.75	0.75	0.80	0.80	0.85	0.90	0.90	0.95	0.95	1.00		
14	0.55	0.65	0.65	0.70	0.70	0.75	0.75	0.75	0.80	0.80	0.85	0.85	0.90	0.90	0.90	0.95	1.00	
16	0.60	0.65	0.70	0.70	0.75	0.75	0.75	0.75	0.80	0.80	0.85	0.85	0.85	0.90	0.90	0.95	0.95	1.00
18	0.65	0.70	0.75	0.75	0.75	0.80	0.80	0.80	0.80	0.85	0.85	0.85	0.90	0.90	0.90	0.95	0.95	1.00
20	0.75	0.80	0.80	0.80	0.85	0.85	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	1.00
22	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.00
24	1.00																	

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table 3 Contour P Factor Values Ridge Systems with ridge height > = 6”

10 year EI = 80

Downhill Slope	Row Grade (Percent)																	
	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	24.00
0	1.00																	
2	0.35	0.70	0.80	0.90	1.00													
4	0.20	0.50	0.60	0.70	0.75	0.85	0.90	1.00										
6	0.15	0.40	0.50	0.60	0.65	0.70	0.75	0.85	0.90	1.00								
8	0.15	0.35	0.45	0.50	0.60	0.65	0.65	0.75	0.80	0.90	1.00							
10	0.20	0.35	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.90	1.00						
12	0.20	0.35	0.40	0.50	0.50	0.55	0.60	0.65	0.70	0.75	0.85	0.95	1.00					
14	0.20	0.35	0.40	0.45	0.50	0.55	0.55	0.65	0.70	0.70	0.80	0.85	0.95	1.00				
16	0.25	0.35	0.45	0.45	0.50	0.55	0.55	0.60	0.65	0.70	0.75	0.85	0.90	0.95	1.00			
18	0.30	0.40	0.45	0.50	0.50	0.55	0.60	0.60	0.65	0.70	0.75	0.80	0.85	0.90	0.95	1.00		
20	0.35	0.45	0.50	0.55	0.55	0.60	0.60	0.65	0.65	0.70	0.75	0.80	0.85	0.90	0.95	0.95	1.00	
22	0.45	0.50	0.55	0.60	0.60	0.60	0.65	0.65	0.70	0.75	0.75	0.80	0.85	0.90	0.90	0.95	0.95	1.00
24	0.55	0.60	0.60	0.65	0.65	0.70	0.70	0.70	0.75	0.75	0.80	0.85	0.85	0.90	0.90	0.95	0.95	1.00
30	0.80	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95
33	1.00																	

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

10 Year EI - 100 "P" Factor Tables IIIe

Table 1 **Contour P Factor Values** **Low (1-3") Ridge or oriented roughness height**

10 year EI = 100 Row Grade (Percent)

Downhill Slope	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00
0	1.00																
2	0.90	0.95	0.95	1.00													
4	0.85	0.90	0.90	0.95	0.95	0.95	0.95	1.00									
6	0.80	0.85	0.90	0.90	0.90	0.90	0.95	0.95	0.95	1.00							
8	0.80	0.85	0.85	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	1.00					
10	0.80	0.85	0.85	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	1.00				
12	0.85	0.90	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95	0.95	1.00			
14	0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.00				
16	1.00																

Table 2 **Contour P Factor Values** **Moderate (3-5") Ridge or oriented roughness height**

10 year EI = 100 Row Grade (Percent)

Downhill Slope	0.00	0.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	5.00	6.00	7.00	8.00	9.00	10.00	12.00	14.00	18.00
0	1.00																	
2	0.60	0.80	0.90	0.95	1.00													
4	0.45	0.65	0.75	0.80	0.85	0.90	0.90	0.95	1.00									
6	0.45	0.60	0.70	0.75	0.75	0.80	0.85	0.85	0.90	0.95	1.00							
8	0.50	0.65	0.70	0.70	0.75	0.80	0.80	0.85	0.85	0.90	0.95	0.95	1.00					
10	0.55	0.65	0.70	0.75	0.75	0.80	0.80	0.80	0.85	0.85	0.90	0.90	0.95	0.95	1.00			
12	0.60	0.70	0.70	0.75	0.75	0.80	0.80	0.80	0.85	0.85	0.90	0.90	0.90	0.95	0.95	1.00		
14	0.60	0.70	0.70	0.75	0.75	0.80	0.80	0.80	0.80	0.85	0.85	0.90	0.90	0.90	0.95	0.95	1.00	
16	0.65	0.70	0.75	0.75	0.80	0.80	0.80	0.80	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.95	0.95	1.00
18	0.75	0.75	0.80	0.80	0.80	0.85	0.85	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.95	0.95	0.95	1.00
20	0.85	0.85	0.85	0.85	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95	0.95	1.00
22	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.00			
24	1.00																	

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table 3 **Contour P Factor Values** **Ridge Systems with ridge height > = 6”**

10 year EI = 100 Row Grade (Percent)

Downhill Slope	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	6.00	8.00	10.00	12.00	14.00	16.00	18.00	20.00	24.00
0	1.00																	
2	0.45	0.75	0.85	0.90	1.00													
4	0.25	0.50	0.60	0.70	0.80	0.85	0.90	1.00										
6	0.20	0.45	0.50	0.60	0.65	0.70	0.75	0.85	0.95	1.00								
8	0.20	0.40	0.50	0.55	0.60	0.65	0.70	0.75	0.85	0.90	1.00							
10	0.20	0.40	0.50	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.90	1.00						
12	0.25	0.40	0.45	0.50	0.55	0.60	0.60	0.65	0.75	0.75	0.85	0.95	1.00					
14	0.25	0.40	0.45	0.50	0.55	0.55	0.60	0.65	0.70	0.75	0.80	0.90	0.95	1.00				
16	0.30	0.40	0.45	0.50	0.55	0.55	0.60	0.65	0.70	0.70	0.80	0.85	0.90	0.95	1.00			
18	0.35	0.45	0.50	0.55	0.55	0.60	0.60	0.65	0.70	0.70	0.80	0.85	0.90	0.90	0.95	1.00		
20	0.40	0.50	0.55	0.60	0.60	0.60	0.65	0.70	0.70	0.75	0.80	0.85	0.85	0.90	0.95	0.95	1.00	
22	0.50	0.60	0.60	0.65	0.65	0.65	0.70	0.70	0.75	0.75	0.80	0.85	0.85	0.90	0.90	0.95	0.95	1.00
24	0.60	0.65	0.70	0.70	0.70	0.75	0.75	0.75	0.80	0.80	0.85	0.85	0.90	0.90	0.90	0.95	0.95	1.00
30	0.85	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95	1.00
33	1.00																	

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVa – C Factors for Cropland (Single Year)
Mulch tillage (Fall Primary Tillage)
E.I. Curve - #14

Crop Sequence	% Cover After Planting					
	20	30	40	50	60	70
Alfalfa (clear seeded) after:						
Corn	.18	.16	.14	.12	---	---
Soybean	.27	.23	.21	---	---	---
CORN after:						
Corn	.21	.18	.15	.12	.09	08
Corn silage	.37	----	----	----	----	----
Soybeans	.34	.29	.24	----	----	----
Small grain	.20	.18	.15	.13	----	----
Meadow (1st year) [1/]	.12	.11	.09	.07	----	----
Meadow (2nd year) [1/]	.19	.16	.13	.10	----	----
Corn Silage after:						
Corn	----	.25	----	----	----	----
Small grain (winter) after:						
Corn silage [2/]	.12	----	----	----	----	----
Soybeans	.14	.13	.09	----	----	----
Small grain	.11	.10	.09	.07	----	----
Small grain (spring) after:						
Corn [3/]	.08	.07	.06	.05	----	----
Corn (Silage) [2/]	.10	----	----	----	----	----
Soybeans	.09	.08	.07	.06	----	----
Small grain	----	----	----	----	----	----
SOYBEANS: (narrow row < 20 in) after:						
Corn	.18	.16	.13	.12	.11	.10
Corn 2 yrs after meadow	.16	.13	.11	.10	----	----
Soybeans	.31	.29	.24	----	----	----
Small grain	.21	.17	.14	.12	----	----
Meadow (1st year) [1/]	.09	.08	.06	.05	----	----
SOYBEANS: (wide row > 20 in) after:						
Corn	.23	.19	.16	.14	.12	.11
Corn 2 yrs after meadow	.18	.15	.12	.11	----	----
Soybeans	.36	.32	.25	----	----	----
Small grain	.24	.20	.17	.14	----	----
Meadow (1st year) [1/]	.12	.08	.07	.06	----	----

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVb – C Factors for Cropland (Single Year) Strip, Ridge, and Mulch tillage (Spring Primary Tillage) E.I. Curve - #14						
Crop Sequence	% Cover After Planting					
	20	30	40	50	60	70
Alfalfa (clear seeded) after:						
Corn	.16	.14	.13	.11	----	----
Soybean	.24	.21	.19	----	----	----
CORN after:						
Corn	.19	.16	.13	.11	.08	.07
Corn silage	.33	---	---	---	---	---
Soybeans	.31	.26	.22	---	---	---
Small grain	.18	.16	.13	.12	---	---
Meadow (1st year) 1/	.11	.10	.08	.06	---	---
Meadow (2nd year) 1/	.17	.14	.12	.09	---	---
Corn Silage after:						
Corn	---	.23	---	---	---	---
Small grain (winter) after:						
Corn silage 2/	.11	---	---	---	---	---
Soybeans	.13	.12	.08	---	---	---
Small grain	.10	.09	.08	.06	---	---
Small grain (spring) after:						
Corn 3/	.07	.06	.05	.04	----	----
Corn (Silage) 2/	.09	----	----	----	----	----
Soybeans	.08	.07	.06	.05	----	----
Small grain	----	----	----	----	----	----
SOYBEANS: (narrow row < 20 in) after:						
Corn	.16	.14	.12	.11	.10	.09
Corn 2 yrs after meadow	.14	.12	.10	.09	----	----
Soybeans	.28	.26	.22	----	----	----
Small grain	.19	.15	.13	.11	----	----
Meadow (1st year) 1/	.08	.07	.05	.04	----	----
SOYBEANS: (wide row > 20 in) after:						
Corn	.21	.17	.14	.13	.11	.10
Corn 2 yrs after meadow	.16	.13	.11	.10	----	----
Soybeans	.32	.30	.23	----	----	----
Small grain	.22	.18	.15	.13	----	----
Meadow (1st year) 1/	.11	.07	.06	.05	----	----

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVc – C Factors for Cropland (Single Year)
No - Tillage
E.I. Curve - #14

Crop Sequence	% Cover After Planting							
	20	30	40	50	60	70	80	90
Alfalfa (clear seeded) after:								
Corn	----	----	----	.11	.09	.07	.06	----
Soybean	.20	.17	.15	.12	----	----	----	----
CORN after:								
Corn	----	----	----	.06	.05	.04	.03	----
Soybeans	.24	.18	.14	.13	.12	.10	----	----
Soybeans w/cover crop	----	----	----	---	---	---	.08	.07
Small grain	----	----	----	.10	.09	.06	.04	----
Meadow (1st year) [1/]	----	----	----	.03	.03	.02	.01	----
Meadow (2nd year) [1/]	----	----	----	.06	.05	.04	.03	----
Corn Silage after:								
Corn	---	---	---	---	---	.09	---	---
Small grain (winter) after:								
Corn silage [2/]	.11	---	----	---	---	---	---	---
Soybeans	.07	.06	.05	---	---	---	---	---
Small grain	----	----	----	.05	.05	.04	.04	---
Small grain (spring) after:								
Corn [3/]	----	----	----	.06	.05	.04	.03	----
Corn (Silage) [2/]	.10	----	----	----	----	----	----	----
Soybeans	.08	.07	.06	----	----	----	----	----
SOYBEANS: (narrow row < 20 in) after:								
Corn	----	----	----	.11	.10	.08	.05	----
Corn 2 yrs after meadow	----	----	----	.09	.08	.07	.05	----
Soybeans	.21	.18	.15	----	----	----	----	----
Small grain	----	----	----	.12	.10	.07	.05	----
Meadow (1st year) [1/]	----	----	----	.04	.03	.02	.02	----
SOYBEANS: (wide row > 20 in) after:								
Corn	----	----	----	.12	.11	.08	.05	----
Corn 2 yrs after meadow	----	----	----	.09	.08	.07	.05	----
Soybeans	.25	.20	.16	----	----	----	----	----
Small grain	----	----	----	.13	.12	.08	.05	----
Meadow (1st year) [1/]	----	----	----	.04	.03	.02	.02	----
SOYBEANS: w/cover crop after:								
Corn	----	----	----	----	.06	.05	.04	----
Soybeans w/cover crop (< 20 inch row)	----	----	.13	.11	.10	.09	----	----
Soybeans w/cover crop (> 20 inch row)	----	----	.14	.12	.10	.09	----	----

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVd – C Factors for Cropland (Single Year) Plow E.I. Curve - #14		
Crop Sequence	% Cover After Planting	
	Fall	Spring
Alfalfa (clear seeded) after:		
Corn	.26	.23
Soybean	.36	.31
CORN after:		
Corn	.33	.29
Corn silage	.43	.36
Soybeans	.40	.36
Small grain	.36	.30
Meadow (1st year) 1/	.17	.13
Meadow (2nd year) 1/	.30	.24
Small grain (winter) after:		
Soybeans	.19	----
Small grain	.19	----
Small grain (spring) after:		
Corn 3/	.10	.09
Corn (Silage) 2/	.14	.13
Soybeans	.15	.10
Small grain	----	----
SOYBEANS: (narrow row < 20 in) after:		
Corn	.27	.24
Corn 2 yrs after meadow	.25	.20
Soybeans	.36	.32
Small grain	.34	.24
Meadow (1st year) 1/	.14	.10
SOYBEANS: (wide row > 20 in) after:		
Corn	.35	.30
Corn 2 yrs after meadow	.31	.25
Soybeans	.44	.39
Small grain	.43	.32
Meadow (1st year) 1/	.17	.13

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVe – C Factors for Cropland Wheat/Soybean Double Crop E.I. Curve - #14				
Wheat	Soybeans			
		Plow	Disk	No-till
	Plow	.26	.15	.10
	Disk	.22	.10	.05
	No-till	.20	.09	.04

Table IVf – C Factors for Meadow (Full Year – Established) E.I. Curve - #14	
Grass – Legume	.004
Legume Only	.02

FOOTNOTES FOR "C" FACTOR TABLES IVa – IVd

1/ Values are based on meadow with at least 50% grass. If meadows are primarily legumes, multiply factor by 1.2 for conservation tillage systems.

2/ Factors with no residues on surface after planting.

3/ Factors are the same with or without meadow seeding.

All values are based on high production with minimum yields of:

Corn – 100 Bu.
Soybeans – 40 Bu.
Oats – 60 Bu.
Wheat – 45 Bu.
Meadow – 3 tons per acre

For lower levels of management multiply factors by 1.2.

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVg – "C" Factors for Permanent Pasture, Idle Land, or Grazed Woodland [1/]								
Type and Height of Raised Canopy [2/]	**Canopy Cover [3/] Percent**	**Type [4/]**	**Percent Ground Cover [5/]**					
			0	**20**	**40**	**60**	**80**	**95-100**
No appreciable canopy		G	.45	.20	.10	.042	.013	.003
		W	.45	.24	.15	.091	.043	.011
Canopy of tall grasses or bushes with average drop [height of 3 ft. or less]	25	G	.36	.17	.09	.038	.013	.033
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes with average drop height of 6 ½ ft.	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees but no appreciable low brush with average drop height of 13 ft. or more	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.033
		W	.36	.20	.13	.084	.041	.011

1/ The listed "C" values assumes that the vegetation and mulch are randomly distributed over the entire area. For grazed woodland with high buildup of organic matter in the topsoil under permanent forest conditions, multiply the table values by 0.7.

2/ Canopy height is measured as the average fall height of water drops falling from the canopy to ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 feet.

3/ Portion of total area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

4/ G: Cover at surface is grass, grass-like plants, or duff.
W: Cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or litter, or both.

5/ The portion of a grass or weed cover that contacts the soil surface during a rainstorm and interferes with water flow over the soil surface is included in "Cover at the surface." The remainder is included in canopy cover.

Examples: A tall fescue pasture with an excellent stand of grass would have no appreciable raised canopy, the type of cover that contacts the surface is grass "G" and the percent ground cover is 95-100 percent. The "C" factor is .003.

A poorly managed bluegrass pasture having a 25 percent canopy cover of 3 feet or less and a 60 percent grass cover "G" that contacts the surface. The "C" factor would be .038.

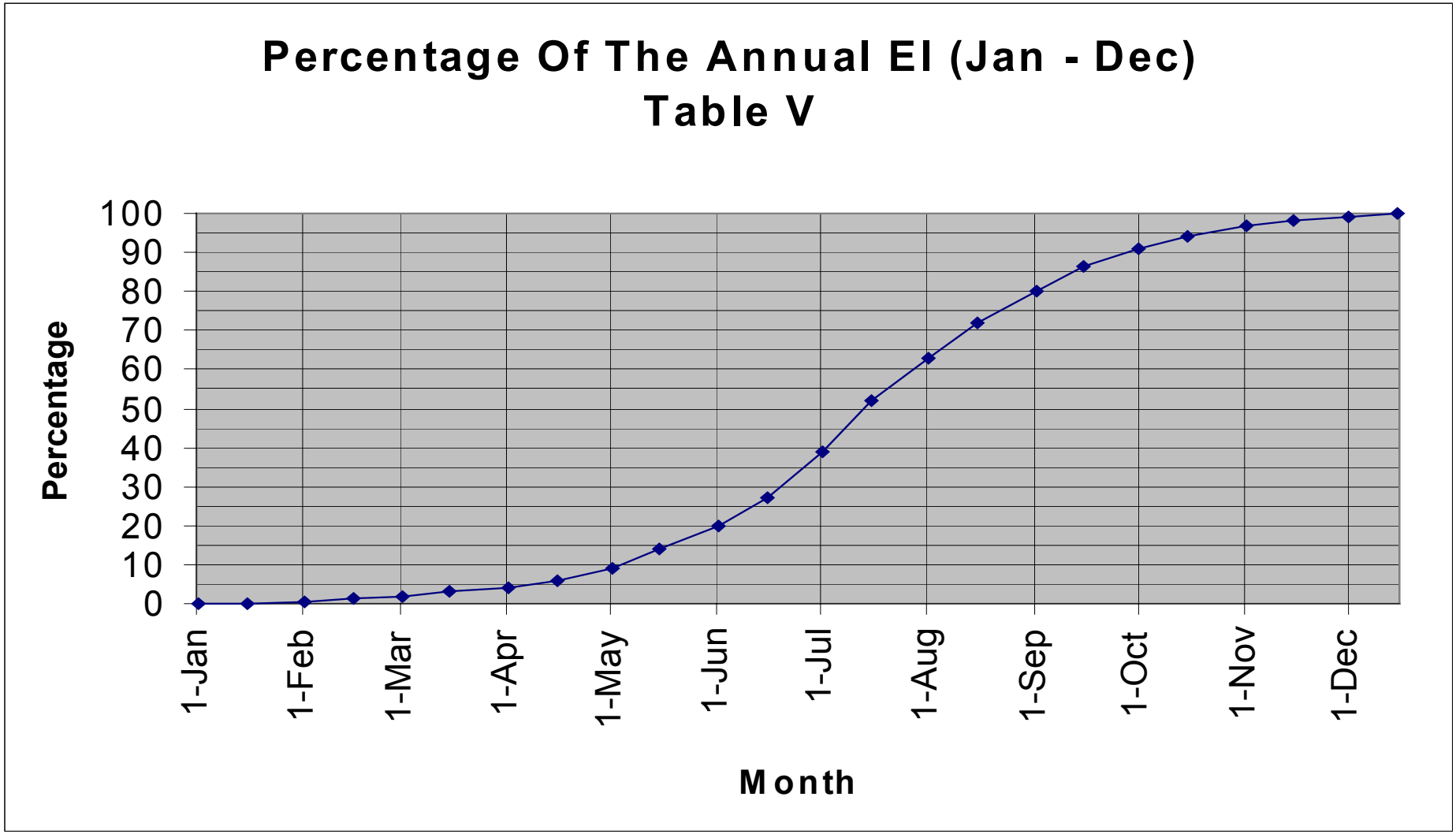
Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Table IVh – "C" Factors for Undisturbed Forestland [1]/

Percent of Area Covered by Canopy of Trees and Undergrowth	Percent of Area Covered by Duff	Factor C
100 – 75	100 – 90	.0001 - .001
70 – 45	85 – 75	.002 - .004
40 – 20	70 – 40	.003 - .009

[1]/ Where effective duff cover is less than 40 percent or canopy cover is less than 20 percent, use Table IVd.

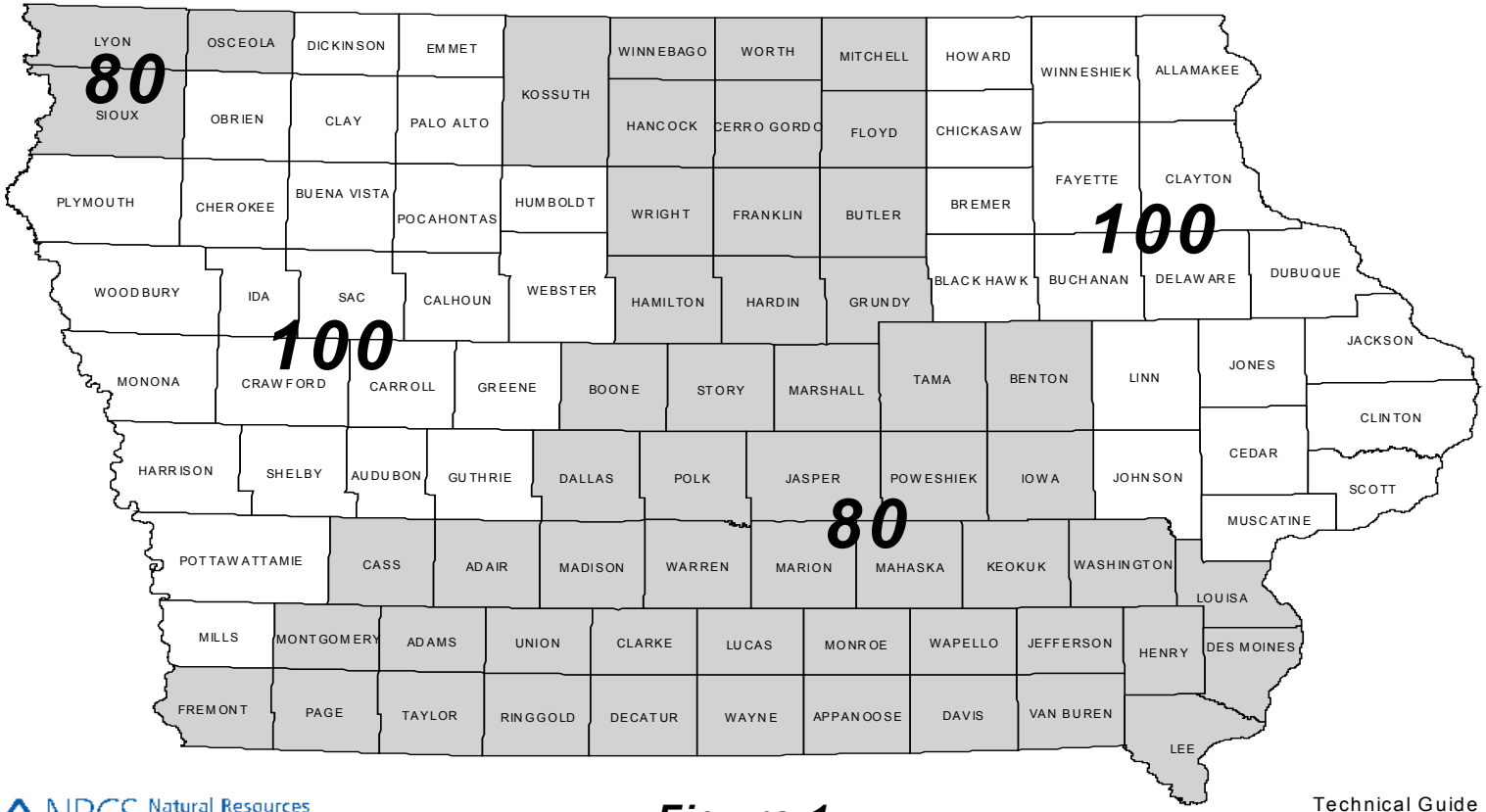
Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).



EI Curve Number 14

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

EI Values For P Factor



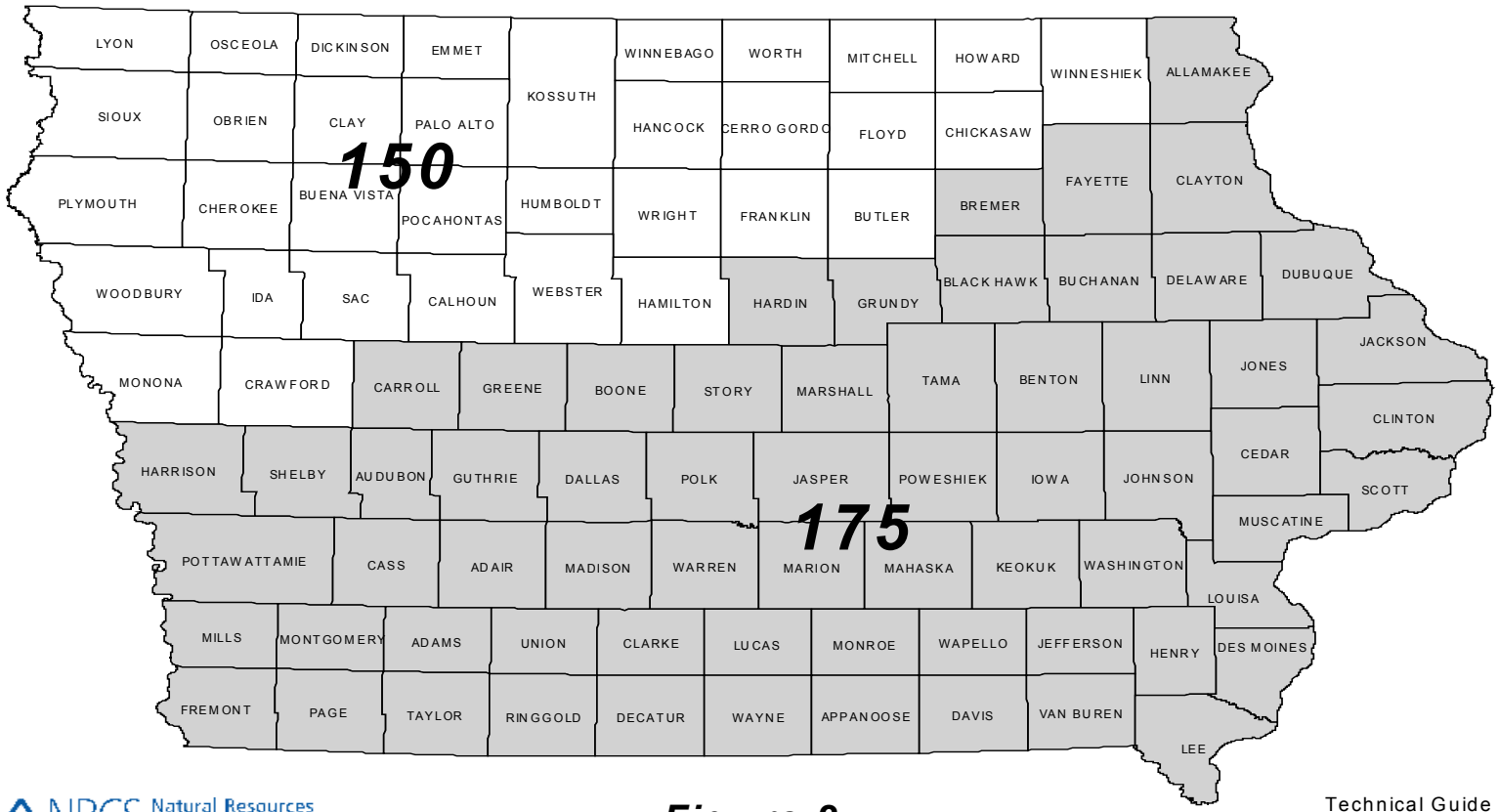
NRCS Natural Resources Conservation Service

Figure 1

Technical Guide
Section I - C - 1

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Rainfall Factors



NRCS Natural Resources Conservation Service

Figure 2

Technical Guide
Section I - C - 1

Conservation practice standards are reviewed and updated periodically. To obtain a current version of this standard contact the Natural Resources Conservation Service office or web site (www.ia.nrcs.usda.gov).

Extracted from Map Unit Descriptions
Soil Survey Area UT 647
North Slope Uinta Mountains Portion

Wasatch Cache National Forest
of October 24, 2006

Introduction

This is an extract from the report of descriptions of the soil mapping units within the North Slope of the Uinta Mountains portion of Soil Survey Area UT647 (SSA-UT647) on the Wasatch Cache National Forest. Because the report is interim in status, these descriptions should be considered draft in nature, and will be superceded when the soil survey and legend are finalized.

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North Slope Uinta Mountains Portion

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223--Duchesne family, cold, 20 to 40 percent slopes

Setting

Landform: moraines
Position on landform: side slopes
Elevation: 9,100 to 10,300 feet
Average annual precipitation: 25 to 35 inches
Average annual air temperature: 35 to 40 degrees F
Frost-free period: 0 to 40 days
Shape of slopes: convex to linear

Composition

Duchesne family, cold soil and similar inclusions: 90 percent
Contrasting inclusions: 10 percent

Characteristics of the Duchesne family, cold Soil

Present vegetation: lodgepole pine, grouse whortleberry, Englemann spruce, subalpine fir, heartleaf arnica, blueberry, currant, strawberry, lupine, Kentucky bluegrass, bluejoint reedgrass, and elk sedge

Typical profile:
1 to 0 inch= duff
0 to 1 inch= dark brown very cobbly sandy loam
1 to 12 inches= brown very cobbly loamy sand
12 to 40 inches= reddish brown very cobbly sandy clay loam
40 to 60 inches= reddish brown extremely cobbly sandy loam

see MU 222

Depth class: very deep
Drainage class: well drained
Parent material: kind= glacial till; source= quartzite
Permeability: moderately rapid over moderate
Available water capacity: low (3.5 to 5.0 inches)
Water supplying capacity: 10 to 15 inches
Potential rooting depth: 60 inches or more
Runoff: rapid
Hazard of water erosion: high
Hazard of wind erosion: slight

Included Areas

Contrasting inclusions:
*areas in meadows under grasses, forbs and sagebrush that range from poorly drained to well drained
*ponded areas
*some organic soils in meadows

Similar inclusions:
*areas with a very cobbly clay subsoil
*areas with a very cobbly loamy sand subsoil
*areas that are very stony
*areas with slopes less than 20 percent and greater than 40 percent

Major Uses

Woodland and wildlife habitat

Major Management Factors

Soil-related factors:

gravel, cobbles and stones

steep slopes

Climate-related factors:

short growing season

Interpretive Groups

Range site:

lodgepole pine - grouse whortleberry

502--Talus-Rock outcrop-Mirror Lake family, cold, complex, 40 to 80 percent slopes

was 505 (whitney) pf 3h2l05

Setting

Landform: mountain slope
Position on landform: sideslopes
Elevation: 9,200 to 12,479 feet
Average annual precipitation: 25 to 35 inches
Average annual air temperature: 35 to 40 degrees F
Frost-free period: 0 to 40 days
Shape of slopes: convex to linear

Composition

Talus: 60 percent
Rock outcrop: 25 percent
Mirror Lake family, cold, soil and similar inclusions: 15 percent

Talus consists of rock fragments that occurs mainly below escarpments and ridges of rock outcrop. It is mostly barren of vegetation.

Rock outcrop consists of exposures of bedrock that occurs mainly on escarpments and ridges. It is mostly barren of vegetation.

Characteristics of the Mirror Lake family, cold, Soil

Position on landform: side slopes
Slope range: 40 to 80 percent
Shape of slopes: convex to linear
Present vegetation: lodgepole pine, grouse whortleberry, Englemann spruce, subalpine fir, heartleaf arnica, blueberry, currant, strawberry, lupine, Kentucky bluegrass, bluejoint reedgrass, and elk sedge

Typical profile:
1 to 0 inch= duff
0 to 2 inches= dark brown very cobbly sandy loam
2 to 13 inches= reddish brown very cobbly sandy loam
13 to 60 inches= reddish brown extremely cobbly loamy sand

Depth class: very deep
Drainage class: well drained
Parent material: kind= glacial till; source= quartzite
Permeability: rapid
Available water capacity: very low (1.5 to 2.5 inches)
Water supplying capacity: 5 to 10 inches
Potential rooting depth: 60 inches or more
Runoff: very rapid
Hazard of water erosion: very high
Hazard of wind erosion: slight

ATTACHMENT 4

ALPINE RANGELANDS OF THE UINTA MOUNTAINS

Ashley and Wasatch National Forests

Region 4

1970



Mont E. Lewis
Range Conservationist
U. S. FOREST SERVICE

ALPINE RANGELANDS OF THE UINTA MOUNTAINS

Ashley and Wasatch National Forests

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1970

Mont E. Lewis
Range Conservationist

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ALPINE RANGELANDS OF THE UINTA MOUNTAINS

(Standards and Guides for Classification)

INTRODUCTION

The alpine portion of the Uinta Mountains has an area of nearly 250,000 acres ranging in elevation from 11,000 to 13,500 feet, all within the boundaries of the Ashley and Wasatch National Forests. At present, 32 grazing allotments extend into the alpine. Sheep on these allotments obtain most of their summer forage in the alpine area.

The Uinta alpine country is also one of the most important water producing areas in the State. With this in mind, this area has been carefully studied to determine the compatibility of grazing use with watershed protection and to develop guidelines and criteria for range analysis. The guidelines presented in this report have been used as a basis for training the range analysis technician in doing the field job.

To develop these criteria and guidelines, field observations and studies were made during the 8-year period, 1955-63. These included the selection and analysis of areas in near-pristine condition to set up standards.

Mr. Olaf C. Olson, Chief Regional Soil Scientist, has given much needed aid in the soil phase of the study from 1960 to 1963.

The report consists of two parts. Part I has to do with basic information pertaining to alpine areas and includes discussion of such factors as geology, soils, soil stability, frost action, plant communities, plant succession, and plant trend. Part II deals with the application of the basic information for range classification and management and includes review of range types, range condition and apparent trend, range suitability, and grazing capacity.

Part I - Basic Information

A. Geology

The central part of the Uinta Mountains, which includes the alpine zone, is a broad, plateau-like crest of a geologic arch. Unlike other mountains of the Rocky Mountain system, it has an east-west axis. The north and south edges of the plateau-like crest are sharply broken and thrown into highly inclined positions (King, 1878). The axis of the arch fold is near the north edge of the broad top where it breaks off to the north at a steep angle (see Fig. 1). The highest part of the mountain is the main ridge extending from Mount Emmons to Gilbert Peak. This includes King's Peak, the highest in Utah, with an elevation of 13,498 feet.

The exposed core of the Uintas is pre-Cambrian quartzite, argillites, conglomerates, and micaeous shales instead of a crystalline core common to many mountains of the Rocky Mountain system. Rock colors vary from dark red and maroon to white, with the darker colors being most common. The cementing is dominantly silica, and coloring material is generally ferric oxide. Ritzma (1959) described the Uintas as a large structural arch with a thick sequence of quartzites, argillites, and shales exposed by erosion along the core or axis of the fold. Weathering has broken up the exposed quartzite to form vast boulder fields throughout the alpine area (Fig. 2).

Much of the surface in the alpine zone was altered greatly by ice and snow during successive glacial periods. Glaciers developed in the headwaters and carved out the cirques. As the glaciers moved out of these catchment areas, U-shaped valleys and canyons resulted. Where the cirques were formed in the more gentle plateau-like highlands and where they did not quite coalesce, a "biscuit-board" topography was formed. This is a common landform in the Uinta alpine. Where cirques coalesced, cols and knife-edge spur ridges were formed. The King's Peak area is an example of this latter topography. Most of the catchment areas and glaciers were above 10,000 feet. At the glacier's greatest advance, 1,000 square miles were covered with ice. With the retreat of the ice, a complex mass of drift material was left behind in the cirques and valleys. The depressed areas were occupied by chains of lakes. In places, morainal debris formed a stair-step series of little basins. In the basins, moraine deposits can be recognized by hummocky terrain.

B. Soil Development

Quartzite is very resistant to weathering. Where it makes up the principal parent material, soil development is a slow process at best. When combined with the low temperatures and short summers common to the alpine climate, there is little wonder that the soils of the alpine portion of the Uinta Mountains are generally shallow and stony. However, where thin shale layers are exposed they contribute beyond their relative bulk in soil building materials.



Fig. 1 - Looking west along the main axis of the Uinta Mountains. The peaks in the background represent roughly the main axis of the anticlinal fold.



Fig. 2 - Weathering has broken up the exposed quartzite to form vast boulder fields throughout the alpine area.

One of the early invaders of these boulder fields is Geum rossii. Here this plant is forming small colonies throughout the rock field area. Before this plant can become established soil materials must accumulate near enough to the surface for the plants to become established. Thereafter, the plants themselves aid in the soil-building process.

Cox (1933) in discussing soils of the James Peak area of Colorado said that alpine soils are generally characterized by their stony, gravelly nature, strong acidity, and heavy leaching. He also showed that lack of stability, except on moderate slopes, prevents the development to maturity of alpine soils. However, the alpine soils of the Uinta Mountains are not all shallow and poorly developed. In some of the more favorable sites, moderately deep, moderately developed soils are found.

1. Agents of Soil Formation

a. On-site weathering

Due to the low temperatures of alpine areas, chemical action is held to a minimum. Consequently, most of the breakdown of the parent material is due to mechanical disintegration or through deposition by wind. Agents of disintegration important in the alpine area are ice (formerly as glaciers), wind, rapid changes in temperature, freezing and thawing of water, grinding action of stone heaps in talus slopes and stone glaciers (gravity), and the action of plants.

b. On-site accumulation of soil material

Loess deposits apparently have been a source of soil-building materials. The silt loam surface horizon so common over much of the area gives strong indications of wind deposition. Also soil materials accumulate by glacial and peri-glacial phenomena, alluvial, and colluvial action--possibly some buried soils.

2. Soil Development Sites

Soil development on six major kinds of sites was observed. The findings on these sites are correlated with major plant communities which are treated later in the report.

a. Glacial moraines

Glaciation in the Uinta Mountains was principally by valley glaciers. The broad drainage heads within the alpine zone were formed as a result of nivation and glacial scour. Most of the transported material was deposited as moraines in areas now occupied by spruce and lodgepole forests. As the ice retreated after the glacial period, some scattered drift, in the form of ground and lateral moraines, was left in the high alpine basins (Atwood, 1909). The soil-building materials of the glacial deposits are an unsorted mixture ranging from clay to boulders.

As the glaciers melted, the snow accumulation areas in the high alpine basins were last to become snow-free; as a consequence, the soils are younger and generally lack in development when compared with areas extending above the ice. Soils on the glacial deposits are shallow and rocky, generally having less than a foot of solum and often consisting of 50 percent or more of stones.

b. Fellfields (ridges above timberline)

Fellfield is defined as a treeless, rock-strewn area, above timberline or in frigid zones, dominated by low plants or by grasses and sedges. This definition could apply to most of the area above timberline. In this report, however, it includes only the areas where very little soil has developed, like on exposed ridges and passes. It does not include meadows, boulder fields, loessal deposits, or the glacial deposits. Pebble mulches are often characteristic of these areas.

Soils of the fellfield are very shallow and poorly developed because of the harsh climate common to these sites. Fellfield areas in general were not covered with glacial ice; consequently, they are relatively old in relation to the basins and other glaciated areas. Of all the alpine soil sites checked, these come the closest to being a residual soil.

c. Boulder fields and talus

Boulder fields are very prevalent in the Uinta alpine. In the process of soil development the boulders are gradually buried. The portions of the boulder field in the more favorable sites, such as on moderate slopes and less exposed areas becomes buried first. There are still vast areas of the boulder fields and talus slopes where little or no soil buildup has taken place. Observations in boulder fields show that soil first develops in small pockets. These small pockets, under the protection of early invading plants, eventually grow into islands and, with continued soil accumulation, the islands grow and eventually coalesce, resulting in a continuous soil cover with occasional projecting boulders. In some areas, so-called rock channels remain. Both Murdock (1950) and Hayward (1952) discussed rock channels. Hayward said, "The persistent rocks may be attributed in part to a lack of time for the climax community to spread a continuous blanket over the original substratum, but their persistency is also associated with the action of water. On the slopes, they serve as runoff channels from melting snow and summer rains, and on the level ground, they remain filled for varying lengths of time with standing water, forming temporary ponds." Some of these "rock channels" can be attributed to frost sorting resulting in such features as "stone nets" and

stone stripes (see section C.2. of this report). Figures 2, 3, and 4 show stages of development of soil and plant communities in the boulder field.

Some of the deeper alpine soils were found in boulder field sites. These were well drained soils of medium depth. The sedge-grass plant community was characteristic of the better soils. This is in agreement with Bliss (1956). In his studies on the Snowy Range of Wyoming, he found that both soil and plant communities reached their best development and greatest maturity on the fairly level, well drained sites. Where site studies have been run on the boulder field sites, soils with depths up to 30 inches were observed. Murdock (1950), in digging in similar sites, found soils up to four feet in depth. These better boulder field soils were of medium texture with moderately developed B_2 horizons.

Most of the area occupied by boulder fields, like those of the fellfield, was above the glacial ice and, therefore, relatively old in relation to other Uinta alpine soils. However, those developed from loess may be younger. Much of the wind-blown material was probably deposited at the close of the last glacial period, but is still continuing as dust storms periodically deposit new materials on the mountain.

d. Alluvial outwash (below boulders or talus)

One of the most active soil development sites on the Uinta alpine is on the alluvial terraces. Terraces and fans are found at the foot of boulder fields and talus slopes. Soils on these sites are formed from the fines flushed out of the boulder fields and talus slopes by snowmelt and summer storms.

Each season during high runoff periods these deposits are subject to modification. There may be deposition in one spot and cutting in others. Figure 5 shows early plant invasion on a recent deposit. In Figure 6, there is a buildup of alluvial materials along a small stream. Figure 7 indicates the lack of soil stability of the alluvial deposits. In Figure 6, there is a buildup of soil materials, while in Figures 7 and 8, soil is being removed from a formerly stabilized area.

On recent deposits where colonies of Geum were becoming established, little or no soil profile development was observed. The soils were an undifferentiated mass of gravelly, sandy loams (see Figure 5). On portions of the same terrace, however, well-developed plant communities were found. Here, the soil profile exhibited the same high degree of development as the productive plant community growing on it (Figure 9).

Soils in excess of 30 inches were observed on alluvial terraces where the deepest soils of the alpine area are generally found.



Fig.3 - A medial stage of soil and vegetation development on a boulder field. However, frost sorting activity is also evident. Geum rossii is the dominant plant around the periphery of the soil islands where it continues to invade further into the boulder field. The Carex rupestris-Geum rossii community occupies the centers of the soil islands. Other important species are Agropyron scribneri, Potentilla spp., Erigeron sp., Paronychia pulvinata, Trifolium dasyphyllum, Selaginella densa, Silene acaulis, and Hymenoxys grandiflora. Species like Kobresia myosuroides and Carex elynoides were found near the center of the larger soil islands.



Fig. 4 - A late stage in the soil and vegetation development of a boulder field. Only occasional boulders protrude above the soil surface. Here, the soils are of medium depth and moderate development.

Kobresia myosuroides is dominant in this community and makes up over half of the herbaceous production. Geum rossii ranks second in importance and is most conspicuous around the protruding boulders. Other species common to the site are Deschampsia caespitosa, Polygonum bistortoides, Carex pseudoscirpoidea, Hymenoxys grandiflora, Carex alba-nigra, and Artemisia scopulorum. Herbage production was approximately 750 pounds per acre, dryweight.

Condition classification excellent.



Fig. 5 - Colonies of Geum rossii on gravel alluvial terrace, at the foot of a talus slope. This is the early stage of development on such sites. Small clumps of Carex tolmiei can also be noted between the Geum colonies. The soil under this colony stage of plant development is a poorly developed, gravelly, sandy loam.



Fig. 6 - Soil deposition at the base of talus and boulder fields. The streambed of this small stream is 12 inches above the surrounding area. A small alluvial fan is being built as a result. Plant communities grade from the Carex aquatilis meadow adjacent to the stream to Deschampsia caespitosa on the damp meadow edge and eventually to sedge-Geum communities on well-drained portions of the alluvial fan.



Fig. 7 - This area receives a considerable amount of drainage water during spring snowmelt periods. The soil strip in the center of the photo is being eroded on the edges despite the 100 percent ground cover of excellent vegetation on the bulk of the strip. There is a question as to the originating cause of the soil erosion taking place on this soil strip. Lateral cutting will probably continue until removal is complete.



Fig. 8 - A broad drainageway below a large snowbank area extends through the center of the bench in the foreground. Note the bank cutting and pocketing along the edges. The Krumholtz spruce (circled) is about six feet from a cutting bank and on the same level as the drainageway. Ring counts showed the spruce to be over 60 years old. This indicates bank cutting is a slow process in the alpine turf.



Fig. 9 - The Geum rossii-Carex tolmiei plant community has developed on an alluvial outwash flat. This is a stabilized area south of the area shown in Fig. 5. Geum rossii and Carex tolmiei make up 85 percent of the vegetation. Other species are Festuca ovina brachyphylla, Poa spp. Deschampsia caespitosa, Plantago tweedyi, Artemisia scopulorum, Polygonum bistortoides, and Potentilla sp. Herbage production was 884 pounds per acre, dryweight. Range condition is good for vegetation and excellent for soil.

The soil is a moderately deep loam that grades into a gravelly loam. It also has a moderately developed B_2 horizon in contrast to the poorly developed soil in Fig. 5.

e. Slopes below seeps and snowdrifts

Slopes develop on rather steep slopes where a continuous summer supply of moisture is available. Soil development is common along small streams originating at snowbanks or sidehill seeps. Soils first form along the stream course, and meadow plants form the main vegetation. As soils build up and the stream is diverted, species of plants common to well drained sites occupy most of the soil strip. As the soil and vegetation cover develop simultaneously, good soils may result on many of the sites.

Soil development on this site is comparable to that of the boulder field and streamside meadow.

f. Meadows and bottom lands

Erosion processes, both natural and induced, concentrate sediment in the low spots such as lake basins, drainage channels, and depressions. Water also accumulates on the same low areas. The sediment provides a good supply of soil-building materials, but the drainage is generally poor, and results in the development of meadow and bog soils. These wetland soils are highly varied. All gradations of soil can be found from the peat-muck soils of the bogs to the well-developed, highly organic soils of the dry meadows.

Peat-muck soils are found in old lake beds or around the edges of present lakes. Often, these soils are very deep and show considerable peat development. They are characterized by layers of peat and muck over a structureless, blue-green often mottled substrata--all indicating a poorly drained soil. Coarse sedge grows on these soils and may produce as much as two tons of air-dry herbage per acre.

Meadows also develop on topographic positions other than around lakes or old lake beds. Where there is a continuous water supply from seeps or streams, a meadow type develops. Poor drainage conditions may result in a gley soil; however, this is not always the case. Many of these meadows are well irrigated, but the soils have the characteristics of better drained sites. The surface soil is characterized by high organic content. Bliss (1956) found a loss on ignition of 59 percent by weight in the surface layer of alpine meadows in Wyoming.

C. Soil Stability

Alpine soils develop in a severe climate and are continually subjected to all the rigors of that climate. Many alpine soils of the Uinta alpine are remarkably resistant to erosion (see Fig. 10). The tough sod and high organic content of the surface soil, plus a high percentage of gravel and stones, make these alpine soils highly resistant to the erosive action of water and wind.

Where erosion does occur it is generally of moderate or less intensity. This is particularly true of the south slope of the mountains. Gullies

are not common, but some large ones do occur in some of the steeper canyon heads of the north slope. The main indicators of soil erosion are bank cutting (mainly in the deeper alluvial soils), sheet erosion where the turf has been damaged, and sediment deposits in lakes.

Most of the lakes observed did not show signs of excessive recent deposition, although occasionally a lake was found where heavy deposits were observed. Figure 11 shows a lake that has been nearly cut in two by the delta of an intermittent stream. The drainage originates on the heavily grazed Kabell Ridge.

1. Factors Influencing Soil Stability

Soil scientists list four primary factors that influence soil erosion: (1) climate, (2) inherent character of the soil, (3) topography, and (4) retardants, such as vegetation. Man has very little influence over the first three factors, but he plays a dominant role in changing the vegetation.

a. Climate

Weather records of the alpine are only fragmentary, however, it is evident that the alpine has the most rigorous climate of all mountain rangelands. It is an area of extremes in temperature, humidity, and wind effects. In many ways, the alpine climate is more severe than that of the arctic.

Annual precipitation on the alpine portion of the Uinta Mountains is estimated to vary between 35 and 50 inches. Three-fourths of this moisture comes in the form of snow. Due to winds and topography, the total moisture varies from site to site. On lee slopes, deep snowdrifts are characteristic while ridgetops and peaks often are bare. Snow distribution is a big factor in alpine plant community distribution. Recent snowfield studies in Norway have shown this relationship (citation by Johnson and Billings, 1962).

Estimates, based on records from Montana and Colorado, indicate that summer storms furnish about one-fourth of the annual precipitation in the alpine. Johnson (1962), in his study of the Beartooth Plateau, found variations from .31 to .59 inch per week. Nine years of records at Corona, Colorado, (11,600 feet elevation) showed 1.63 inches in June, 2.64 inches in July, and 2.24 inches in August (Retzer 1962). A similar summer precipitation pattern is thought to exist on the Uinta Mountains. Observations during the eight years of study have shown some summers to be very dry with periods of ten days or more with no rainfall. Other summers may have rain or hail every day. Many of the summer storms are heavy and may be accompanied by high winds.



Fig. 10 - Rapid melting after a late June snowstorm, base of Leidy Peak, Uinta Mountains.

This 5-inch snow cover melted in about half a day. With this rate of melt the soil percolation rate was not great enough to take care of the water; as a consequence, much of it ran over the surface. Little or no eroding action was observed. The water was running clear as it left this 10 to 15 percent slope.



Fig. 11 - A sand delta extending into a small lake, head of Burnt Fork, near Bennion Lake, Uinta Mountains. Runoff from the ridge above has washed material into this lake. The ridge is a heavily grazed area.

If the average annual precipitation is 40 inches in the Uinta alpine zone, the 250,000 acres within this zone must dispose of 832,000 acre-feet of water annually. With the relatively shallow soils and low vegetation of the alpine zone, the probability is that much less of this water is held and used on the site than would be the case in the lower timbered zones. Observation during snowmelt and during summer storms, plus indicators on the ground, show that a large portion of the precipitation leaves the area as surface runoff. "Washout" pockets are evident in the heavy turf, particularly below "boulder field" slopes where the water runs over the turf.

Average annual temperatures in the alpine, where records are available, are under 30 degrees F. A nine-year record in Colorado (Corona) averaged 27.9 degrees F. Here, December was the coldest month with an average of 9.4 degrees F., the warmest month had an average of 48.8 degrees F. Summer temperatures were very comparable on the Beartooth Plateau (Johnson 1962). Average temperatures varied from 46.4 degrees to 48.3 degrees F. during the study period of three years.

Frosts are frequent on many alpine sites during the growing season. Summer temperature records from eight study sites made by Johnson and Billings (1962), during their study of the Beartooth Plateau, showed an average of 48 percent frost-free days. This percentage varied from 82 percent on a ridge site where air drainage was good to 29 percent on the Carex-Eriophorum meadow.

During the summer season, winds are usually light to moderate during the day and calm at night (Hayward 1952). Johnson (1962) estimated the average wind velocity as 9 mph in July to 17 mph in January on the Beartooth Plateau. On the Uinta Mountains, strong winds of several days' duration may occur at times during the summer. Winds of 40 to 50 miles per hour are not uncommon (Hayward 1952). Retzer (1962) cited winds of 160 mph on Pikes Peak in Colorado.

Hayward (1952), in discussing the Uinta Mountains, said that relative humidity usually varies from 35 to 75 percent. However, it may drop to near 10 percent during the daytime during periods of clear weather.

b. Soil erodibility

Several methods have been used to appraise the erosion resistance of a soil. A recent approach is to represent this resistance as an "erodibility index." The two soil characteristics used in determining this index are surface aggregate detachability and profile permeability. These two characteristics are assigned numerical ratings, the product of which gives the erodibility index.

Soil granules must be detached before they can be transported by water; therefore, strength and size of the surface aggregates determine the detachability of the soil granules.

Profile permeability of a soil is dependent upon the surface texture, soil depth, and the presence or absence of obstructing layers, such as clay or solid bedrock.

Alpine soils of the Uinta Mountains are generally of medium texture, varying from sandy loams to silt loams in the surface horizon. The surface aggregates of these soils are rather weak and poorly defined. Soil depths vary from very shallow to medium (generally 12 to 30 inches). Development of the "B" horizon is slight to medium. Gravel and stoniness characterize many of the alpine soils. As a result of the combination of these characters, the erodibility index generally falls in the medium classification. In other words, characters favoring erosion are just about balanced by those characters that resist erosion. Light to medium soils have a high infiltration rate, yet the soil aggregates are generally weak, which subjects them to a high degree of detachability. Soils are generally shallow, which limits their water storage capacity, yet many have little or no restricting layers to reduce their permeability. Stones and gravel may also be present to aid in holding the soil in place.

An exception to this general rule is found in the areas of shale-derived soils which are very unstable although rather limited in extent (Fig. 30). Their "erodibility index" varies from moderately high to high. Rapid erosion is taking place wherever these soils do not have adequate ground cover. Any grazing use that damages the plant cover may have serious consequences on these areas.

c. Topography

Topography, as it affects the erosion hazard, is primarily a factor of slope. Slope increases the velocity of running water which increases its erosive power. Range allotment analysis data from the Wasatch National Forest showed a rather strong correlation between degree of slope and range condition when soil stability was used as a basis for range condition.

Most of the range portion of the Uinta alpine has rather gentle topography. The forage-producing areas are found in the broad basins, on terraces, and on broad ridgetops. It is only under special situations that soils have been able to develop on the steeper sites. Most of these steep areas are covered with talus or are exposed bedrock.

d. Ground cover (vegetation, litter, and naturally occurring rock)

Through the study of relic or lightly grazed areas, a number of characteristics were observed in the Uinta alpine area. First, observations on stable sites show that ground cover is nearly complete; that is, vegetation, litter, and naturally occurring surface rock, where present, give the soil almost complete protection. Even on very rocky areas, very little soil is exposed. Second, the vegetation is naturally very short. In the cushion plant communities, the vegetation may be less than two inches in height. The average alpine turf does not exceed four inches, except in protected spots. Third, most of the alpine plant communities have a very tough sod, generally about six inches thick. The numerous roots, plus the organic matter, may constitute over 50 percent of the top layer of soil. This tough sod gives the alpine turf its stability, despite the rigorous climatic conditions and the medium erodibility index. Fourth, natural climatic action is keeping many sites in an unstable condition, particularly on steeper slopes and in the transition zones between the raw rock and stabilized areas.

The soil stability phase of range condition classification is based upon the amount of ground cover present and upon the degree of erosion. Reduction of ground cover and the resulting breakup of the sod are the "earmarks" of changes in condition. When the ground cover deteriorates due to excessive grazing, the results are reflected in loss of vigor in the forage plants and thinning or "wearing out" of the turf. Weakly anchored plants, such as mosses and Selaginella, are easily damaged by trampling and their removal leaves areas of bare soil.

2. Cryopedogenic Features

Cryopedogenic features are the result of frost action on the soils with indirect effects on vegetation. These features are common, but not extensive, on Uinta alpine areas and are characterized by frost hummocks, frost boils, stone nets, stone stripes, and solifluction terraces. All of these features leave their characteristic pattern on the ground and vegetation. Most of them are associated with a breakdown in soil stability, particularly when in their active stages. Instability is obviously accelerated by grazing animals, and it is often difficult to separate the basic causes. In range analysis, no attempt is made to identify the causes, but only to point out and classify the degree of instability. If a site is naturally unstable, it would be folly to add the burden of grazing use to it. Any process or activity that breaks the sod and exposes bare soil also accelerates the frost action. Vegetation and accumulated organic matter form an insulating layer which slows down heat loss and minimizes frost penetration.

a. Frost hummocks

Frost hummocks develop as a result of frost thrusting. They are associated with damp or wet sites where the water table is perched on a silty or clayey layer for at least the early part of the summer season. Hummocks vary in size from a few inches to several feet in diameter and to over three feet in height.

Billings and Mooney (1959), in their studies on the Medicine Bow Mountains of Wyoming, suggested that frost hummocks (peat hummocks) were the first stage in a degradation cycle through frost scars to sorted polygons. In this process, the apex of the hummock is broken and the center eroded away.

Intermixed frost hummocks and frost scars were observed in the Uinta alpine areas (Figures 12 and 13). Sheep trampling was observed on the broken mounds. This probably enlarges the breaks and prevents healing.

b. Frost boils

Frost boils are areas of bare soil where the light-colored subsoil has been thrust to the surface by frost action. They generally vary from two to four feet in diameter. Like the frost hummocks, they are found on gentle topography and on sites having perched water tables on silty or clayey horizons at shallow depths. As long as these frost boils are active, the frost churning prevents the establishment of plant colonies. However, as they become inactive, plants will eventually invade the bare areas. Johnson (1962) found Stellaria umbellata, Trifolium parryi, and Salix anglorum to be the early invaders on frost boils (Fig. 14).

c. Stone nets

In the Uintas, stone nets have been observed on both well-drained and relatively wet sites. Stone nets on the dry sites appear to be inactive, whereas those on the wetter sites show evidence of recent activity. There is a strong possibility that the stone nets on dry sites date back to a time of periglacial activity. Soil adjacent to and beneath the stone nets showed a rather strongly developed soil profile (silt loam "A" horizon over a silty clay loam "B" horizon). A soil trench dug through a stone net indicated comparable profile development under the soil net as was found in the adjacent tundra. This soil development indicates a considerable period of stability.

Studies on the Beartooth Plateau showed no evidence that the stone nets on summits and ridges are presently active and suggested that these patterns were produced during a period of higher soil moisture which could have been held nearer the surface by permafrost (Johnson and Billings, 1962 - see Fig. 15).



Fig. 12 - Frost hummocks and frost scars in a meadow. As the soil is raised above the general level by the frost, the sod in the center breaks and exposes the soil. Often large areas become bare as a result of this action. Trampling by sheep was observed to increase the size of the sod breaks and thus contribute to the instability.

Deschampsia meadow in fair condition.



Fig. 13 - Frost hummocks in various stages of their cycle. As a result of frost action subsoil material is forced upwards towards the ground surface forming a hummock. Breaks then occur at the hummock apex and erosion removes the topsoil and light-colored subsoil is exposed. Eventually the entire hummock is removed by erosion and only a bare area or frost boil remains.

Vegetation rating - good.



Fig. 14 - Frost and heavy grazing have combined in breaking up the sod in this area. Note the thinness of the vegetal cover. This is the second stage of frost action. The circular cupped-out areas were caused by loss of topsoil.

Dry meadow site in poor condition. Compare with Fig. 13 where the vegetation was rated in good condition.



Fig. 15 - Stone nets resulting from frost sorting on an alpine area. This sorting process results from differential movement of stones and fines as a result of frost action. Geum rossii grows vigorously along these stone channels due to additional moisture obtained by extending its roots into the soil under the loose stones.

d. Stone stripes

Stone stripes are similar to stone nets in origin, but have elongated rather than circular patterns.

Investigators feel they are a result of frost heaving on slopes where gravity is a big factor in the sorting process. Johnson and Billings (1962) found that they occurred on lee slopes with gradient of 8° to 18°. Sorted patterns on the Uinta Mountains considered to be stone stripes were found on rather gentle slopes (see Fig. 16.)

e. Solifluction terraces

Solifluction is a mass movement downslope of saturated soil (Johnson, 1962), and is related to the frost patterns in that cungeliturbation (frost action processes) is a factor in its development. As observed on the Uinta Mountains, the terrace faces are generally from one to three feet high. As the soil mass moves downslope, it may override the old soil surface. Sod on the face of the terrace tends to check its movement, but occasionally chunks of sod break loose and fall at the toe of the terrace face.

Solifluction terraces are found on slopes below snowdrifts and seeps. Billings and Mark, in their studies in New Zealand, found that these terraces developed only on slopes of seven degrees or above (Fig. 17).

Sheep, in walking across solifluction terraces, tend to break the sod and thus weaken its stabilizing power on the face of the terrace.

3. Effects of Wind and Surface Water

Wind and running water over the surface also leave their marks on the alpine turf.

As snowmelt water moves off the slopes and out of the boulder fields, much of it runs over the soil surface until it eventually reaches natural drainage channels. Where the concentration of water is great enough, particularly at the base of boulder fields, much gouging of the turf is evident, leaving numerous pockets generally varying from two to six inches deep, but sometimes exceeding a foot in depth. Some head cutting also occurs in drainage channels. Head cutting does not appear to progress very readily because of the tough, tenacious sod.

Wherever the sod is broken, wind becomes a factor in removing soil. Bare areas are enlarged by wind blowing out loose material and tunneling into the turf around the edges of breaks. Retzer (1962) reports large wind-eroded areas in Colorado, concentrated near the ridgetops and heads of major valleys. In these exposed sites where the wind is strongest, any sod break provides a starting point for wind erosion, and may result in the removal of the soil from sizable areas.



Fig. 16 - A stone stripe. These have similar origin to stone nets. They have elongated patterns rather than circular.



Fig. 17 - Solifluction is common on this slope, showing particularly well on the lower third of the photo. The willows at the crest of the slope indicate a moist condition. Here is a place where the natural soil movement is compounded by grazing use. Sheep trailing across this face have helped break up the sod and it appears that natural healing is being blocked by the trampling on this face. At the time of this photo, the area showed evidence of heavy grazing use.

Where the sod is completely broken, sizable bare areas are beginning to show.

D. Plant Communities

Alpine vegetation is characterized by a patchwork of mixed plant communities. Individual communities may vary from less than a square rod up to several acres in extent. A homogeneous community seldom exceeds 100 acres. The boundaries between the communities vary from abrupt to diffused. The latter is more common and results in much overlapping of the plant communities.

The amount of moisture available during the growing season is the main factor that determines which species will be found on a particular site. Aspect, slope, and wind exposure control the snow distribution, which in turn determines, to a large extent, the plant community that grows on the site. Johnson (1962), in his alpine studies on the Beartooth Plateau, found that depth of winter snow accumulation and time of snowmelt were of great importance in local distribution of alpine species. He classed Deschampsia caespitosa sites as snowbed vegetation. Geum turf characterized the exposed sites where wind removed much of the snow. Water accumulation, due to poor drainage, resulted in such bog vegetation as the Carex scopulorum community. Johnson (1962) also cites the extensive studies made by European investigators Gzaerevoll and Dahl on the influence of snow distribution on alpine plant communities.

In the alpine areas of the Uinta Mountains, 10 to 15 species constitute the bulk of the vegetation cover. Geum rossii is the most common and was found to be dominant or codominant on two-thirds of the sites studied. Carex pseudoscirpoidea was a major constituent of the community on half of the study sites. On the drier, more exposed sites, Carex rupestris is a major species. Deschampsia caespitosa is the characteristic species of dry and wet meadows. Other important species are Trifolium nanum, T. dasyphyllum, Festuca ovina brachyphylla, Antennaria spp., Kobresia myosuroides, Carex elynoides, Polygonum bistortoides, Danthonia intermedia and Poa spp. Carex tolmiei is one of the most important alpine species found on the north slope of the Uintas but has only occasional occurrence on the south slope.

1. Carex rupestris and Cushion Plant Communities

The Carex rupestris and cushion plants occupy the driest, most exposed sites of all the alpine plant communities. They are confined, primarily, to the ridgetops, open passes, and other areas where the soils are shallow. These sites are exposed to the winds so that snow accumulation is greatly reduced (Fig. 18).

The soils on these xeric sites are usually shallow and have a high stone content. Both of these factors are consistent with low water-holding capacity. There are interesting exceptions to the above rules. One Carex rupestris site on a 12,000-foot mountain was found to be of medium depth with moderate soil development. Evidence would indicate that this is an old soil that developed under climatic conditions different from the present.

The cushion plants form the most primitive community and occupy the driest, least developed sites. Griggs (1956) listed Silene acaulis as the most aggressive pioneer in the Rocky Mountain fellfield. Other important pioneer plants are Paronychia pulvinata, Trifolium nanum, and Arenaria obtusiloba. The cushion plant communities are found in small localized areas with a comparatively small acreage.

Carex rupestris is found in various amounts in most of the cushion plant communities. However, on the better sites, it becomes dominant or codominant with the cushion plants. This species also occurs in other alpine communities. Johnson and Billings found the percentage of drummond sedge and Geum rossii to be inversely related on the Beartooth Plateau.

The following species are common in the cushion plant and Carex rupestris communities:

Dominant Plants

Carex rupestris
Silene acaulis and/or Paronychia pulvinata
Trifolium nanum

Other Important Species

Selaginella spp.	Smelowskia calycina
Trifolium dasyphyllum	Lloydia serotina
Festuca ovina brachyphylla	Carex elynoides
Potentilla spp.	Poa rupicola
Arenaria obtusiloba	Trisetum spicatum
A. fendleri	Draba fladnizensis
Helictotrichon mortonianum	Erigeron simplex
Trifolium parryi	Kobresia myosuroides

2. Geum-Sedge and Sedge-Geum Communities

All gradations are found between nearly pure stands of Geum to types with a strong sedge aspect. A large percentage of the alpine range is found within the broad range of these communities (Fig. 19).

Geum rossii has its greatest dominance in the early invasion of boulder fields (Hayward, 1952, and Murdock, 1950). This plant is able to extend its long roots to a considerable depth between the rocks and under the rock channels and stone nets, thus making use of moisture and nutrients that are not available to the shallower-rooted grasses and sedges.

Geum-rossii also extends its dominance into dry meadows in association with Deschampsia caespitosa. Johnson and Billings classified such areas as snowfield communities. As the poorly drained sites are approached, the Geum gives way almost entirely to the Deschampsia.



Fig. 18 - The cushion plant community which is characterized by such low-growing plant forms as Carex rupestris, Silene acaulis, and Paronychia pulvinata. This community is found on the very shallow residual soils and is common on high, exposed ridgetops and passes. Where these sites have not been used excessively for sheep bed grounds, they are generally in good condition. They are not particularly attractive to sheep because of the low forage production. The high stone and gravel content of soils on these sites makes them resistant to damage by livestock.

Condition classification is excellent.



Fig. 19 - Geum-sedge community. The vegetation on this site is principally Geum rossii and Carex rupestris.



Fig. 20 - Sedge-grass community. This is the nearest approach to climax found on the Uinta Mountains. The dominant species is Kobresia myosuroides. Sedge and grasses make up over three-fourths of the herbage. The soil was of medium depth. The silt loam "A" horizon is 11 inches thick which overlies a 10-inch silty, clay loam "B" horizon. The dryweight herbage production was 726 pounds per acre.

This site was classed in excellent condition.

Major species associated with the Geum are Carex pseudoscirpoidea and Deschampsia caespitosa. The former is often codominant with the Geum in the better drained areas, but is replaced by the Deschampsia as imperfectly drained situations become evident.

Species commonly found in these communities are:

Dominant and Codominant Species

Geum rossii	Carex pseudoscirpoidea
Deschampsia caespitosa	

Other Important Species

Festuca ovina brachyphylla	Potentilla concinaeformis
Danthonia intermedia	P. diversifolia
Artemisia scopulorum	Polygonum bistortoides
Carex rupestris	Sedum stenopetalum
Antennaria spp.	Erigeron spp.
Poa spp.	Trifolium spp.
Kobresia myosuroides	Carex elynoides

3. Sedge-Grass Community

The sedge-grass community, as characterized in this report, is considered as the nearest approach to an alpine climax of any community found in the Uinta Mountains (see Fig. 20). The dominant species is either Kobresia myosuroides or Carex elynoides. It is very difficult to separate these two species in the field as seed heads are usually very scarce for both species, their growth habits are very similar and they occupy a comparable ecologic position. Frequent collections of both species have been made in the alpine portion of the Uinta Mountains. This community has been recognized by various students of alpine flora. Osborn (1959) and Marr (1961) considered Kobresia myosuroides to be the dominant species in certain alpine sites on the Front Range of Colorado. Johnson and Billings (1962) considered Carex elynoides as forming a distinctive community of the Geum turf on the Beartooth Plateau of Wyoming and Montana.

On the Uinta Mountains, the community occurs on the most stable portions of high ridges and slopes and above the areas subjected to glacial action. The soils are generally from 15 to 26 inches in depth and show good development for such high elevations.

Records of transect studies within the community showed considerable variation in the quantity of the different plant constituents. The dominant species determines the aspect and makes up 28 to 55 percent of the composition by weight. Geum rossii is generally present, but in a rather inconspicuous role. Wheatgrass, bluegrass, and other grasses are also common to this community.

The vegetation of this community forms a dense turf. Except for the protruding boulders, it forms practically a complete ground cover. Forage production, depending on the effective depth of soil, varies from 500 to 700 pounds per acre air-dry.

Species common to this community are:

Dominant Species

Carex elynoides or Kobresia myosuroides

Other Important Species

Geum rossii	Carex pseudoscirpoidea
Festuca ovina brachyphylla	Poa spp. (rupicola and lettermani)

Other Species

Agropyron scribneri	Trisetum spicatum
A. trachycaulum	Carex haydeniana
Carex alba-nigra	C. rupestris
C. phaeocephala	Deschampsia caespitosa
Artemisia scopulorum	Hymenoxys grandiflora
Polygonum bistortoides	Potentilla diversifolia
Erigeron leiomeris	Solidago multiradiata
E. simplex	Danthonia intermedia
E. melanocephalus	

4. Wet Meadow and Bog Communities

There are a number of wetland situations grouped under the wet meadow classification grazing from bogs in old lakebeds to stringer meadow strips along streams. Characteristic vegetation communities are found on the various wetland sites, depending on the degree of drainage or lack of drainage. Some of the communities are small and insignificant from the range management point of view, and only the more important ones will be discussed.

Many of the wet meadow areas are too wet for sheep grazing and are generally in good to excellent condition.

The Carex aquatilis community is found on the very wet or boggy sites of the wet meadow complex. This community may form the first zone adjacent to open water and may extend into the water for a short distance. It may also extend over the entire area of old lakebeds. Wet peat soils are associated with this community. Species common to the community are:

Dominant Species

Carex aquatilis

Associated Species

Mosses	Eriophorum chamissonis
Carex illota	Caltha leptosepala
C. bipartita	Sedum rhodanthum
Pedicularis groenlandica	Eleocharis pauciflora

Moss fills the interspaces between herbaceous plants, thus forming a complete ground cover of vegetation.

Carex saxatilis Community

Hayward (1952) based his wet meadow classification on this community. Recent field checks have shown it to be one of numerous meadow communities. It was found to be mostly in intermittent ponds and lakes and in areas gouged out in other communities by heavy runoff. This sedge is tolerant to relatively deep standing water for part of the season. Nearly pure stands of Carex saxatilis var. major are common to many sites or it may be associated with such species as Juncus albescens, J. mertensianus, Deschampsia caespitosa, Carex nelsonii, C. nigricans, and Eriophorum chamissonis. Often clumps of Salix are also found within the community. Many of these associated species grow on raised hummocks within the Carex saxatilis community.

Deschampsia caespitosa Community

This is the most extensive community of the wet meadow complex (see Fig. 21). Moisture supply is adequate throughout the season and only excessive in the spring. Soil profiles generally show some mottling which indicates a degree of imperfect drainage. This community often forms the intermediate zone between the Carex aquatilis community and the dry meadow, or forms narrow borders along alpine streams.

Species common to the community are:

Carex ebenea	Potentilla diversifolia
C. bipartita austromontana	Juncus albescens
C. illota	J. drummondii
C. nelsonii	Eleocharis pauciflora
C. bigelovii	Pedicularis groenlandica
C. nigricans	Gentiana spp.
C. media	Polygonum bistortoides
Phleum alpinum	

Salix colonies are also found associated with this community (Salix planifolia, S. drummondiana and others).



Fig. 21 - Wet meadow in excellent condition. Adjacent to open water - Carex aquatilis.

Bulk of wet meadow - Deschampsia caespitosa community.

Associated species - Carex ebenea, Caltha leptosepala, Phleum alpinum, Pedicularis groendlandica, two species of moss, Sedum rhodanthum, two species of Gentiana, Potentilla sp., Polygonum bistortoides with colonies of Salix.

Wet meadow edge - Antennaria sp. Castilleja sp. with Juncus drummondii.

Cupped-out areas in meadows - Carex saxatilis major.

The estimated dryweight production was 850 pounds per acre.

5. Dry Meadow or Deschampsia-Geum Community

Separation of dry meadows from closely related types and subtypes may be rather difficult. The dry meadow community grades gradually from wet and semiwet meadows and merges with the dryland communities. It is closely associated with the Deschampsia caespitosa community, but is drier and the associated species are different (Fig. 22). Soil moisture is plentiful early in the summer season but may be lacking by late summer. Soils are relatively deep but fairly well drained. Positioned in the basins and at the foot of slopes, the dry meadow community is supplied with moisture from adjacent areas.

Common to the dry meadow community is a mixture of species from the wetter and drier alpine sites. The two most important species are Deschampsia caespitosa and Geum rossii. On range in good or excellent condition, Deschampsia is the dominant plant. Polygonum bistortoides and Carex pseudoscirpoidea also may be common in the type.

The dry meadow community is rather common on the Uinta alpine areas, is a favorite of grazing animals, and heavy use and damage to the plant cover have occurred in many areas.

The following species are common to the Deschampsia-Geum community:

Dominant Species

Deschampsia caespitosa

Most Important Associated Species

Geum rossii	Carex pseudoscirpoidea
Polygonum bistortoides	

Other Important Species

Festuca ovina brachyphylla	Danthonia intermedia
Trisetum spicatum	Poa leptocoma
Potentilla spp.	Juncus drummondii
Trifolium parryi	Luzula spicata
Artemisia scopulorum	Trifolium dasyphyllum
Sedum stenopetalum	Erigeron peregrinus
Antennaria corymbosa	E. simplex
Lewisia pygmaea	Eritrichium nanum elongatum
Saxifraga rhomboidea	Sibbaldia procumbens
Silene acaulis	Stellaria longipes

6. Alpine Shrub Community

Shrub communities of the alpine area of the Uinta Mountains are the willow, dryad, and alpine heath. Only the willow-field community is large enough in area to be important to grazing management. The taller species of willow ordinarily occur as small colonies in meadows, along streams, and around lakes, occasionally forming willow fields.



Fig. 22 - Dry meadow. The important species in this community are Deschampsia caespitosa, Geum rossii, and Carex pseudoscirpoidea.

The taller species of willow range from two to four feet in height and include such species as Salix planifolia, S. glauca glabrascens and S. drummondiana. Associated with taller willows are the grasses and sedges common to the meadow communities (Fig. 23).

Sheep grazing has been very damaging to some species of willow. Hedged and dead willow clumps are common on heavily grazed ranges.

Willows are quite susceptible to wind and snow blast damage, and exposed twigs may be killed back as much as six inches.

The dwarf willow clumps are too small to be given much consideration in vegetation classification. They occur in colonies of only a few feet in diameter. Three species of dwarf willow found in the Uinta Mountains are Salix nivalis var. saximontana, S. cascadensis, and S. anglorum var. antiplasta (Fig. 24). The latter, which is known as the rock willow, is found on rocky slopes.

Another low alpine shrub found on the High Uintas is the dryad or Dryas octopetala. This species, like the dwarf willow, forms only small colonies. It is more commonly found on the north and east slopes of ridges.

Alpine heath are infrequent on the Uintas. They either form small colonies within the major types and communities or the plants are associated with the sedges and forbs as a part of the community. Vaccinium caespitosum and V. scoparium, which are common to the conifer zone, extend into the lower portions of the alpine zone where they occur in meadow communities. Kalmia polifolia and Gaultheria humifusa are found occasionally along the borders of lakes and streams and in rock fields.

7. Conifer Community

Only the upper edge of the spruce forest adjacent to the alpine zone is considered in this report. Scattered trees and open parks characterize this community (Fig. 25). It extends into the heads of drainages and along terraces and benches, often extending to the base of the peaks. The drier sites within this area are generally in poor condition due to heavy grazing. The conifer community is one of the heaviest grazed portions of all the high elevation types.

The understory vegetation of this type consists of a mixture of alpine and spruce zone species. The vegetation varies from two to three inches in height and production is generally between 300 and 400 pounds per acre dry weight. Under protection, the production may approach 500 pounds. The soils of this type are highly acidic which probably restricts the production of herbaceous vegetation.



Fig. 23 - Alpine-shrub community. This willow type is closely associated with the meadow communities. The planeleaf willow (Salix planifolia) is one of the most common species found in the alpine area.

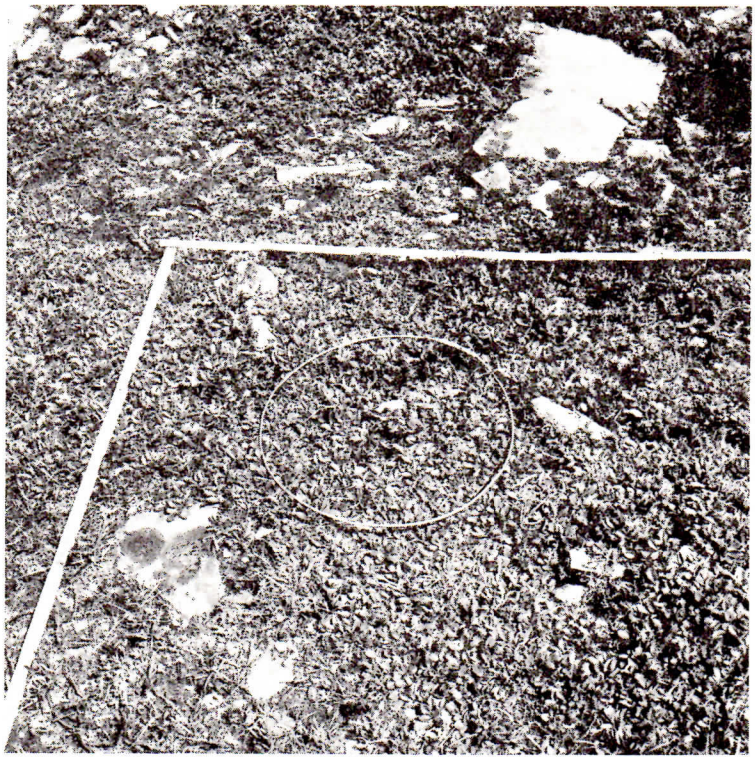


Fig. 24 - Alpine dwarf willow community.

The dwarf willow (Salix nivalis saximontana) makes up most of the herbage in this site on the west terrace of Bald Mountain. Associated species are Carex rupestris, Festuca ovina brachyphylla, Danthonia intermedia, Smelowskia calycina, Potentilla diversifolius, and Artemisia scopulorum.

The soil in this site is receiving protection from a 95 percent ground cover. The rock present is a normal part of the cover and is covered with lichens.



Fig. 25 - Open timberline spruce community.

This is one of the heaviest used types of the high elevation range. Utilization studies and pellet group counts showed that this area was being grazed by sheep at a rate of 70 sheep days per acre. The low vigor of the vegetation reflects this heavy use.

Highly acid subsoil may also be a contributing factor to the low forage production.

Herbaceous species common to the upper-elevation spruce forests are:

Most Common Species

Deschampsia caespitosa	Lewisia pygmaea
Carex pseudoscirpoidea	Sibbaldia procumbens

Other Common Species

Achillea millefolium lanulosa	Polemonium pulcherrimum
Agoseris glauca	Polygonum bistortoides
Antennaria spp.	Potentilla glaucophylla
Artemisia scopulorum	Saxifrage rhomboidea
Arenaria spp.	Sedum stenopetalum
Campanula rotundifolia	Selaginella spp.
Danthonia intermedia	Solidago multiradiata
Erigeron spp.	Taraxacum officinale
Luzula spp.	Thlaspi fendleri
Poa alpina	Trifolium parryi
P. nervosa	Trisetum spicatum
Phleum alpinum	

E. Alpine Plant Succession

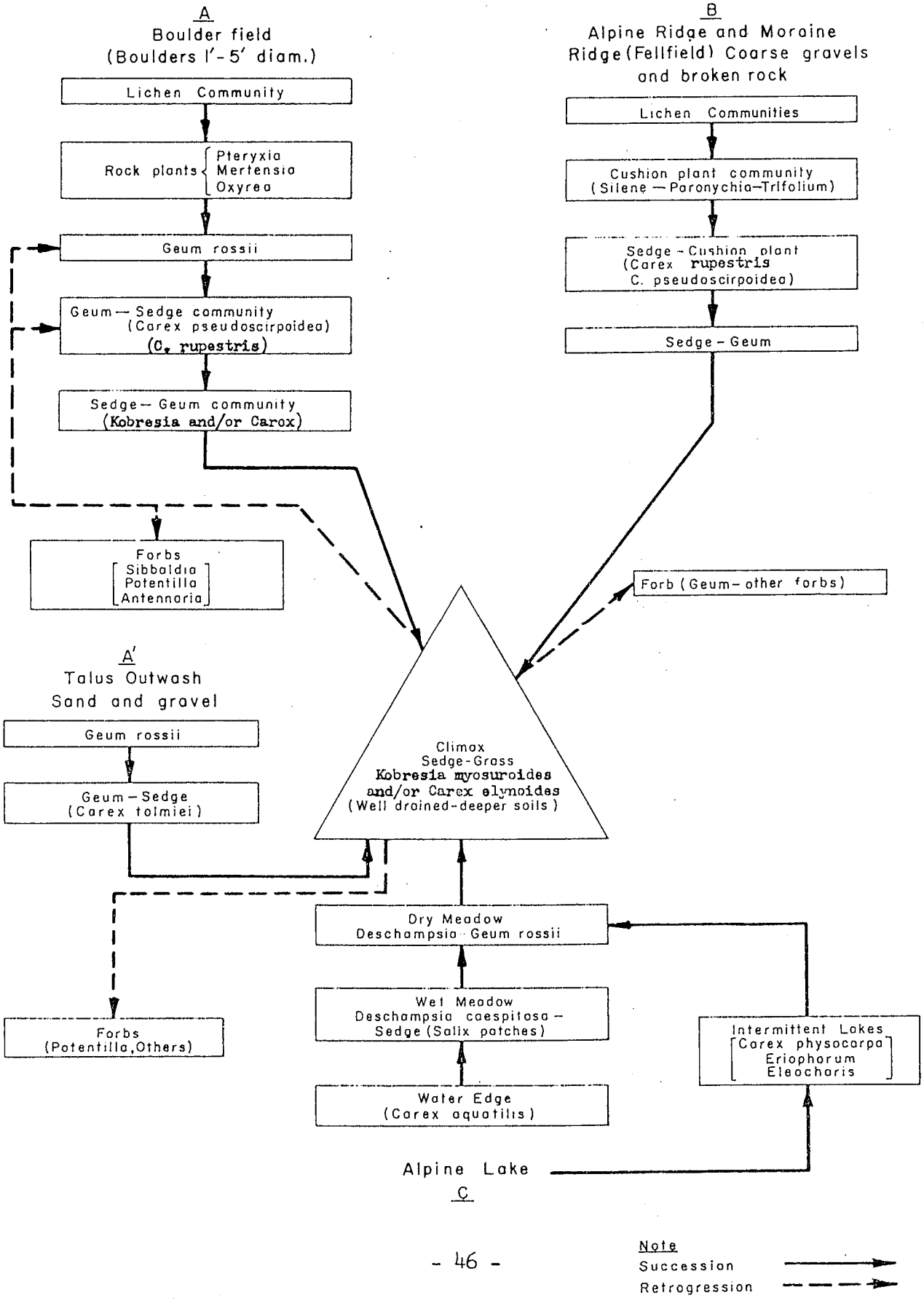
Evidence of three main lines of succession was observed in the alpine zone of the Uinta Mountains (Fig. 26). Two lines of succession start from boulder fields (A) and the fellfield (B). The third line, the hydrarch succession (C), progresses from the alpine lake. Closely associated with the boulder fields are the alluvial deposits at their bases. Here, the plant development on raw alluvium is represented by the line A'. The chart shows all of these lines of succession developing to a sedge-grass climax.

Climax is herein used with reservation. The described communities, rather than replacing one another, may be a reflection of the specific environment. For example, the cushion plant communities may remain as such due to the extremely xeric condition under which they exist, and would change only with a change in environment (climate or geologic). A change in climate would probably explain the medium depth soil under a Carex rupestris-cushion plant community on the summit of Leidy Peak. The vegetation appears to be in balance with the climatic factors (moisture and wind), yet the soil reflects a period of more favorable climate on the site.

If any community could be considered climax, the sedge-grass with Kobresia or Carex elynoides as dominant species would come closest to qualifying. This community is found on the deepest, best-developed soils and on some of the oldest development sites above the reach of heavy glacial action.

ALPINE COMMUNITIES-SUCCESSION AND RETROGRESSION

Fig. 26



The three lines of succession are described as follows:

1. Boulder Field Succession

The boulder field so common to the Uintas is the origin of one of the main lines of plant succession. The boulders, as they appear in fresh talus, present a uniform red hue. With age, the monotonous color of the raw boulders is broken by an array of yellow, green, brown, and black crustose lichens which are the earliest pioneer plants. As little pockets of soil accumulate between the boulders, due to loess deposits and mechanical breakdown of the quartzites, such vascular plants as Pteryxia, Mertensia, and Oxyria become established. One of the early and most important pioneers in the boulder fields is the ubiquitous Geum rossii (Fig. 2). This plant forms the fringe that surrounds the soil islands and progressively invades into the boulder field from all points of its periphery (Murdock 1950, Hayward 1952). This plant is also the dominant species along the edge of rock channels of stone nets. As time progresses and larger islands of soil are formed, sedges and grasses become more important in the mixture and eventually gain dominance. Sedges first to become associated with the Geum were found to be Carex rupestris and C. pseudoscirpoidea.

The Geum-sedge community (principally Carex rupestris) is common to small soil islands and soil centers of stone nets. These sites are dry due to excessive drainage. Much more available moisture is found adjacent to the open boulder fields and along stone channels where vigorous growth of Geum rossii occurs. This plant can send its roots for a considerable distance under the edge of the boulder field and rock channels to obtain additional moisture.

The sedge-grass community occupies the sites where the mantle is more or less continuous or where the soil islands are large. The sedge-grass community is considered to be the highest developed plant community of the alpine area. In this community, Carex elynoides or Kobresia myosuroides may often completely occupy the site to the total exclusion of other species; however, in most cases, Geum rossii is an important associate.

Closely associated with the boulder fields and talus slopes are the alluvial deposits at their bases. A study was made of a talus outwash area in the head of Henry's Fork on the Wasatch Forest. As as result of runoff water flushing finer materials out of a talus slope, a considerable accumulation of sand and fine gravel had been deposited on a terrace.

Geum-rossii and Carex tolmiei were the first important plants to become established on these raw materials. Both spread by vegetative means and colonies of these species eventually invaded the entire area, resulting in a sedge-Geum community. When the community reached an advanced state of development, a large number of species common to the sedge-grass community was found. Plant

succession was reflected in the development of the soil from raw sand and gravel to fairly well developed, moderately deep soil. Figure 5 shows the colony stage and Figure 9 the developed Carex-sedge community.

2. Fellfield Succession

The sites on which the fellfield communities begin are somewhat different than the boulder field. The rock is broken up so there is a mixture of all sizes, from boulders to gravel and sand. A pebble mulch often characterizes the ground surface. The early stage of lichens is found on the rock and may also be found on the gravel where some stability is maintained. Cushion plants are the early invaders of these harsh sites. Soil collects under their spreading mats and eventually covers the rocks and gravel. Such plants as Silene acaulis, Paronychia pulvinata and Trifolium nanum are the most important species in the early stages of vascular plant establishment. An early plant to become associated with the cushion plants and one that eventually becomes dominant in the community is Carex rupestris. This stage of development is common in the Uintas. Geum-rossii also develops to become a codominant with the sedge. Where soils are able to develop to a sufficient depth, the sedge-grass climax eventually becomes established. Succession on the fellfield sites is very slow because these are some of the harshest sites found in the alpine area. Their usual lack of stability does not allow sufficient soil to develop to support plants of the higher successional stages.

3. Hydrarch Succession (from glacial lakes)

The numerous lakes left by the glaciers have been, or are in the process of being filled with sediment and plant remains. As the filling process advances and the water becomes shallow, meadows are established. Our interest in range classification begins with the wet meadow and not with the successional stages of the lake itself. Many of the shallow lakes have been filled with sediment and have become meadows.

Two main communities are considered here in the successional line. In the wetter portion of the meadow and extending out from the open water is the Carex aquatilis community. Standing water is often found over much of the area. Water sedge is dominant on this site and generally makes up a large percentage of the vegetation.

The Deschampsia caespitosa community occurs adjacent to the water sedge meadow where excess water is much less prevalent. Drainage is poor and the site remains quite wet throughout the year. It is, however, free from excess surface water much of the season and has a much firmer, less saturated soil than the sedge meadow.

Hayward (1952) based his wet meadow type on Carex saxatilis. This plant was found to be dominant in some of the high intermittent lakes and pockets cupped out by heavy runoff, but not an important meadow community.

The dry meadow is the third step in the hydrarch succession. As the water table becomes lower in relation to the soil surface, a different group of species become a part of the plant community. The dry meadow is a meeting place of some of the wetland and mesic species. Deschampsia continues as an important constituent, but dryland sedges and Geum become important associates. With improved drainage, the dry meadow gradually grades into the sedge-grass community.

F. Range Trend

1. Retrogression and Secondary Succession

Outside species are generally not available for invasion into the alpine zone. The climatic restrictions associated with this zone preclude species from the lower zones to a large extent. As a consequence, species present and adapted to the alpine zone have a part in the secondary succession, as well as in the primary. Livestock grazing is the most important factor that causes composition change and, if severe enough, will set the stage for secondary succession to take place. Also, natural processes are continually at work breaking down the vegetal cover. Frost, running water, and wind are the more important ones.

Geum rossii was found to be the most aggressive increaser where vegetation was thinned and also as an active invader of areas. On harsher sites, however, Silene acaulis invades and reinvades. Griggs (1956), in his studies of the fellfield, found Silene the principal invader of areas disturbed by roadbuilding.

There are a number of forbs besides Geum and Silene that increase when the original vegetal cover is thinned out or disturbed. The main ones are Sibbaldia procumbens, Potentilla spp., Antennaria spp., Polygonum bistortoides, Cerastium arvense, Ivesia gordonii, and Erigeron spp. Even Trifolium dasyphyllum and T. parryi thrive best where the grass and sedge species are thinned out. Of the grasses and sedges, Carex pseudoscirpoidea and C. rupestris often increase in the stand when other vegetation is thinned out. Poa alpina is most consistently found in bared areas.

In an area just above timberline, two soil levels were studied as to species composition. The upper level was considered to be the original, while the lower had lost a six-inch top layer through erosion. Thirteen species were listed on the study plot and were classified as follows:

Upper Level Only	Both Levels	Lower Levels Only
Poa spp.	Geum rossii	Achillea lanulosa
Danthonia intermedia	Polygonum bistortoides	Stipa lettermani
Artemisia scopulorum	Carex pseudoscirpoidea	Erigeron simplex
Festuca ovina brachyphylla	Arenaria sp.	Foliose lichen
Agropyron trachycaulum		

2. Rate of Change

Little specific information is available on rates of change (trend) in the alpine rangelands. General observations and comparisons between areas with different grazing histories indicate that the process is slow. However, recent changes in management plus data from an inclosure indicate that considerable change can accrue in a relatively short time. For example, allotments that were rested for two years in succession showed a marked improvement in plant vigor, as was indicated by increase of seedhead production.

The Kidney Lakes exclosure showed some measurable changes after eleven years of protection from grazing by domestic livestock. Besides improvement in plant vigor as reflected in individual plant size, there was some change in plant composition. The more important forage species which were classed as "Desirables," showed an increase from 65 percent of the composition in 1956 to 82 percent in 1967. Carex species showed increases of 20 percent (based on frequency measurements). Polygonum bistortoides, one of the more palatable species, increased from 0 to 10 percent of the plant composition. Sedum stenopetalum, a nonforage species, was reduced from 15 percent to 0. Achillea also showed a decrease from 12 percent to 4 percent. The change in vegetation composition changed the range vegetation condition rating from fair to good.

Part II - Range Analysis and Determination of Grazing Capacity on Alpine Range

The purpose of range analysis is to gather and evaluate data needed to develop allotment management plans which will insure proper management of the range environment to best meet the needs of the resources and the grazing animals. Basic information for developing guides and standards for range classification is assembled in Part I of this report.

Basic steps in range environmental analysis are discussed as follows:

First: Delineation of range types.
Second: Range condition classification.
Third: Determination of suitability.
Fourth: Determination of current and potential forage production.

A. Delineating Vegetation Types

In range environmental work, the vegetation is classed into types. Not all vegetation types are represented on alpine areas. Following are the major range types found on the Uinta alpine:

Type 1 - Grassland
Type 2w - Wet meadow
Type 2d - Dry meadow
Type 3 - Perennial forbs
Type 5 - Browse-shrub
Type 6 - Conifer
Type 7T - Heavy timber
Type 8 - Barren

If scanty or no vegetation is growing in the rock field the area would be classified as 8 (Barren). However, if small patches of herbaceous vegetation occur throughout the type, they should be given a percentage rating and be given a separate classification.

Because of its close relationship to the alpine, the open conifer forest of the upper spruce zone is also described. Here many of the species common to the alpine zone and the forest zone are mixed.

Types may include several plant communities. The major ones are listed under the types.

1. Classification of major plant communities by range types

Type 1 - Grasslands

a. Carex rupestris - cushion plant community
b. Sedge-Geum community
c. Sedge-grass community

Type 2w - Wet meadow

a. Carex aquatilis community
b. Deschampsia caespitosa community

Type 2d - Dry meadow

a. Deschampsia-Geum community

Type 3 - Perennial forbs

a. Cushion plant community
b. Geum-sedge

Type 5 - Shrubs

a. Willow fields

Type 6 - Conifer

a. Upper spruce zone

Types 7 and 8 - Nonrange and barren

B. Range Condition and Basis for its Classification

Condition of alpine range is judged by different standards than most rangelands because it does not follow the usual pattern. Heavy grazing does not change the plant composition to the degree commonly understood and expected on other range areas. Alpine ranges may show damage due to heavy grazing use, yet the plant composition may show very little change. The changes taking place are more of a "wearing out" process wherein the plants are thinned out and reduced in vigor.

Condition guides used for the alpine type are based on the results of site analyses made on areas that have had little or no past grazing use. Most of the sites studied had a ground cover (vegetation plus litter and naturally occurring surface rock) approaching 100 percent. Studies on areas that had deteriorated because of heavy past grazing use showed a marked reduction of ground cover and decline in plant vigor rather than changes in plant composition. Consequently, degree of change in ground cover and herbage production were used as the main criteria for determining range condition. Thus, on most alpine sites in deteriorated condition the soil stability classification will be much lower than the vegetation condition classification.

Guides for rating range condition in the alpine are found in the exhibits at the end of Chapter 40 of the Range Environmental Analysis Handbook. The following guides are used in condition classification:

1. Guide for rating vegetal condition (R-4 Range Environmental Analysis Handbook, Exhibits 41-J and 41-J1).

2. Guide for rating soil stability for alpine types (R-4 Range Environmental Analysis Handbook, Exhibit 41-L, parts I and II).

3. Species list for alpine (R-4 Range Environmental Analysis Handbook, Exhibit 41-I). Many of the foregoing photos in this report illustrate range condition. Many of them show examples of good or excellent condition range because the object of the study was to seek out near-pristine areas to use as a basis for classification. The following photos depict range conditions on a variety of sites:

Fig. 4 - Sedge-Geum community in excellent condition.
Fig. 9 - Geum-sedge community in good to excellent condition.
Fig. 12 - A Deschampsia meadow in fair condition.
Fig. 14 - Dry meadow site in poor condition.
Fig. 18 - Carex-rupestris cushion plant community in excellent condition.
Fig. 20 - Sedge-grass community in excellent condition.
Fig. 21 - Wet meadow (Deschampsia) in excellent condition.
Fig. 22 - Dry meadow in good condition.
Fig. 23 - Alpine-shrub type in good condition.
Figs. 28, 29, and 30 depict different degrees of very poor condition.

C. Guide for Adjusting Herbage Production

From plant development and productivity studies by Billings and Bliss(1959), approximate growth-time curves were developed for well drained sites (ridge above snowbanks) and the imperfectly drained site (below snowbanks), Fig. 27. These two curves should measure the two outside limitations of plant development. The other sites could be fitted in between these two curves as they deviate from one to the other. These curves should give useful guidance in estimating the year's maximum production for all alpine sites.

D. Determination of Suitability

Suitability criteria for alpine range is based on limitations set by one or more of factors such as accessibility, animal preference, soil erodibility, slope, and ground cover. These limitations may be set by the habits of the grazing animals or by the instability of the sites.

Sheep inherently have a preference for certain areas and plants. They will concentrate on some areas and avoid others. Their grazing habits can be learned through studying pellet group distribution or watching them graze. Wet meadows are usually not preferred by sheep but the drier edges around them are. Thick willow patches greatly restrict grazing and may show use only around the periphery of larger patches. If given a choice and not driven, sheep will generally bypass areas containing sparse vegetation.

Resistance of soils to erosion, steepness of slope, and the amount of ground cover are factors that must be carefully evaluated in determining range suitability. Soils with a high or moderately high erosion index are very susceptible to erosion. If a protective ground cover of vegetation and litter cannot be maintained under grazing use, the area should



Fig. 28 - Alpine turf in very poor condition. This site has approximately 35 percent bare soil. It is a concentration area with a long history of heavy use. Lack of soil stability places it in the very poor condition class.



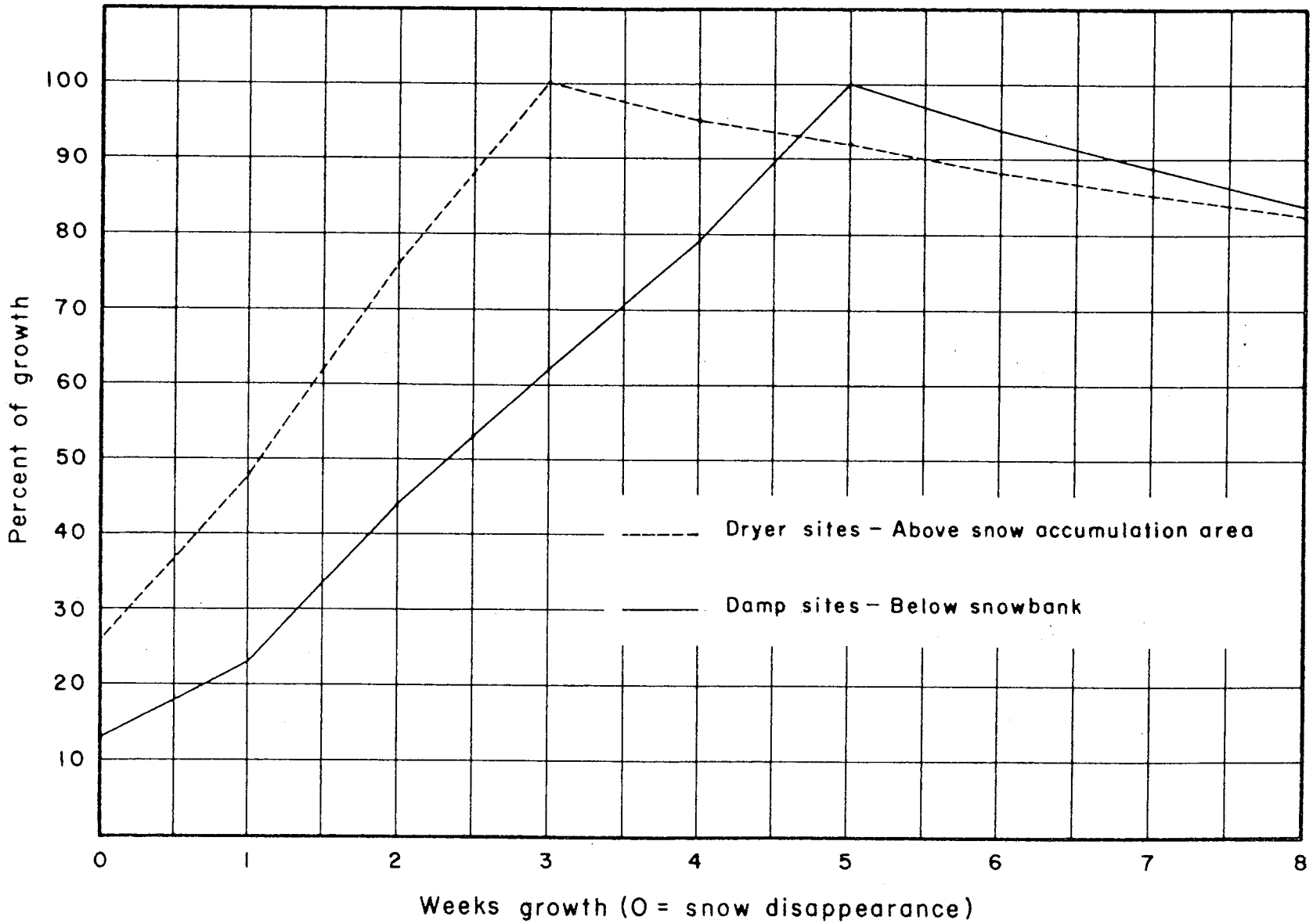
Fig. 29 - Geum-sedge community in very poor condition and unsuitable for livestock grazing. The soils on this 40 percent slope are very unstable.



Fig. 30 - Soil from shale parent material is very difficult to manage. Severe erosion is taking place on this site. Such areas are classed in very poor condition and unsuitable for grazing use.

GROWTH CURVES OF ALPINE PLANTS

Figure 27



be classed as unsuitable and closed to livestock use. Soil on shale areas of the Uinta alpine are in this classification. There is much more leeway in managing range with low to medium erodibility indexes. The bulk of the soils in the alpine area are in the medium category.

Slope is a suitability factor involving limitations due to the inverse relationship between degree of slope and stability of the soil and cover. Soils on slopes are generally shallower and solifluction and other sodbreaking activities are more prevalent. Slopes over 20 percent should be heavily sodded before they are considered as suitable for grazing.

Ground cover is one of the most important site factors that determines whether an area should be grazed and/or the degree of use that should be allowed. In the better developed plant communities, observations show grazing use to be a most important factor contributing to reduced ground cover and sodbreaking. Sheep trails cutting through the sod were obvious in the heavily used portions of the range. Site analysis and grazing impact studies indicate that serious erosion problems develop when about 30 percent of the soil becomes bare.

E. Grazing Capacity

Grazing capacity of the alpine ranges depends on the following major factors. First, it must be based on only those areas which have the inherent characteristics to sustain grazing without damaging the resources. Second, the degree of use will depend on current range conditions. Obviously the grazing use on poor condition suitable range should be limited to the extent that the condition will improve. Third, it will depend on the present and potential production capacity of the various sites of suitable range. Fourth, the kind of management system, and the quality of livestock management provided by the grazing permittee will, to a degree, determine the areas that can be used and the intensity of use.

1. Application of the Suitability

Grazing capacity must be based only on suitable range. Where suitable and unsuitable range areas are separate and distinct, management planning can be done with clear-cut decisions. It is where the two are intermixed that careful decisions are required. Much of the alpine range of the Uinta Mountains is in this latter category.

Guides for allowed use of such areas will depend on the damage that will result to the unsuitable portions while the suitable range is being grazed. The damage will generally depend on the basic stability (or lack of stability) of the unsuitable range.

Unsuitable areas on steeper slopes and on shale outcrops must be given full protection from grazing livestock, even though intermingled areas of suitable range remain ungrazed. Also, grazing capacity of adjacent suitable areas will depend on the control that can be given to the grazing livestock.

On areas of moderate topography and where the soils have a high degree of erosion resistance, improved management and light to moderate stocking rates may allow recovery of the sore spots and improve the general range condition. Such range should be classed suitable even though parts of it are in very poor condition.

2. Available Forage

The alpine types are generally low producing areas. The short season, low temperatures, and drying winds all have a tendency to inhibit growth of the inherently low-stature plants of the alpine areas. The plants do, however, make the maximum use of the time and conditions under which they have to grow. Billings and Bliss (1959) found that many of the alpine plants begin growth when temperatures at soil level were near the freezing point of water. They found that species like Carex elynoides, Geum rossii, and Deschampsia caespitosa began growth while still covered with snow.

These same authors found that the plants reached maximum flowering in approximately three weeks after the initiation of growth and matured their seed in seven to eight weeks. A maximum forage crop was produced in three to four weeks followed by a decline (Fig. 27). A number of factors influence the rate and amount of growth made by alpine plants. The major ones are topographic position, aspect, and release date from snow. These factors in turn have major influence on temperature, available moisture, and length of growing season. Studies in the Medicine Bow Mountains of Wyoming showed a production range of 0.6 to 2.3 grams per square meter per day on transects below the snowbank and 0.6 to 1.1 grams per square meter per day on the ridge transect above the snowbank (Billings and Bliss, 1959).

Bliss, (1956) found that under the most severe microclimate of the ridgetop, Carex rupestris had an average daily stem elongation of 2.3 cm., while on the south slope, elongation was 5.3 cm.

Bliss (1956) also found that oven-dry plant productions per square meter varied with sites as follows:

	Production	
Location	Grams per sq. meter	Pounds per acre
Ridge	26.7	235
Wet meadow	112.4	1,000
South slope	112.0	1,000
North slope	44.8	400

In this case, the severe ridge site and the north slope were less productive than the meadow. Here, available moisture was the most important factor of production. In the alpine environment, the warmer south slopes were more productive than the north slopes.

Studies of the various alpine plant communities in pristine or near-pristine conditions have given some guides on forage production. Table 1 summarizes the information from 26 site studies made on the Uinta Mountains. Most of these sites were in at least good condition.

Table 1 - SUMMARY OF RANGE SITE STUDIES

Plant Community	Dry Weight Production in Pounds					
	Total Herbage	Percent Forage	Forage Production	Forage for Use	S.D./A.* 6.6 lbs. Allowance	S.A. per Sheep Month
Carex rupestris	477	68	324	97	14	2.1
Geum-sedge	424	62	263	79	12	2.5
Dry meadow	647	74	479	144	22	1.3
Wet meadow	1283	100	1283	513	77	.38
Carex-Kobresia-Grass	734	87	639	192	29	1.0
Open spruce	350	95	332	100	15	2.0

*The general stocking guides above are based on 40 percent utilization of forage species on wet meadows and 30 percent on the other five communities.

3. Management Systems for the Uinta Alpine

Logistic problems common to the alpine areas of the Uinta Mountains make management supervision very difficult. As a result, planned management has often not received good on-the-ground application. To accomplish an improved and acceptable system of management two points must be considered. First, a system must be developed that is easy for the herder to follow. Second, it should be easy to check compliance with the management plan. A planned-rest system would fit the above requirements probably better than other systems. If an entire unit is rested each year, followup checks would be easy for anyone to make. In developing a planned-rest system, it is important that the unit be tied to natural well defined areas. This may require combining allotments in some instances. Another requirement for managing the alpine allotments is that there must be sufficient land area to maneuver sheep herds.

F. Stocking Rates Guide

Following are general guides for tentative stocking of sheep on suitable range under a system of once-over moderate grazing on alpine areas of the Uinta Mountains.

Community	Sheep Days Per Acre	Acres Per Sheep Month
Carex rupestris	10 to 15	1.5 to 2.5
Geum-sedge	9 to 15	2 to 3
Dry meadow	15 to 30	1 to 2
Wet meadow	30 to 60	1/3 to 1
Sedge-grass	15 to 40	3/4 to 1.5
Open spruce	10 to 15	1.5 to 2.5

Under planned rest models the use may be increased some. However, present use records agree quite well with these estimates.

SUMMARY AND CONCLUSIONS

The alpine area of the Uinta Mountains is found on the exposed pre-Cambrian quartzite that makes up the core of the mountain.

Soils are shallow and rocky over much of the alpine area; however, moderately deep soils have developed on moderate slopes and more protected areas.

Soil development was reviewed for six major alpine sites: glacial moraines, fellfields, boulder fields, alluvial terraces, slopes below snowdrifts, and bottom lands.

Erosion rates are moderate over most of the alpine area regardless of the severe climate. The alpine turf is very tough and gives excellent protection to the soils once it has developed.

Normal and accelerated erosion are very difficult to separate. Frost is an important factor in breaking the turf and allowing the forces of erosion a chance to act. Livestock grazing and particularly the mechanical action of trampling is a heavy contributor to the turf breakup. Features due to frost action are frost hummocks, stone nets, stone stripes, and solifluction terraces.

Alpine vegetation is characterized by a patchwork of mixed plant communities which gradually grade into each other. Major communities are Carex rupestris-cushion plant, Geum-sedge, sedge-Geum, sedge-grass, wet meadows and bogs, dry meadow, and alpine shrub, with a closely associated open conifer type of minor importance.

There is evidence that alpine plant succession develops along three major lines of succession--namely, boulder field, fellfield, and alpine lake. All progressively develop toward a sedge-grass community of well drained, moderately deep soils, which is considered the nearest approach to the climatic climax found in this alpine area. Native forbs such as Geum rossii, Sibbaldia procumbens, Potentilla spp., Trifolium dasyphyllum, and Antennaria spp., are the major increasers and invaders in disturbed areas. Outside species are excluded because of the rigorous climate. Once an area has been disturbed, upward trend in condition is slow.

In range classification, the plant communities are grouped into six vegetation types. These are grasslands, wet meadows, dry meadows, perennial forb, shrub, and transition conifer. Poor condition of alpine areas is reflected primarily in reduced ground cover and low plant vigor.

Range suitability is based on a series of limiting factors. The major ones are accessibility, soil erodibility, and slope.

Alpine range of the Uinta Mountains can continue to be grazed provided the stocking is brought in line with capacity and management is raised to a higher standard. The major problems of the past have been overstocking and lack of management. It will be necessary to close critical areas to grazing.

Major considerations are range suitability, range condition, present and potential productivity of the various sites, and the kind of management system and the quality of livestock management provided by the permittee. Grazing capacity of suitable range should be based on a rate of moderate once-over use. Management planning must incorporate a system of use that provides for basic plant growth and soil stabilization requirements. It must also be fully coordinated with the needs of other resources and grazing animals.

APPENDIX

High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	1. POLYPODIACEAE - Fern F.									
CRAC2-	Cryptogramma acrostichoides R. Br.							x		
CYFR -	Cystopteris fragilis (L.) Bernh.		x	x						
WOSC -	Woodsia scopulina D. C. Eaton			x				x		
	2. ISOTACEAE - Quillwort F.									
ISBO -	Isotes bolanderi Engelm.	x								
	3. SELAGINELLAECEAE - Selaginella F.									
SEDED-	Selaginella densa densa Rydb.						x	x		
SEWA -	S. watsoni Underw.			x			x			
	4. PINACEAE - Pine F.									
ABLA -	Abies lasiocarpa (Hook) Nutt.			x						
JUCOS-	Juniperus communis L. var. saxatilis Pall.		x	x						
PIEN -	Picea engelmannii Parry			x						
PIFL -	Pinus flexilis James			x						
PICO -	P. contorta Dougl.		x							
	5. SPARGANIACEAE - Burreed F.									
SPAN -	Sparganium angustifolium Michx.	x								
SPMI -	S. minimum Fries.	x								
	6. POTAMOGETONACEAE - Pondweed F.									
POALT2-	Potamogeton alpinus var. tenuifolius (Raf.) Ogden	x								
POIL -	P. illinoensis Morong.	x								
	7. GRAMINEAE - Grass F.									
AGSA -	Agropyron saxicola (Scribn. & Smith) Piper							x		
AGSC -	A. scribneri Vasey								x	
AGSU -	A. subsecundum (Link) Hitch.		x	x						
AGTR -	A. trachycaulum (Link) Malte						x	x		
AGHU -	Agrostis humilis Vasey	x	x							
AGSC?-	A. scabra Willd.		x	x	x					
AGVA -	A. variabilis Rydb.			x			x			
ALAE -	Alopecurus aequalis Sobol.				x					
ALAL2-	A. alpinus Smith						x			
BRCI -	Bromus ciliatus L.						x			
CACAC-	Calamagrostis canadensis (Michx.) Beauv. var. canadensis				x		x			
CAPU -	C. purpurascens R. Br.							x		
CASC -	C. scopulorum M. E. Jones		x	x						

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High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	7. GRAMINEAE - Grass F. (Cont.)									
DAIN -	Danthonia intermedia Vasey						x			
DECA -	Deschampsia caespitosa (L.) Beauv.			x	x	x	x			
FEOVB-	Festuca ovina brachyphylla (Schult.) Piper							x	x	
GLBO -	Glyceria borealis (Nash) Batch.							x		
HEMO -	Helictotrichon mortonianum (Scribn.) Henr.								x	
HIOD -	Hierochloe odorata (L.) Beauv.				x					
KOCR -	Koeleria cristata (L.) Pers.							x		
PHAL -	Phleum alpinum L.						x		x	
POAL -	Poa alpina L.				x					
POEP -	P. epilis Scribn.						x			
POFE -	P. fendleriana (Steud.) Vasey						x			
POIN -	P. interior Rydb.			x	x					
POLE2-	P. leptocoma Trin.						x			
POLE3-	P. lettermani Vasey							x	x	
PONE -	P. nervosa (Hook.) Vasey	x	x							
PORU -	P. rupicola Nash						x	x	x	
POSA -	P. sandbergii Vasey		x				x			
TRSP -	Trisetum spicatum (L.) Richt.			x			x	x		
TRWO -	T. wolfii Vasey						x			
	8. CYPERACEAE - Sedge F.									
CAAB -	Carex ablata L. H. Bailey				x	x				
CAAIN-	C. albo-nigra Mack							x	x	
CAAQ -	C. aquatilis Wahl.				x	x				
CAAT2-	C. athrostachya Olney				x					
CAAT3-	C. atrata L.				x	x				
CAAU2-	C. aurea Nutt.				x					
CABE -	C. bella L. H. Bailey			x						
CABI -	C. bigelovii Torr.					x				
CABIA-	C. bipartita Bell. var. austro-montana F. J. Herm.				x	x				
CABR4-	C. brunnescens (Pers.) Poir.				x	x				
CABU -	C. buxbaumii Wahl.			x						
CACA3-	C. canescens L.				x					
CACA4-	C. capillaris L.									x
CACA5-	C. capitata L.						x	x		
CACH -	C. chalciolepis Holm						x	x		
CADI2-	C. disperma Dewey		x	x						
CAEB -	C. ebenea Rydb.				x	x	x			
CAEG -	C. egglestonii Mack			x						
CAEL3-	C. elynoides Holm						x	x		
CAEN -	C. engelmannii L. H. Bailey								x	

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High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	8. CYPERACEAE - Sedge F. (Cont.)									
CAFE2-	Carex festivella Mack.				x					
CAGE -	C. geyeri Boott		x	x						
CAHA3-	C. haydeniana Olney						x	x		
CAHA2-	C. hassei L. H. Bailey		x	x						
CAHE5-	C. hepburnii Boott									x
CAHEE-	C. heteroneura var. epapillosa (Mack) F. J. Herm.			x	x	x				
CAHO2-	C. hoodii Boott			x						
CAIL -	C. illota L. H. Bailey				x					
CAIN4-	C. interior L. H. Bailey				x					
CAKE2-	C. kelloggii W. Boott				x					
CALA2-	C. lanuginosa Michx.				x					
CALE4-	C. leporinella Mack.				x	x				
CALI2-	C. limosa L.				x					
CAMES-	C. media R. Br. var. stevenii (Holm) Fern.				x	x				
CAMI4-	C. misandra R. Br.						x			
CANE3-	C. nelsonii Mack.				x	x				
CANI2-	C. nigricans C. A. Meyer				x					
CANO -	C. nova L. H. Bailey				x	x				
CAOC2-	C. occidentalis L. H. Bailey		x							
CAPA6-	C. paupercula Michx.				x					
CAPE2-	C. pelocarpa F. J. Herm.						x	x	x	
CAPH2-	C. phaeocephala Piper								x	
CAPR -	C. praeceptorum Mack.			x						
CAPS -	C. pseudoscirpoidea Rydb.							x		
CAPY -	C. pyrenaica Wahl.						x			
CARA2-	C. raynoldsii Dewey							x		
CARO3-	C. rossii Boott		x	x						
CARO4-	C. rostrata Stokes					x				
CARU -	C. rupestris All.								x	
CASAM-	C. saxatilis var. major Olney					x				
CASU2-	C. subnigricans Stacey						x	x		
CATO -	C. tolmiei Bott							x		
CAVE2-	C. vernacula L. H. Bailey					x				
CAVE3-	C. vesicaria L.					x				
ERAN -	Eriophorum angustifolium Roth.				x					
ERCH3-	E. chamissonis C. A. Meyer					x	x			
ELMA -	Eleocharis macrostachya Britton				x					
ELPA3-	E. pauciflorus (Lighf.) Link				x	x				
KOMY -	Kobresia myosuroides (Vill.) Fiori							x		
	9. JUNCACEAE - Rush F.									
JUAL -	Juncus albescens (Lange) Fern.					x				
JUCA -	J. castaneus Smith							x		
JUDR -	J. drummondii E. Meyer			x	x		x	x	x	

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High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	9. JUNCACEAE - Rush F. (Cont.)									
JUHA -	J. hallii Engelm.				x		x			
JULO -	J. longistylis Torr.		x	x						
JUME -	J. mertensianus Bong.				x	x				
JUPA -	J. parryi Engelm.	x	x							
LUSP -	Luzula spicata (L.) DC.						x	x		
LUPA -	L. parviflora (Ehrh.) Desv.			x	x					
	10. LILIACEAE - Lily F.									
ALBR -	Allium brandegei S. Wats.		x	x						
ALBR2-	A. brevistylum S. Wats.		x							
LLSE -	Lloydia serotina (L.) Reichb.							x	x	
VECA -	Veratrum californicum Dur.			x						
ZIEL -	Zigadenus elegans Pursh		x	x						
	11. ORCHIDACEAE - Orchid F.									
HADI -	Habenaria dilatata (Pursh) Hook.				x					
SPRO -	Spiranthes romanzoffiana Cham. & Schlecht.				x					
	12. SALICACEAE - Willow F.									
SAAR -	Salix arctica Pall.				x					x
SABEP-	S. bebbiana Sarg. var. perrostrata (Rydb.) Schn.				x					
SACA -	S. cascadensis Cock.							x		
SADR -	S. drummondiana Barrett					x				
SAGE -	S. geyeriana Anderss.				x					
SAGL -	S. glauca L.		x		x	x				
SAMY -	S. myrtillifolia Anderss.				x					
SANIS-	S. nivalis Hook. var. saximontana (Rydb.) Schn.						x	x		
SAPL -	S. planifolia Pursh				x	x	x			
SAWO -	S. wolfii Bebb.				x					
	13. BETULACEAE - Birch F.									
BEGL -	Betula glandulosa Michx.					x				
	14. POLYGONACEAE - Buckwheat F.									
ERUMM-	Eriogonum umbellatum Torr. var. majus Hook .			x						
ERUMM2-	E. umbellatum Torr. monocephalum Torr. and Gray			x						
OXDI2-	Oxyrea digyna (L.) Hill									
POBI2-	Polygonum bistortoides Pursh					x	x	x		
POBIL-	P. b. var. linearifolium (S. Wats.) Small					x	x	x		
POVI2-	P. viviparum L.					x	x			

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High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer: LP	Upper El. Conifer: ES-AF	Upper El. Conifer: Meadow	Alpine: Wet Meadow	Alpine: Dry Meadow	Alpine: Alpine Turf	Alpine: Fellfield	Alpine: Boulderfield
	15. PORTULACACEAE - Purslane F.									
CLME -	Claytonia megarhiza (A. Gray) Parry			x						
LEPY -	Lewisia pygmaea (A. Gray) Rob.			x			x	x		
LEPYN-	L. p. var. nevadensis S. Wats.						x			
	16. CARYPHYLLACEAE - Pink F.									
ARCOS2-	Arenaria congesta Nutt. var. subcongesta (S. Wats.) S. Wats.			x						
ARFE3-	A. fendleri A. Gray								x	
AROB -	A. obtusiloba (Rydb.) Fern.						x		x	
ARRO -	A. rossii Rich.						x		x	
ARRU -	A. rubella (Wahl.) Smith						x	x		
CEAR -	Cerastium arvense L.						x			
LYAP -	Lychnis apetala L.							x	x	
LYDR -	L. drummondii (Hook.) S. Wats.			x				x		
LYKI -	L. kingii S. Wats.							x		
PAPU -	Paronychia pulvinata A. Gray							x	x	
SASAH -	Sagina saginoides (L.) Karst. var. hesperia Fern.		x							
SIACS-	Silene acaulis L. spp. subacaulescens (F.N. Williams) C.L. Hitch. & Mag.							x	x	
STLO -	Stellaria longifolia Muhl.		x	x						
STLO2-	S. longipes Goldie						x			
STUM -	S. umbellata Turcz.			x						
	17. NYMPHAEACEAE - Water Lily F.									
NUPO -	Nuphar polysepalum Engelm.	x								
	18. RANUNCULACEAE - Crowfoot F.									
ACCO -	Aconitum columbianum Nutt.				x					
ANMU -	Anemone multifida Poir.		x	x						
ANPA -	A. parviflora Michx.				x					
AQCOA-	Aquilegia coerulea James var. alpina A. Nels.									x
AQCOP-	A. c. var. pinetorum (Tides.) Payson									x
AQSC -	A. scopulorum Tides.								x	
CALE -	Caltha leptosepala DC.				x	x				
CLHI -	Clematis hirsutissima Pursh			x						
RAALM-	Ranunculus alismaefolius Geyer var. montana S. Wats.				x					
RAAQ -	R. aquatilis L.	x								
RAESA-	R. eschscholtzii var. adoneus (Gray) C. L. Hitch.				x			x		
RAESA2-	R. e. var. alpinus (Wats.) C.L.Hitch.				x			x		
RARES-	R. repens L. var. strigulosus Freyn.	x								
THSP -	Thalictrum sparsiflorum Turcz.				x					
THAL -	T. alpinum L.									x
TRLA2-	Trollius laxus Salisb.				x	x				

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High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	19. CRUCIFERAE - Mustard F.									
ARDR -	Arabis drummondii Gray		x	x					x	
ARHOR-	A. holboellii var. retrofracta (Graham) Rydb.							x	x	
ARLE -	A. lemmonii S. Wats.								x	
ARLY -	A. lyallii S. Wats.								x	
DRAU -	Draba aurea M. Vahl.						x	x		
DRDE -	D. densifolia Nutt.								x	
DRFL -	D. fladnizensis Wulfen								x	
DRNIE-	D. nivalis Lilj. var. exigua (Schulz) C. L. Hitch.								x	
DROL -	D. oligosperma Hook.								x	
DRRE2-	D. reptans (Lam.) Fern.						x			
DRSO -	D. sobolifera Rydb.									x
DRSTN-	D. stenoloba Ledeb. var. nana (Schulz) C. L. Hitch.						x			
PARY -	Parrya rydbergii Botsch.							x		
ROAL -	Rorippa alpina (S. Wats.) Rydb.	x								
SMCAA-	Smelowskia calycina C. A. Meyer var. americana (Regel & Herd.) Roll.								x	
	20. CRASSULACEAE - Orpine F.									
SERH -	Sedum rhodanthum A. Gray					x	x	x		
SEST -	S. stenopetalum Pursh		x	x					x	
	21. SAXIFRAGACEAE - Saxifrage F.									
MIST	Mitella stauropetala Piper						x			
RICEI-	Ribes cereum var. inebrians (Lindl.) C. L. Hitch.		x	x						
RIIN -	R. inerme Rydb.		x							
RIMO -	R. montigenum McCl.		x	x						
SAAD -	Saxifraga adscendens L.									x
SACE2-	S. cernua L.									x
SACR -	S. chrysantha A. Gray								x	
SADE -	S. debilis Engelm.			x						
SAOD -	S. odontoloma Piper		x							
SARH -	S. rhomboidea Greene			x	x	x	x			
	22. ROSACEAE - Rose F.									
DROCH-	Dryas octopetala L. var. hookeriana (Juz.) Briet.						x	x	x	
GERO -	Geum rossii (R. Br.) Ser.						x	x	x	x
IVGO -	Ivesia gordonii (Hook.) T. & G.			x						
POBI3-	Potentilla biennis Greene							x		
POCO8-	P. concinna Richards							x	x	

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High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	22. ROSACEAE - Rose F. (Cont.)									
PODI2-	Potentilla diversifolia Lehm.					x	x	x		
POFR4-	P. fruticosa L.			x	x		x			
POQU -	P. quinquefolia (Rydb.) Rydb.			x						
RUPA -	Rubus parviflorus Nutt.		x							
RUIDS-	R. idaeus L. ssp. sachalinensis (Levl.) Focke		x	x						
SIPR -	Sibbaldia procumbens L.						x	x	x	
SOSC -	Sorbus scopulina Greene		x							
	23. LEGUMINOSAE - Legume F.									
THMO2-	Thermopsis montana Nutt.		x	x						
TRDA -	Trifolium dasyphyllum T. & G.						x			
TRNA -	T. nanum Torr.								x	
TRPA -	T. parryi Gray						x		x	
	24. GERANIACEAE - Geranium F.									
GERI -	Geranium richardsonii Fisch. & Trautv.			x						
	25. CALLITRICHACEAE - Water Starwort F.									
CAVE4-	Callitriche verna L.	x								
	26. CELASTRACEAE - Staff-tree F.									
PAMY -	Pachystima myrsinites (Pursh) Raf.		x							
	27. RHAMNACEAE - Buckthorn f.									
CEVE -	Ceanothus velutinus Dougl.		x							
	28. VIOLACEAE - Violet F.									
VIADB-	Viola adunca Smith var. bellidifolia (Greene) Harr.						x			
VIMAP-	V. macloskeyi var. pallens (Banks) C. L. Hitch.					x				
VINE -	V. nephrophylla Greene					x				
	29. ELAEAGNACEAE - Oleaster F.									
SHCA -	Shepherdia canadensis (L.) Nutt.		x							
	30. ONAGRACEAE - Evening Primrose F.									
EPALA-	Epilobium alpinum L. var. alpinum		x	x	x					
EPALC-	E. a. var. clavatum (Trel.)C.L.Hitch.								x	
EPALM-	E. a. var. nutans (Hornem.) Hook.				x					
EPAN -	E. angustifolium L.		x							
EPGL2-	E.glandulosum Lehm.		x							
	31. UMBELLIFERAE - Carrot F.									
ANRO -	Angelica roseana Hend.		x							x

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	31. UMBELLIFERAE - Carrot F. (Cont.)									
LIFIT-	Ligusticum filicinum var. tenuifolium (S. Wats.) Mathias & Constance					x	x			
LOHE -	Lomatium hendersonii Coult. & Rose									x
ORAL -	Oreoxis alpina (A. Gray) Coult. & Rose								x	
POEA -	Podistera eastwoodae (Coult.& Rose) Mathias & Constance								x	
PSMO -	Pseudocymopterus montanus (A. Gray) Coult. & Rose								x	
	32. ERICACEAE - Heath F.									
ARUVU-	Arctostaphylos uva-ursi (L.) Spreng.		x	x						
GAHU -	Gaultheria humifusa (Graham) Rydb.						x			
KAPOM-	Kalmia polifolia Wang. var. microphylla (Hook.) Rehd.						x			
PYASP-	Pyrola asarifolia purpurea (Bunge) Fern.		x							
PYVI -	P. virens Schweiss		x							
VACA -	Vaccinium caespitosum Michx.		x			x				
VAMY -	V. myrtillus L.		x	x						
VAOC -	V. occidentale A. Gray		x							
VASC -	V. scoparium Leib.		x	x		x				
	33. PRIMULACEAE - Primrose F.									
ANSE2-	Androsace septentrionalis L.			x			x	x		x
DOAL -	Dodecatheon alpinum (A. Gray) Greene			x	x					
PRPA -	Primula parryi Gray			x	x		x			
	34. GENTIANACEAE - Gentian F.									
FRSP -	Frasera speciosa Dougl.		x							
GEAL -	Gentiana algida Pall.				x	x				
GEAM -	G. amarella L.					x				
GECA -	G. calycosa Griseb.								x	
GEFR -	G. fremontii Torr.				x	x				
GEPA -	G. parryi Engelm.				x	x				
GETE -	G. tenella Rott.				x	x				
SWPE -	Swertia perennis L.				x					
	35. POLEMONIACEAE - Phlox F.									
PHCO -	Phlox condensata (A. Gray) E. Nels.								x	
POEX -	Polemonium eximium Greene							x		
POPUD-	P. pulcherrimum var. delicatum (Rydb.) Cronq.								x	x
POPUP-	P. p. Hook. var. pulcherrimum								x	x
POVIM-	P. viscosum Nutt. ssp. mellitum (A. Gray) J. F. Davids.								x	

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Symbol		Lakes	Upper El. Conifer: LP	Upper El. Conifer: ES-AF	Upper El. Conifer: Meadow	Alpine: Wet Meadow	Alpine: Dry Meadow	Alpine: Alpine Turf	Alpine: Fellfield	Alpine: Boulderfield
	36. HYDROPHYLLACEAE - Waterleaf F.									
PHGL3-	Phacelia glandulosa Nutt.									x
	37. BORAGINACEAE - Borage F.									
ERNAE-	Eritrichium nanum (Vill.) Schrad. var. elongatum (Rydb.) Cronq.							x		
LARE -	Lappula redowskii (Hornem.) Greene								x	
MECI2-	Mertensia ciliata (James) G. Don.						x	x	x	
MEVI2-	M. viridis (A. Nels.) A. Nels.									x
	38. SCROPHULARIACEAE - Figwort F.									
BEAL -	*Besseya alpina (A. Gray) Rydb.							x	x	
CAMI5-	Castilleja miniata Dougl.		x							
CAOC3-	C. occidentalis Torr.					x				
CAPU4-	C. pulchella Rydb.						x			
CARH -	C. rhexifolia Rydb.						x			
CASU3-	C. sulphurea Rydb.						x			
CAVI2-	C. viscida Rydb.			x			x			
MILE2-	Mimulus lewisii Pursh				x					
PEBRP-	Pedicularis bracteosa var. paysonia (Pennell) Cronq.						x			
PEGR2-	P. groenlandica Retz.				x	x				
PEPA2-	P. parryi Gray				x				x	
PERA2-	P. racemosa Dougl.			x	x					
PEPR2-	Penstemon procerus Dougl.								x	
PEUI -	P. uintahensis Pennell			x			x	x		
PEWH -	P. whippleanus A. Gray			x			x			
VESEH-	Veronica serpyllifolia var. humifusa (Dickson) Vahl.				x					
VEWO -	V. wormskjoldii Roem. & Schult.				x					
	39. PLANTAGINACEAE - Plantain F.									
PLTW -	Plantago tweedyi A. Gray						x			
	40. CAPRIFOLIACEAE - Honeysuckle F.									
LOIN -	Lonicera involucrata (Rich.) Banks		x	x	x					
SARAM-	Sambucus racemosa L. var. microbotrys (Rydb.) Kern. Peeb.		x	x						
	41. CAMPANULACEAE - Bellflower F.									
CAPA3-	Campanula parryi Gray						x	x		
CARO2-	C. rotundifolia L.						x			
CAUN -	C. uniflora L.							x		
	42. VALERIANACEAE - Valerian F.									
VAED -	Valeriana edulis Nutt.				x		x			
VAOC2-	V. occidentalis Heller				x		x			

*No record but should be present.

APPENDIX

High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	43. COMPOSITAE - Sunflower F.									
AGGL -	Agoseris glauca (Pursh) Raf.						x			
ANALM-	Antennaria alpina var. media (Greene) Jeps.					x				
ANCO -	A. corymbosa E. Nels.						x			
ANNEA-	A. neglecta var. attenuata (Fern.) Cronq.							x	x	
ANRO2-	A. rosea Greene		x	x						
ANUM -	A. umbrinella Rydb.			x						
ARCHF-	Arnica chamissonis ssp. foliosa (Nutt.) Maguire			x						
ARCO4-	A. cordifolia Hook.		x	x						
ARDI2-	A. diversifolia Greene			x						
ARMO -	A. mollis Hook.			x			x			
ARPA4-	A. parryi Gray			x						
ARSO -	A. sororia Greene				x					
ARMI3-	Artemisia michauxiana Bess.							x		x
ARNOS-	A. norvegica Fries var. saxatilis (Bess.) Jeps.							x	x	
ARSC2-	A. scopulorum Gray						x	x	x	
ASFOA-	Aster foliaceus Lindl. var. apricus Gray								x	x
ASGL -	A. glaucodes Blake						x			
CHAL2-	Chaenactis alpina (Gray) M.E. Jones								x	x
CIEA -	Cirsium eatoni (Gray) B. L. Robins			x				x		x
CIFO -	C. foliosum (Hook.) DC.		x	x						
CIPO -	C. polyphyllium (Rydb.) Petr.									x
ERACD-	Erigeron acris L. var. debilis Gray			x	x	x				
ERCOG-	E. compositus Pursh var. glabratus Macoun.							x		
ERLE -	E. leiomeris A. Gray			x				x		x
ERME2-	E. melanocephalus A. Nels.							x	x	
ERPE -	E. peregrinus (Pursh) Greene			x			x			
ERSI -	E. simplex Greene							x		
HAPA2-	Haplopappus parryi A. Gray		x							
HAPY -	H. pygmaeus (T. & G.) Gray							x	x	
HYACA-	Hymenoxys acaulis (Pursh) Parker var. arizonica (Greene) Parker						x		x	
HYGR -	H. grandiflora (T. & G.) Parker						x	x	x	
SEAT -	Senecio atratus Greene									x
SECA -	S. canus Hook.								x	x
SECR -	S. crassulus A. Gray			x						
SECY -	S. cymbalarioides Buek.				x					
SEERK-	S. eremophilus Rich. var. kingii (Rydb.) Greenm.			x						
SEFR -	S. fremontii T. & G.									x
SEMU2-	S. multilobatus Torr. & Gray							x		x

APPENDIX

High Elevation Plants of the Uinta Mountains

Symbol		Lakes	Upper El. Conifer			Alpine				
			LP	ES-AF	Meadow	Wet Meadow	Dry Meadow	Alpine Turf	Fellfield	Boulderfield
	43. COMPOSITAE - Sunflower F.									
SESE2-	Senecio serra Hook.		x	x						
SEST2-	S. streptanthifolius Greene		x	x						
SETR -	S. triangularis Hook.		x	x	x					
SOMU -	Solidago multiradiata Ait.			x		x	x			
SOSPN-	S. spathulata DC. var. nana (A. Gray) Cronq.		x							
TALY -	Taraxacum lyratum (Ledeb.) DC.									x
TAOF -	T. officinale Weber		x	x		x				

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ATTACHMENT 5



West Fork Black's Fork
Wilderness Values Degraded

Watershed Conditions

Uinta Wilderness, Utah

West Fork Black's Fork
East Fork Black's Fork
Lake Fork
Middle Fork Beaver Creek
Burnt Fork

October 30, 2006
Revised August 29, 2007

Report

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Middle Fork Beaver Creek
Wilderness Values Preserved

Introduction

Since 1999, several visits have been made to the West Fork Black's Fork and other watersheds in the Uintas. The purpose of these visits was to document conditions in order to compare the grazed watersheds, West Fork Black's Fork, East Fork Black's Fork and Lake Fork with ungrazed watersheds, Middle Fork Beaver Creek and Burnt Fork. This report is an update of our previous report issued on July 8, 2002.

During August and September, 2000 the Middle Fork Beaver Creek watershed was surveyed for ground cover and residual vegetation. During September 2001, the West Fork Blacks Fork watershed was surveyed for ground cover and residual vegetation. In September, 2002, the East Fork Black's Fork and Lake Fork watersheds were surveyed for ground cover and residual vegetation. During September 2006, sediment core samples were taken from potential Colorado cutthroat trout spawning habitats in the West Fork Black's Fork, East Fork Black's Fork, Middle Fork Beaver Creek and Burnt Fork. During these and other visits, photo points were established and observed conditions documented.

Ground cover surveys were conducted in key areas consisting of sensitive upland portions of high elevation meadows. In these key areas, plot locations were determined using a Garmin GPS 12 handheld global positioning system. Ground cover data were collected using the Beltline Transect method employed by the U.S. Forest Service. This method is described in FSM 2209.21-93-1 (R-4 Amendment) and employs use of a nested frequency plot frame to collect 8 ground cover observations at 20 locations along five radial transects from the plot center for a total of 800 observations for each key area. Plants were clipped at three locations on alternating transects for drying and weighing to determine plant standing crop. Plot clippings were taken from 2' x 2' areas at the end of the belt transects. Plant samples were air dried and weighed. Ocular estimates were made of ground cover conditions at other upland locations.

Sediment core samples were collected in the West Fork Black's Fork, East Fork Black's Fork, Middle Fork Beaver Creek and Burnt Fork during early September, 2006. The McNeil sediment core sampling method was used to collect samples in potential spawning substrates (gravel dominated) in each of these streams. Three samples were taken at each location, processed through sieves to separate the sample into each of nine size fractions and then the volume displacement of each size fraction was measured. The size fractions <6.35 mm and <0.85 mm were compared with established criteria.

With the exception of the sediment core sampling data which was collected in September 2006, the data and photographs used in this report were provided to the Forest Service in March, 2006 for inclusion in the Administrative Record for the West Fork Black's Fork.

Results

Maps of survey locations, topography, soils, geology, vegetation and capability analysis are provided in **Appendix 1**. Photographs and narrative descriptions of survey locations are provided in **Appendix 2**. Tabular data including lat/long and observations for each location surveyed are provided in **Appendix 3**.

Ground Cover and Residual Vegetation: The results of the ground cover surveys are provided in Table 1. Abbreviations are used for the locations such that WF = West Fork Black's Fork, EF = East Fork Black's Fork, MF = Middle Fork Beaver Creek, BF = Burnt Fork, LF = Lake Fork. Transect data provide all ground cover factors (bare, litter, rock, crust, grass, forb), while ocular survey locations provide only the bare ground percent.

Table 1. Ground Cover Percent for Surveyed Locations.

Location	Rock	Crust	Litter	Grass and grasslikes	Forbs	Bare Ground
WF1						50
WF2						50
WF3						50
WF4						60
WF5						60
WF6						50
WF7						70
WF12	3.5	0.0	3.6	2.1	23.3	67.5
WF14	2.1	1.4	19.1	13.1	23.8	40.5
WF15	15.0	0.9	3.6	3.4	13.6	63.5
WF16	7.3	13.6	20.5	14.1	18.8	25.7
WF17	7.1	1.4	9.4	8.8	25.3	48.1
Averages	7.0	3.4	11.3	8.3	20.9	52.9
BF1						0
MF1	1.1	8.1	10.3	61.3	19.3	0
MF3	8.2	18.5	18.0	35.0	19.9	0.1
MF4	5.8	14.5	17.6	46.9	14.9	0.4
Averages	5.0	13.7	15.3	47.7	18.0	0.2
EF1						45
EF2						75
EF3						95
EF8						60
EF9						50
EF11						40
EF13						65
EF14	14.0	17.1	7.0	8.9	13.0	40
EF15	16.9	1.8	17.5	17.9	18.1	27.8
EF23	10.5	1.6	25.6	18.1	15.1	29
Averages	13.8	6.8	16.7	15.0	15.4	52.7
LF1						70
LF2	6.6	0.8	27.8	14.0	13.9	42
LF3						55
Average						55.7

Residual vegetation amounts at transect locations are provided in Table 2.

Table 2. Residual Vegetation

Location	Residual Vegetation lb/acre
WF12	176.5
WF14	266.1
WF15	127.9
WF16	151.0 (rested)
WF17	133.0
Average	170.9
MF1	630.1
MF3	355.8
MF4	609.3
Average	531.7
EF14	90.8
EF15	309.9
EF23	193.1
Average	197.9
LF2	91.3

The data and photographs show major differences in upland ground cover characteristics and residual vegetation between high elevation meadows in the grazed watersheds (East Fork Black's Fork, West Fork Black's Fork and Lake Fork when compared with the ungrazed Middle Fork Beaver Creek watershed. The Middle Fork Beaver Creek watershed has been closed to livestock grazing for over 20 years. Bare ground for locations surveyed averaged 0.2%, ranging from a low of 0 to a high of 0.4%. Grass cover averaged 47.7% with a range of 35% to 61.3%. Forb cover averaged 18% with a range of 14.9% to 19.9%. Residual vegetation averaged 531.7 lb/acre. See photographs in Appendix 2, pages 30 – 37.

The West Fork Blacks Fork has been grazed by 1250 ewe/lamb pairs of domestic sheep from July 6 to September 15 each year with an additional 1400 ewe/lamb pairs trailing through the allotment in July and September each year[1]. The ground cover data collected from the West Fork Blacks Fork locations reflect this annual heavy use. Bare ground for the locations surveyed averaged 52.9%, ranging from a low of 25.7% to a high of 70%. Grass cover averaged 8.3% with a range of 2.1% to 14.1%. Forb cover averaged 20.9% with a range of 13.6% to 25.3%. It should be noted that Unit 1 forbs were dominated by dandelion and yarrow. Residual vegetation in these upland locations at the end of the grazing season in the West Fork Blacks Fork averaged 170.9 pounds per acre, consisting mostly of species non-forage species not generally preferred by sheep. See photographs in Appendix 2, pages 2 – 23.

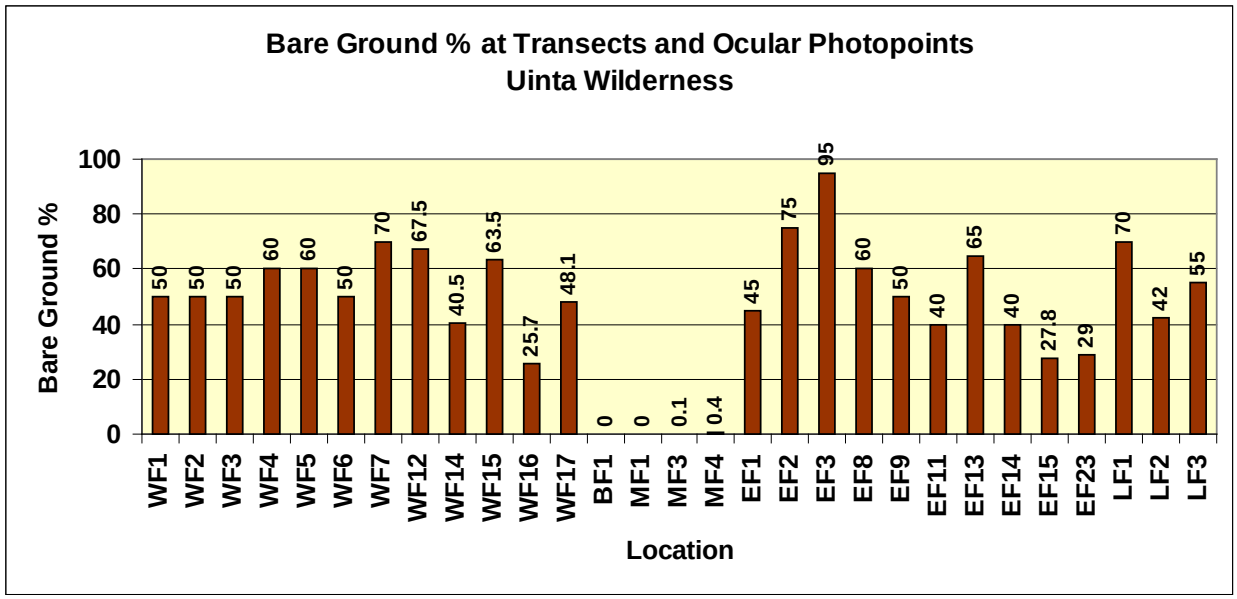
[1] USDA. 1999. Predecisional Environmental Assessment for West Fork Blacks Fork Allotment Management Plan. Wasatch-Cache National Forest.

According to the Rangeland Health EIS, the East Fork Black's Fork is grazed by 1350 ewe/lamb pairs[2]. The Rangeland Health EIS did not present any information on trailing of additional sheep or seasons. The ground cover data collected from East Fork Black's Fork locations also reflect heavy use by sheep. Bare ground for the locations surveyed averaged 52.7%, ranging from a low of 27.8% to a high of 95%. Grass cover averaged 15.0% with a range of 8.9% to 18.1%. Forb cover averaged 15.4% with a range of 13.0% to 18.1%. Residual vegetation in upland meadows at the end of the grazing season in the East Fork Black's Fork averaged 197.9 pounds per acre. See photographs in Appendix 2, pages 39 – 58.

Ground cover was surveyed at three locations in the Lake Fork watershed in the Ashley National Forest because this area is grazed by sheep trailed through the West Fork Black's Fork. No information is available at this writing as to numbers of sheep or seasons. Bare ground averaged 55.7%. At the transect location, grass cover was 14.0% and forb cover was 13.9%. Residual vegetation at the end of the grazing season was 91.3 lb/acre. See photographs in Appendix 2, pages 60 - 63.

Bare ground data are illustrated in Figure 1.

Figure 1. Bare Ground Percent in Uinta Watersheds.



Determination of Capable Acres: In 1964, the R-4 Range Analysis Handbook was published, reflecting the passage of the Multiple Use and Sustained Yield Act[3]. That handbook prescribed a systematic determination of capability (then called suitability) for grazing allotments and detailed methodologies for assessing capability, determining range condition, setting stocking rates and measuring use by livestock and wildlife. Capability criteria included consideration of slope, distance to water, soil erosion

[2] USDA. 1996. FEIS Rangeland Health and Record of Decision. Wasatch-Cache National Forest.
[3] Iverson, Floyd. 1964. R-4 Range Analysis Handbook.

hazard, ground cover and forage production. In 1998, Region 4 published guidance for Forest Plan revisions[4]. That guidance included these criteria:

1. Areas with less than 30% slopes (for cattle) and less than 45% slopes (for sheep).
2. Areas producing more than or having the potential to produce an average of 200 pounds of forage per acre on an air dry basis over the planning period.
3. Areas with naturally resilient soils (not unstable or highly erodible soils).
4. Areas where ground cover is sufficient to protect soil from erosion – the minimum percentage cover will be 60% unless local data is available for use in setting more specific ground cover requirements.
5. Areas accessible to livestock (without such factors as dense timber, rock or other physical barriers).
6. Areas within one mile of water or where the ability to provide water exists.

The FEIS[5] for the Wasatch-Cache National Forest Revised Forest Plan completed capability analysis using the following criteria.

1. Capable of producing at leas 200 pounds per acre on an annual basis. Spruce, fir, pine, Douglas fir, oak and barren areas were identified as not being capable.
2. Having a dominant land slope gradient of less than 45% for sheep.
3. Within one mile of surface water.

The distance to water criteria, ground cover minimum and soil erosion hazard prescribed in the 1964 R4 Handbook and the Region 4 Guidance published in 1998 were not used in the Forest Plan capability analysis.

We obtained the Forest Service GIS layers for the Wasatch-Cache National Forest including the data for the watersheds described in this report. A capability analysis was performed based on the three Forest Plan criteria summarized above. The vegetation maps in Appendix 1 show the vegetation types in the West Fork Black's Fork and other watersheds surveyed in this report. The overall summary of vegetation types in the WFBF are provided in Table 3.

Inspection of Table 3 provides insight into the capability of the West Fork Black's Fork watershed for grazing. Most lands fall into the non-forage producing categories of barren (44%) and conifer. The criteria were applied in a GIS analysis, producing the result shown in Table 4. See photographs in Appendix 2 for illustrations of the barren lands in the WFBF and EFBF (pp 9, 10, 11, 18, 20, 52, 53, 60, 61).

Using the WCNF's own criteria, only 854 of 14,787 acres or 5.8% of the area of the West Fork Black's Fork allotment were determined as capable. See the Capability Map in Appendix 1, which illustrates the patchy and unconnected nature of the small isolated capable lands. Remember that these capable acres do not reflect soil erosion hazard or ground cover condition as should be the case.

[4] USDA. 1998. Rangeland Capability and Suitability Determinations for Forest Plan Revisions R-4 Revised 2/20/98.
[5] USDA. 2003. Final Environmental Impact Statement Wasatch Cache National Forest. Intermountain Region Forest Service, Wasatch Cache National Forest.

Soil map unit descriptions were obtained from the Wasatch Cache National Forest[6]. Table 5 summarizes the soil map units for the West Fork Black's Fork, showing that 75.8% of the land that has been classified as to erosion hazard is in the high to very high soil erosion hazard class or 56.7% of the entire allotment area. These are shown in Appendix 1 Soil Maps.

Table 3. Summary of Vegetation Types for the West Fork Black's Fork.

	Pasture					
Vegetation Type	**001**	**002**	**003**	**04a**	**04b**	***Total***
AC (Aspen conifer)	28.0	0	0	0	0	*28.0*
AL (Alpine)	0.0	1.3	86.4	105.5	13.7	*207.0*
BA (Barren)	20.2	946.8	2,955.8	1,547.4	1,042.3	*6,512.4*
LP (Lodgepole)	2.1	0	0	0	0	*2.1*
MC2 (Mixed conifer 2)	2,208.0	1,108.4	0	0	7.6	*3,324.0*
SF (Spruce fir)	232.4	1,251.9	1,659.8	238.7	617.3	*4,000.0*
SG (Sagebrush grass)	79.2	0.0	0.0	0.0	0.0	*79.2*
WA (Water)	0.0	0.0	0.0	14.3	0.0	*14.3*
WM (Wet meadow)	179.8	183.7	131.7	67.1	57.6	*619.8*
Total	*2,749.7*	*3,492.0*	*4,833.7*	*1,972.9*	*1,738.6*	***14,786.8***

Table 4. Capable Acres for the West Fork Black's Fork

Vegetation Type	**Pasture 1**	**Pasture 2**	**Pasture 3**	**Pasture 4a**	**Pasture 4b**	***Total Capable Acres***
AC (Aspen conifer)	28	0	0	0	0	*28*
AL (Alpine)	0	0	68	104	14	*186*
SF (Spruce fir)	0	0	1	0	0	*1*
SG (Sagebrush grass)	30	0	0	0	0	*30*
WM (Wet meadow)	180	180	128	66	54	*609*
Total Capable Acres	*239*	*181*	*197*	*171*	*67*	***854***

The trailing of sheep over Red Knob Pass entails herding them over steep, non-capable slopes that are classed as very high erosion hazard (Soil Map Unit 502, for example). See Appendix 1 Soil maps. The geomorphic maps and descriptions also show these as extremely steep erosional slopes[7]. See Appendix 1 Geomorphology maps. See Appendix 2 photos (pp 60 – 62).

Erosion: The preceding capability analysis shows that most of the land in the West Fork Black's Fork allotment is at elevated risk of erosion. The same is true of the East Fork Black's Fork which is grazed by sheep belonging to a WFBF permittee. The Soil Maps and Geomorphology Maps in Appendix 2 and their descriptions clearly depict

[6] Wasatch-Cache National Forest. 2006. Map Unit Descriptions Soil Survey Area UT 647 North Slope Uinta Mountains.
[7] Munroe, Jeffrey S. 2000. Legend for North Slope Geomorphic Mapping

this risk. Mont E. Lewis, in his 1970 report[8] on the Uinta Mountains, provided numerous examples of grazing-induced erosion in these sensitive areas.

Table 5. Soil Map Units and Erosion Hazard for the WFBF.

	Pasture						
LTA Code	**001**	**002**	**003**	**04a**	**04b**	***Total***	**Erosion Hazard**
102	60.0	0	0	0	0	*60.0*	slight
104	285.0	240.2	142.0	0	0	*667.1*	slight
208	88.6	0.0	0.0	0	0	*88.6*	slight
221	69.6	0.0	0	0	0	*69.6*	slight
222	772.7	503.5	380.3	0	3.1	*1,659.7*	slight
223	320.7	516.2	259.1	0	0.0	*1,096.0*	high
225	890.6	639.1	832.3	4.8	2.8	*2,369.5*	very high
484	63.8	0.0	0.0	0.0	0.0	*63.8*	very high
501	0.0	165.1	3.8	0.0	0.0	*168.8*	moderate to high
502	146.0	967.0	2,223.9	410.7	491.4	*4,239.0*	very high
503	0.0	0.0	362.1	221.3	240.3	*823.7*	no description
520	52.7	0.0	264.8	152.1	0.0	*469.6*	very high
525	0.0	0.0	307.4	832.8	383.4	*1,523.6*	no description
531	0.0	460.9	53.1	276.8	555.6	*1,346.3*	no description
Unknown	0.0	0.0	5.0	74.5	62.0	141.5	
Total	*2,749.7*	*3,492.0*	*4,833.7*	*1,972.9*	*1,738.6*	***14,786.8***	

Photographs in Appendix 2 (pp 7, 8, 12, 14, 20, 40, 42, 43, 45, 47, 48, 54 as well as others) show examples of reduced ground cover, accelerated erosion and soil pedestaling in the WFBF, while photos (App 2, pp 35, 37) show healing upland erosion features in the Middle Fork Beaver Creek after over two decades of rest from sheep grazing.

Photographs in Appendix 2 (pp 3, 4, 9, 22 – 27, 30, 32, 43, 43, 45, 51 - 54) show denuded and destabilized stream banks from sheep trampling and grazing, loss of undercut banks and in-stream habitat and scouring of stream banks from high flows induced from lack of ground cover and stabilizing vegetation in upper basins. The Forest Service has attributed the stream bank damage in the West Fork Black's Fork to century old tie-hacking, or avalanche debris. Yet, in the East Fork Black's Fork, the same scouring features occur in upper elevation meadows above where any tie hacking or avalanche debris occurred. The lack of these erosional features in the ungrazed watersheds of Burnt Fork and Middle Fork Beaver Creek also refute these claims that grazing is not the cause of these riparian problems, but instead, it is other activities.

Lakes in the West Fork Black's Fork and East Fork Black's Fork are being rapidly filled with sediment due to accelerated erosion of adjacent uplands from sheep grazing and trampling. Photos in Appendix 2 (pp 36 and 42) illustrate the heavy sediment load into Lake EJOD from grazing and trampling of surrounding barren lands and a

[8] Lewis, Mont E. 1970. Alpine Rangelands of the Uinta Mountains Ashley and Wasatch National Forests Region 4. Mont E. Lewis, Range Conservationist, U.S. Forest Service.

small lake in the EFBF being rapidly filled by sediment from gullies and denuded slopes grazed by sheep. Mont E. Lewis in his report provided the example of a lake that had been nearly "cut in two" by the delta of an intermittent stream. As Lewis stated, "The drainage originates on the heavily grazed Kabell Ridge."

Spawning Habitat for Colorado River Cutthroat Trout: Sample results from sediment core samples collected in September, 2006 are provided in Table 6. Photographs of the sample locations are provided in Appendix 2 (pp 24, 28, 38, 59).

Table 6. Sediment Fines and Predicted Survival of Salmonids to Emergence

Sample Description	(<6.35 mm) Fines %	(<0.85 mm) Fines %	Survival Egg to Emergence %
Burnt Fork A	31.3	10.6	
Burnt Fork B	26.0	11.1	
Burnt Fork C	19.7	7.0	
Average	**25.7**	**9.5**	**44.0**
East Fork Black's Fork A	35.5	10.4	
East Fork Black's Fork B	31.4	12.0	
East Fork Black's Fork C	21.3	8.6	
Average	**29.4**	**10.3**	**34.8**
Middle Fork Beaver Creek A	27.0	10.7	
Middle Fork Beaver Creek B	15.9	9.5	
Middle Fork Beaver Creek C	35.8	11.5	
Average	**26.2**	**10.6**	**42.7**
West Fork Black's Fork A	37.0	14.9	
West Fork Black's Fork B	40.0	16.2	
West Fork Black's Fork C	33.8	13.3	
Average	**36.9**	**14.8**	**19.8**

Salmonid species such as Colorado River cutthroat trout require clean, sediment-free substrate for successful spawning[9]. Two criteria based on sediment size fractions are used for evaluating spawning habitat condition. The first of these is the percent of subsurface sediment <0.85 mm, which is considered "intrusive fines" which fill the interstices between gravel particles[10]. The second is the percent of subsurface sediment <6.35 mm which is considered "trapping fines", which impact the ability of fry to escape the substrate material in which the eggs were buried[11]. Idaho DEQ has set thresholds for these criteria of 10% <0.85mm and 27% <6.35 mm[12]. The Bridger Teton National Forest has determined that to be in compliance with the Forest Plan water quality standard and Wyoming DEQ, fine sediments <6.4 mm must be less than 20%.

[9] Chapman, D. W. 1988. Critical Review of Variables Used to Define Effects of Fines in Redds of Large Salmonids. Trans. Am. Fish. Soc. 117:1-21.
[10] McNeil, W. J. and W. H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. U.S. fish and Wildlife Service Spec. Sci. Rep. Fish. No. 469:15.
[11] Kondolf, G. M. 2000. Assessing Salmonid Spawning Gravel Quality. Trans. Am. Fish. Soc. 129:262-281.
[12] Idaho DEQ. 2003. Guide to Selection of Sediment Targets for Use in Idaho TMDLs.

Inspection of the sample results above show that the ungrazed watersheds, Burnt Fork and Middle Fork Beaver Creek meet the 27% criteria for sediment fines <6.35 mm. The grazed watersheds, West Fork Black's Fork and East Fork Black's Fork exceed this criterion. Middle Fork Beaver Creek, Burnt Fork, East Fork Black's Fork either meet or very slightly exceed the criterion for fines <0.85mm, while the West Fork Black's Fork was clearly above the criterion.

These data provide more meaning when the percent survival of trout to emergence is calculated. Irving and Bjorn of Idaho DEQ developed an empirical relationship based on measurements of emergence and sediment content[13]. The equation follows:

$Y = 101.7/(1 + e(-2.2+0.1x))$ where Y = survival and x = sediment fines <6.35mm

This equation was used to calculate the survival rates shown in Table 6. The West Fork Black's Fork had the lowest survival from egg to emergence, at 19.8%. The East Fork Black's Fork was next at 34.8% with the ungrazed watersheds of Middle Fork Beaver Creek at 42.7% and Burnt Fork at 44.0%.

Discussion

The differences in ground cover between the ungrazed Middle Fork Beaver Creek and the grazed West Fork Black's Fork, East Fork Black's Fork and Lake Fork are stark, with ground cover in the grazed watersheds greatly reduced below potential as demonstrated by data and observations in the ungrazed Middle Fork Beaver Creek. The Rangeland Health EIS and ROD cited earlier show that potential ground cover for alpine grasslands is 97 – 100%. Data provided in the Pre-decisional EA for the West Fork Black's Fork for a key area showed that bare ground percent increased from 5% in 1961 to 39.5% in 1997. The average ground cover across all grazed upland locations surveyed for this study is less than 50%, with grasses and forbs greatly reduced in cover and production in the grazed watersheds in comparison to the ungrazed watersheds.

Plot clippings in the grazed and ungrazed watersheds were compared showing residual amounts in . The vegetation production in the Middle Fork Beaver Creek averaged 531.7 pounds/acre and ranged from 355.8 to 630.1 pounds per acre. These figures agree with Holechek et al (1998), which gives a range of 445 to 623 pounds/acre[14]. End of season residual vegetation in the West Fork Blacks Fork averaged 170.9 pounds/acre with a range of 127.9 to 266.1 pounds per acre. Comparing means, the residual vegetation in the West Fork Blacks Fork watershed is 170.9/531.7 or 32% of that in the Middle Fork Beaver Creek. Plot WF16 from Unit 4B, which was rested in 2001, was 151 pounds, indicating that current production is greatly reduced from potential.

---

[13] Irving, D.B., and T.C. Bjornn. 1984. Effects of Substrate Size Composition on Survival of Kokanee Salmon and Cutthroat and Rainbow Trout Embryos. Idaho Cooperative Fishery Research Unit, University of Idaho, Moscow. Technical Report 84-6.

[14] Holechek, Jerry L., Rex D. Piper and Carlton H. Herbel. 1998. Range Management Principles and Practices. Prentice-Hall, New Jersey. 542p.

Capability analysis using the criteria and data from the Wasatch Cache National Forest showed that only 5.8% of the WFBF allotment is capable for sheep. This analysis did not include consideration of soil erosion, ground cover and distance to water, which the Intermountain Region has identified since 1964 as critical components of such an analysis. If the soil erosion hazard and ground cover criteria of 60% minimum were considered, there would be no capable acres in the West Fork Black's Fork. Recall that ground cover at the 12 locations we surveyed in the WFBF averages 47.1%.

Consider what Mont E. Lewis, Range Conservationist, reported regarding grazing capability in the Uinta Mountains over 25 years ago. In his survey of the Uinta Mountains, Lewis pointed out the following factors that must be considered in determining whether grazing is suitable or not. *"Soils with a high or moderately high erosion index are very susceptible to erosion. If a protective ground cover of vegetation and litter cannot be maintained under grazing use, the area should be classed as unsuitable and closed to livestock use. Soils on shale areas of the Uinta alpine are in this classification. … Slopes over 20% should be heavily sodded before they are considered as suitable for grazing. …In the better developed plant communities, observations show grazing use to be a most important factor contributing to reduced ground cover and sod breaking. Sheep trails cutting through the sod were obvious in the heavily used portions of the range. Site analysis and grazing impact studies indicate that serious erosion problems develop when about 30% of the soil becomes bare."* Lewis also indicated that wet meadows are not usually preferred by sheep and that *"Unsuitable areas on steeper slopes and on shale outcrops must be given full protection from grazing livestock, even though intermingled areas of suitable range remain ungrazed."* Clearly, the Forest Service has ignored this long standing set of recommendations specific to the Uinta Mountains and continued to allow sheep grazing in spite of the clear unsuitability and the resulting damage.

The Universal Soil Loss Equation (Ruhe, 1975) predicts that for a given slope and soil, increased runoff and erosion are directly related to reduced ground cover[15]. Dr. Paul Packer, retired research scientist for the U.S. Forest Service provided results of watershed research relating watershed characteristics to runoff and erosion in northern Utah forests[16]. This manuscript was provided to the Evanston Ranger District in a previous comment letter. It shows that when ground cover falls below potential and slope increases, overland flow increases rapidly, accompanied by soil erosion. At slopes of 35%, soil erosion is seven times greater than on slopes of 5%. The paper also indicates that trampling of more than 10% of the soil surface at ground cover of 70 – 75% increases soil erosion beyond limits affording protection.

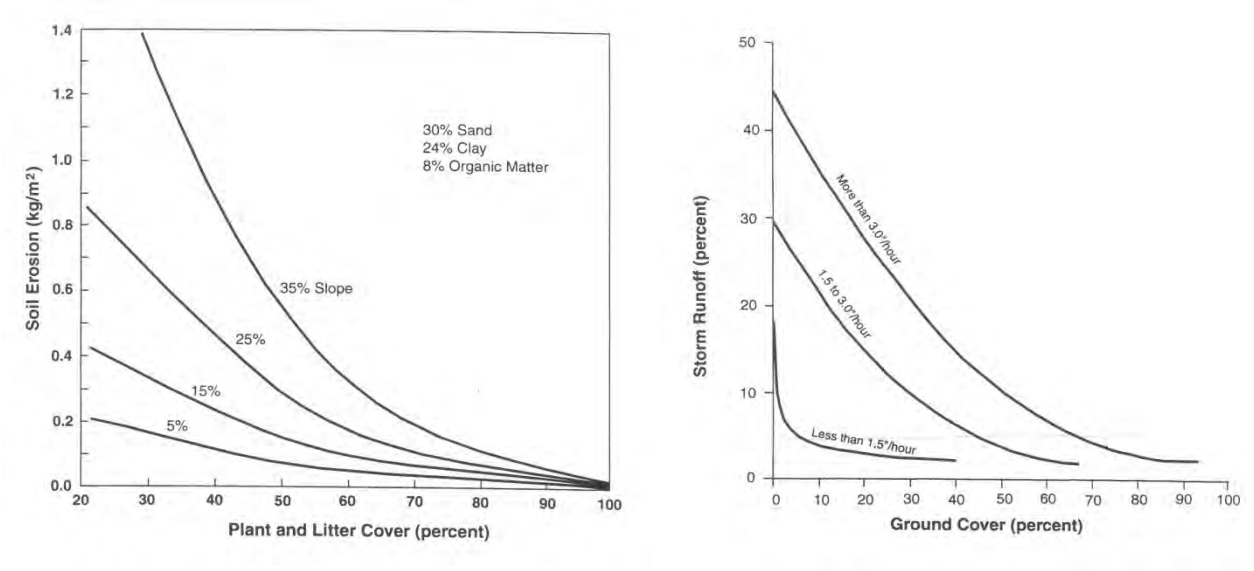
Other research validates the relationship between livestock grazing, reduced ground cover and increased runoff and soil erosion. A 20 year study by the U. S. Geological Survey in Colorado evaluated the difference in sediment yield and runoff in watersheds grazed by livestock and afterwards when grazing was halted. Complete grazing exclusion resulted in a reduction of 40% of runoff over the 20-year period, and

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[15] Ruhe, Robert V. 1975. Geomorphology: Geomorphic Processes and Surficial Geology. Houghton Mifflin Co. Boston. 246p.

[16] Packer, Paul E. undated. Requirements for Watershed Protection on Western Mountain Lands. Research Forester, Retired, U.S. Forest Service.

sediment yield decreased by 63 percent[17]. Peak storm runoff from a 120 hectare basin in Arizona was estimated to be 2 to 3 times greater when heavily grazed than when lightly grazed[18]. In a case study recently completed for the Bear River Range in Idaho, we have found that at the 60% ground cover capability criteria allowed by the Intermountain Region, erosion is 15 times greater than at potential ground cover conditions[19].



Charts from Packer Manuscript

When the low percent ground cover, highly erodible soils, steep slopes and lack of residual vegetation at the end of the grazing season in the WFBF are taken into account, it is clear that severe erosive forces are at work here. The stream sediment samples taken in the ungrazed and grazed watersheds clearly show these differences in erosion. The loss of vegetative cover and grazing until vegetation is dormant, without allowing time for regrowth, leaves the watershed with little resistance to overland flow during spring snowmelt or summer storms. Observations in both the WFBF and Middle Fork Beaver Creek watersheds during August and September make it clear that upland vegetation is going dormant by mid-August. To continue grazing these areas until mid-September is clearly not in accord with sound range management principles and does not allow protection of the watershed during snowmelt. While camped on a tributary of the West Fork Blacks Fork in 1999, a flash flood resulted from a rainfall of less than 0.1". Figure 2 is a hydrograph of the Blacks Fork downloaded from the U.S. Geological Survey website showing extremes of peak

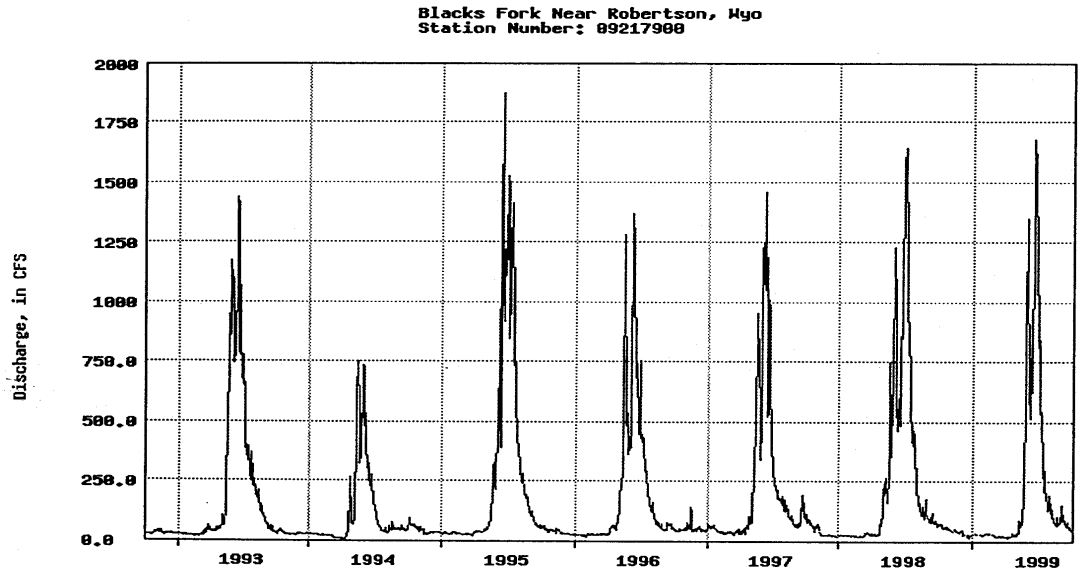
[17] Lusby, Gregg C. 1979. Effects of Grazing on Runoff and Sediment Yield from Desert Rangeland at Badger Wash in Western Colorado, 1953 – 1973. Geological Survey Water Supply Paper 1532-1.

[18] Trimble, S.W. and A.C. Mendel. 1995. The cow as a geomorphic agent, a critical review. Geomorphology 13:233-253.

[19] Brawer, Judi, John Carter, Amy Haak and Matt Mayfield. 2006. Spatial Analysis of Forest Service Capability Criteria for Watershed Management and Soil Conservation. Presentation at the International Soil and Water Conservation Conference, Keystone, Colorado.

flows during snowmelt that illustrate the lack of the watershed's ability to retain water.

Figure 2. Black's Fork Hydrograph



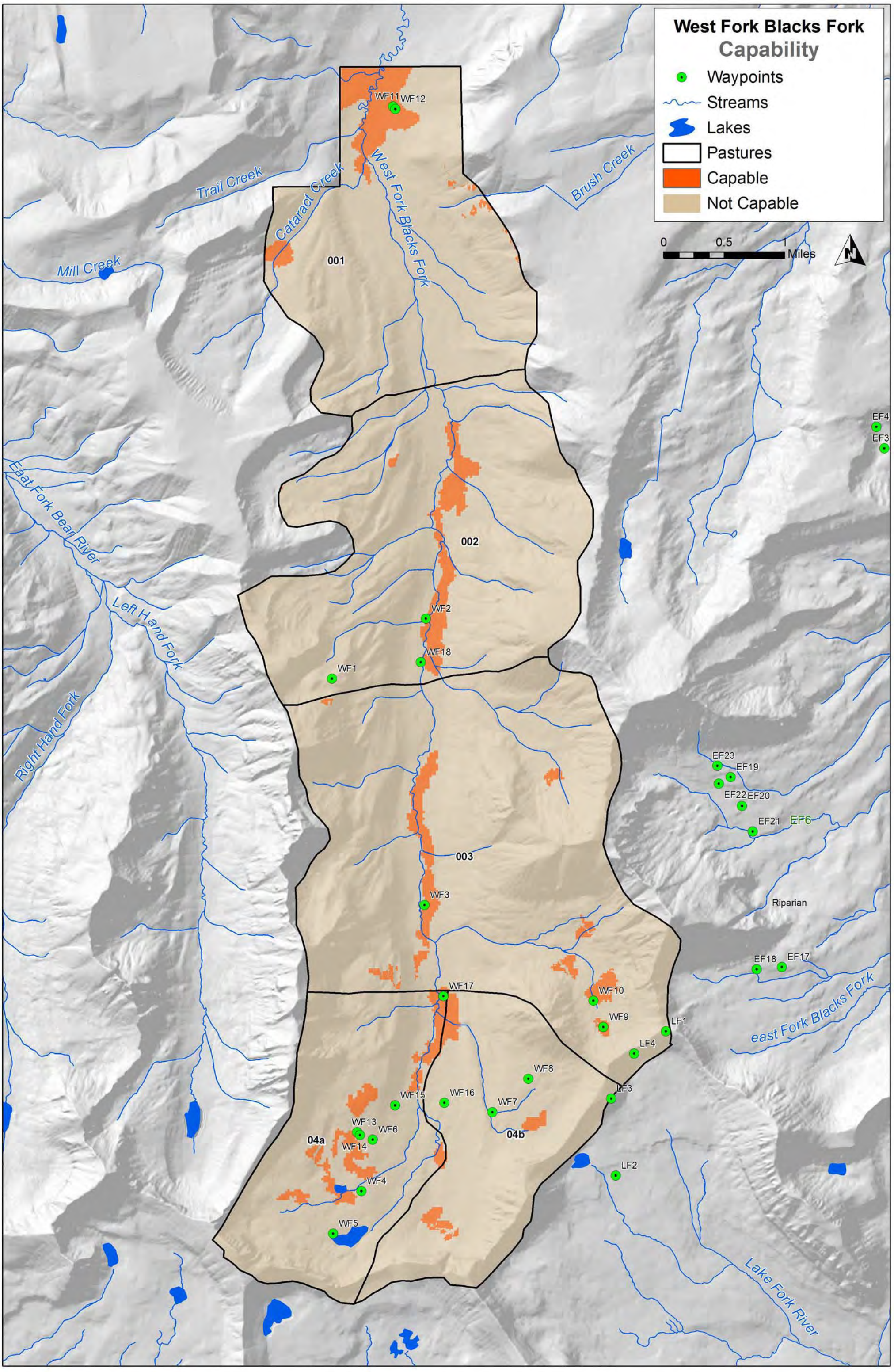
The Forest Service blames gophers and snowbeds for reduced ground cover, blames tie hacking and avalanche debris for stream scouring in the West Fork Black's Fork. The ground cover data and photographs we have provided across wide areas of the grazed and ungrazed drainages in the Uintas clearly illustrate that gophers and snowbeds are not at fault for reduced ground cover. The presence of scoured banks in the East Fork Black's Fork upstream of any tie hacking activities or avalanche debris blockages clearly illustrate these are not the cause of bank scouring in the WFBF as do the recovering streams in the Middle Fork Beaver Creek and Burnt Fork. The extreme flows induced by lack of ground cover in the upper watersheds are the cause.

The Forest Service should acknowledge these facts, that it is sheep grazing on sensitive, highly erodible soils and steep slopes that have reduced ground cover, reduced plant community productivity, increased erosion and runoff and flood forces, leading to the bank scouring and impairment of cutthroat trout spawning habitat. If what the Forest Service claims were true, then they would acknowledge that the gophers, snowbeds, tie-hacking and avalanche blockages are adding to the risk of grazing to the watershed beyond any acceptable level and they would close the West Fork Black's Fork to grazing.

The photographs provided in Appendix 2 show the differences between similar areas in the currently grazed West Fork Blacks Fork, East Fork Black's Fork, Lake Fork and the long-term ungrazed Middle Fork Beaver Creek. These photos illustrate what confronts wilderness visitors as they travel along the trails, meadows, streams and forests in the West Fork Blacks Fork. They are confronted with wet meadows where domestic sheep and herder's horses have trampled the wet meadows into mudholes; upland stretches where a wide strip has been laid bare, the trail widened and adjacent

areas denuded of vegetation; stream crossings where sheep and herder's horses have trampled banks out of existence over an area much wider than the trail itself; forest understory turned to dust and lacking herbaceous vegetation; meadows stripped of their wildflowers and grasses; bare and eroding uplands and slopes; ground littered with sheep and horse manure, where one must move sheep manure to find a place big enough to place a backpacking tent. On top of this, there is the constant smell of sheep manure instead of clean, cool air and flowers. Couple this with the constant bleating of sheep instead of the singing of birds and chattering of squirrels and you have the visual, olfactory and auditory impressions of the West Fork Blacks Fork – **A Wilderness Area That is Not!**

Appendix 1


West Fork Blacks Fork
Capability
Waypoints
Streams
Lakes
Pastures
Capable
Not Capable
0
0.5
1
Miles
N
WF11
WF12
Trail Creek
Cataract Creek
West Fork Blacks Fork
Brush Creek
Mill Creek
001
002
003
04a
04b
East Fork Bear River
Left Hand Fork
Right Hand Fork
WF2
WF18
WF1
WF3
WF17
WF10
WF9
WF8
WF15
WF16
WF7
WF13
WF6
WF14
WF4
WF5
LF1
LF4
LF3
LF2
EF4
EF3
EF23
EF19
EF22
EF20
EF21
EF6
Riparian
EF18
EF17
east Fork Blacks Fork
Lake Fork River

Middle Fork Beaver Creek
Geomorphology

Poison Mountain
Beaver Creek
West Beaver
Thompson Peak
Burro Peaks
Burnt Fork
M Fk Beaver Creek
Thompson Creek
Kabell Creek
Shale Creek
MF1
MF2
MF3
MF4
MF5
BF1

Map Unit Symbol

Allotments	2	11	20	31	40
Waypoints	3	12	21	32	41
Roads	4	13	22	33	42
Streams	5	14	24	34	43
Lakes	6	15	25	35	44
	7	16	27	36	45
	8	17	28	37	
	9	18	29	38	
	10	19	30	39	

N

0 0.5 1 Miles

Luke Lym
Mill Creek
Middle Fork Blacks Creek
Trail Creek
Cataract Creek
Brush Creek
Little East Fork
Mill Creek
Larson
West Fork Blacks Fork
Left Hand Fork
East Fork Blacks Fork
West Fork Blacks Fork
East Fork Bear River
East Fork Blacks Fork
EF6
Lake Fork River
Ottoson Creek
Oweep Creek

WF11 WF12 WF2 WF18 WF1 WF3 WF17 WF10 WF9 WF8 WF15 WF16 WF7 WF13 WF6 WF14 WF4 WF5

EF4 EF5 EF3 EF1 EF2 EF23 EF19 EF22 EF20 EF21 EF16 EF13 EF6 EF8 EF7 EF18 EF17 EF10 EF9 EF14 EF12 EF15 EF11

LF1 LF4 LF3 LF2

West Fork Blacks Fork/East Fork Blacks Fork/Lake Fork
Geomorphology

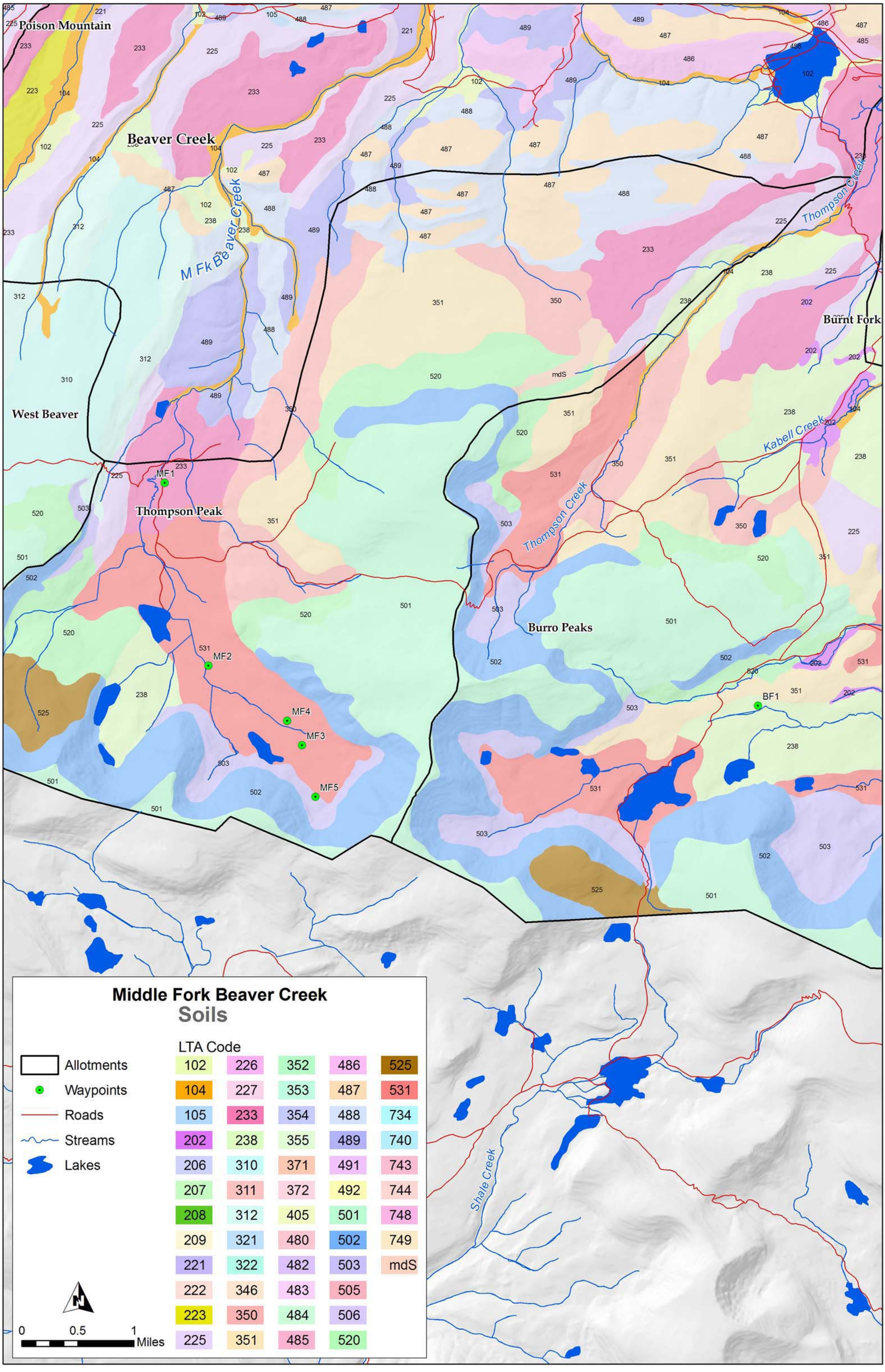
Allotments
Waypoints
Roads
Streams
Lakes

Map Unit Symbol

2	11	20	31	40
3	12	21	32	41
4	13	22	33	42
5	14	24	34	43
6	15	25	35	44
7	16	27	36	45
8	17	28	37	
9	18	29	38	
10	19	30	39	

N

0 0.5 1 Miles


Poison Mountain
Beaver Creek
M Fk Beaver Creek
Thompson Creek
Burnt Fork
West Beaver
Thompson Peak
Kabell Creek
Thompson Creek
Burro Peaks
Shale Creek
MF1
MF2
MF3
MF4
MF5
BF1
Middle Fork Beaver Creek
Soils
LTA Code
Allotments
Waypoints
Roads
Streams
Lakes
102 226 352 486 525
104 227 353 487 531
105 233 354 488 734
202 238 355 489 740
206 310 371 491 743
207 311 372 492 744
208 312 405 501 748
209 321 480 502 749
221 322 482 503 mdS
222 346 483 505
223 350 484 506
225 351 485 520
0 0.5 1 Miles

Luke Lym
Mill Creek
Larson
Middle Fork Blacks Fork
not an allotment
West Fork Blacks Fork
East Fork Blacks Fork
East Fork Bear River
Trail Creek
Cataract Creek
Mill Creek
West Fork Blacks Fork
Brush Creek
Little East Fork
Left Hand Fork
east Fork Blacks Fork
Lake Fork River
Ottoson Creek
Oweep Creek
LAKE FORK
SIN REC LVSTK
EF6
WF1
WF2
WF3
WF4
WF5
WF6
WF7
WF8
WF9
WF10
WF11
WF12
WF13
WF14
WF15
WF16
WF17
WF18
EF1
EF2
EF3
EF4
EF5
EF7
EF8
EF9
EF10
EF11
EF12
EF13
EF14
EF15
EF16
EF17
EF18
EF19
EF20
EF21
EF22
EF23
LF1
LF2
LF3
LF4

West Fork Blacks Fork/East Fork Blacks Fork/Lake Fork

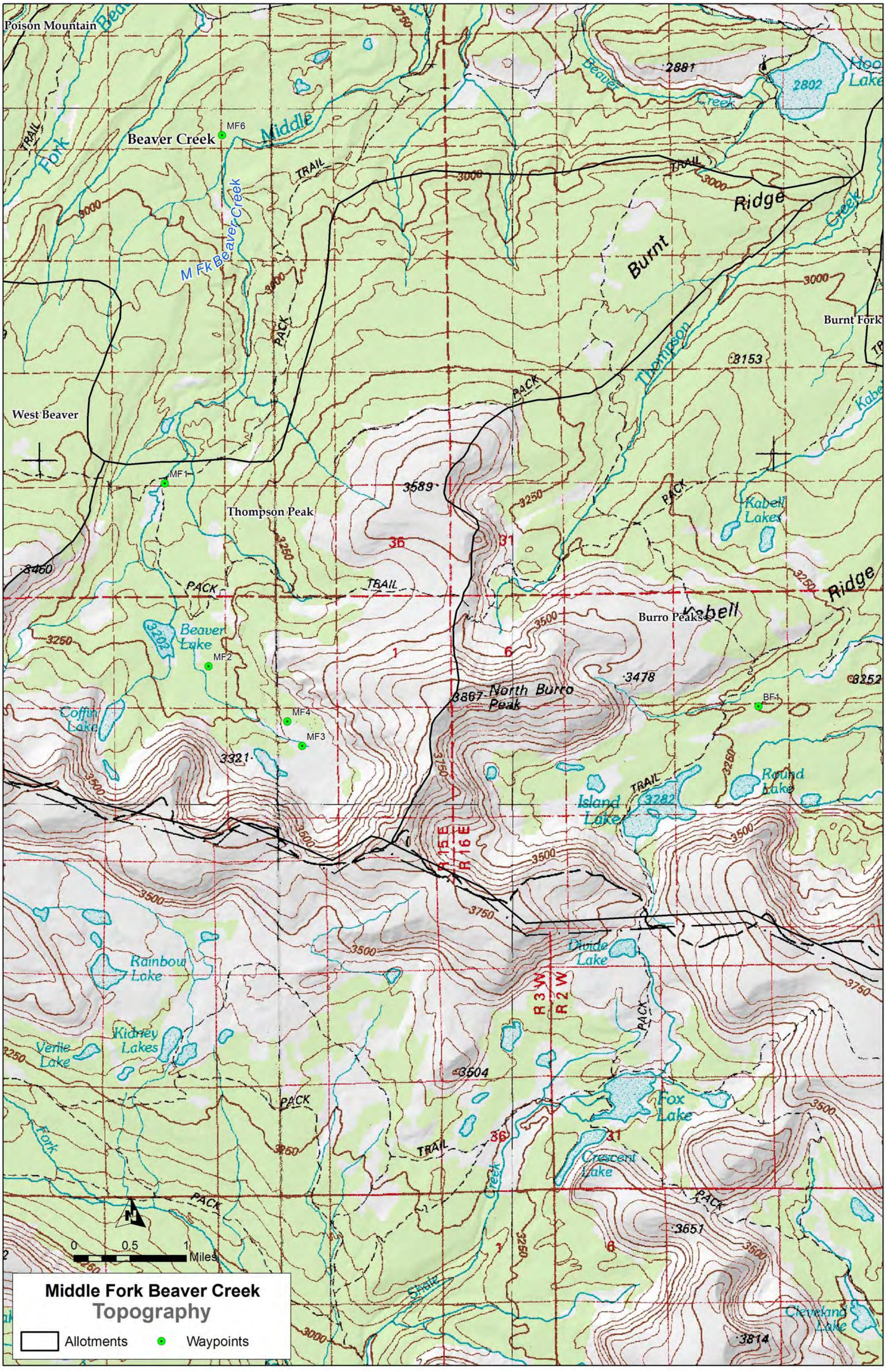
Soils

- Waypoints
- Allotments
- Roads
- Streams
- Lakes

LTA Code

102	226	352	486	525
104	227	353	487	531
105	233	354	488	734
202	238	355	489	740
206	310	371	491	743
207	311	372	492	744
208	312	405	501	748
209	321	480	502	749
221	322	482	503	mdS
222	346	483	505	AM
223	350	484	506	UB
225	351	485	520	

0 0.5 1 Miles


Poison Mountain
Beaver Creek
MF6
Middle Fork
TRAIL
3000
M Fk Beaver Creek
PACK
Burnt Ridge
Burnt Fork Creek
Thompson
2881
2802
Hoo Lake
Beaver Creek
3153
West Beaver
MF1
Thompson Peak
3589
3250
36
31
3460
Kabell Lakes
Kabell Ridge
Burro Peaks
Beaver Lake
3202
MF2
1
6
3478
3252
North Burro Peak
3867
BF1
Coffin Lake
MF4
MF3
3321
3500
3750
R 15 E
R 16 E
Island Lake
3282
Round Lake
Divide Lake
R 3 W
R 2 W
Rainbow Lake
Kidney Lakes
Verlie Lake
3504
Fox Lake
Crescent Lake
3651
Cleveland Lake
3814
Shale Creek
N
0
0.5
1
Miles
Middle Fork Beaver Creek
Topography
Allotments
Waypoints

West Fork Blacks Fork/East Fork Blacks Fork/Lake Fork

Topography

Waypoints

Allotments

0 0.5 1 Miles

Luke Lym

Mill Creek

Larson

Middle Fork Blacks Fork

not an allotment

West Fork Blacks Fork

East Fork Blacks Fork

East Fork Bear River

WF19
WF12
WF11
WF2
WF18
WF1
WF3
WF17
WF10
WF9
WF8
WF15
WF16
WF7
WF13
WF6
WF14
WF4
WF5
LF1
LF4
LF3
LF2
EF24
EF4
EF5
EF3
EF1
EF2
EF23
EF19
EF22
EF20
EF21
EF16
EF13
EF6
EF8
EF7
EF9
EF10
EF14
EF12
EF15
EF11
EF18
EF17

Mount Beulah
Tokewanna Peak
Red Knob
Mount Lovenia
Explorer Peak
Ottoson Basin
The Cathedral
Cleveland Peak

Allsop Lake
Dead Horse Lake
Boot Lake
Continent Lake
Ledge Lake
Crater Lake
Lambert Lake

OLD INDIAN TREATY BOUNDARY

R 11 E
R 12 E
R 7 W
R 6 W

ROCK CREEK

LAKE FORK

Poison Mountain
Beaver Creek
M Fk Beaver Creek
West Beaver
Thompson Peak
Burro Peaks
Burnt Fork
MF1
MF2
MF3
MF4
MF5
BF1

Middle Fork Beaver Creek
Vegetation

Allotments
Waypoints
Roads
Streams
Lakes

0 0.5 1 Miles

Veg Code

AC	CO	MC2	SG
AG	DF	MM	TF
AL	IS	PJ	TS
AS	LI	PP	UR
BA	LP	QS	WA
BH	MA	SD	WI
CA	MC	SF	WM

Luke Lym
Mill Creek
Larson
East Fork Bear River
West Fork Blacks Fork
Middle Fork Blacks Fork
East Fork Blacks Fork
Left Hand Fork
West Fork Blacks Fork
east Fork Blacks Fork
Lake Fork River
Ottoson Creek
Oweep Creek
Riparian
LAKE FOR
SIN REC LVSTK

WF1 WF2 WF3 WF4 WF5 WF6 WF7 WF8 WF9 WF10 WF11 WF12 WF13 WF14 WF15 WF16 WF17 WF18
EF1 EF2 EF3 EF4 EF5 EF6 EF7 EF8 EF9 EF10 EF11 EF12 EF13 EF14 EF15 EF16 EF17 EF18 EF20 EF21 EF22 EF23
LF1 LF2 LF3 LF4

West Fork Blacks Fork/East Fork Blacks Fork/Lake Fork
Vegetation

- Waypoints
- Allotments
- Roads
- Streams
- Lakes

0 0.5 1 Miles

Veg Code

AC	CO	MC2	SG
AG	DF	MM	TF
AL	IS	PJ	TS
AS	LI	PP	UR
BA	LP	QS	WA
BH	MA	SD	WI
CA	MC	SF	WM

WEST FORK BLACK'S FORK

APPENDIX 2

PHOTO DOCUMENTATION

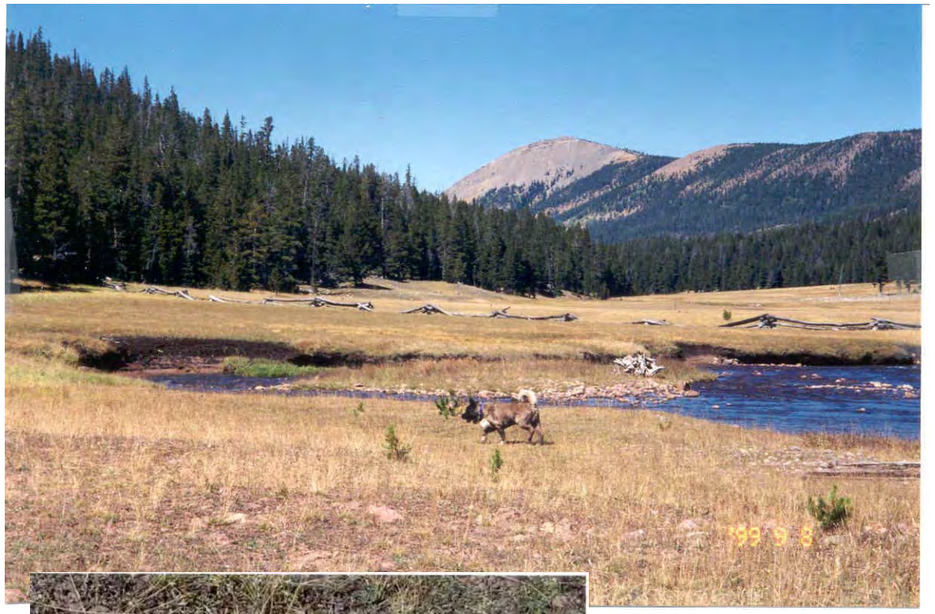




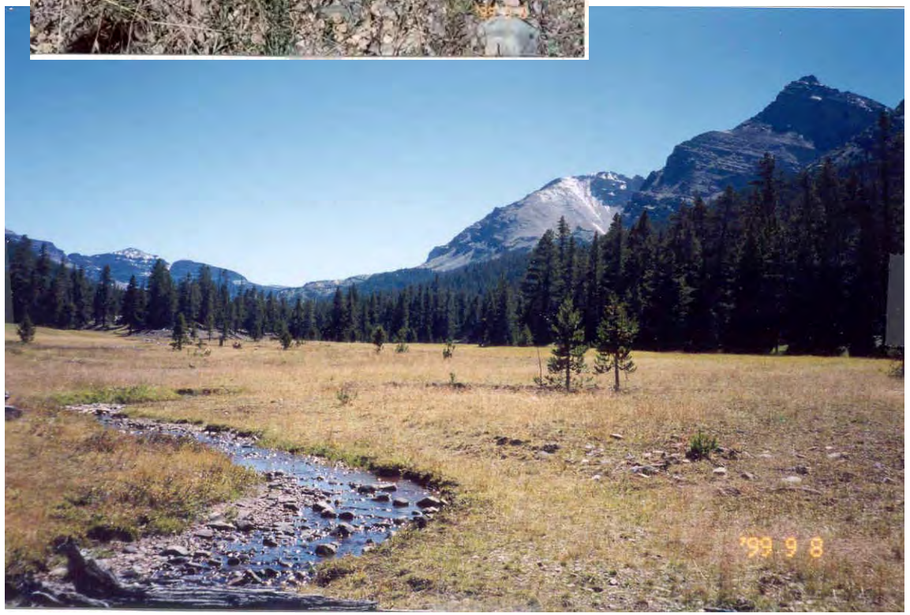


WF1 9/8/99

<u>Unit 2</u>. 12 sheep counted here. Ground cover on shoreline in aquatic influence zone ocular estimate = 65% veg, 30% rock, 5% bare. Uplands outside aquatic influence zone ground cover consisted of an estimated 50% bare ground with remainder being rocks and vegetation cover. Sedimentation in lake from these grazed slopes is evident due to loss of buffering capacity when vegetation is grazed close to the soil surface and soil is exposed.









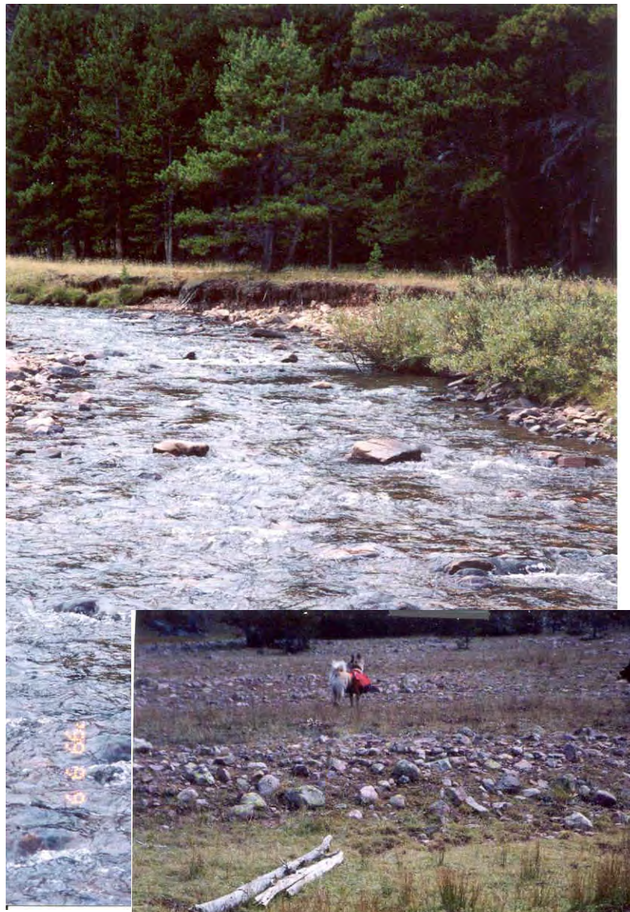




WF2 9/8/99

<u>Unit 2</u>. West Fork Black's Fork River. Upper photos show view downstream of eroded banks where sheep water, bank scouring from high flows. Photos to left show upland portion of meadow adjacent to the river with estimated 50% bare ground and small tributary. As at right, stream banks show breakdown and hoof shear. The river lacks undercut banks or instream habitat for cutthroats trout and overhanging grasses are lacking.











WF3 9/9/99

<u>Unit 3</u>. Upper photos provide Views up and down the WFBF showing browsed willows, stream bank scouring and erosion from high flood forces. Lower photos show upland/wet meadow transition with upland plants consumed and sparse ungrazed sedges/rushes remaining in patches. Adjacent upland ground cover was estimated at 50% bare, 15% rock, 10% litter, 10% sedges/grasses. Trail damage from trailing sheep is shown at left on a small stream crossing on main trail.







WF4 9/10/99

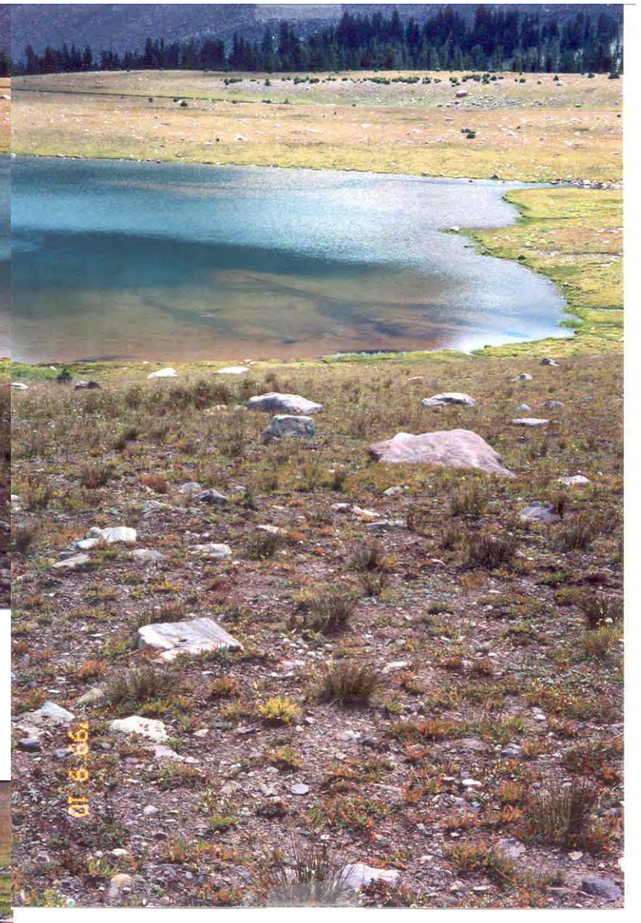
<u>Unit 4A</u>. Left and middle photos are in Unit 4A near the outlet of lake EJOD. These views of this bench are from west to north. Typical upland ground cover was estimated at about 50-60% bare soil, grass 5%, sedge 5-10%, litter 1%, forb 5-10%, rock 5%. The upper right photo shows ground cover condition. The photo in the lower right is the view across to Unit 4B and Red Knob.















WF4 cont'd 9/10/99

<u>Unit 4A</u>. Upper photos show Lake EJOD with barren upland slopes resulting in the lake being rapidly filled with sediment due lack of vegetation to buffer watershed erosion during runoff. These soils are highly erodible and should not be grazed. The photo at left shows a small outlet stream with sedges along stream margins. These are not heavily grazed, but uplands and other vegetation are heavily grazed into the edge of the aquatic influence zone. The stream channel appears widened from trampling.



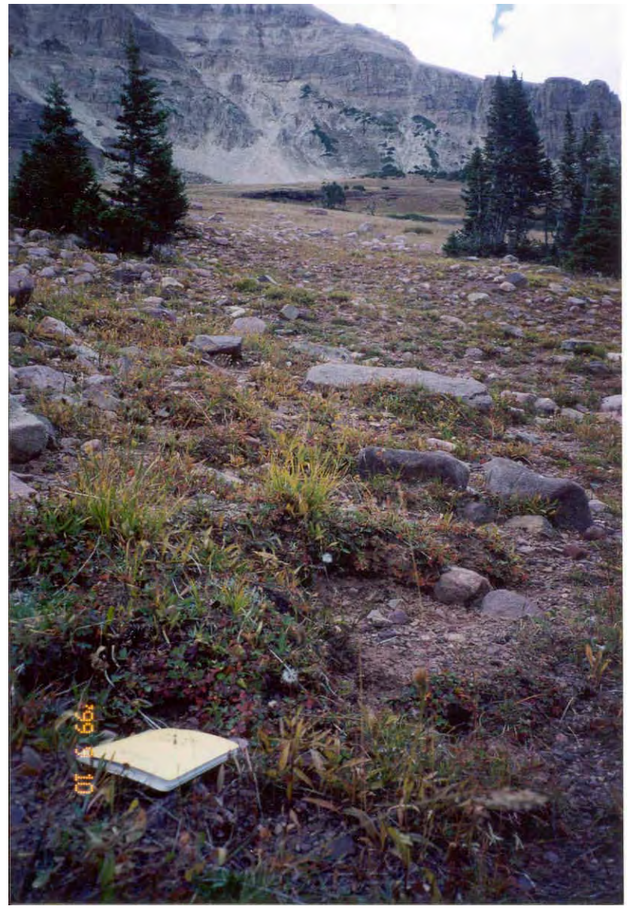


WF5 9/10/99

<u>Unit 4A</u>. At Left - Representative ground cover in uplands near Dead Man Lake, estimated at 60% bare, 15% rock, 15% grass/sedge, 10% forb and a trace litter. Plants are pedestaled by erosive forces.

WF6 9/10/99

<u>Unit 4A</u>. At Right - Mid slope location illustrating ground cover with bare soil at an estimated 50% with severe soil pedestaling. Low productivity is evident in these uplands surrounding Dead Horse Lake and Lake EJOD.

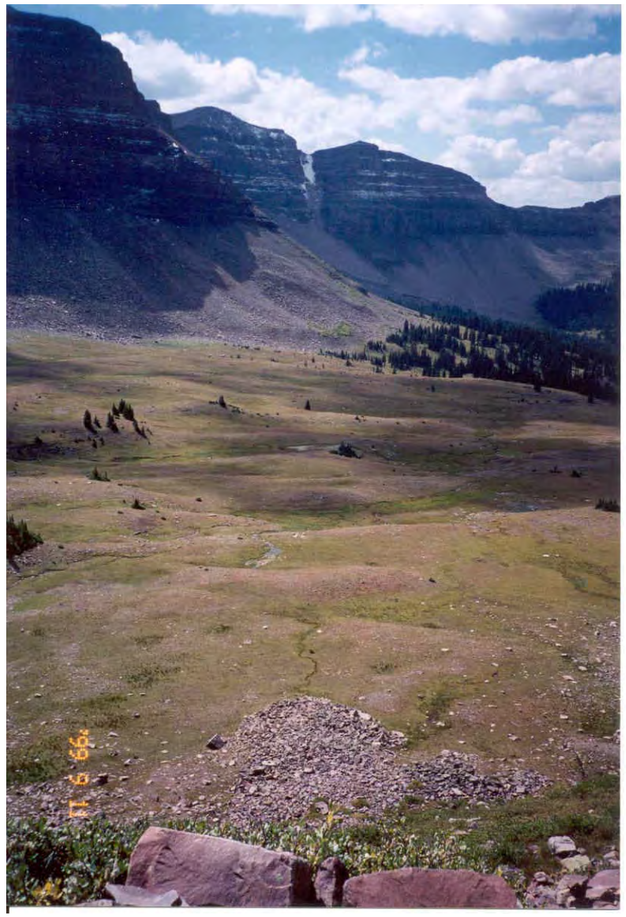






WF7 9/11/99

Unit 4B. Photos show upland with estimated 70% bare ground, 15% rock, 15% forbs, trace grasses, litter. Soil erosion and erosion pedestals are evident on these slopes.









WF8 9/11/99

<u>Unit 4B</u>. Upper left photos show Unit 4B from trail below Red Knob on way to pass, near rock cairn. Uplands in Unit 4B show bare ground and heavy use. Upper right photo is a view back to Unit 4A. Right photo is a small stream trampled and widened with no defined channel. The bench in Unit 4B is estimated at about 75% upland and 25% wet meadow complexes.







WF8 9/11/99

<u>Unit 4B</u>. This view from the ridge looking down into the unnamed basin in Unit 4B shows steep slopes, talus and barren uplands with sensitive soils interspersed with small stream and wet meadow complexes. Little forage is found here.





WF9 9/11/99

<u>Unit 4B</u>. Closer view of unnamed basin in Unit 4B with barren uplands, high percent bare ground in uplands and interspersed wet meadows with greater ground cover. Everything except sedges/rushes in wet meadows are heavily grazed with little residual.







WF10 9/11/99

<u>Unit 4B</u>. Close-up view of denuded uplands with little residual vegetation in this unnamed basin. The stream bank is heavily trampled and eroding from sheep watering and grazing. Herders have tie stakes for horses in the wet meadow. This is not unusual to find in the Uintas where herder's horses are picketed in wet meadows and adjacent to streams.







WFBF - No Waypoints 9/12/99

Photos of trail damage in West Fork Black's Fork illustrating degraded wilderness values.









WFBF - No Waypoints 9/12/99

<u>Unit 1</u>. Photos along the WFBF of barren forest understory, eroding trails and roads on the approach to the Wilderness. Sediment from these areas may be impacting streams and sensitive trout species.











WF11 9/12/99

<u>Unit 1</u>. Small meadow adjacent to trail showing high percent bare ground and soil pedestaling.



WF12 9/23/01

<u>Unit 1</u>. Overview of ground cover transect location.









WF12 9/20/01

<u>Unit 1</u>. Ground cover transect. 67.5% bare, 3.63% litter, 3.5% rock, 2.13% grass, 23.25% forbs. Residual vegetation = 176.5 lb/acre. The site is dominated by dandelion and yarrow. Soil pedestaling and erosion are evident.











WF13 9/21/01

<u>Unit 4A</u>. Lower photos and upper right photo are views across the bench in Unit 4A. They show widespread denudation of uplands. The only pockets of good ground cover occur in low lying, wet areas, not uplands. The upper left photo provides a view across to Unit 4B and Red Knob showing barren upland slopes .





WF14 9/21/01

<u>Unit 4A</u>. Unit 4A ground cover transect location 1. Ground cover is 40.5% bare, 19.13% litter, 2.13% rock, 1.38% crust, 13.13% grass and sedge, 23.75% forb. Residual vegetation is 266.1 lb/acre. Vegetation is dominated by sedges, rushes, antenarria, or cinquefoil, plants not generally used by sheep.













WF15 9/21/01

<u>Unit 4A</u>. Upper left photos show barren sideslope in Unit 4A viewed from Unit 4B. Other photos show the location close-up and 4A ground cover transect no. 2. The area is heavily grazed, barren, pedestaled and eroding. Ground cover is 63.5% bare, 3.63% litter, 15% rock, 0.88% crust, 3.38% grass and sedge, 13.63% forbs. Residual vegetation is 127.9 lb/acre, consisting of sedges, cinquefoil and other species that did not appear to be used by sheep.

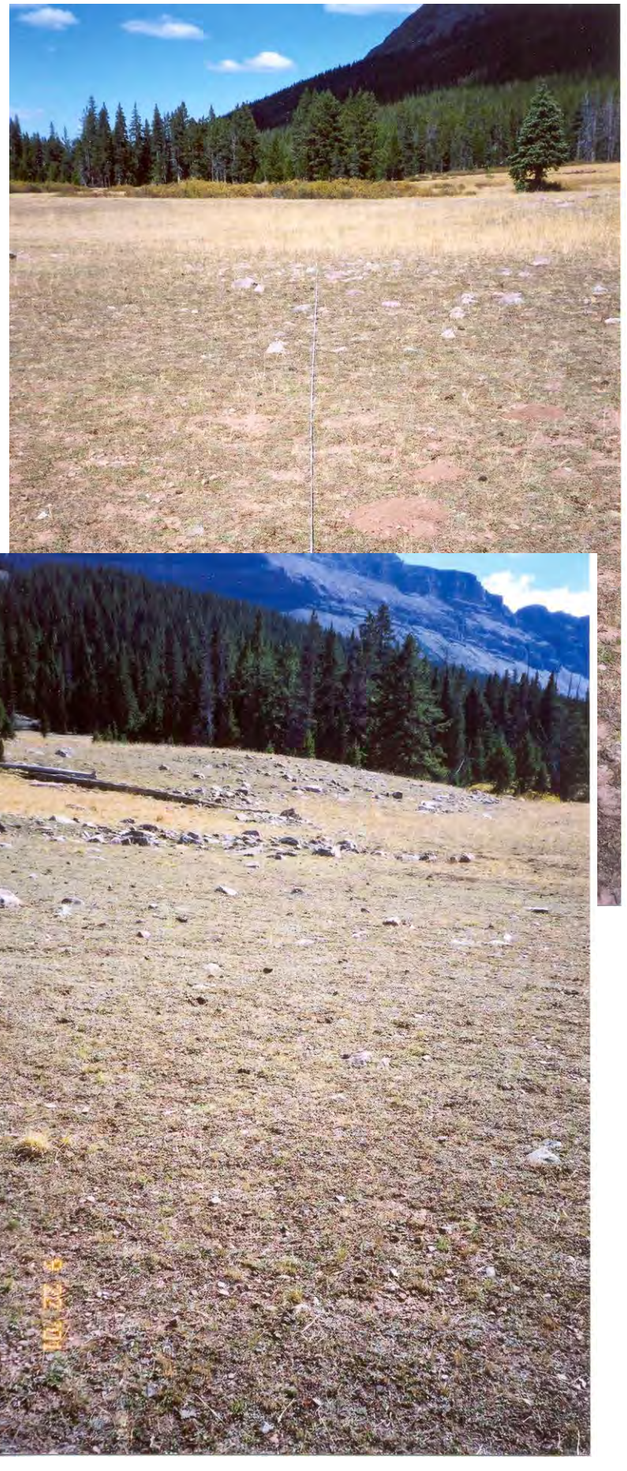






WF16 9/22/01

<u>Unit 4B</u>. Ground cover transect location with ground cover = 25.74% bare, 20.53% litter, 7.34% rock, 13.57% crust, 14.07% grass and sedge, 18.76 forb. Residual vegetation = 151.0 lb/acre, dominated by sedges not generally used by sheep. This unit was rested in 2001.











WF17 9/22/01

<u>Unit 3,4</u>. This ground cover transect location is in a forest opening at the boundary of Units 3 and 4. The upper right photo shows stream bank damage adjacent to this ground cover transect location. The ground cover at this transect = 48.05% bare, 9.35% litter, 7.09% rock, 1.39% crust, 8.82% grass and sedge, 25.29 forb. Residual vegetation = 133 lb/acre, stubble height of grasses <1", sedges not eaten. Forbs are prostrate forms not generally available as forage.







WF18 9/23/01

Heavy use in upland meadow adjacent to the West Fork Black's Fork. The stream bank is trampled and eroding into the WFBF.





WF19 9/6/06
40° 52.961' N, 110° 40.204 W

West Fork Black's Fork. Upper photos of sediment core sample location in West Fork Black's Fork. Lower photos show close view of stream substrate and scoured stream banks from high flows.













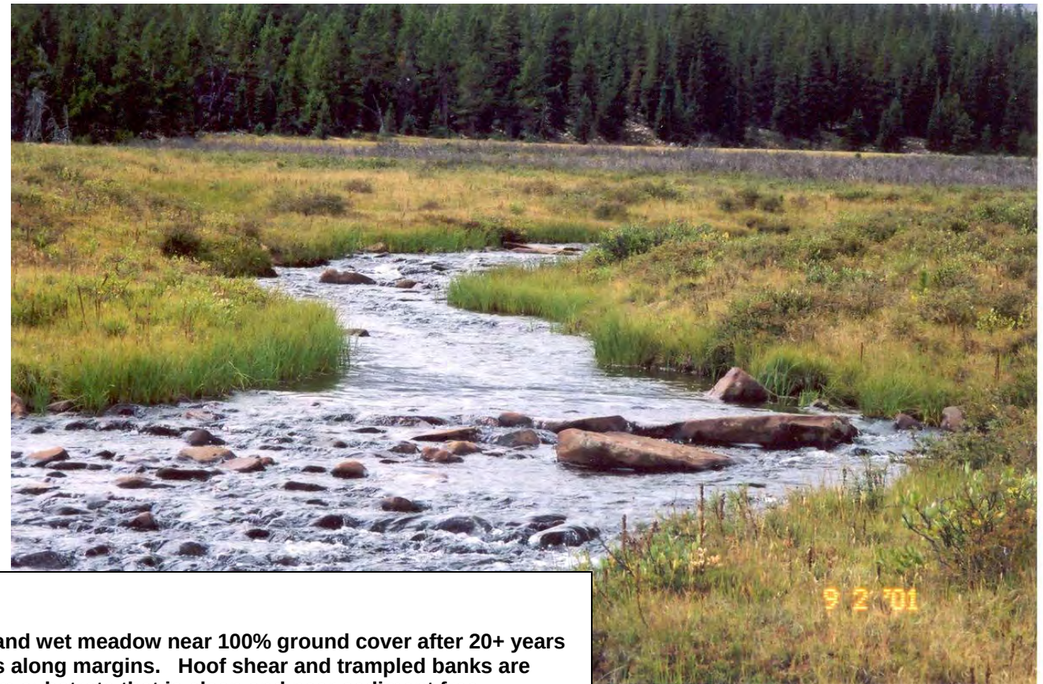
WF19 9/6/06

Bank scouring and sluffing along West Fork Black's Fork downstream of sediment core sample site









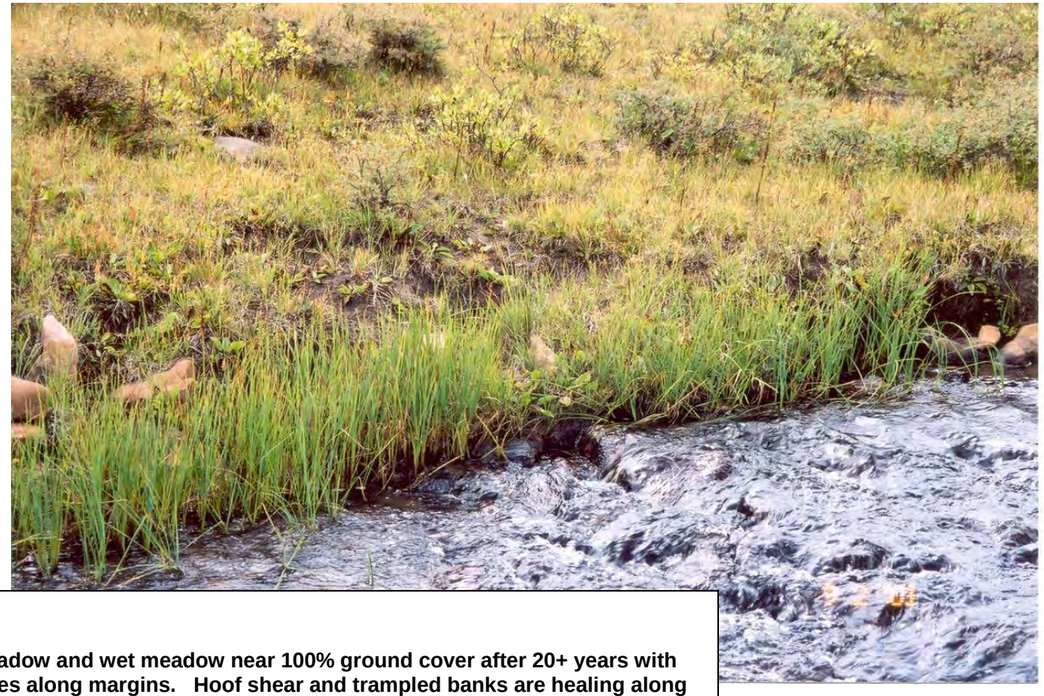
BF1 9/2/01

Meadow and tributary of Burnt Fork. Forest understory, upland meadow and wet meadow near 100% ground cover after 20+ years with no livestock. Stream banks gradually building as exhibited by sedges along margins. Hoof shear and trampled banks are healing along stream margins. Undercut banks are developing with stream substrate that is clean and near sediment free.









BF1 cont'd. 9/2/01

Meadow and tributary of Burnt Fork. Forest understory, upland meadow and wet meadow near 100% ground cover after 20+ years with no livestock. Stream banks gradually building as exhibited by sedges along margins. Hoof shear and trampled banks are healing along stream margins. Undercut banks are developing with stream substrate that is clean and near sediment free







BF2 9/8/06
40° 53.816 N, 110° 05.291 W

Left photos of Burnt Fork sediment core sample site in embayment at side of channel. Right photo of stream profile measurement.







Burnt Fork Near Trailhead 9/8/06

Fence not maintained leading to cattle trespass into wilderness.

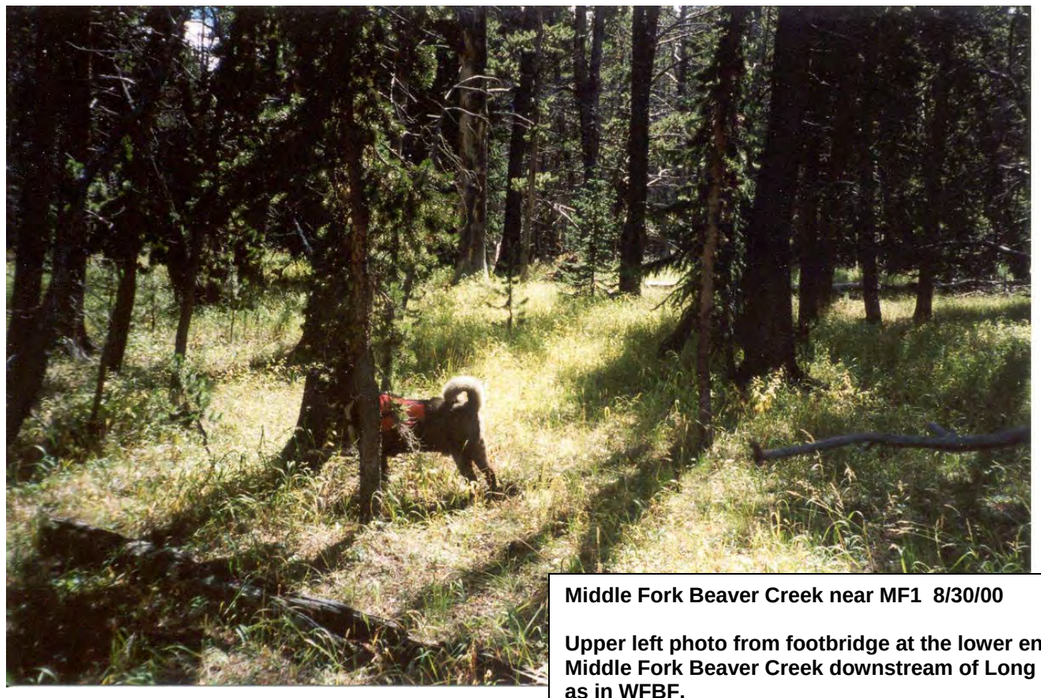


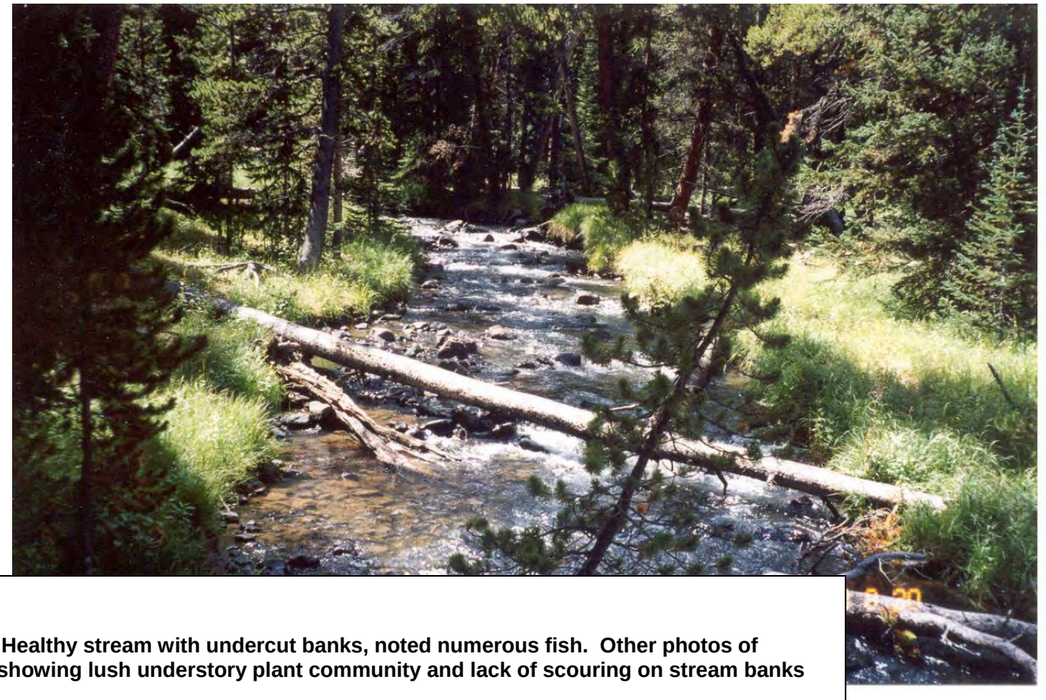












Middle Fork Beaver Creek near MF1 8/30/00

Upper left photo from footbridge at the lower end of Long Meadow. Healthy stream with undercut banks, noted numerous fish. Other photos of Middle Fork Beaver Creek downstream of Long Meadow footbridge showing lush understory plant community and lack of scouring on stream banks as in WFBF.









MF1 8/30/00

Long Meadow ground cover transect. Upper and left photos are views along transect lines and typical ground cover. Ground Cover = 0% bare, 10.25% litter, 1.13% rock, 8.13% crust, 61.25% grass, 19.25% forbs. Vegetation = 630.1 lb/acre. Lower right photos shows adjacent lodgepole forest with complete ground cover and healthy vegetation.









MF2 9/2/00

Upper right photo of small, unnamed tributary of Middle Fork Beaver Creek. Bank is undercut with overhanging grasses and is stabilized with vegetation and mosses. Upper left photo is Beaver Lake and a small inlet stream at right. Note lush plant community after 20+ years rest from livestock.

Photo at left is at the outlet of Coffin Lake. The forest understory and meadows around Beaver Lake and on way to and from Coffin Lake were inspected revealing ground cover near 100% in all areas except on steepest, unstable slopes.





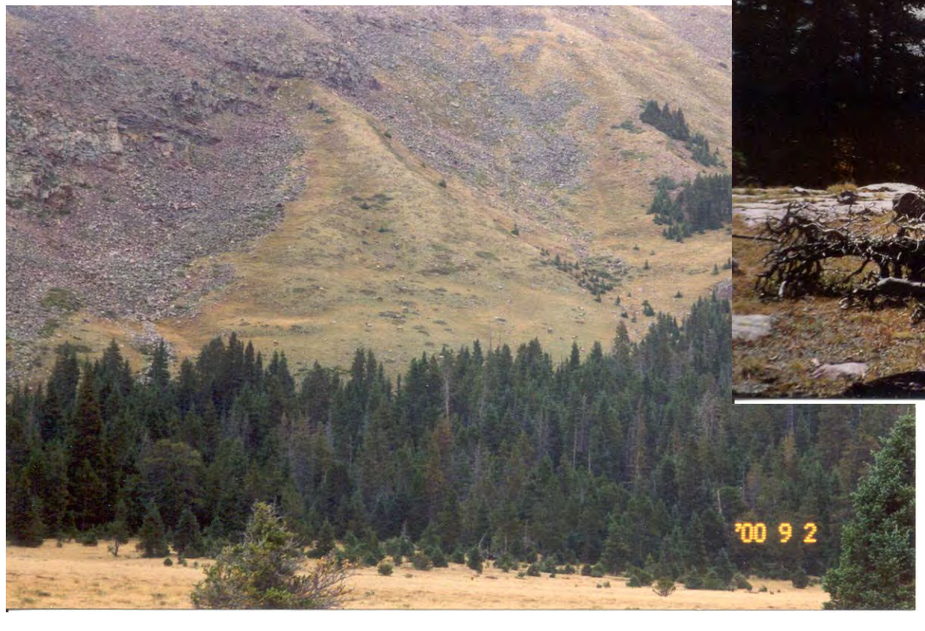




Overview of vicinity of MF3 and MF4 9/3/00

Photos of upper basin showing vegetation cover that is near complet. Lower left photo is telephoto of steep slope with 12 elk grazing. Note that even at this distance, one can tell vegetation cover is good in areas with soil development, with no dominant signs of bare ground as occur on slopes such as these in WFBF.











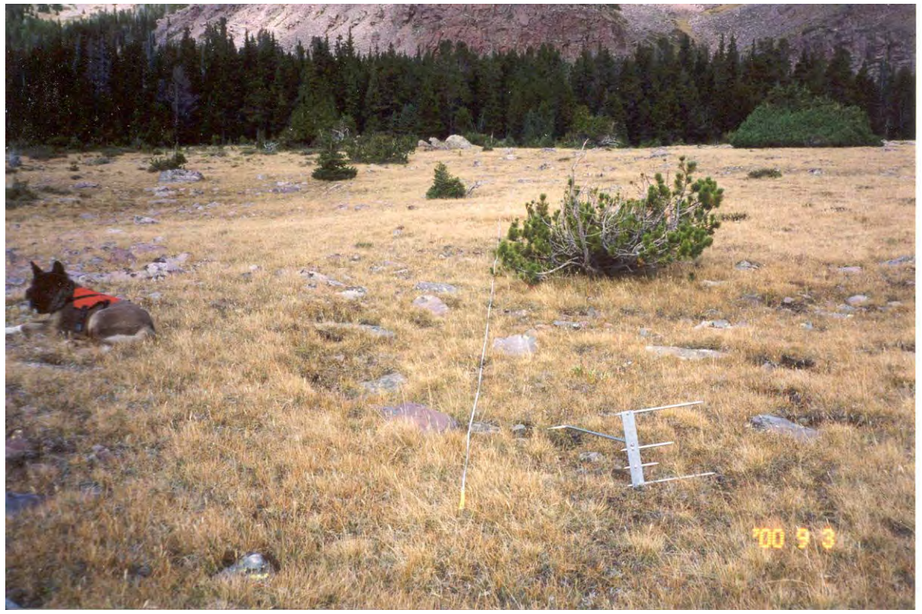






MF3 9/3/00

Upper Basin ground cover transect location 1. Upper photos are along transect legs. Lower right photo is of typical ground cover. Ground cover = 0.13% bare, 17.98% litter, 8.23% rock, 18.53% crust,35.00% grass, 19.87% forbs. Resdual vegetation = 355.8 lb/acre.









MF4 9/3/00

Upper Basin ground cover transect location 2. Left and upper photos are along transect lines. Note healing erosion feature in photo at left. Upper right photo is of typical ground cover. Lower right photo is of nearby upland forest understory. Ground cover = 0.38% bare, 17.63% litter, 5.75% rock, 14.5% crust, 46.88% grass, 14.88% forbs. Residual vegetation = 609.3 lb/acre.









Middle Fork Beaver Creek Trail 9/4/00

Main Middle Fork Trail between Beaver Lake and Long Meadow. Compare narrow bare strip of trail and vegetated stream crossing here to those in WFBF that are wide and barren, clearly illustrating a degradation of wilderness values in the WFBF.





MF5 9/14/05

Photos show healing of erosion channels in Middle Fork Beaver Creek meadow after 20+ years rest from sheep grazing.







MF6 9/7/06

40° 54.889 N, 110° 13.093 W

Middle Fork Beaver Creek. Left photos are an overview of the sediment core sampling site. Right photo of substrate at sample site.

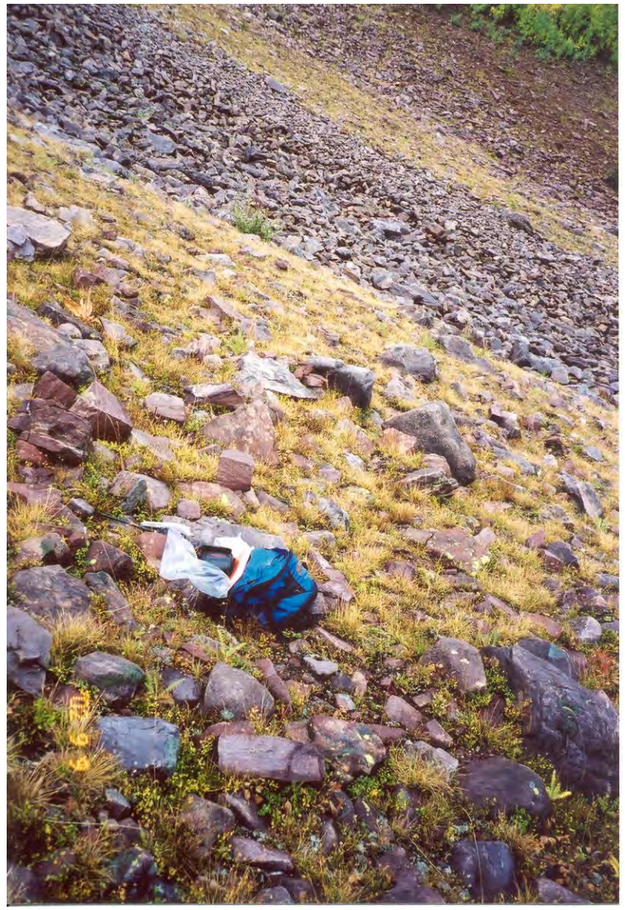




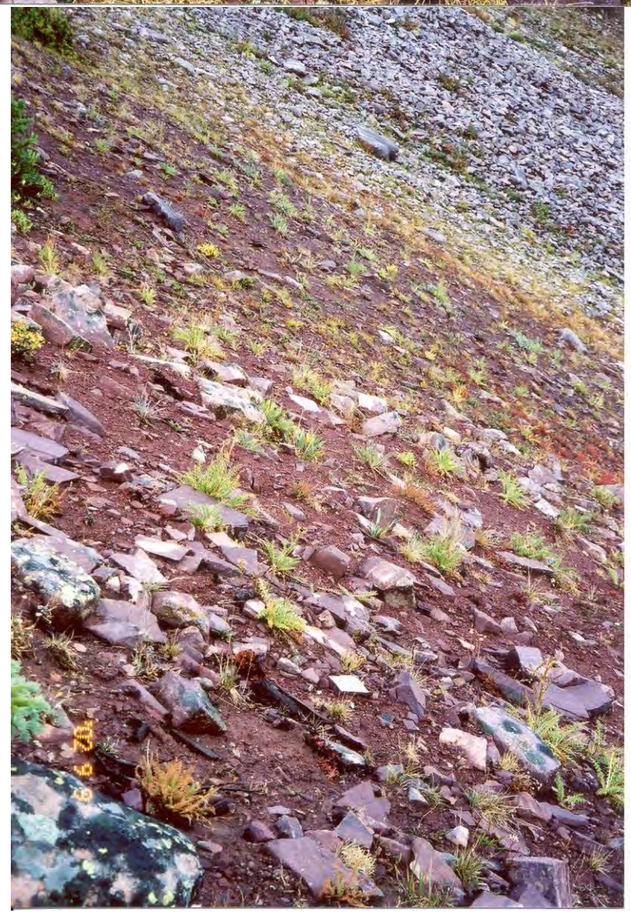


EF1 9/9/02

East Fork Black's Fork. Photos of east facing slope showing vegetation growing between talus slopes.









EF1 Cont'd 9/9/02

East Fork Black's Fork. View of east facing slope showing vegetation growing between talus slopes where soil development has occurred. Upper photos illustrate potential ground cover near 100% in vegetated patches on lower, more moist portion of slope. Here, the estimted ground cover is 50% rock, 15% crust, 20% grass/sedge, 5% forb. Photos at right show results of sheep use on upper upper slope. Estimated ground cover here is 50% rock, 45% bare with remainder vegetation. Remaining plants include yarrow, thistle, sedges not eaten by sheep.



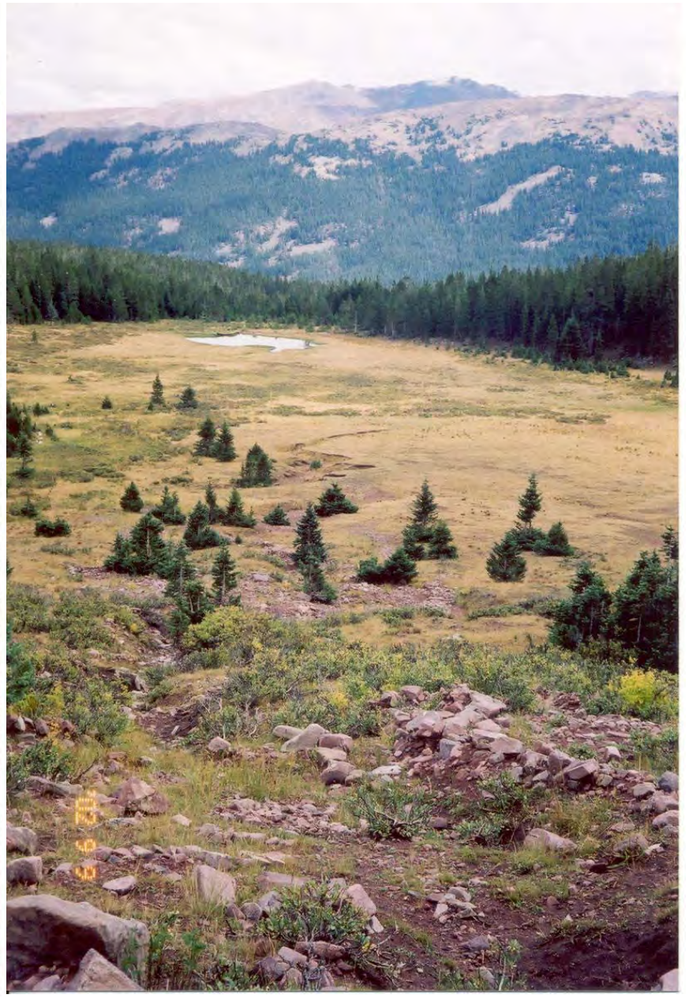




EF2 9/9/02

East Fork Black's Fork. Upper left photo North of Tokewana Peak in upland forest opening. The area has been heavily grazed with estimated ground cover 75% bare, 20% rock and grass/forb 5%. Yarrow is the dominant forb. Soil pedestaling is evident. The upper right photo is a view across to an unnamed peak showing what appears to be a barren area on top. Nearby moraine has been depleted of vegetation. Lower right photo is of forest understory showing ground cover estimated at 2% rock, 2% grass/sedge, remainder bare ground at 95%. Soil pedestals and erosion are evident









EF4 9/9/02

East Fork Black's Fork. Upper left photos show consequences of grazing on steep slopes resulting in denuded upper slopes, accelerated runoff with resulting erosion and gullying. Active headcuts are present in gullies and soil pedestals are common in upland sites.

EF5 9/9/02

Lower right photo shows a small stream that is draining into the lake is loaded with excessive sediment from this erosion. The lake has become shallow and is filling rapidly. These visual impacts and ecological damage from sheep grazing along with widespread sheep manure and smell lingers and are a degradation of wilderness values.
EF5 9/9/02.

EF6 9/11/02 at right

East Fork Black's Fork. Upper right photo shows severe bank erosion from sheep trampling and grazing for several hundred feet along this tributary of the East Fork Black's Fork.

EF7 9/11/02 below

East Fork Black's Fork. Heavy sediment load in tributary stream, bank scour from flash flooding and high flows. Adjacent uplands estimated at 50% bare ground from grazing.









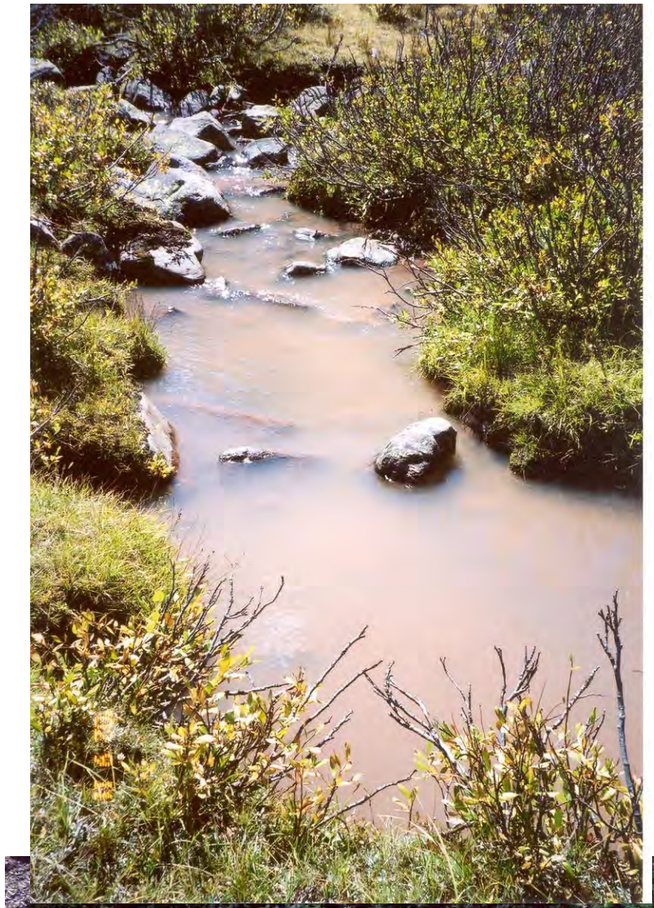
EF8 at left 9/11/02

East Fork Black's Fork. Uplands showing effects of sheep grazing. Estimated ground cover is 60% bare, 20% rock, 5% crust, 15% grass/forb.

EF9 below 9/11/02

East Fork Black's Fork. Forest opening showing condition of openings and understory that is heavily grazed. Estimated ground cover is 50% bare, 20% rock, 20% moss/lichen, 10% grass/forb.

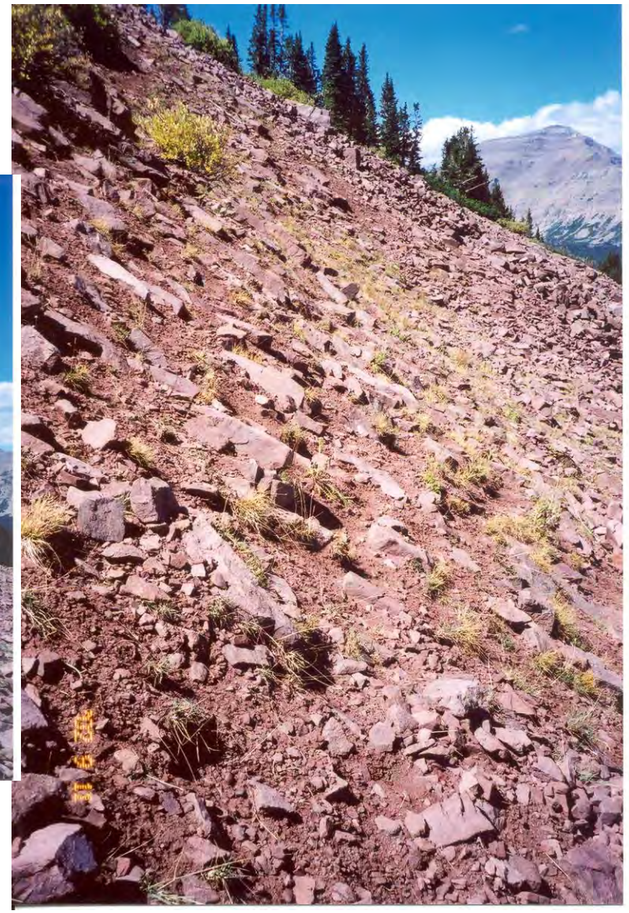












EF10 9/11/02

East Fork Black's Fork. Left photo is of a small stream carrying a heavy silt load from recent rain. Lower photos show adjacent sideslopes that are suffering accelerated erosion from sheep grazing and are delivering sediment directly into the stream. These slopes consist of very unstable soils that are easily displaced by walking across them, yet sheep are grazed on these. Thistle is common with little else on these slopes. The upper right photo is upstream showing active headcutting.







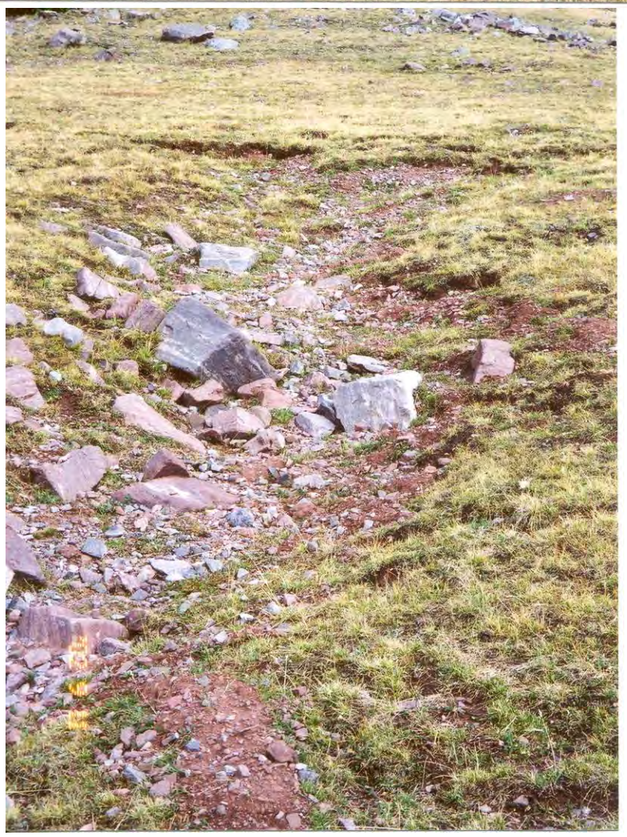


EF11 9/11/02

East Fork Black's Fork. Upper photos show toe of slope that is heavily grazed as evidenced by stubble heights of all vegetation except rushes/sedges <1", even in mesic sites. Upland ground cover is estimated at 40% bare, 40% rock, 10% crust, 10% grass/forb. The lack of residual vegetation and low ground cover results in little erosion protection during runoff. The lower left photo shows a view across the basin with its consistent "mowed" appearance of little residual vegetation on uplands similar to WFBF.

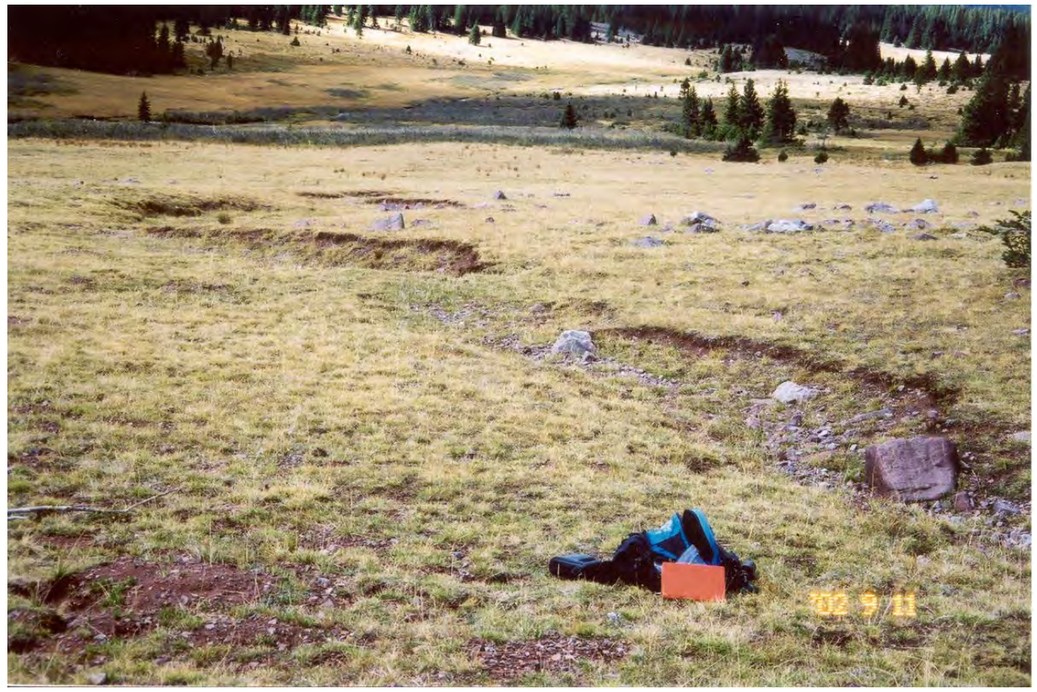






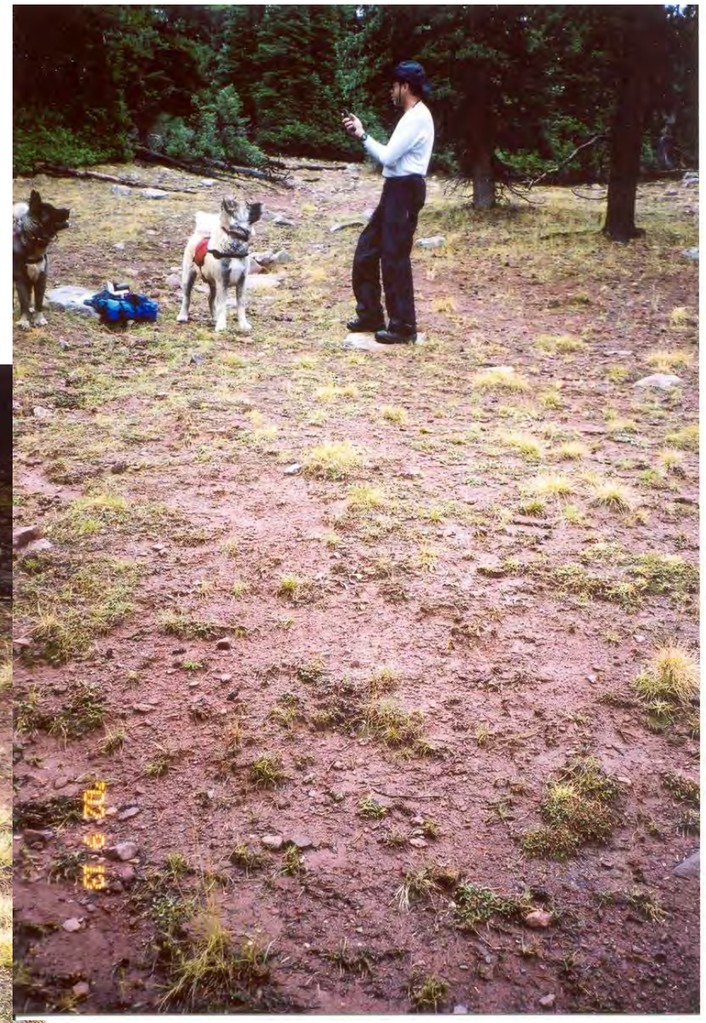
EF12 9/11/02

East Fork Black's Fork. Left and lower right photos show active headcuts and gully erosion in the mesic portion of this meadow stemming from heavy use of slopes and uplands that leaves stubble <1". This loss of buffering capacity coupled with lowered ground cover results in accelerated runoff and erosive forces. The lower right photo provides a view across the basin showing the heavily used and "mown" appearance of uplands.



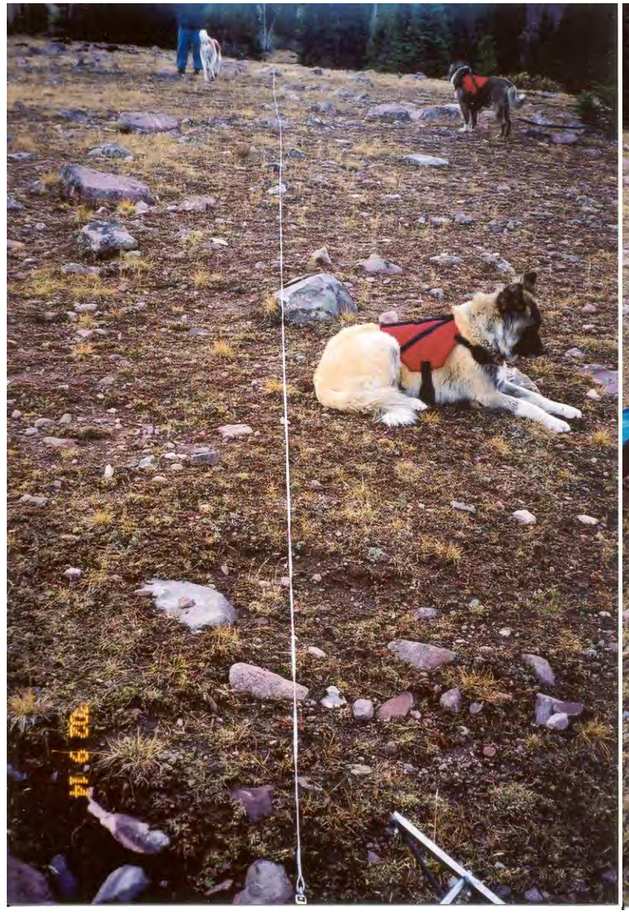


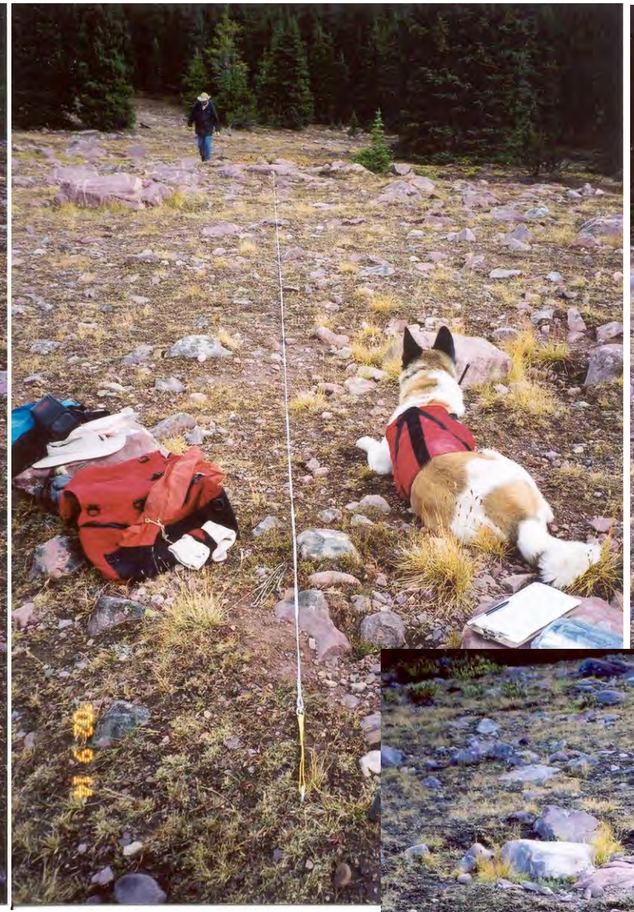




EF13 9/13/02

East Fork Black's Fork. Upper left photo is a view across the east basin fromEF13 on the north ridge showing slopes and meadows below Mt. Lovenia and Wasatch. Eroding upland slopes and intermixed, mesic meadow areas are readily observable. Photos at right are at EF13 along the north side of east basin in forested area. Heavy sheep use is evidenced by manure and trailing. Sheet erosion, pedestals and gully formation are present. Estimated ground cover is 65% bare, 15% rock, 5% sedge/grass, 5% forb, 5% litter, 10% moss/lichen.



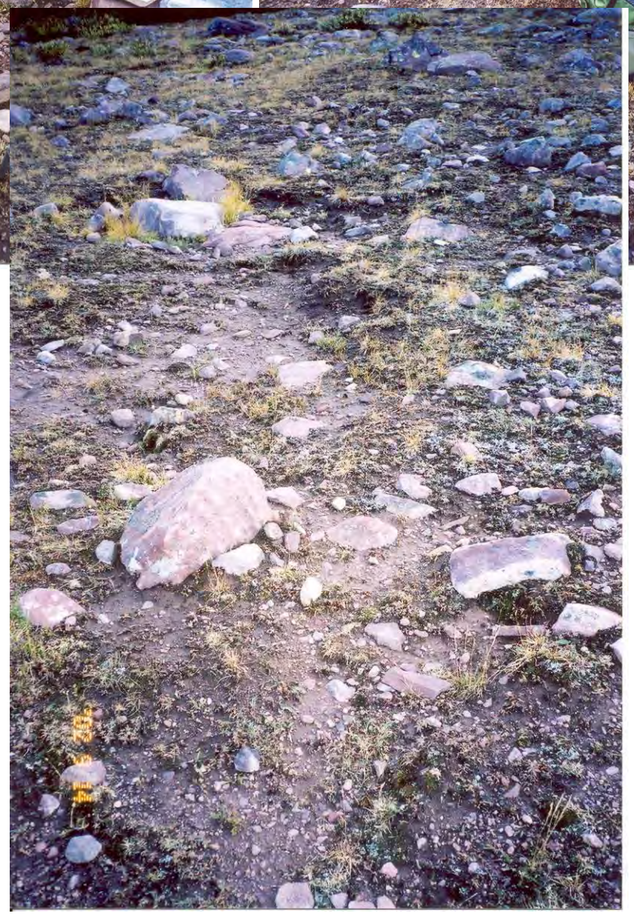




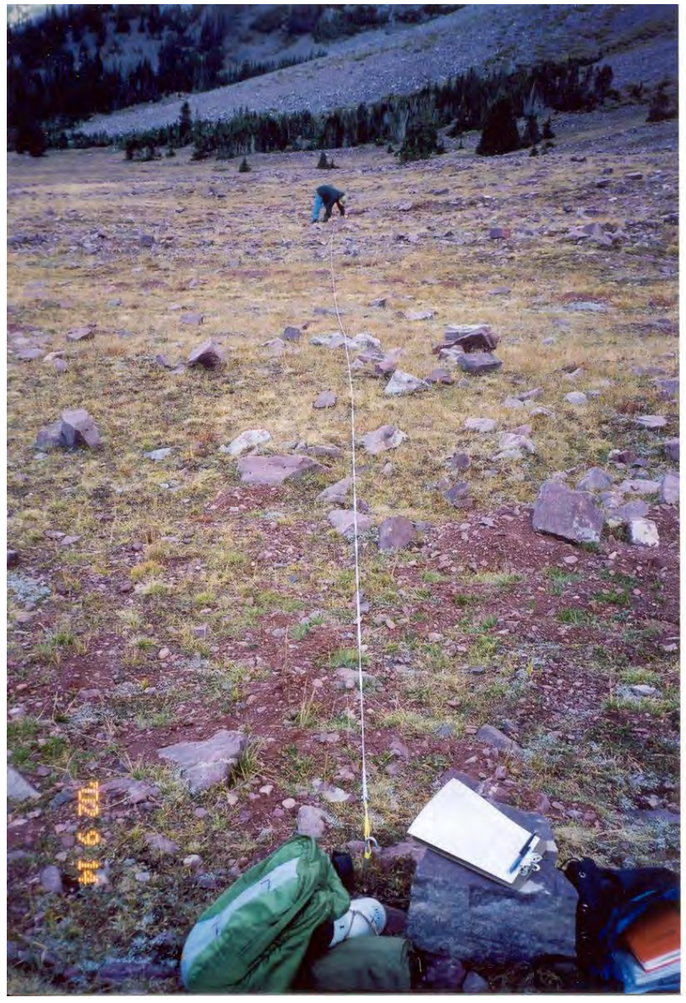
EF14 9/14/02

East Fork Black's Fork. East Basin ground cover plot no. 1. Upper photos are along transect lines. Lower photos show ground cover, soil pedestas and erosion. Ground cover is 40% bare, 7% litter, 14% rock, 17.1% crust, 8.9% grass, 13% forbs. Residual vegetation = 90.8 lb/acre.

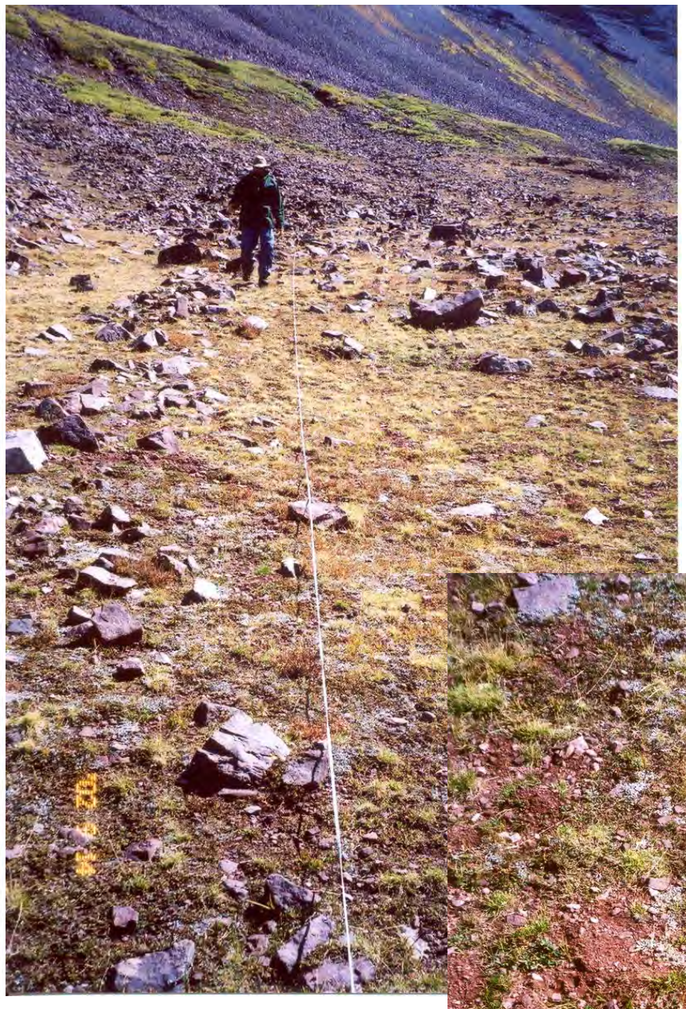


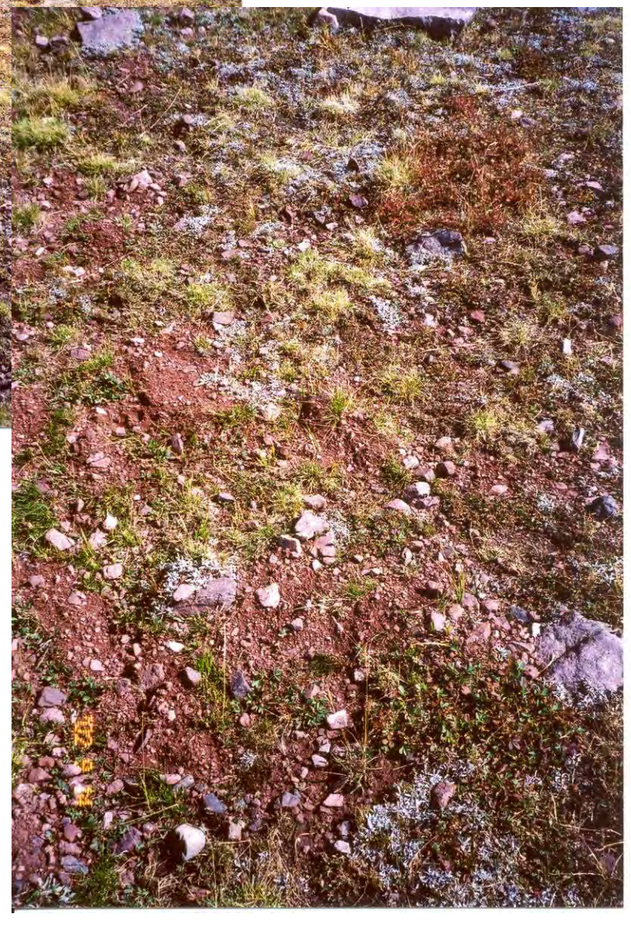












EF15 9/1402

East Fork Black's Fork. East Basin ground cover plot no. 2. Upper photos are along transects. The lower right photo shows ground cover. Ground cover is 27.8% bare, 17.5% litter, 16.9% rock, 1.8% crust, 17.9% grass, 18.1% forbs. Overland flow paths pedestals and small erosion channels are evident. Stubble height <1" Residual vegetation = 309.9 lb/acre.









EF16 9/14/02

East Fork Black's Fork. East Fork showing bank erosion and scouring from sheep trampling and high flows. This is above any place where historic tie-hacking could occur and is due to loss of bank cover combined with high flood forces from the upper basin where vegetation is grazed close to the ground on slopes and uplands and bare ground is excessive. The heavy sediment load is evident in views showing stream bottom.

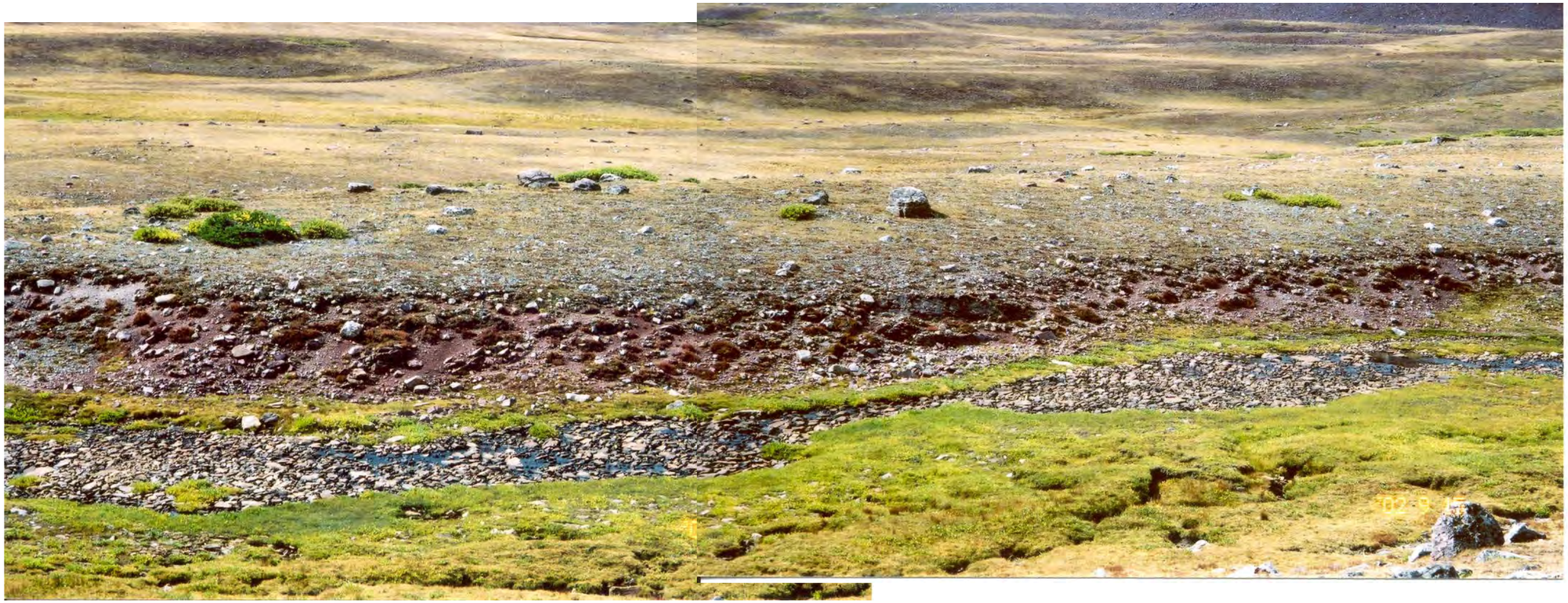






EF17 9/15/02

East Fork Black's Fork. These photos provide views across EFBF upper basin below Mt. Lovenia and Red Knob Pass. They show "mown" uplands from heavy grazing, with resulting bare slopes and erosion into stream channel. Upland site in foreground has been stripped of vegetation.



EF18 9/15/02

East Fork Black's Fork. View of EFBF upper basin showing barren areas and closeup of stream banks. These show severe erosion of uplands adjacent to stream and and heavy use on uplands, leaving little for runoff and erosion protection during snowmelt and storms.



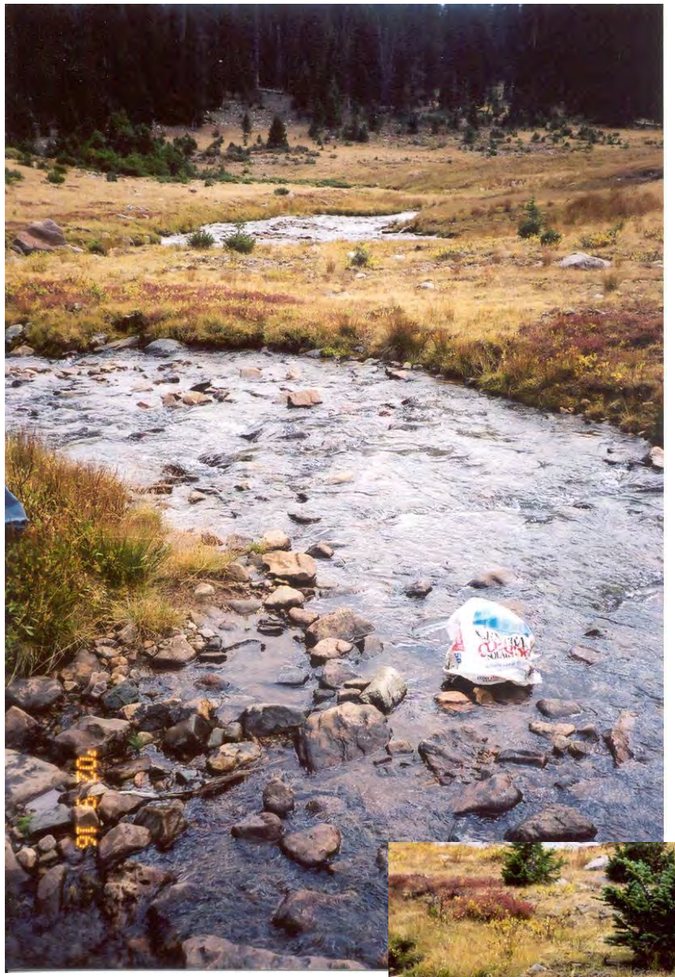




EF19 9/16/02

East Fork Black's Fork. Down gradient of EFBF West Basin ground cover location (EF23) showing erosion gullies with active head cutting, draining the site





EF20 9/16/02 Upper photos

East Fork Black's Fork. Side slope denuded by sheep, increasing sediment load into stream. Solar Salt bag in stream.

EF21 9/16/02 Lower photos

East Fork Black's Fork. Hoof shear, bank trampling and stream widening with loss of undercut banks.

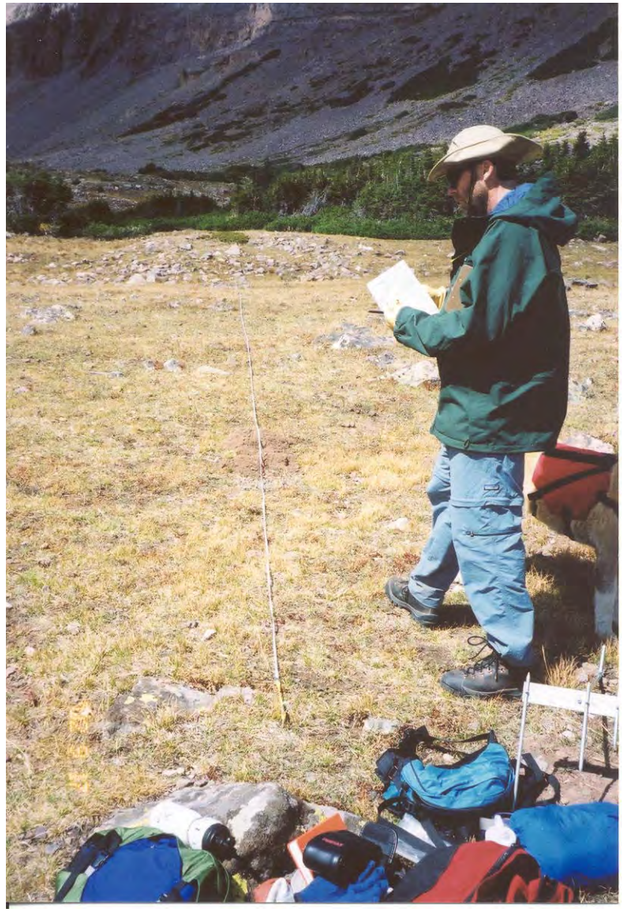




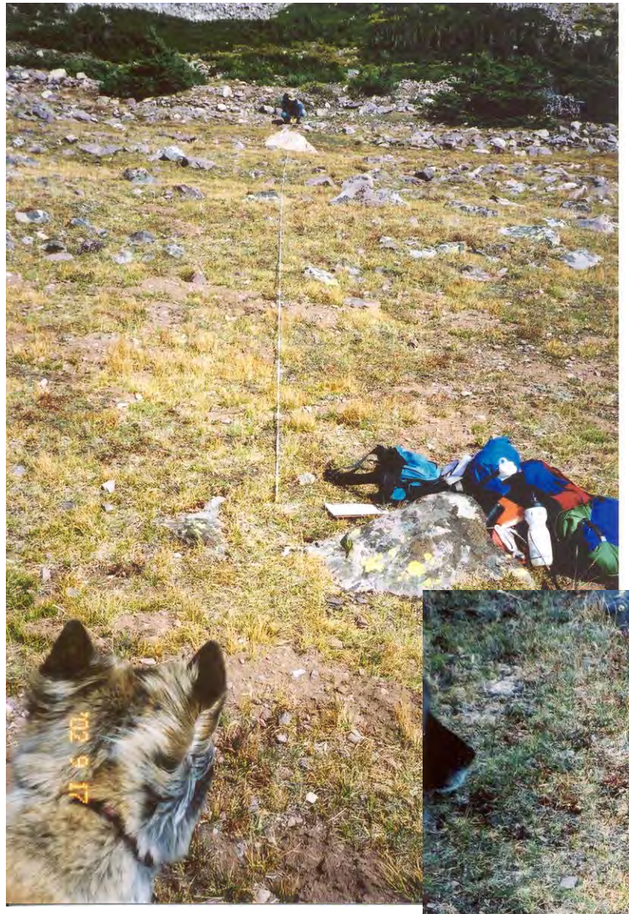


EF22 9/17/02

East Fork Black's Fork. Upland slope with bare ground, soil pedestals and evidence of sheet erosion. Active headcut and gully in background.









EF23 9/17/02

East Fork Black's Fork. EFBF West Basin ground cover location GC1. Upper photos along transect lines. Lower right photo of ground cover. Ground cover = 29% bare, 25.6% litter, 10.5% rock, 1.6%crust, 18.1% grass/sedge, 15.1% forb. Lots of sheep manure, pedestals, sheet erosion, headcuts in this area, with loose, erodible soil. Yarrow is a dominant forb. Residual vegetation = 193.1 lb/acre







East Fork Black;s Fork 9/17/02

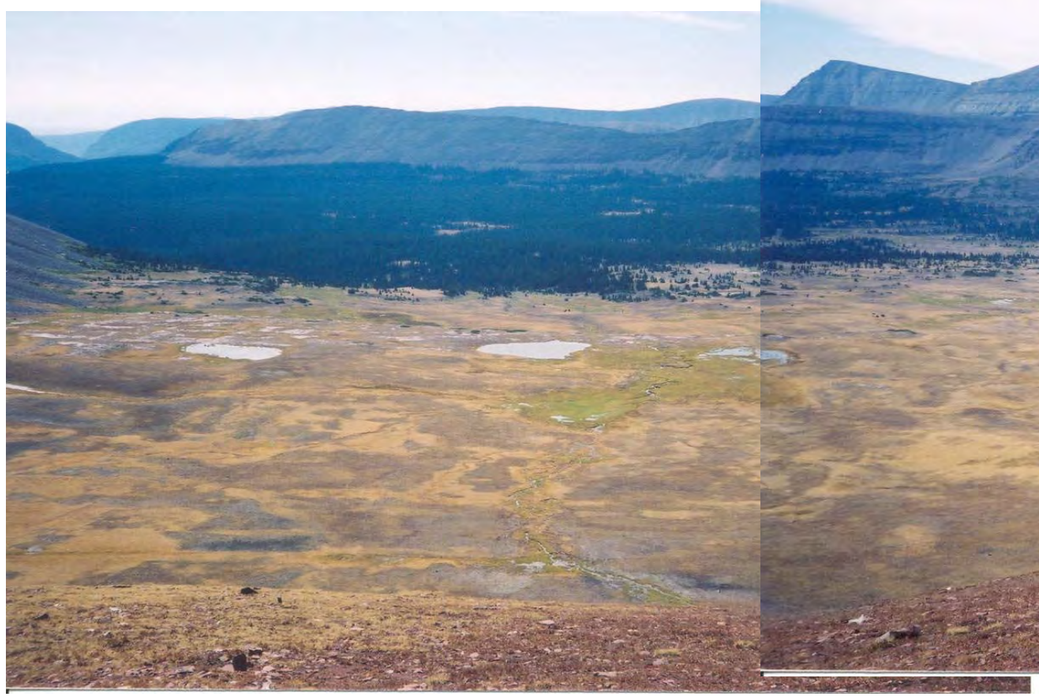
No waypoint here. Meadow south of ford on EFBF showing bare soil. Soil pedestals and sheet erosion evident throughout.





EF24 9/6/06
40° 52.548 N, 110° 32.580 W

East Fork Black's Fork. Photos of sediment core sampling site.

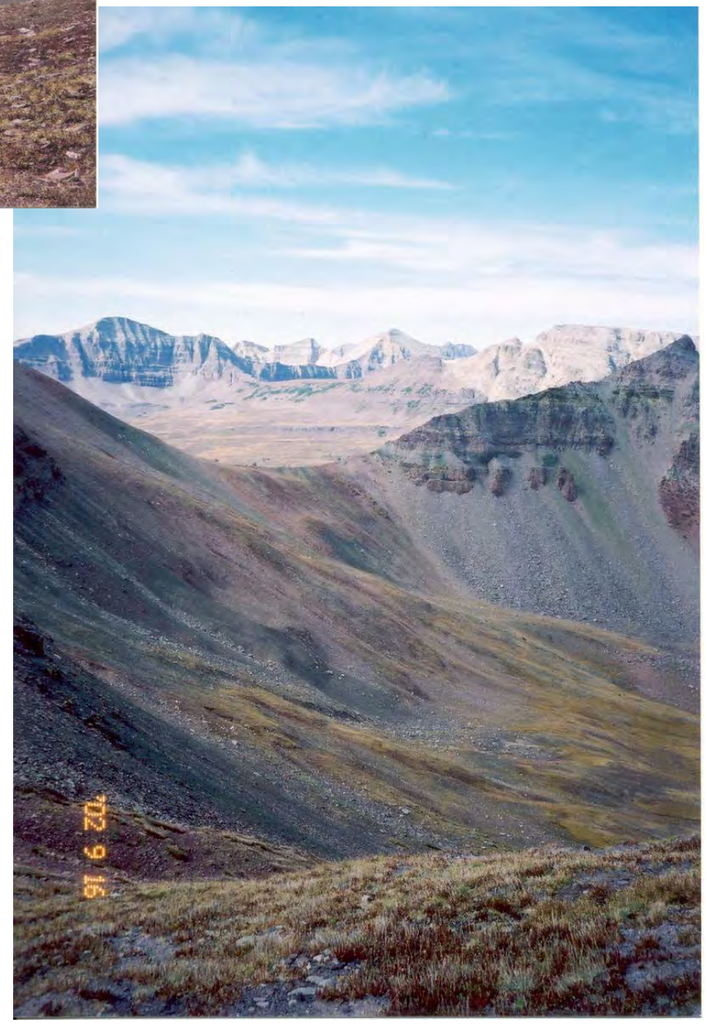


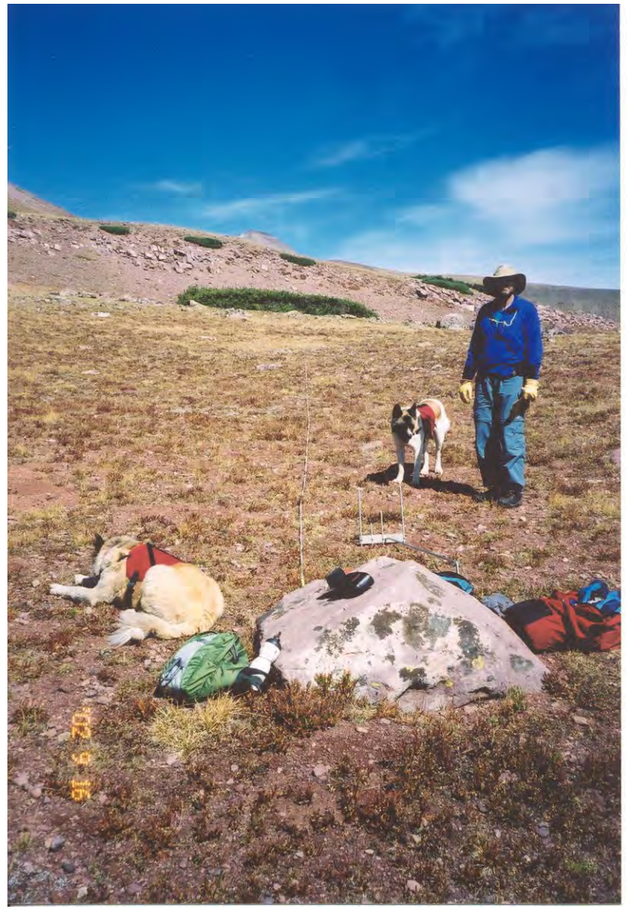




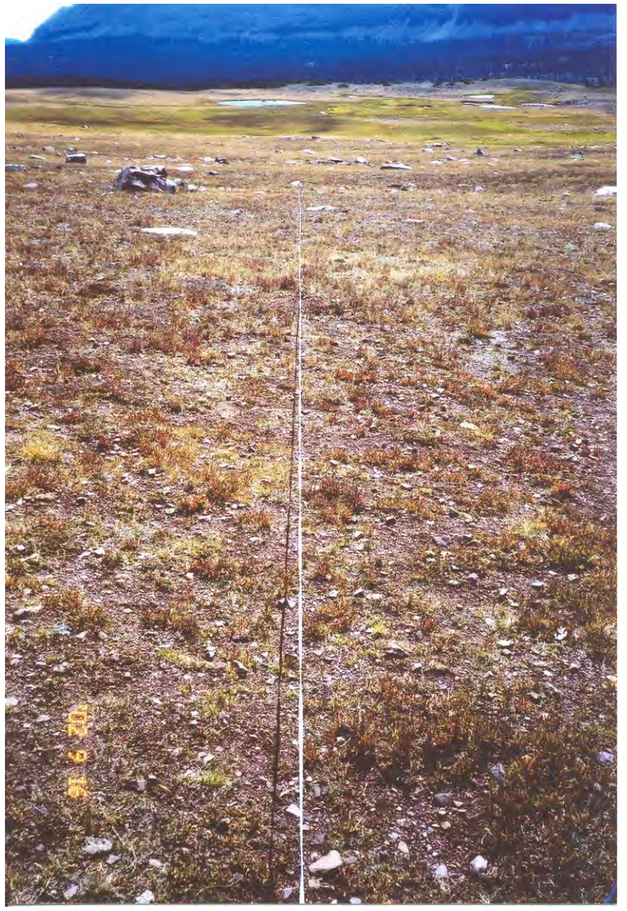
LF1 9/16/02

Upper photos show Lake Fork Basin from Red Knob Pass showing denuded, steep slope in foreground and large expanses of upland with little vegetation. Small, wetland areas lie between these The photo at right is to the east across upper Lake Fork Basin and East Fork Black's Fork showing steep erodible slopes not suitable for sheep grazing or trailing. The photo at left shows consequences of sheep trailing and grazing across this high elevation area with sensitive soils and short growing season. Estimated ground cover here is 70% bare, 20% rock, remainder vegetation and litter.







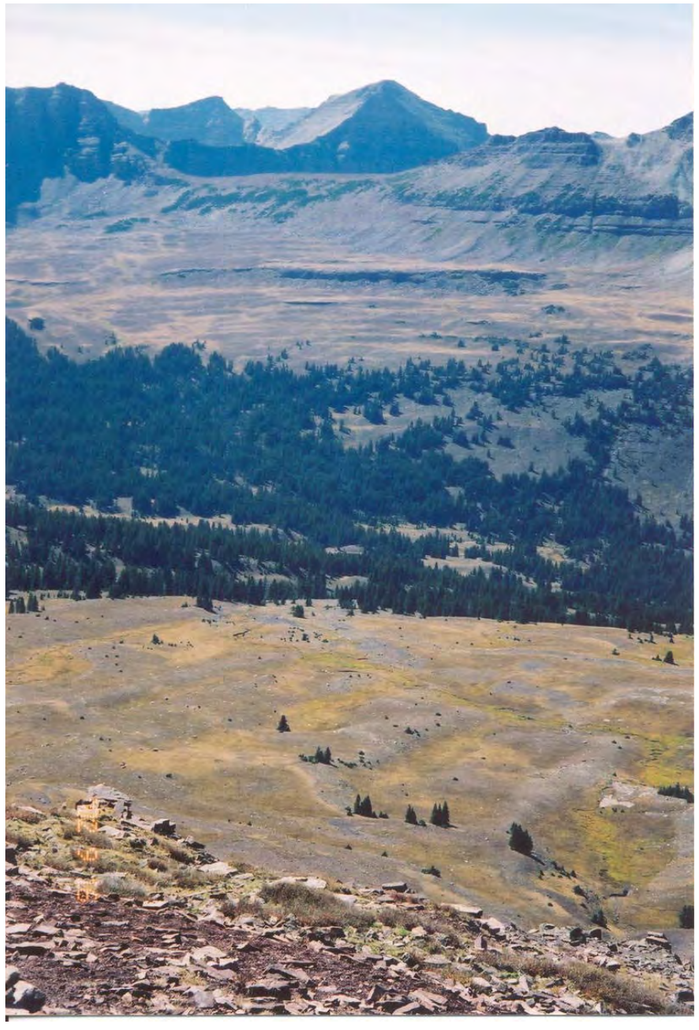




LF2 9/16/02

Upper Lake Fork watershed ground cover transect. Upper photos are along transect lines. Photo of ground cover is at right. Transect included some wet meadow thus underestimated upland bare ground. Soil pedestals and erosion flow pathsare evident. Ground cover = 42% bare, 27.8% litter, 6.6% rock, 0.8% crust, 14% grass/sedge, 13.9 forb. Residual vegetation = 91.3 lb/acre. Lower left photo shows steep slope below Red Knob Pass with loose erosive soil having lost vegetative cover from sheep trailing and grazing.

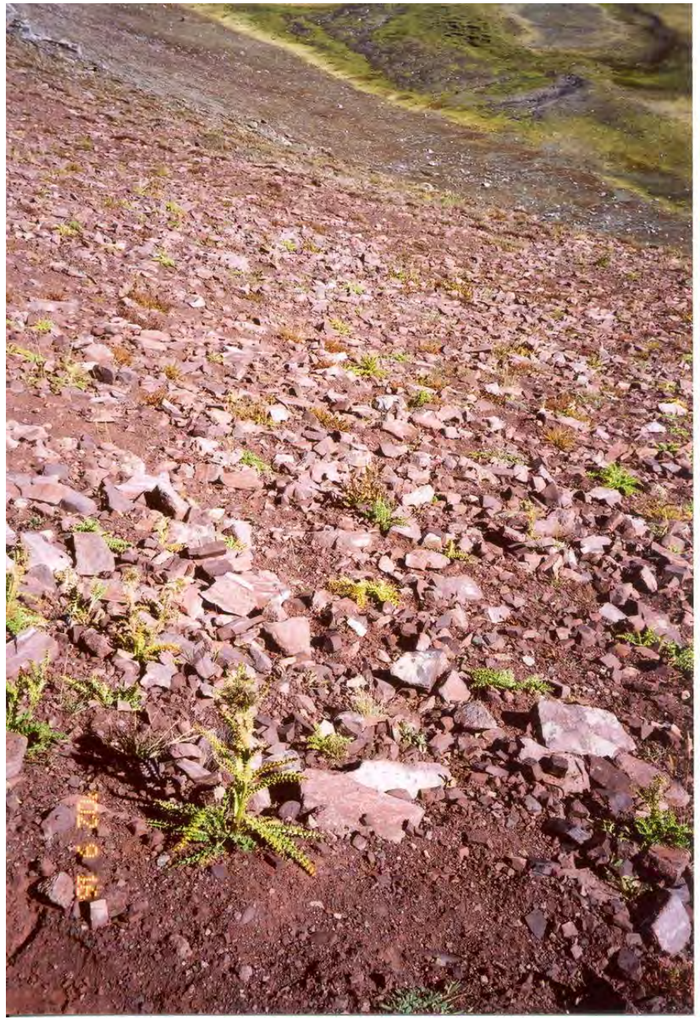


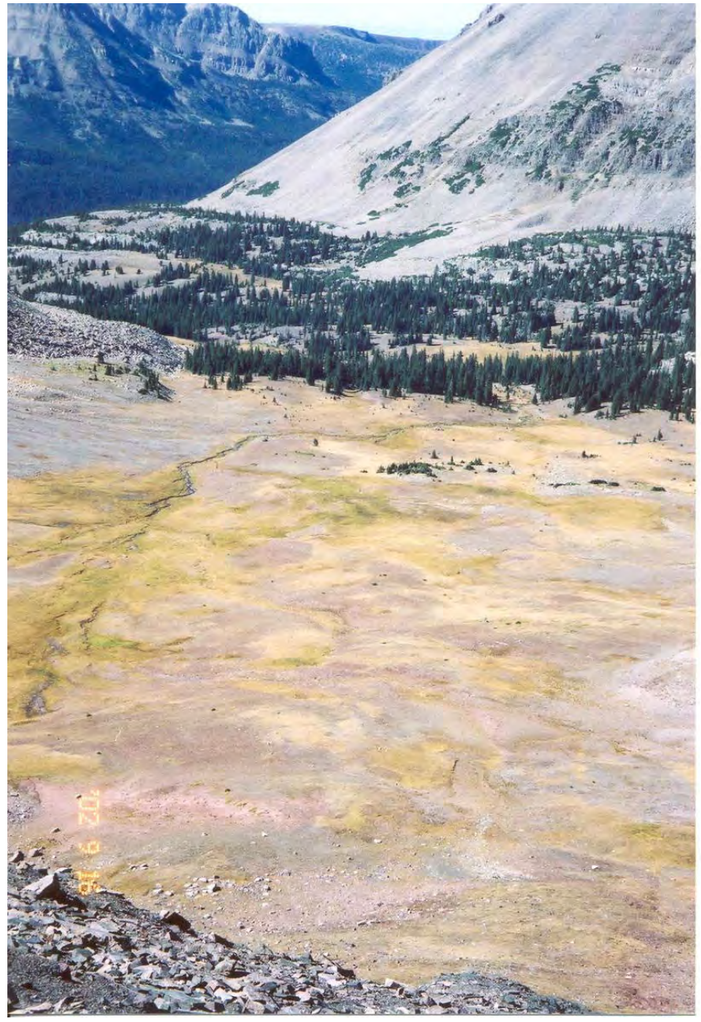


LF3 9/16/02

Upper Lake Fork Basin. The right photo is a view of the steep slope below Red Knob Pass over which sheep are trailed, showing thistle and lack of herbaceous cover. The soil is loose and easily displaced downslope by trampling. The photo at left is a view across Lake Fork Basin showing uplands with little vegetation cover and that "mown" appearance from heavy sheep grazing which leaves little to no buffering against runoff. Estimated ground cover on this slope is 55% bare, 45% rock, 5% vegetation and litter.







LF4 9/16/02

Upper Lake Fork Basin. The left photo is further up slope from LF3 below Red Knob Pass showing thistle, lack of herbaceous cover and loose, eroding soil from thousands of sheep trailing up and down the slope. At right is a view across Upper Lake Fork Basin showing barren lands with little vegetation remaining after grazing. The green areas are low lying wet meadow and riparian areas.

Appendix 3

Location ID	Watershed	Date	Lat	Long	Elevation	Photo Nos	Notes
						Roll 1	
WF1	West Fork Blacks Fork	9/8/1999	40 48.719	110 40.634	11044	2,3,8	12 sheep here; shoreline soils groundcover 65% veg, 30% rock, 5% bare; on side slopes where erosive forces greater, approximately 50% bare with remainder rocks and vegetation cover
WF2	West Fork Blacks Fork	9/8/1999	40 49.149	110 39.740		10, 11, 12, 13, 14, 15	West Fork, view downstream showing eroded banks where sheep water, upland portion of meadow with about 50% bare ground, view along small tributary, views downstream of WFBF showing old fence, sluffing banks. All banks show breakdown and hoof shear. No undercut banks or instream habitat for cutthroats. Overhanging grasses lacking.
WF3	West Fork Blacks Fork	9/9/1999	40 47.087	110 39.764		21, 22, 23, 24, 25	Upland with approx 50% bare, 15% rock, 10% litter, 10% sedges/grasses. Views up and down WFBF showing browsed willows, streambank erosion from high flood forces, and upland/wet meadow transition with upland plants consumed, sparse sedges/rushes remaining in patches. Trail damage at stream crossing on main trail.
						Roll 2	
WF4	West Fork Blacks Fork	9/10/1999	40 45.027	110 40.372	10900	14, 15, 16, 17, 18, 22, 23, 24, 25.	In pasture 4A near outlet of lake EJOD. Views of bench from west to north and typical upland ground cover with about 50-60% bare soil, grass 5%, sedge 5-10%, litter 1%, forb 5-10%, rock 5%. Also view across to 4B and Red Knob. Small outlet stream showing sedges along stream margins not heavily grazed, but uplands severely grazed. Views of Lake Ejod showing bare erdoing upland slopes, lake being filled with sediment from these slopes and lack of vegetation to buffer watershed erosion during runoff
WF5	West Fork Blacks Fork	9/10/1999	40 44.721	110 40.641		19, 20	Representative ground cover in uplands near Dead Man Lake, estimate 60% bare, 15% rock, 15% grass/sedge, 10% forb. Trace litter.
						Roll 3	
WF6	West Fork Blacks Fork	9/10/1999	40 45.398	110 40.264		1	Mid slope location illustrating bare soil at estimated 50%, soil pedestaling, low productivity and high rock cover.
WF7	West Fork Blacks Fork	9/11/1999	40 45.591	110 39.129		4,5	Unit 4B on way to Red Knob. Photos show upland with estimated 70% bare ground, 15% rock, 15% forbs, trace grasses, litter. Soil erosion and pedestaling evident on slopes.
WF8	West Fork Blacks Fork	9/11/1999	40 45.831	110 38.786		8,9,10	Crossing Unit 4B below Red Knob on way to pass, near rock cairn. View back to Unit 4A and uplands in Unit 4B showing heavy use and bare ground. Small stream trampled and widened with no defined channel. Benches about 75% upland and 25% wet meadow complexes. Photo 16 from near Red Knob pass on trail. Photo 18 across to Lake Ejod and Dead Horse.
	West Fork Blacks Fork	9/11/1999	no gps point			16, 18	Photo 16 from near Red Knob pass on trail. Photo 18 across to Lake Ejod and Dead Horse.
	West Fork Blacks Fork	9/11/1999	no gps point			19, 20, 21	View from ridge looking down into unnamed basin in Unit 4B. Shows barren uplands interspersed with small stream and wet meadow complexes. Little forage here.
WF9	West Fork Blacks Fork	9/11/1999	40 46.202	110 38.072		23, 24	Closer view of unnamed basin with barren uplands, high percent bare ground in uplands and interspersed wet meadows with greater ground cover. Everything except sedges/rushes heavily grazed with little residual.
						Roll 4	

WF10	West Fork Blacks Fork	9/11/1999	40 46.392	110 38.166		1, 2, 4, 5	Closer view of denuded uplands with little residual vegetation. Stream bank heavily trampled and eroding from sheep watering. Herder tie stake for horses in wet meadow.
	West Fork Blacks Fork	9/12/1999	no gps point			15, 16, 17, 18, 19, 20, 21, 22	Photos of trail damage in wilderness from trailing sheep and herder's horses, road damage and denuded lodgepole understory.
WF11	West Fork Blacks Fork	9/12/1999	40 52.840	110 40.033		23, 24, 25	Photos 23 - 25 of small meadow along trail showing lack of cover, soil pedestaling.
						Roll 1	
WF12	West Fork Blacks Fork	9/20/2001	40 52.822	110 40.012		23, 24, 25	Unit 1 ground cover transect. 67.5% bare, 3.63% litter, 3.5% rock, 2.13% grass, 23.25% forbs. Residual vegetation = 176.5 lb/acre. Dandelion, yarrow, dry and pedestaled.
						Roll 2	
WF13	West Fork Blacks Fork	9/21/2001	40 45.45	110 40.41		1, 2, 3, 4, 5	Photos across bench in Unit 4A, heavily grazed and barren. Pockets of good ground cover in low lying, wet areas, not uplands. Views across to Unit 4B and Red Knob.
WF14	West Fork Blacks Fork	9/21/2001	40 45.43	110 40.383	10957	6, 7, 8	Unit 4A #1 ground cover transect. 40.5% bare, 19.13% litter, 2.13% rock, 1.38% crust, 13.13% grass and sedge, 23.75% forb. Residual 266.1 lb/acre. Sedges, antenarria, cinquifoil or potentilla?, grasses, rushes,
WF15	West Fork Blacks Fork	9/21/2001	40 45.643	110 40.05		9, 10, 11, 12, 20, 21	Unit 4A #2 ground cover transect, heavily grazed and barren. 63.5% bare, 3.63% litter, 15% rock, 0.88% crust, 3.38% grass nd sedge, 13.63% forbs. Residual vegetation 127.9 lb/acre. Photos 20, 21 taken on the 22nd looking back at this slope from a slope on the east side of the WFBF showing extensive area of bare and eroding hillside.
WF16	West Fork Blacks Fork	9/22/2001	40 45.661	110 39.582	10534	17, 18, 19	Unit 4B ground cover transect. 25.74% bare, 20.53% litter, 7.34% rock, 13.57% crust, 14.07% grass and sedge, 18.76 forb. Residual vegetation = 151.0 lb/acre
	West Fork Blacks Fork	9/22/2001				24	Stream bank damage adjacent to Unit 3 ground cover transect location
						Roll 3	
WF17	West Fork Blacks Fork	9/22/2001	40 46.43	110 39.587		1, 2, 3, 4, 5	Unit 3 ground cover transect. 48.05% bare, 9.35% litter, 7.09% rock, 1.39% crust, 8.82% grass and sedge, 25.29 forb. Residual vegetation 133 lb/acre, stubble height of grasses <1", sedges not eaten. Forbs prostrate forms.
WF18	West Fork Blacks Fork	9/23/2001	40 48.836	110 39.79		8, 9, 10	Heavy use in meadow and trampled, eroding stream bank of WFBF.
	West Fork Blacks Fork	9/23/2001				11, 12, 13	Unit 1 ground cover location overview.

BF1	Burnt Fork	9/2/2001	40 50.416	110 07.661		6, 7, 8, 9, 10, 11, 21, 23	Meadow and tributary of Burnt Fork. Forest understory, upland meadow and wet meadow near 100% ground cover after 20+ years with no livestock. Stream banks gradually building as exhibited by sedges and old hoof shear that is healing along margins. Undercut banks developing and stream substrate clean and near sediment free.
						Roll 1	
	Middle Fork Beaver Creek	8/30/2000	no gps point			4	At footbridge lower end of Long Meadow. Healthy stream with undercut banks, noted numerous fish.
MF1	Middle Fork Beaver Creek	8/30/2000	40 52.19	110 13.71		5, 6, 7, 8, 10, 25	Long Meadow ground cover transect. 0% bare, 10.25% litter, 1.13% rock, 8.13% crust, 61.25% grass, 19.25% forbs. Vegetation = 630.1 lb/acre. Photo 10 of adjacent lodgepole understory with complete ground cover and healthy vegetation. Photo 25 taken on 9/4 of ground cover at transect.
	Middle Fork Beaver Creek	8/30/2000	no gps point			11, 12, 13	Photos of Middle Fork downstream of Long Meadow footbridge showing lush understory plant community and lack of scouring on stream banks as in WFBF.
	Middle Fork Beaver Creek	9/1/2000	no gps point			17, 18	Beaver Lake and small inlet stream with lush plant communities after 20+ years rest from livestock.
						20	At outlet of Coffin Lake. Surveyed forest understory and meadows around Beaver Lake and on way to and from Coffin Lake. Ground cover near 100% in all areas except on steepest slopes.
						Roll 2	
MF2	Middle Fork Beaver Creek	9/2/2000	40 50.769	110 13.279		1	Small, unnamed tributary of Mfork. Showing undercut bank with overhanging grasses, streambank stabilized with vegetation and mosses.
	Middle Fork Beaver Creek	9/3/2000	no gps point			2, 3, 4, 5, 6, 7	Photos of upper basin showing good vegetation cover. Photo 2 is telephoto of steep slope with 12 elk grazing. Note that even at this distance, can tell vegetation cover is good, no dominant signs of bare ground as occur on slopes such as these in WFBF.
MF3	Middle Fork Beaver Creek	9/3/2000	40 50.144	110 12.330		8, 9, 10, 11, 12	Upper Basin ground cover transect location 1. Photos are north, west, south, east from plot center. Photo 12 of typical ground cover. 0.13% bare, 17.98% litter, 8.23% rock, 18.53% crust,35.00% grass, 19.87% forbs. Vegetation = 355.8 lb/acre.
MF4	Middle Fork Beaver Creek	9/3/2000	40 50.335	110 12.479		13, 14, 15, 16, 17, 18	Upper Basin ground cover transect location 2. Photos are north, west, south, east from plot center. Photo 17 of ground cover. Photo 18 of upland forest understory on way back to Beaver Lake from Upper Basin ground cover sites. 0.38% bare, 17.63% litter, 5.75% rock, 14.5% crust, 46.88% grass, 14.88% forbs. Vegetation = 609.3 lb/acre.
	Middle Fork Beaver Creek	9/4/2000	no gps point			21, 22, 23	Main Middle Fork Trail just below Beaver Lake on way to Long Meadow. Compare narrow bare strip of trail and vegetated stream crossing here to those in WFBF that are wide and barren.
MF5	Middle Fork Beaver Creek	9/14/2005	567176 E	4520082 N		151, 152	Show healing of erosion channels after 20 years rest from sheep grazing.
						Roll 1	

EF1	East Fork Blacks Fork	9/9/2002	40 50.238	110 34.939		5, 6, 7, 8, 9, 10, 11	View of east facing slope showing vegetation growing between talus slopes. Photos 8, 9 illustrating potential ground cover near 100% in vegetated patches on lower, more moist portion of slope. Here estimted ground cover is 50% rock, 15% crust, 20% grass/sedge, 5% forb. Photos 10 - 11 of upper slope showing results of sheep use. Estimated ground cover here is 50% rock, 45% bare with remainder vegetation. Plants include yarrow, thistle, sedges.
EF2	East Fork Blacks Fork	9/9/2002	40 50.137	110 35.256		12, 13	North of Tokewana Peak in upland forest opening. Heavily used with estimated ground cover 75% bare, 20% rock and grass/forb 5%. Yarrow is dominant forb. Soil pedestaling evident. View across to unnamed peak showing what appears to be a barren area on top. Nearby moraine has no vegetation.
EF3	East Fork Blacks Fork	9/9/2002	40 50.362	110 35.384		14	Forest understory showing ground cover. Estimated 2% rock, 2% grass/sedge, remainder bare ground at 95%. Soils pedestals and sheet erosion evident.
EF4	East Fork Blacks Fork	9/9/2002	40 50.517	110 35.458		15, 16, 17	Consequences of grazing on steep slopes. Fresh sheep sign and smell lingers. Shows erosion, pedestaling, headcutting and gullies formed down gradient in photo 17.
EF5	East Fork Blacks Fork	9/9/2002	40 50.475	110 35.216		18	Photo 18 shows heavy sediment load in stream from slope and gully erosion. Sheep have trampled the area around this stream and small pond. The small pond is almost filled with silt.
EF6	East Fork Blacks Fork	9/11/2002	40 46.895	110 34.080		21	Severe bank erosion from sheep trampling and grazing for several hundred feet.
EF7	East Fork Blacks Fork	9/11/2002	40 46.787	110 34.041		22, 23	Heavy sediment load in stream, bank scour from flash flooding and high flows. Adjacent uplands estimated at 50% bare ground from grazing.
EF8	East Fork Blacks Fork	9/11/2002	40 46.777	110 34.218		24	Uplands showing effects of sheep grazing. Estimated bare 60%, rock 20%, 5% crust, 15% grass/forb.
EF9	East Fork Blacks Fork	9/11/2002	40 46.669	110 34.204		25	Forest opening showing condition of openings and understory heavily grazed. Estimated 50% bare, 20% rock, 20% moss/lichen, 10% grass/forb.
						Roll 2	
EF10	East Fork Blacks Fork	9/11/2002	40 46.433	110 34.242		1, 2, 3, 4, 5	Stream carrying heavy silt load from yesterday rain. Adjacent sideslope eroded by grazing. Upstream showing active headcutting, bare and eroding slopes feeding directly into stream. Very unstable soils that are easily displaced by walking, yet sheep are grazed across them. Thistle common, little else growing in upland.
EF11	East Fork Blacks Fork	9/11/2002	40 45.941	110 33.508		6, 7, 8	At toe of slope showing heavy grazing. Stubble heights of all vegetation except rushes/sedges <1", even in mesic sites. Upland ground cover estimated at 40% bare, 40% rock, 10% crust, 10% grass/forb. No runoff protection. Broader view across basin reveals consistent "mowed" appearance similar to WFBF.
EF12	East Fork Blacks Fork	9/11/2002	40 46.386	110 33.583		9, 10, 11, 12	Active headcut and gully erosion in mesic portion of meadow stemming from heavy use of slopes leaving stubble <1". Photo 11 provides a view across the basin showing the heavily used and "mown" appearance with uplands .
	East Fork Blacks Fork	9/13/2002	no gps point			17	View across east basin from north ridge showing slopes and meadows below Mt. Lovenia and Wasatch. Can see eroding slopes and intermixed, mesic meadow areas.
EF13	East Fork Blacks Fork	9/13/2002	40 47.364	110 33.961	10954	18, 19	Along north side of east basin in forested area. Heavy sheep use as evidenced by manure and trailing. Sheet erosion, pedestals and gully in early stage of forming. Estimated ground cover 65% bare, 15% rock, 5% sedge/grass, 5% forb, 5% litter, 10% moss/lichen.

EF14	East Fork Blacks Fork	9/14/2002	40 46.357	110 34.112	11073	20, 21, 22, 23, 24, 25	East Fork East Basin ground cover plot GC1. Photos at 0, 144, 288 degrees (p20, 21, 22) along transects. Photos 23, 24 of ground cover, soil pedestaling and erosion. Photo 25 overview north. Ground cover 40% bare, 7% litter, 14% rock, 17.1% crust, 8.9% grass, 13% forbs. Vegetation = 90.8 lb/acre.
						Roll 3	
EF15	East Fork Blacks Fork	9/14/2002	40 46.152	110 33.478	11127	1, 2, 3, 4	East Fork East Basin ground cover plot GC2. Photos at 0, 144, 288 degrees (p 1, 2, 3) along transects. Photo 4 of ground cover. Ground cover 27.8% bare, 17.5% litter, 16.9% rock, 1.8% crust, 17.9% grass, 18.1% forbs. Overland flow and small erosion channels evident. Stubble height <1" Vegetation = 309.9 lb/acre.
EF16	East Fork Blacks Fork	9/14/2002	40 47.337	110 34.563	10543	5, 6, 7, 8, 9	East Fork showing severe bank erosion from sheep trampling and high flows. This is above any place where historic tie-hacking could occur and is due to loss of bank cover combined with high flood forces from the upper basin where residual vegetation is grazed to the ground on slopes and uplands.
EF17	East Fork Blacks Fork	9/15/2002	40 46.630	110 36.379	11380	23, 24, 25	View across EFBF upper basin below Mt. Lovenia and Red Knob Pass. Shows "mown" uplands from heavy grazing, bare slopes and erosion into stream channel.
						Roll 4	
EF18	East Fork Blacks Fork	9/15/2002	40 46.613	110 36.618	11412	1, 2	EFBF upper basin, closeup of stream banks showing severe erosion and heavy use on uplands, leaving little for runoff and erosion protection during snowmelt and storms.
LF1	Lake Fork Basin	9/16/2002	40 46.170	110 37.482	12235	3, 5, 6, 7	At Red Knob Pass. Photo across upper WFBF to west showing steep erodible slopes not suitable for sheep grazing or trailing. Photo 5 shows consequences of sheep trailing across this high elevation area with sensitive soils and short growing season. Estimated ground cover 70% bare, 20% rock, remainder vegetation and litter. Photos 6 and 7 panorama of upper Lake Fork Basin showing denuded, steep slope in foreground and large expanses of upland with little vegetation. Small, wetland areas lie between these
LF2	Lake Fork Basin	9/16/2002	40 45.131	110 37.961	11288	10, 11, 12, 13, 14	Upper Lake Fork watershed ground cover transect. Photos show belt at 0, 144 and 288 degrees with photo of ground cover. Transect included some wet meadow thus underestimated upland bare ground. Soil pedestals and erosion flow paths evident. Ground cover 42% bare, 27.8% litter, 6.6% rock, 0.8% crust, 14% grass/sedge, 13.9 forb. Vegetation = 91.3 lb/acre.Photo 14 shows steep slope below Red Knob Pass with loose erosive soil having lost vegetative cover from sheep trailing and grazing.
LF3	Lake Fork Basin	9/16/2002	40 45.687	110 38.002	11937	15, 16	View of steep slope below Red Knob Pass showing thistle and lack of herbaceous cover. Soil loose and easily displaced downslope by trampling. View across Lake Fork Basin showing moraines with little vegetation cover and that "mown" appearance from heavy sheep grazing. Estimated ground cover 55% bare, 45% rock, 5% vegetation and litter.
LF4	Lake Fork Basin	9/16/2002	40 46.010	110 37.781	12070	17, 18	Further up slope below Red Knob Pass showing thistle, lack of herbaceous cover and loose, shifting soil. View across Upper Lake Fork showing barren lands and little vegetation remaining after grazing.
EF22	East Fork Blacks Fork	9/17/2002	40 47.953	110 36.970	11192	21	Typical upland slope with bare ground, soil pedestals and evidence of sheet erosion. Active headcut and gully in background.
EF23	East Fork Blacks Fork	9/17/2002	40 48.081	110 36.981	11272	22, 23, 24, 25	EFBF West Basin ground cover location GC1. 29% bare, 25.6% litter, 10.5% rock, 1.6%crust, 18.1% grass/sedge, 15.1% forb. Lots of sheep manure, pedestals, sheet erosion, headcuts in this area, with loose, erodible soil. Yarrow a dominant forb. Vegetation = 193.1 lb/acre

						Roll 5	
EF19	East Fork Blacks Fork	9/16/2002	40 47.999	110 36.856	11170	1, 2, 3	Vicinity of EFBF West Basin ground cover location showing erosion gullies, headcutting, draining the site
EF20	East Fork Blacks Fork	9/16/2002	40 47.790	110 36.749	11025	4, 5	Side slope denuded by sheep, sediment feeding into stream. Solar Salt bag in stream.
EF21	East Fork Blacks Fork	9/16/2002	40 47.606	110 36.649	10929	6, 7	Hoof shear, bank trampling and stream widening
	East Fork Blacks Fork	9/17/2002	no gps point			13, 14, 15	Meadow south of ford on EFBF showing heavy grazing, bare soil.

ATTACHMENT 6

United States Department of Agriculture

Forest Service

Wasatch Cache NF

18-8A→E

Reply to: 2200/2500

Date: November 4, 1993

Subject: Sheep Driveway Resource Conditions

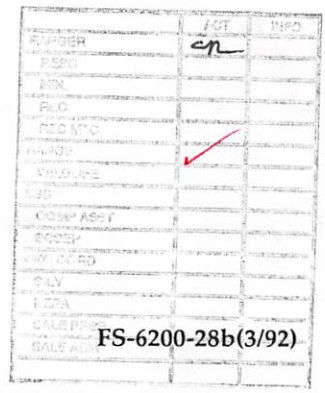
To: Mountain View and Evanston District Rangers

Enclosed is a copy of the report on resource conditions along the high elevation (alpine and high subalpine) portions of the Sheep Driveway on the Mountain View District. Visits by the Forest Ecologist and Soil Scientist to the Mountain View District occurred on August 2, 3, 16, and 17 to evaluate existing conditions along various portions of the sheep driveway that crosses the district. To document conditions, ground cover was measured at three locations on the driveway, one site near but not on the driveway, and one late seral site that has not been grazed for over 15 years. Nested frequency was measured for all species on one driveway location as was depth of topsoil. Nested frequency, and depth of topsoil was also measured at the late seral site. All but one site had gentle slopes and represented similar site characteristics; one site was at a slightly lower elevation and had a greater percent slope.

To summarize our findings, ground cover, species composition, and depth of topsoil differ greatly on some portions of the sheep driveway when compared to the late seral site. Topsoil depth on the late seral site averaged over 11 inches while on the sheep driveway it was less than 2 inches. Plant frequency data was significantly different between the late seral and sheep driveway site. While species composition is important, we are less concerned with the actual species composition than we are with the amount of ground cover. In Mont Lewis' 1970 report on conditions in the high Uinta Mountains, he noted that "serious erosion problems develop when about 30 percent of the soil becomes bare". While bare soil on the late seral site was approximately 0.5 percent, along the sheep driveway it ranged from 6.5 to 52.5 percent. When percent rock and pavement are added to those figures, there is approximately 7 percent for the late seral site and ranged from nearly 24 percent to over 86 percent along the sheep driveway.

EVANSTON R.D.

NOV 8 '93



Caring for the Land and Serving People

FS-6200-28b(3/92)

Also of concern, existing national and regional standards that limit soil erosion and the loss of long term soil site productivity are being exceeded along most portions of the driveway; these same standards are being exceeded in many of the pastures as well.

This report shows the outcome of our study and explains why we are concerned with existing conditions along the sheep driveway.

Sincerely,

Wayne Padgett

WAYNE PADGETT
Forest Ecologist

Richard L Williams

For PAUL FLOOD
Forest Soil Scientist

Enclosure

CC:
Susan Giannettino
Kathy Anderson

November 4, 1993

SHEEP DRIVEWAY CONDITIONS
MOUNTAIN VIEW RANGER DISTRICT
WASATCH-CACHE NATIONAL FOREST

Prepared by

Paul Flood, Forest Soil Scientist
Wayne Padgett, Forest Ecologist

Results

Alpine communities that represent near climax conditions in the Uinta Mountains (occurring on sites similar to those we sampled along the sheep driveway) are characterized by nearly 100 percent ground cover and are dominated by *Kobresia myosuroides* and/or *Carex elynoides* and are included in the **Sedge-Grass Community** described by Lewis (1970). *Geum rossii* is usually present but is not a dominant species.

The late seral site (Site 6), with its codominance of *Geum* and *Kobresia*, is included in Lewis' **Sedge-Geum Community.** Table 1 shows the frequency measurements for this site, as well as for a similar site along the sheep driveway. Note that the late seral community has a higher frequency of species representative of the later seral status (including *Kobresia*, *Carex pseudoscipoidea*, and *Smelowskia calycina*). Ground cover measurements for this area are: 25.8 percent vegetation; 55.5 percent litter; 11.5 percent moss; 4.5 percent rock; 2.3 percent pavement; and 0.5 percent bare soil. Table 2 shows the ground cover measurements for all sampled sites. Some exposed rock is expected in the Uinta Mountain alpine area. On unimpacted and low impact sites such as this area, cryptobiotic lichens are commonly present on the rock surface down to where the vegetation and/or litter covers the rock. Most rocks on this site had this appearance. On driveway sites, these lichens were often totally absent. Where present in minimal amounts, they often occurred at an elevated position several inches above the ground surface level.

Three communities we sampled (Site 1/5, Site 2, and Site 3) belong to the earlier seral **Geum-Sedge Community** described by Lewis. Site 4, while probably included in this community, had very little vegetation and did not fit the description well. Frequency measurements for Site 1/5 show a high percentage of increaser species (*Poa alpina*, *Erigeron simplex*, *Trifolium dasyphyllum*, *Potentilla* spp., and *Sedum stenopetalum*). Care was taken to not measure frequency on the site representing the poorest conditions. Ground cover for each of the sites along the driveway are shown in Table 2. Site 2 respresented an area off the immediate sheep driveway, but still with current grazing. This site, near Site 1/5, has a high percent cover of rock, but fairly good cover of vegetation and litter. Site 4 represents some of the highest percent soil and pavement ground cover as well as high cover of rock. Steepness of gradient appeared to be the most important characteristic noted in changes in percent ground cover; the steeper the gradient, the higher the impacts. Site 4, had the steepest observed gradient of those sampled and had the highest difference in ground cover values when compared to the late seral Site 6 (Chi Square = 5595).

All sites sampled were "similar (i.e. similar aspect, elevation, landform, landscape position, and geomorphic history) to landtype 501, mapped as part of the 1986-1992 Soil Resource Inventory of the North Slope of the Uinta Mountains; and to Unit UB3, mapped as part of the Ashley National Forest Land Systems Inventory. Inventory data from the North Slope Soil Resource Inventory indicates that the most common soil component of landtype 501 is Mirror Lake series, Typic Cryoboroll, with a loamy skeletal texture.

Sample sites 1,4, and 5 were tentatively classified as Typic Cryorthents with sandy skeletal textures, due mostly to the shallow depths of surface soil horizons with accumulated organic matter observed. Surface horizon depths ranged from 0 to 6 inches, with a mean value of 1.6 inches, and a standard deviation of 1.5 inches.

Sample sites 3 and 6 were tentatively classified as Typic Cryoborolls with loamy skeletal textures, due mostly to the thick surface horizons with accumulated organic matter observed. Surface horizon depths ranged from 6 to 18 inches, with a mean depth of 12 inches, and a standard deviation of 4.6 inches. For surface soil horizon characterics of sampled sites see Table 3.

More specific information is noted for each site in Appendix A.

Table 1. High Uinta Sheep Driveway, Nested Frequency

SPECIES	LATE SERAL	18-8A SITE 1/5 (Driveway)
Graminoids		
Carex pseudoscirpoidea	380	346
Kobresia myosuroides[1]	345	0
Festuca ovina var. brachyphylla	56	266
Luzula spicata	44	44
Agropyron trachycaulum	12	25
Danthonia intermedia	7	59
Poa alpina[2]	1	36
Deschampsia cespitosa	0	83
Trisetum spicatum	0	33
Poa spp.	0	21
Carex rupestris	0	3
Forbs		
Geum rossii[2]	304	338
Artemisia scopulorum	204	238
Phlox pulvinata	139	225
Smelowskia calycina	137	5
Polygonum bistortoides[2]	113	205
Erigeron simplex[2]	90	148
Trifolium andinum	87	0
Castilleja pulchella	61	0
Paronychia pulvinata	57	0
Potentilla spp.[2]	29	199
Saxifraga rhomboidea	21	8
Cerastium berringianum	17	0
Campanula uniflora	17	0
Trifolium dasyphyllum[2]	12	225
Gentianella tenella	11	0
Unknown No. 1	9	26
Trifolium parryi[2]	7	0
Arabis spp.	7	0
Unknown No. 2	4	0
Sedum stenopetalum	3	144
Allium spp.	0	114
Draba spp.	0	33
Dryas octopetala	0	19
Stellaria spp.	0	15
Sibbaldia procumbens[2]	0	10
Arrenaria congesta	0	9
Silene spp.[2]	0	7
Antennaria microphylla[2]	0	6
Senecio fremontii	0	3
Phlox spp.	0	3
Ivesia gordonii[2]	0	3

[1] May include *Carex elynoides* which Lewis (1970) noted is difficult to separate from *Kobresia myosuroides* in the vegetative state, but which is also considered as ecological equivalents.

[2] common increasers on bared soils

SHEEP DRIVEWAY CONDITIONS

Introduction

Sheep grazing in the alpine and high subalpine zone of the Uinta Mountains has resulted in changes in surface soil depth, species composition and percent ground cover. Areas along the sheep driveway (Map 1), in general, show even greater impacts than do areas off the driveway, although impacts can be noted wherever grazing occurs. Studies were undertaken during August 1993 to determine the extent of those impacts along the sheep driveway. The location of sample sites are shown on this map.

Lewis (1970) stated that:

> *Ground cover is one of the most important site factors that determines whether an area ahould be grazed and/or the degree of use that should be allowed. In the better developed plant communities, observations show grazing use to be a most important factor contributing to reduced ground cover and sodbreaking. Sheep trails cutting through the sod were obvious in the heavily used portions of the range. Site analysis and grazing impact studies indicate that serious erosion problems develop when about 30 percent of the soil becomes bare.*

We felt that, because of the importance of ground cover, and because of the limited amount of time available to conduct studies, we would concentrate our efforts on collecting ground cover data. In addition, data were collected to document the depth of the existing top soil (surface horizon of organic accumulation), and plant frequency data were collected on one driveway site and one late seral site.

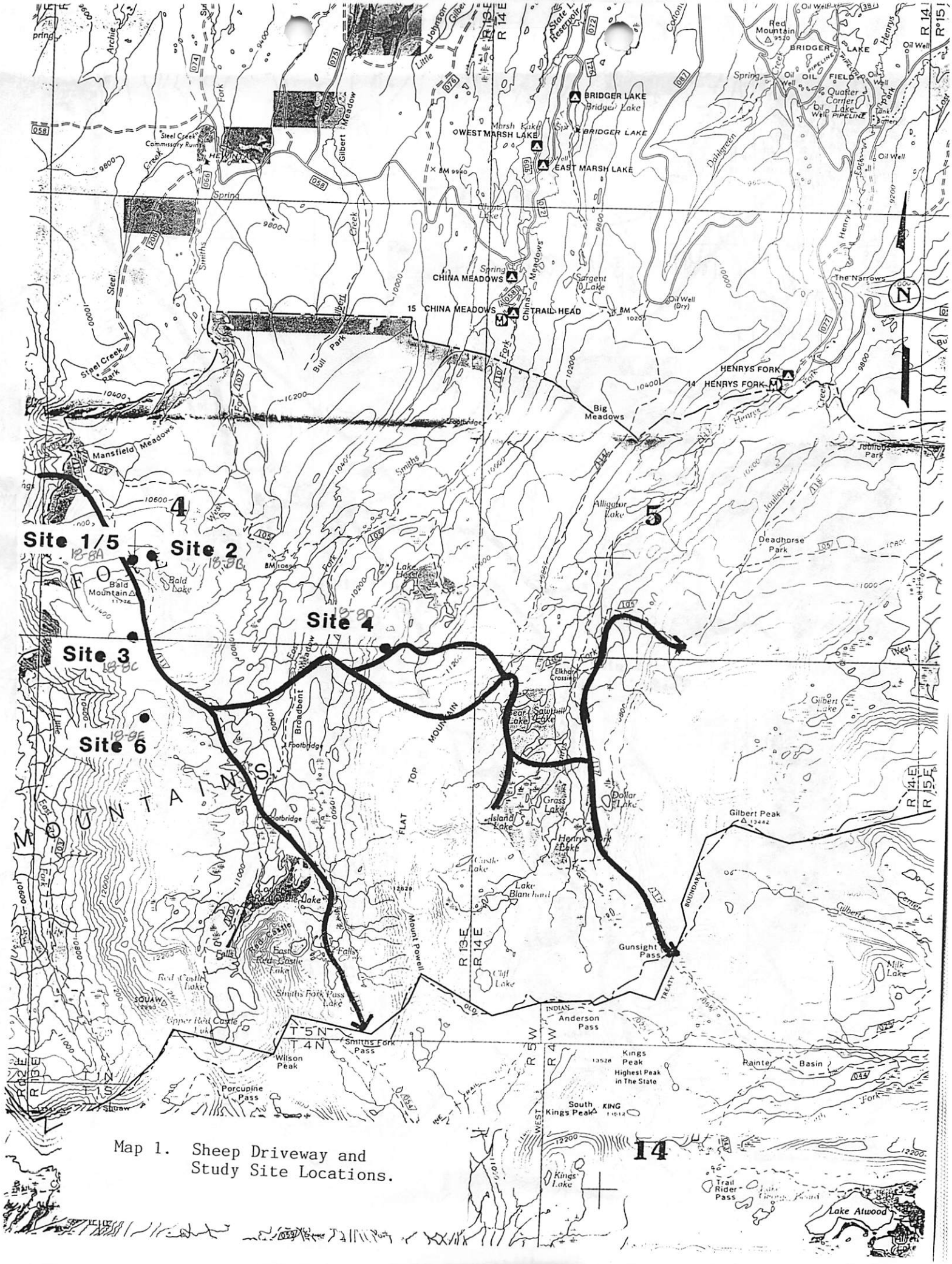
Methods

Ground cover studies were conducted at five sites and nested frequency data were collected at two sites. Methods used follow those described in the 1993 Forest Service Handbook (FSH 2209.21, Chapters 44.3 and 44.4). In general, five transects were established at each of the five location. Twenty nested frequency plots were sampled at 5 ft intervals along each 100 ft transect, for a total of 100 samples per site. Four points on the nested frequency frame were used to determine ground cover. Whatever lies immediately below each point is place in one of the following categories: vegetation; litter; moss; rock; pavement; or soil. A total of 80 points per transect (400 points per site) were used to determine percent ground cover in each category.

Measurements of top soil depth were taken along the transects established for measuring vegetation frequency. The relative darkness of the soil color can be used as an indicator of how much organic matter has accumulated in a given soil horizon. In "Keys to Soil Taxonomy" (1992), the soil color is the primary property used to identify the presence of a **Mollic** soil horizon, a diagnostic used to classify soils at the highest level of taxonomy, the soil order. Generally, a mollic horizon will have dark color and low chroma (values of 3 or less when moist).

Moistened and crushed soil samples were compared to color chips on a Munsell soil color chart. The depth at which soil chroma changed from a "2" or "3" to at least a "4" was recorded as the depth of the surface horizon of organic matter accumulation, hereafter referred to as "topsoil". Four points were sampled along each transect on the sheep driveway site. Twenty points were sampled along four transects of the late seral site. Mean "topsoil" depth and standard deviation were calculated for each site, with the exception of site 2, from those data.

Also at each site (except site 2), measurements of soil texture, clay content, rock fragment content, and soil temperature at 20 inches were made for surface and subsurface soil layers. Observations of slope gradient and aspect, landform type, and landscape position were also made at each site.



Map 1. Sheep Driveway and Study Site Locations.

Table 2. Percent Ground Cover at High Elevation Uinta Mountain Sites

	18-8A Site1/5	18-8B Site 2	18-8C Site 3	18-8D Site 4	18-8E Site 6
Vegetation	16.5	19.0	20.8	4.3	**25.8**
Litter	43.3	52.5	42.8	9.5	**55.5**
Moss	0	0.3	8.3	0	**11.5**
Rock	15.0	19.0	4.8	18.0	**4.5**
Pavement	1.8	2.8	6.5	15.8	**2.3**
Soil	23.5	6.5	16.5	52.5	**0.5**

Site 1/5 = Chesne Bunk, Bald Mountain, 11,200 ft elevation; Boulder Field, Geum-Sedge Community
Site 2 = Chesne Bunk, Bald Mountain, 11,200 ft elevation; Boulder Field, Geum-Sedge Community
Site 3 = Bald Mountain, 11,400 ft elevation; Boulder Field, Geum-Sedge Community
Site 4 = Flat Top Mountain, 11,000 ft elevation; Boulder Field
Site 6 = Bald Mountain, 11,800 ft elevation, Boulder Field, Late Seral Sedge-Geum Community

Table 3. Surface Soil Horizon Characteristics at High Elevation Sites

	18-8A Site 1/5	18-8B Site 2	18-8C Site 3	18-8D Site 4	18-8E Site 6
Munsell Color (Hue-Value/Chroma)	7.5YR 3/2	-	7.5YR 3/2	2.5YR 3/4	**5YR 2.5/2**
Depth Range	0 to 6"	-	6 to 9"	0 to 6"	**8 to 18"**
Mean Depth	1.6"	-	-	-	**11.9"**
Standard Deviation	1.4"	-	-	-	**4.6"**
Sample Size	80	-	2	2	**20**

For site locations and elevations see Table 2

Discussion

Resource impacts have occurred, and continue to occur, as a result of driving sheep in the Uinta Mountain alpine and high subalpine zones. A loss of ground cover has resulted in the loss of topsoil and, productivity has likely been impacted as well. It should be noted that many of the soils in the alpine zone have formed from quartzitic sandstone, a parent material which yields very sandy and rocky soils that are inherantly infertile. Consequently, a large amount of any given sites productivity is heavily dependent upon the presence of a thick surface horizon of accumulated organic matter (topsoil). While species composition is not a primary concern for this area, ground cover is. If conditions improve, we believe that there would be a positive change in species composition.

Sheep trail both onto the Ashley National Forest in early summer and back in the early Fall. The trail follows a variety of landscapes, from gently sloping grounds to areas with gradients well over 30 to 50 percent. As slopes increase ground cover decreases dramatically and soil erosion becomes a dominant feature of the landscape. In some areas topsoil has been eroded entirely and soil productivity has been reduced. The growing season in the alpine zone is very short, meaning that topsoil forms at a very slow rate and species have little opportunity to recover from the high amount of grazing and trampling that occur. While Lewis (1970) noted that serious erosion problems occur when 30 percent soil is exposed, we do not want to allow this much bare soil to exist; we do not want sites to exist at their threshold. For alpine landtypes with less than 15% slope gradients, we suggest that at least 70 to 80% of ground cover be comprised of vegetation, litter, and moss. Up to 30% of the ground surface may be made up of rock, pavement, and baresoil, however, no more than 20% should be in the pavement or bare soil condition.

Standards and guidelines for assessing the effects of activities on soil disturbance have been proposed for the revision process of the WCNF forest plan. These standards are adopted from exisiting National and Regional soil quality standards, and are consistent with the Forest Service goal of maintaining or improving longterm soil site productivity and soil hydrologic function by minimizing soil erosion and maintaining ground cover.

Specifically, proposed guidelines would maintain long term soil site productivity by limiting the amount of an activity area, affected by soil erosion or with poor ground cover, to no more than 15% of the activity area acreage.

The limiting standard for ground cover to minimize soil erosion is discussed above.

The limiting standard for soil erosion that results in a loss of soil site productivity is when past or present activities have or will result in a loss of either 2 inches or 50% of the humus enriched topsoil (A horizon), or both.

18-8A 18-8D 18-8C 18-8E

Similarities were seen in the reddish colored sandy and gravelly soils observed at or near the ground surface on sites 1/5 and 4 and in the subsoil horizons at sites 3 and 6. The data collected in this study and previous soil mapping work suggests that all these sites had thick humus enriched "topsoil" horizons at one time, and that accelerated erosion has in effect converted sites 1/5 and 4 to a poorer condition.

18-8A 18-8D

Combined with the remote and isolated nature of site 6, this evidence makes it logical to assume that site 6 represents the potential condition for "topsoil" thickness for these high elevation sites in the High Uinta mountains.

18-8E

18-8A 18-8C 18-8D

From the results in Table 3, it is clear that sites 1/5,3, and 4 all exceed the limiting stndard for soil erosion, when compared with site 6. Although site 2 was not sampled for "topsoil" depths, other evidence suggests that this site exceeds the standard also.

18-8B

18-8E

When these results are considered with the data on ground cover characteristics from Table 2, and with pictorial evidence (Photos 1 and 2, Appendix A) of soil erosion features on sites 1 through 5 , a disturbing trend in long term soil site productivity on both the pasture and driveway portions of grazing allotments at high elevations in the Uinta Mountains is apparent.



19-8D

Photo 1 - Pedestaling of vegetation as a result of soil erosion at Site 4 above Hessie Lake.



See also study 19-9
19-10
19-11
A. Jamieson 5/2016

19-8D

Photo 2 - Broken sod and land subsidence leading to rill erosion on Site 4 (above Hesse Lake)

Precise calculations have not been made on how much of total allotment (activity area) acreage have the eroded or poor ground cover conditions detailed in this study, so it is not possible at this time to state if soil quality **guidelines** are being met. However, it is clear that unacceptable "topsoil" loss that exceeds soil quality **standards** is both widespread and common. Only in the most remote and little used portions of the allotments, such as site 6, are acceptable conditions present.

Recommendations

Numerous references have been made in this report to disturbing trends in ground cover condition and topsoil thickness occurring on along the sheep driveway and within pastures on the Red Castle and Hessie Lake-Henry's Fork range allotments. What conclusions can be drawn from these references of **urgent** needs to change management?

Replacing lost topsoil on injured sites is a long term proposition requiring hundreds and perhaps thousands of years. Therefore, from this standpoint, there is little urgent need to begin the rehabilitation process immediately. However, it does make sense to stop the bleeding as soon as possible. Consequently, identification and treatment of the most serious erosion concerns should begin quickly so that the healing process can begin.

Within the driveway portions of the allotments, the most serious conditions of hillslope erosion, unravelling, vegetation loss, and sediment delivery to streams occur at specific locations where sheep bands must climb out of and into adjacent basins using narrow paths on steep slope gradients. The gullied hill sides above the East Fork Blacks Fork, above, and east and west, of Broadbent Meadows in the East Fork Smiths Fork, and above Hessie Lake, are examples of soil erosion that has not stabilized, is continuing to accelerate, and is delivering sediment into live streams.

Within the pasture portions of the allotments, the most disturbing trend is the formation of headcutting gullies in the gently sloping landforms on Bald Mountain and Flat Top. It is unusual to find flat, stable landforms at such high elevations, these ones in particular represent a delicate balance between sodforming vegetation and natural erosive forces. While the mechanism is not yet clear, it is apparent that wherever sheep graze in the presence of high levels of gopher activity, sod is broken down and gullies form in the subsiding land surfaces. The active appearance of these gullies, along with the widespread amount of heavy gopher activity, indicate that these gullies are not stable and can be expected to increase in these areas.

To summarize, the most urgent need is to improve ground cover conditions so that accelerated soil erosion is halted at the specific locations noted above and where further monitoring detects sites with similar conditions.

Management options that meet this need could include:

1) Long Term Rest

Step point observations of ground cover conditions in closed allotments containing similar sites indicate reduced amounts of bare soil and increased coverage of surface rock with nitrogen fixing cryptobiotic lichens. These conditions were observed on the sheep driveway portions of an allotment within the Burnt Fork drainage that has been closed since 1982. A similar response could be expected with longterm rest of similar sites within the above allotments.

2) AUM reductions

There are no known reference areas that demonstrate an improvement of ground cover conditions to acceptable standards as a result of AUM reductions on high elevation grazing allotments within the Uinta

Mountains. There are, however, sites on which ground cover has been measured using Parker 3-Step and Range Analysis methods that could be resampled to determine possible changes in conditions. Present day bands are undoubtedly smaller than what must have historically grazed these areas, yet standards meant to maintain long term soil site productivity are still being exceeded. In fact, disturbing trends of increasing and accelerating soil erosion are shown in this study. only along the driveway. Additional monitoring since 1993 has shown overall stable to upward trend. 5/2016 P. Lamm

Other alternatives that could halt accelerated soil erosion and improve ground cover conditions to acceptable standards may exist.

References

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APPENDIX A - SITE CHARACTERISTICS AND PLANT COMMUNITY INFORMATION FOR LATE SERAL COMMUNITY AND COMMUNITIES ALONG THE SHEEP DRIVEWAY.

18-8A
Site 1/5 **Geum-Sedge Community**
Bald Mountain, Chesne Bench
Elevation: 11,200 ft



Originally, this site was sampled for ground cover only (Site 1)18-8A; we later returned to sample nested frequency as well (Site 5)18-8A. When compared to the late seral site (Table 1), there is a significant difference in species composition using the Chi Square test at the 5 percent significance level. There is a lack of *Kobresia myosuroides* on this site, as well as a decrease in *Smelowskia calycina*. There was an accompanying increase in *Festuca ovina* var. *brachyphylla*, *Potentilla* spp., *Trifolium dasyphyllum*, *Sedum stenopetalum*, and *Allium* spp. Frequency of other species of graminoid and forbs are also quite different. Only *Carex pseudoscirpoidea*, *Geum rossii*, and *Artemisia scopulorum* remain dominant species on both sites. Lewis (1970) noted that in succession away from potential that – Without trend data cannot determine if increasing or decreasing. A. Cameron 5/2016

As shown in Table 2, this site has an obvious increase in both bare soil and in exposed rock.
opinion. No trend data. 5/2016 A. Cameron

Slope gradients ranged from 8 to 12%, and slope aspect was north. "Topsoil" depth ranged from 0 to 6 inches, with a mean depth of 1.6 inches. The subsurface soil was typified by very gravelly and sadny textures with chromas of 4. The temperature at 20 inches was 40 degrees, indicating a cryic soil temperature regime.

18-8B

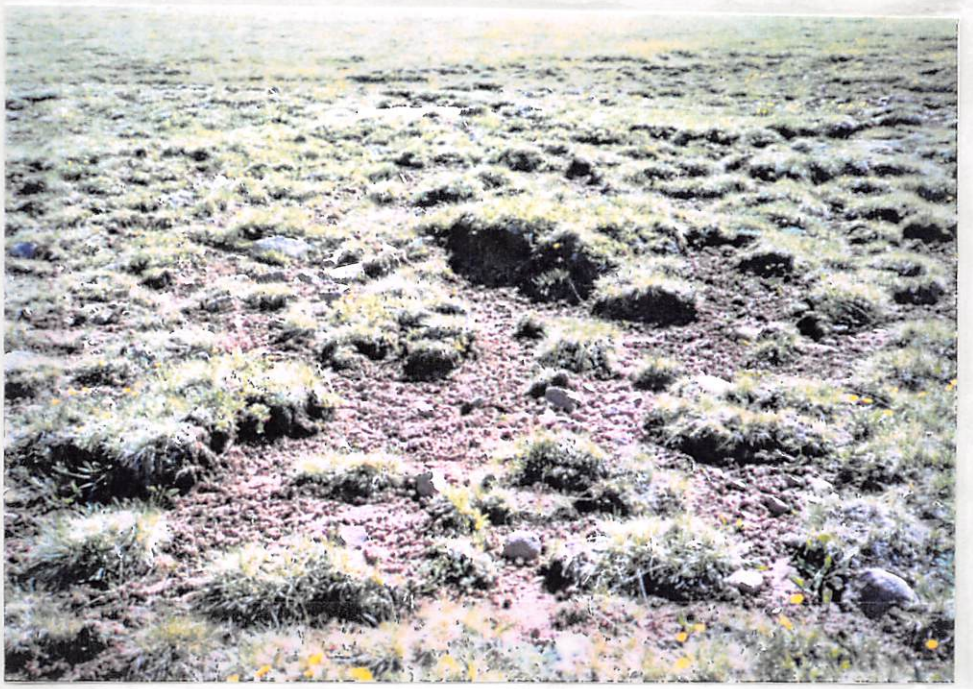
Site 2. **Geum-Sedge Community**
Bald Mountain, Chesne Bench
Elevation: 11,200 ft



Only ground cover measurements were made for this site. Notes were taken on the dominant species occurring here and the community was placed in the **Geum-Sedge Community** described by Lewis (1970). This site was chosen originally as a comparison for Site 1; this site represents somewhat better conditions, but is not intended to represent potential or even late seral conditions. When compared to the Late Seral site 18-8E (Site 6) it can be seen that Site 2 has slightly higher exposed soil, more rock, and less vegetation and moss cover (Table 2). Chi square tests shows Site 2 to be different from Site 6, but with a lower significance than the other sites.

18-8C

Site 3. **Geum-Sedge Community**
Bald Mountain,
Elevation: 11,400 ft



Only ground cover measurements were made for this site. Notes were taken on the dominant species occurring here and the community was placed in the **Geum-Sedge Community** described by Lewis (1970).

Depth and organic matter content of the surface and subsurface soil horizons were characterized as well. "Topsoil" depth ranged from 6 to 9 inches. The shallowest depths occur within headcutting gullies scattered about the grazing pasture area. These gullies are unusual features for these gently sloping landforms. They are shallow, "U" shaped structures that apear to have formed due to land surface subsidence rather than erosive downcutting by concentrated surface runoff. No surface or subsurface water sources are associated with the gullies. In all cases, intense gopher activity was noted in the areas with heaviest gully occurence.

18-8D See also study in this area. A. Cameron 5/2016

Site 4. **Geum-Sedge Community**
Flat Top Mountain,
Elevation: 11,000 ft



Only ground cover measurements were made for this site. Notes were taken on the dominant species occurring here and while the community was placed in the **Geum-Sedge Community** described by Lewis (1970), it does not seem to fit any community descriptions very closely. *Ivesia gordonii*, *Antennaria* spp., and scattered graminoids were components of the vegetation cover. *Geum rossii*, which is vegetatively similar to *Ivesia gordonii*, was not noted for this site.
Slope gradient was 10 to 12 %, aspect was east-north-east, and bare soil made up more than 50 percent of the ground cover. Lewis (1970) noted that when ground cover is less than 70 percent, the potential for surface erosion becomes very high. While it may not be possible or reasonable to manage for nearly 100 percent ground cover, values should not exceed the 30 percent threshhold mentioned by Lewis.

The depth of the humus enriched "topsoil" ranged from 0 to 6 inches. The shallowest "topsoil" depths occurred at lower sideslope positions immdiately below and adjacent to a driveway used to move sheep bands onto the Hessie Lake-Henry's Fork allotment. This driveway has indications of accelerated erosion, with many gullies formed from slope crest to bottom that range from 2 to 5 feet wide and deep. "Topsoil" depths become progressively thicker farther away from the driveway, ranging to 9 inches at a distance of about 1/4 mile.

18-8E

Site 6 **Late Seral Sedge-Geum Community**
Bald Mountain
Elevation: 11,800 ft

Area is grazed by sheep/ personal experience Rizzo 6-8-16



Nested frequency, ground cover, and the depth and organic matter content of the surface and subsurface soil horizons were measured for this site so that we might be able to make a comparison between this and one site along the sheep driveway (Site 1/5). While this is not considered to be a climax community using standards established by Lewis (1970) for the Uinta Mountains, we consider it to be late seral because of the species composition and the amount of ground cover. Because of the amount of *Geum rossii* still present on the site (frequency value of 304), this cannot be considered as the potential **Sedge-Grass Community**. Other species present in abundance, such as *Kobresia myosuroides* and *Carex pseudoscirpoidea*, however, indicate a trend towards potential given that the area has been excluded from grazing for over 15 years.

This site has less than 8 percent combination of soil, pavement, and rock exposed. Of the exposed rock, most (if not all) is probably natural for this site. Lewis (1970) noted that potential ground cover in the High Uintas should approach nearly 100 percent; this area comes the closest to that potential.

Comparing the results of nested frequency data from Site 1/5 (18-8A) and Site 6 (18-8E), the sites are different (Chi Square test). The late seral site is classified as a Sedge-Geum Community (Lewis 1970), likey succeeding to a Climax Sedge-Grass Community; Appendix A shows the alpine community succession from page 46 in Lewis' 1970 report for the Uinta Mountains. The sheep driveway site, which was considered to be one of the better conditions sites along the driveway, is classified as a Geum-Sedge Community because it lacks the *Kobresia myosuroides-Carex elynoides* component (Table 1). Exposed rock, pavement, and soil on the late seral site is less than 8 percent; in comparison, this value is approximately 40 percent (Table 2).

The slope gradient on this site was 17%, slope aspect was north. The "topsoil depth ranged from 9 to 18 inches, with a mean depth of 12 inches. The subsurface soil was typified by very gravelly and sandy textures

with chroma colors of 4. The temperature at 20 inches in depth was 36 degrees, indicating a soil temperature regime of cryic or perhaps pergelic.

An interesting feature of this site was the widespread occurence of cryptobiotic lichens. The lichens appeared to congregate in the rockfell inclusions in this landform, however very little surface rock anywhere at this site was not covered by some sort of lichens.

DS-SD06

USDA Forest Service

[N]TED FREQUENCY DA

Forest 19 District 5 Allotment 18-8E

Study Name and/or Number Sheep Driveway 06 Belt Number 1 Direction 108

Ecological Site ~~PNC~~ Late Seral Boulderfield - sedge - Geum community

Conducted by Date 8/17/93

	Species		Sample Number																			Total Frequency
	Symbol	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Grasses	Komy	K	4	4	4	3	4	3	4	3	4	4	4	4	3	4	4	3	4	4	3	3	73
	Caps		4	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	79
	Feov				3						1			2	1	3	3		3		3		19
	Lusp			2				4	1														7
	AG TR	AG TRAC.													1				3				4
Forbs	ARSC	Artemisia scopulorum	3	4	3	3	4	1				2	3			3			2	2	3		33
	CAPU	Castilleja pulchella				2	3	3			3					3		1					15
	CEBE	Cerastium beeringianum			2				3						3		1						9
	ERSI	Erigeron Simplex			2							3	1	3									9
	GERO	Geum rossii	4	4	3	4	3	4		4	3	3	3	3	1	3	4	4	4	4	3	3	64
	PHPU	Phlox pulvinata	2	3	3			3	3					2		1			1		3	2	23
	POBI	Polygonum bistortoides	3		3	3	3	1		3	2	1	3										22
	SMCA	Smelowskia calycina	1	3	3			3	3			1	2	1	3	4	2	3	4	3	4	4	44
	TRAN	Trifolium andinum densely leaf pose												3	3		2		2	2	2		14
	TRDA	Trifo. dasyphyllum lvs entire																					
	TRPA	Trifo parryi lvs toothed																					
	PAPU	Paronychia pulvinata												2			3		1	3	3		15
	SA UN	SAXIFRAGA RHOMBOIDEA					1				3	3											7
	AR	ARABIS SPP.							3	3			3	3	3	3	3	4	1	4	2	3	35
	CA UN	CAMPANULA UNIFLORA							1	2													3
	POTEN	POTENTILLA								1					1		1	2		3	1	2	11
	UNK #1	UNK #1														1							1
	UNK #2	UNK FUZZY ROSETTE																	1				1
	GE TE	GENTIANELLA TENELLA																		1	3	3	7
Shrubs																							

Ground Cover	Veg.	Lit.	Rock	Pave	Moss	Soil	Total
Dot Tally	⊠⊠:	⊠⊠⊠	:	—	⊠⊠:	—	
Totals	23	30	2	0	25	0	80

Other Species:

All shrub measurements are made on last 50 feet of each of the 5 belts.

SHRUB HEIGHT

SHRUB DENSITY

			Species				
Age Class	Seedling Sprout	S					
	Young Sapling	Y					
	Mature	M					
	Deteriorating	D					
	Dead	X					
Form Class	All Available	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
	Largely Avail.	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
Mostly Unavailable							
Unavailable							

LINE INTERCEPT

Species					
Inches of Intercept					
TOTAL					

Description of Location:

USDA Forest Service

NESTED FREQUENCY DATA

Forest 19 District 5 Allotment

Study Name and/or Number Belt Number 2 Direction 148

Ecological Site PNC

Conducted by Date 9/17/93

	Species		Sample Number																			Total Frequency
	Symbol	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Grasses	Komy	Kobresia myosuroides	4	4	3	4	4	3	4	4	4	4	3	4	4	3	4	3	3	2	3	4	71
	Caps	Carex pseudoscirpoidea	3	3	4	4	4	4	4	4	4	3	3	4	4	4	4	4	3	4	4	3	74
	Feovi	Festuca ovina (mid)												1	1	4							6
	Lusp	Luzula spicata																					
Forbs	Arsc	Artemisia scopulorum	3	3	1	4	3	3	3	2	3	3	4	3	4	4	4	4	4	1	2	2	60
	Capu	Castilleja pulchella					1	4		1	1	2			3								12
	Cebe	Cerastium beeringianum						1															
	Ersi	Erigeron simplex					2	1	1			4		3	3	3	3	3	2	4	3		32
	Gero	Geum rossii	4	4	4	3	3	3	2	1	2	3	3	4	3	3	3	4	4	3	4	4	64
	Phpu	Phlox pulvinata				2				3	3		3	3	4	2	3	1	3	1	4	1	33
	Pobi	Polygonum bistortoides	1		3	4						1		2		4		3			2		20
	Smca	Smelowskia calycina				3	1	3	2												1	1	11
	Tran	Trifolium andinum (incorrectly accepted)					3				3								2	.			8
	Trda	Trifolium dasyphyllum (lus entire)										2			2			2	3	3			12
	Trpa	Trifolium parryi (lus toothed)																2				3	5
	Papu	Paronychia pulvinata								3	3							3		2	3		
		ARABUS (MUSTARD)						1							1				3	3	3	3	
		SAXAFRAG Thromboidia											2			1		1					
		Campanula uniflora																					
		UNKN (MARS)											1					3				1	
		UNKN WHITE 5 PETAL															3						
	Sp	Sedum																	2				
Shrubs																							

Ground Cover	Veg.	Lit.	Rock	Pave	Moss	Soil	Total
Dot Tally	⊠⊠X	⊠⊠⊠⊠ ⊠	..	.		.	
Totals	26	50	2	1		1	80

Other Species:

R4-2200-22 (4/88)

All shrub measurements are made on last 50 feet of each of the 5 belts.

SHRUB HEIGHT

SHRUB DENSITY

			Species				
Age Class	Seedling Sprout	S					
	Young Sapling	Y					
	Mature	M					
	Decadent	D					
	Dead	X					
Form Class	All Available	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
	Largely Avail.	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
Mostly Unavailable							
Unavailable							

LINE INTERCEPT

Species					
Inches of Intercept					
TOTAL					

Description of Location:

USDA Forest Service

NESTED FREQUENCY DATA

Forest 19 District 5 Allotment

Study Name and/or Number Belt Number 3 Direction 216

Ecological Site DNC

Conducted by Date 8/17/93

	Species		Sample Number																			Total Frequency
	Symbol	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Grasses	Vomy		4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	3	4	4	4	
	Caps		4	4	3	4	3	3	3	4	4	3	4	4	4	4	4	3	4	4	4	4	
	Feov									4											2	1	
	Lusp																	3		2			
			3						1		2	3	2	3	3		1	3		3	1		
	Arsc			1							3							3					
	Capu																						
	Cabe																						
	Ersi			2	1			2			1				3		1		1				
	Gero		3	3	4	2	2	3	3	4	4	4	3	3	4	3	3	4	4		3	1	
	Phpu		3	1		3				1	1			1	3	3		3	1	3	1	3	
	Pobi									2	3		3	3	4			2	1	3	3	1	
	Smca			2	1			1	3	3	3	3				1		4					
	Tran			2	3	3		4				1					4			.		3	
	Trdg																						
	Trpa																						
Forbs	Arabis			3	3	2	3	3	2					1	1	3	3		2			3	
	PAPI			2			3	3			3												
	Potrn								1	3	1												
	Saxifrag																			1			
Shrubs																							

Ground Cover	Veg.	Lit.	Rock	Pave	Moss	Soil	Total
Dot Tally							
Totals	25	47	7	1			

Other Species:

All shrub measurements are made on last 50 feet of each of the 5 belts.

SHRUB HEIGHT

SHRUB DENSITY

			Species				
Age Class	Seedling Sprout	S					
	Young Sapling	Y					
	Mature	M					
	Decadent	D					
	Dead	X					
Form Class	All Available	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
	Largely Avail.	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
Mostly Unavailable							
Unavailable							

LINE INTERCEPT

Species					
Inches of Intercept					
TOTAL					

Description of Location:

USDA Forest Service

NOTED FREQUENCY DA

Forest 19 District 5 Allotment

Study Name and/or Number Belt Number 4 Direction 284

Ecological Site PNC

Conducted by Date 8/17/92

	Species		Sample Number																			Total Frequency
	Symbol	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Grasses	Xomy		4	3	4	4	3	4	4	4	4	4	4	4	4	3	4	4	4	4	4	4	
	Caps		4	4	4	3	4	4	4	4	3	4	4	4	3	4	4	4	4	3	4	4	
	Feov			1	1				3		1	1						3		1		3	
	Lusp		3	3	3				3	3	3					3				3	1		
	AGTR																						
Forbs	ARSC	ARTEMISIA SCOPULORUM	3	4	3	4	2		3		3	3	3	2	2	4	4			4	3	2	
	Capu	CASTILLEJA PULCHELLA								1			1		1	3	2		2				
	Cebe	CERASTIUM BEERINGIANUM									4			1									
	Ersi	ERIGERON SIMPLEX	1		3		3			3	3		3				1		3		3		
	Gero	GEUM ROSSII	2	3	3	4	3	3	3	2	3	3	3	3	4	3	1	3	2	3	2	4	
	Phpu	PHLOX PULVINATA	3		1		1	2		3	3		2		1	1		1	3		4	1	
	Pobi	POLYGONUM BISTORTOIDES	4	3	2	3	3		3				2		2		1	3		2	3	1	
	Smca	SMELOWSKIA CALYCINA				2						3	1	3	2	3		3		3			
	Tran	TRIFOLIUM AND.									2						2		4				
	Trda	TRI DASYPH.																					
	Trpa	TRI PARRYI									2												
	Papu	PARONYCHIA PULVINATA															1					3	
	SA UN	SAXIFRAGA RHOMBOIDEA	1						1														
	ARAB	ARABIS SPP					3	3		3	3	2	1	3		3		2	3	1			
	CA UN	CAMPANULA UNIFLORA										2		3			2	1	2			1	
	POTEN	POTENTILLA														1		3					
	UNK#1	UNK #1																					
	UNK#2	UNK #2 FUZZY ROSETTE																					
	GETE	GENTIANELLA TENELLA																					
Shrubs																							

Ground Cover	Veg.	Lit.	Rock	Pave	Moss	Soil	Total
Dot Tally	⊠::	⊠⊠⊠⊠:	::	::	⊠	/	
Totals	13	50	3	4	11	0	80

Other Species:

All shrub measurements are made on last 50 feet of each of the 5 belts.

SHRUB HEIGHT

SHRUB DENSITY

			Species					
Age Class	Seedling Sprout	S						
	Young Sapling	Y						
	Mature	M						
	Decadent	D						
	Dead	X						
Form Class	All Available	Lightly Hedged						
		Moder Hedged						
		Closely Hedged						
	Largely Avail.	Lightly Hedged						
		Moder Hedged						
		Closely Hedged						
Mostly Unavailable								
Unavailable								

LINE INTERCEPT

Species					
Inches of Intercept					
TOTAL					

Description of Location:

USDA Forest Service

NOTED FREQUENCY DA

PAGE #2

Forest 19 District 5 Allotment

Study Name and/or Number Belt Number 5 Direction 348

Ecological Site PNC

Conducted by Date 8/17/93

	Species		Sample Number																			Total Frequency
	Symbol	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Grasses	KOMY		3	4	3	4	3	3	3	4	4	4	3										
	CAPS		4	4	4	4	4	3	3	4	4	3	4										
	LUSP		1																				
	AG TR			2		3		3															
	DAIN		2	3																			
	FEOV										3		4										
	POA ALP											1											
	ARSC				1	3	3	1	1			1	3										
	CAPU		3	1		2				1		2	1										
	CEBE										2												
	ERSI			3	3				2	2													
	GERO		2	3	3	4	3	4		2	3	3	4										
	PAPU		1	2		1				3	4		1										
	POBI											3	1										
Forbs	SMCA			3	2	3	3	4	3	3	1		3										
	TRAN		3	3	3	1	3		1				3										
	TRDA																						
	TRPA																						
	PAPU		3	1	3																		
	SALN											3											
	ARAB		3	1	4	4	4	4	4	4	4	2	4										
	CALN											3											
	POTEN								3	2			1										
	UNK #1																						
	UNK #2																						
	BETE			2		2																	
Shrubs																							

Ground Cover	Veg.	Lit.	Rock	Pave	Moss	Soil	Total
Dot Tally	⊠	⊠ ▯	·	:	⊠·	·	
Totals	10	19	1	2	11	1	44

Other Species:

All shrub measurements are made on last 50 feet of each of the 5 belts.

SHRUB HEIGHT

SHRUB DENSITY

			Species				
Age Class	Seedling Sprout	S					
	Young Sapling	Y					
	Mature	M					
	Decadent	D					
	Dead	X					
Form Class	All Available	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
	Largely Avail.	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
Mostly Unavailable							
Unavailable							

LINE INTERCEPT

Species					
Inches of Intercept					
TOTAL					

Description of Location:

USDA Forest Service

NOTED FREQUENCY DA

Forest 19 District 5 Allotment

Study Name and/or Number Belt Number 5 Direction 348

Ecological Site DNC

Conducted by Date 8/17/93

	Species		Sample Number																			Total Frequency
	Symbol	Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
Grasses	Komy													4			3	4					
	Caps													4	4	4	4	4	4	4	4	4	
	Feov															3			3		3	-	
	Lusp														2								
	DA IN																						
														4	3		4	3		3	4	3	
	Arsc													3	2		1		1		4	2	
	Capu																						
	Cebe															1		1		2	1		
	Ersi													4	4	3	3	4	3	3		4	
	Gero													4		2	2	1		3	3	3	
	Phpu														3					2	2	3	
	Pobi													1	4	3	3	3	2				
	Smca													4	4	4	1	3	4	.			
	Tran																						
	Trdg																						
Forbs	Trpa													1								3	
	Saxgibsa															3	1		3		3	1	
	Arabis																	-			3		
	UNKN (Mors)														3	3							
	PA PU													3									
	Potrn													1									
	Sedum																						
Shrubs																							

Ground Cover	Veg.	Lit.	Rock	Pave	Moss	Soil	Total
Dot Tally	⁘	⁘	⁘	⁘			
Totals	6	26	3	1			36

Other Species:

All shrub measurements are made on last 50 feet of each of the 5 belts.

SHRUB HEIGHT

SHRUB DENSITY

			Species				
Age Class	Seedling Sprout	S					
	Young Sapling	Y					
	Mature	M					
	Decadent	D					
	Dead	X					
Form Class	All Available	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
	Largely Avail.	Lightly Hedged					
		Moder Hedged					
		Closely Hedged					
Mostly Unavailable							
Unavailable							

LINE INTERCEPT

Species					
Inches of Intercept					
TOTAL					

Description of Location:

ATTACHMENT 7

Site 8-03A

Shows Big Meadow which is a large area which the writeup indicates has with 29% bare soil with all bare soil attributed to gophers. The 1978 plot data shows 15% bare soil with no mention of gophers. The 2013 plot photo below belies the 1978 plot photo and 2013 plot photo shown here for comparison. No gopher activity is shown in the plot frame in 2013. Contrast with Fall Creek photo from 2009.

Photos Overview and Plot 08/26/2013

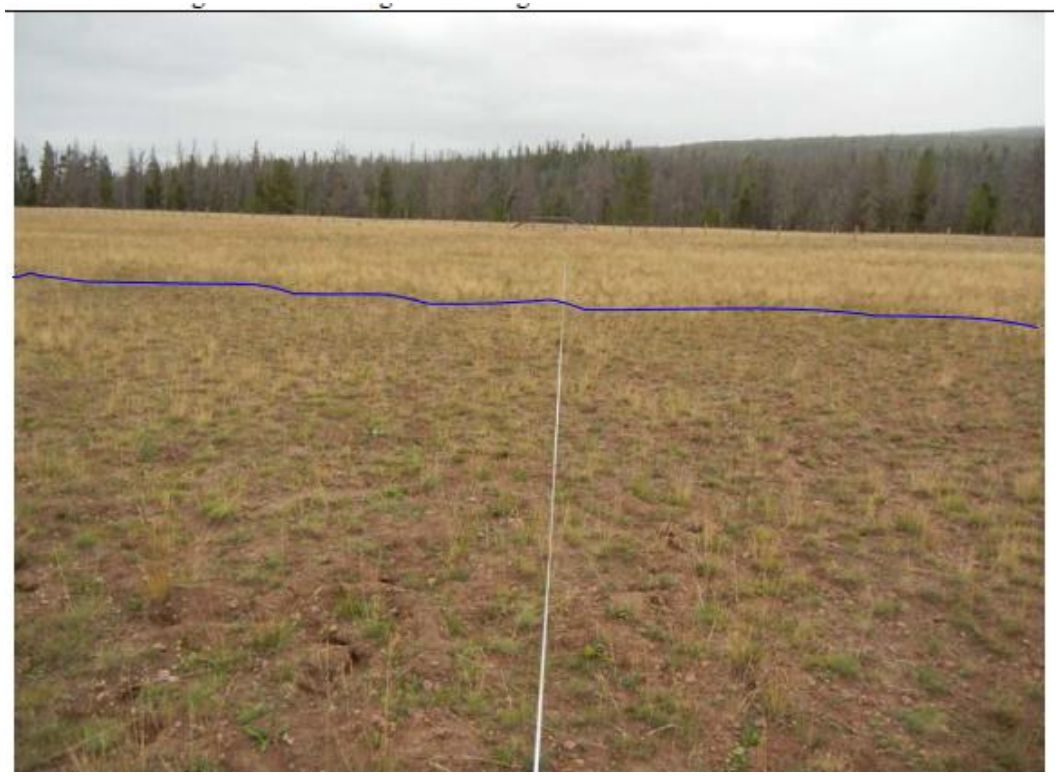




Photo 07/28/1998





Site 08-04

Belt 1 with 44% bare soil and gravel mulch from assoc with gophers. Note that “Even dandelion was estimated with only 1% canopy cover. This suggests a need for gophers to plow a high percent of the area in order to sustain themselves in winter.” Here the FS admits what we have been saying..reduced cover and productivity leads to more gopher activity. Then, “By comparison the road that runs through the driveway has 100% bare soil.”

Photos 08/26/2013

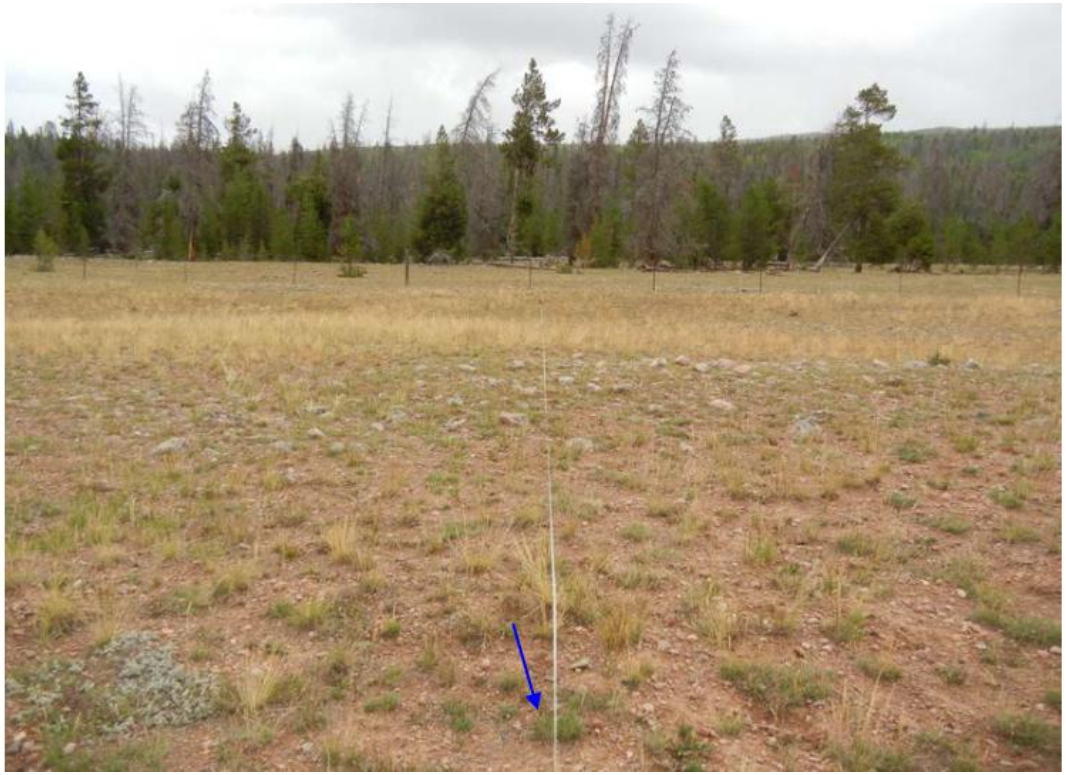




Photo 7/27/1998


1

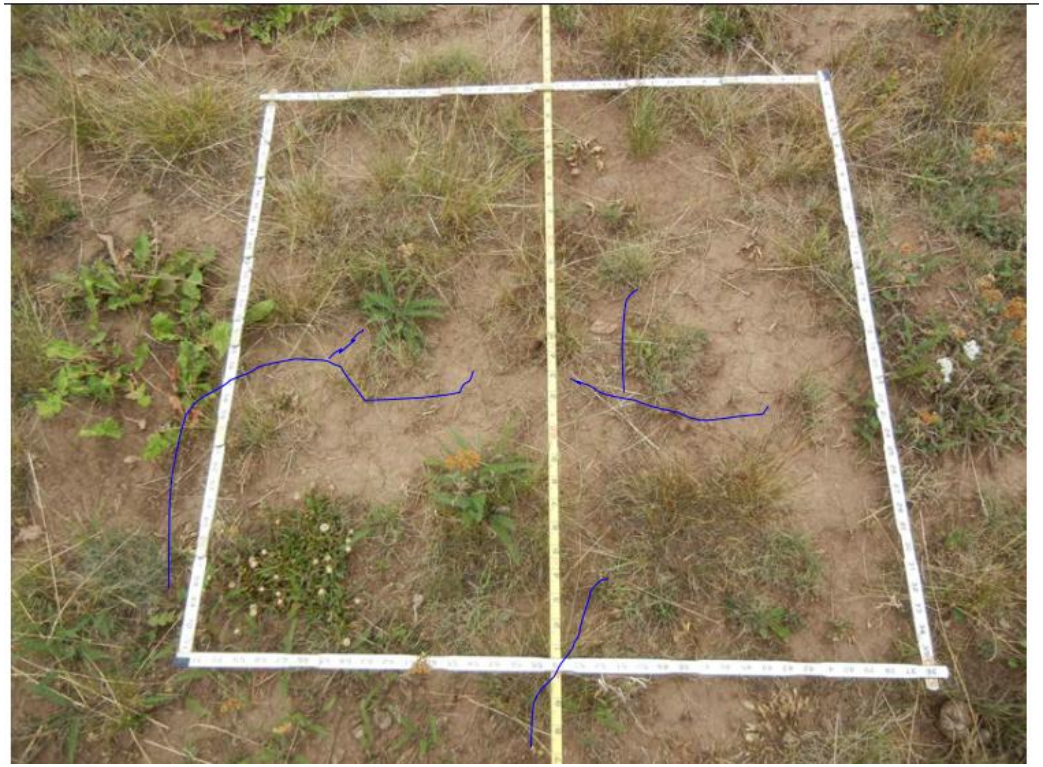

1

08-09A 82% ground cover (18% bare) site highly selected by pocket gophers. Don't see the gopher activity and if these are prior eskers, why flattened? Trampled by sheep.

Photos 8/27/2013



Photos 7/17/2003 Poor production

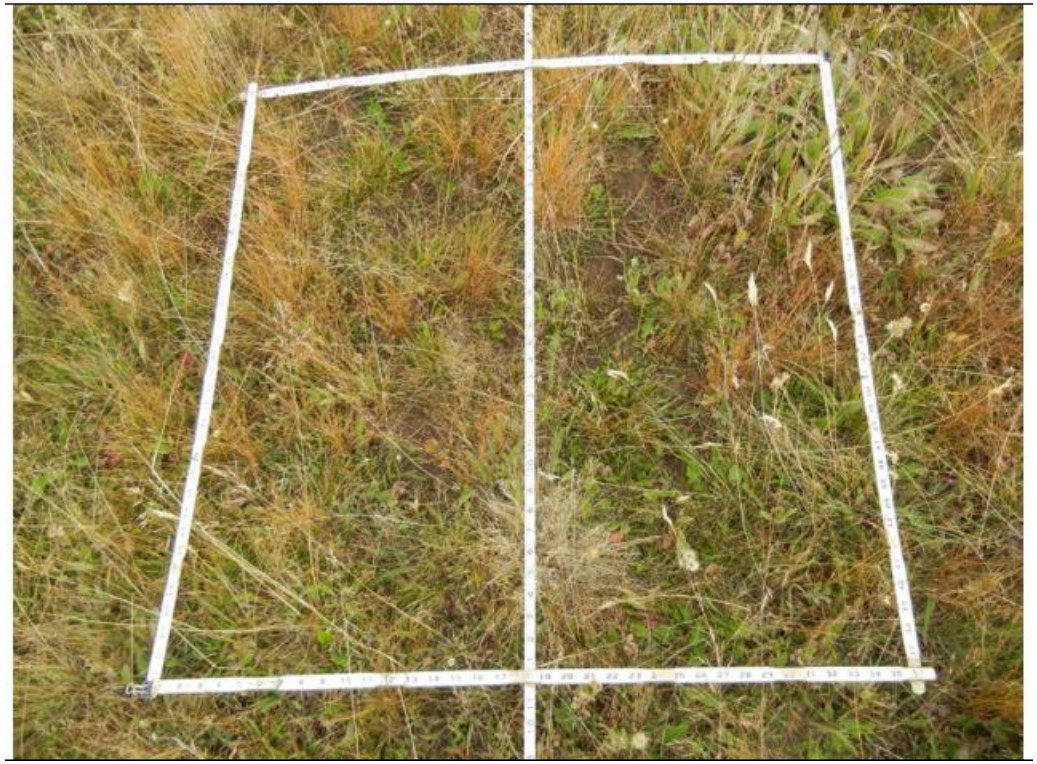





1

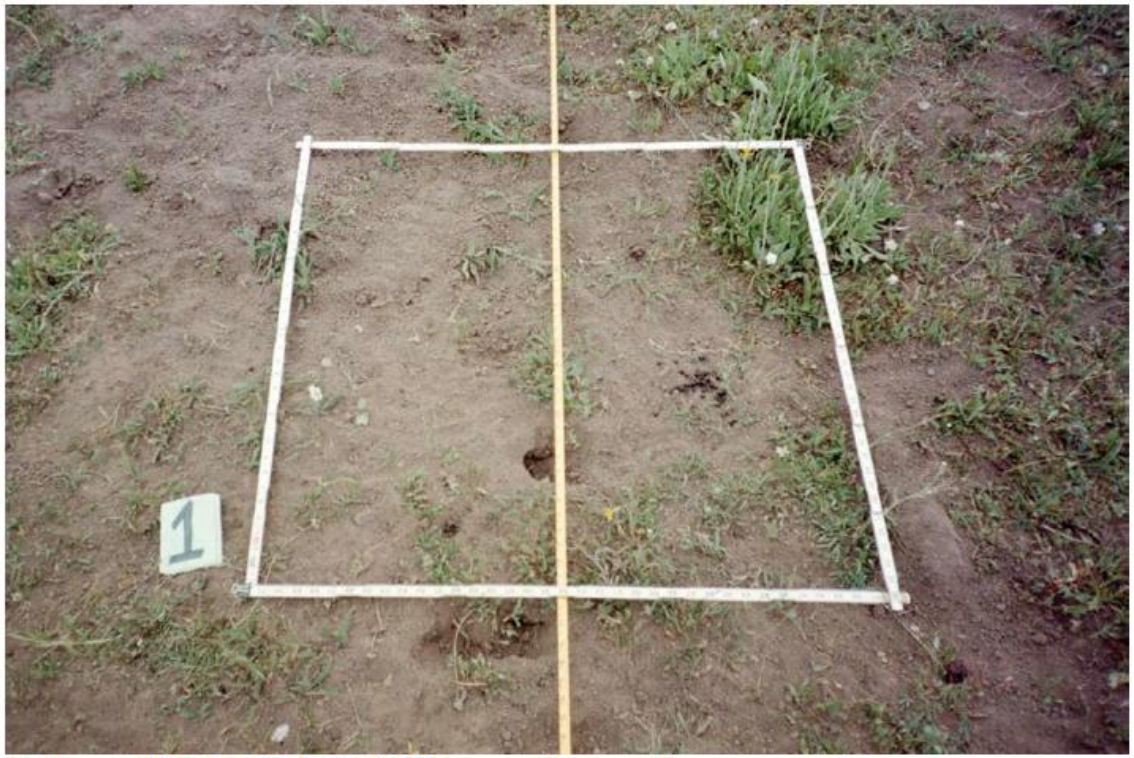
08-09B 2013 Noted decrease in gopher activity due to tree mortality and increased groundwater in meadow. 64% ground cover in 2003 and 98% in 2013. Note does not appear grazed in 2013 photo.





Photos 7/17/2003

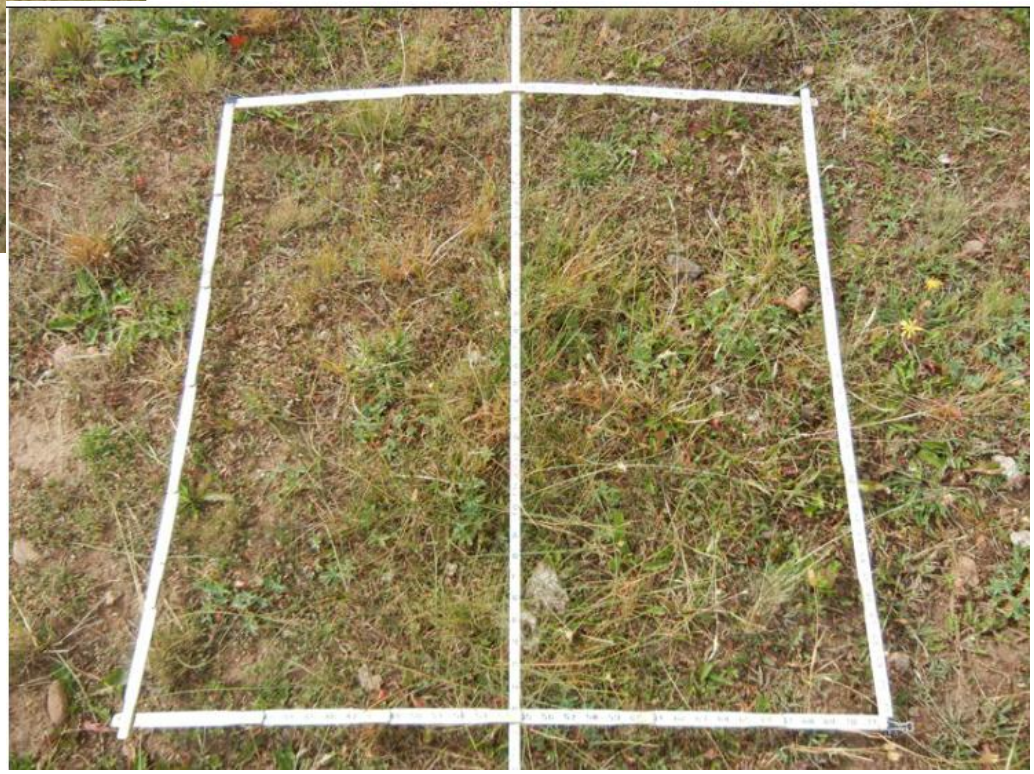




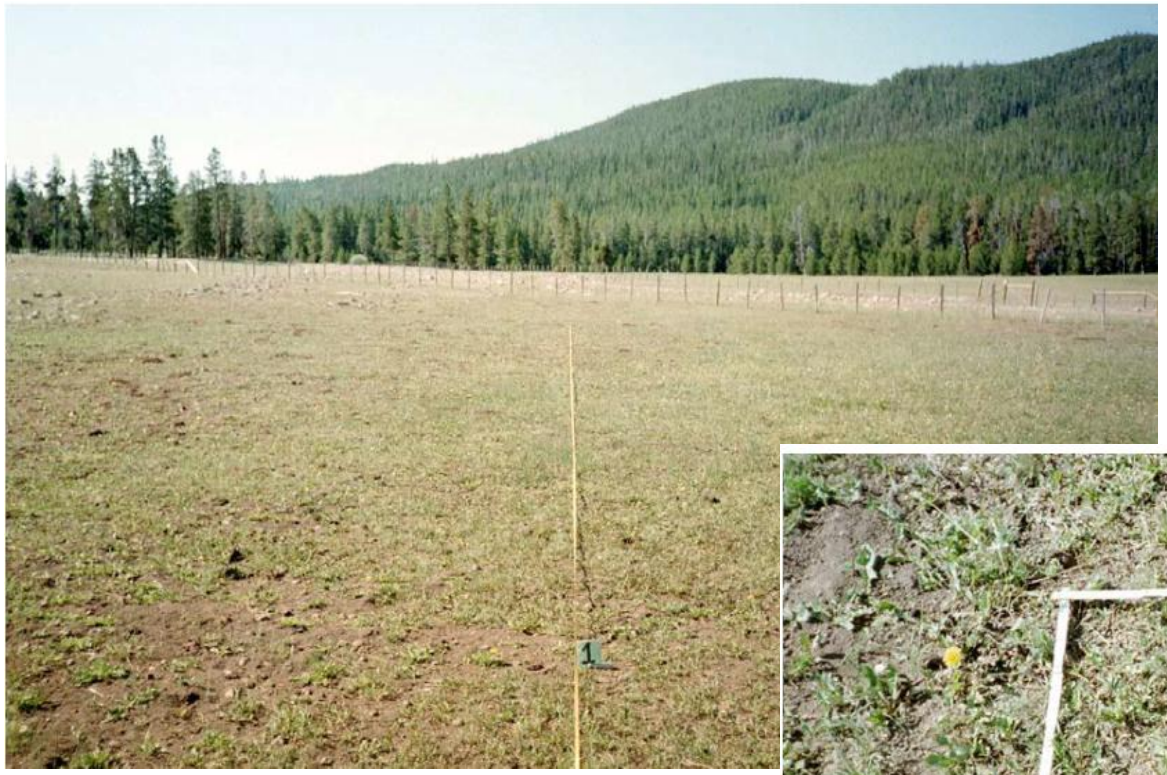
08-09C 73.4% ground cover (26.6% bare) with 14% gopher eskers. Note on page 6 that where gophers not active ground cover 100%..

Photos 08/27/2013





Photos from 7/17/2003 check precip by yrs looks dry





08-21E Gopher activity greater than in 2004 production less than in 2004

Photos 8/26/2013





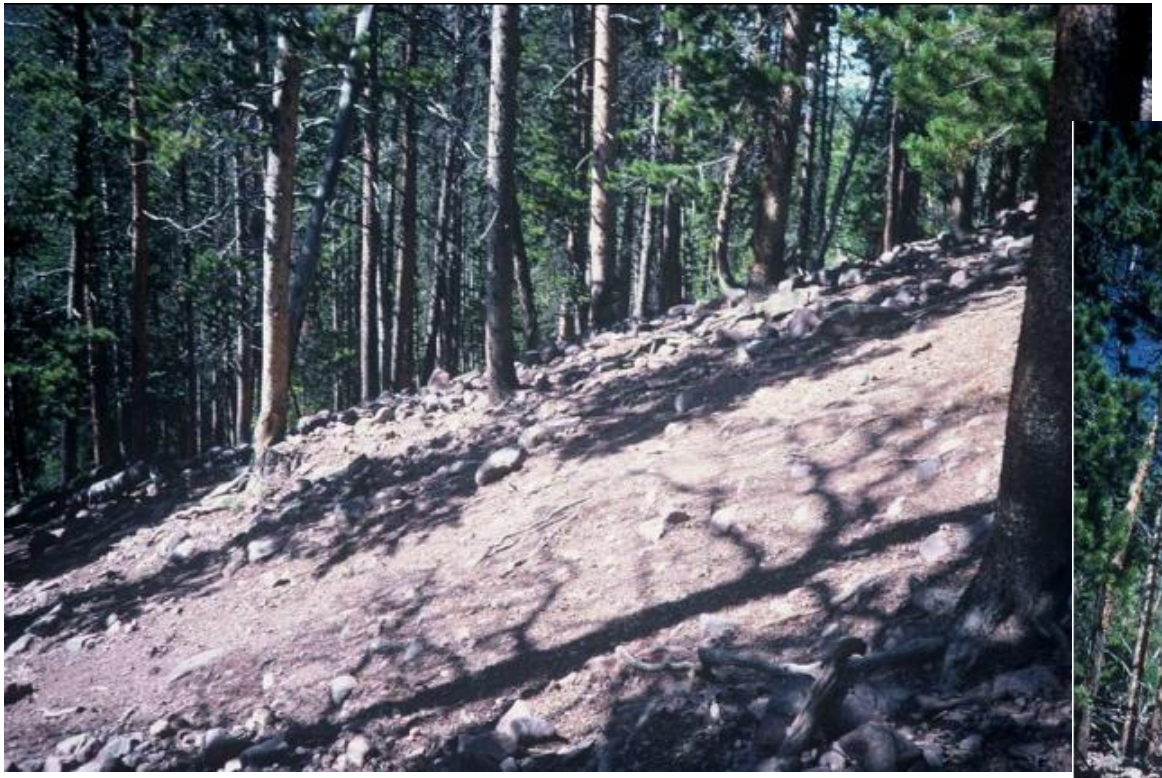
Photos 8/24/2004





08-26A Little or no ground cover where sheep trail up. Studies show less than 5% ground cover (p14) Tree roots severely exposed with trees dying and falling over.

Photos 9/10/1991





08-26A contd. Severe soil loss, rilling taking place (p19)





08-26A contd. Exhibit fresh soil movement, piled up behind logs (p22). Big gully developed (p23)





08-26A contd. Near the top of the ridge or on top leading to Mansfield Meadows (p24). Extreme rilling, beginning of gully (p26)





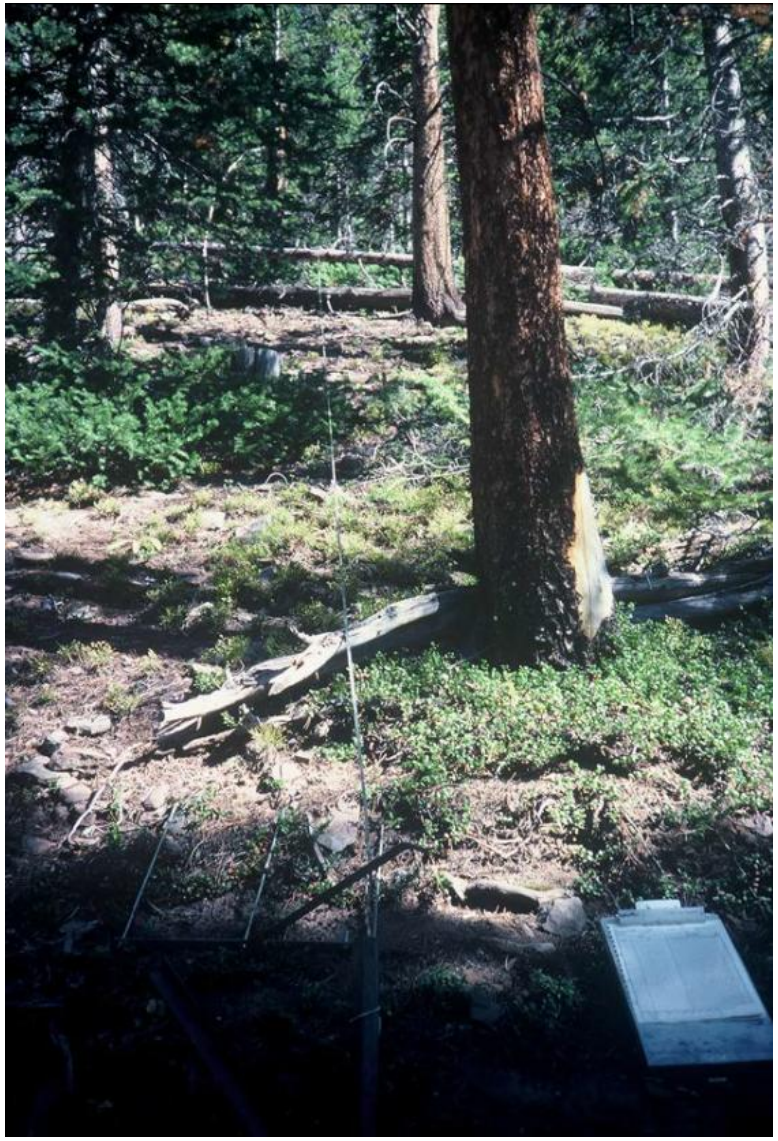
08-26A contd. Main draw completely blown out (p27). Additional photos show East Fork at bridge with no greenline, barren and

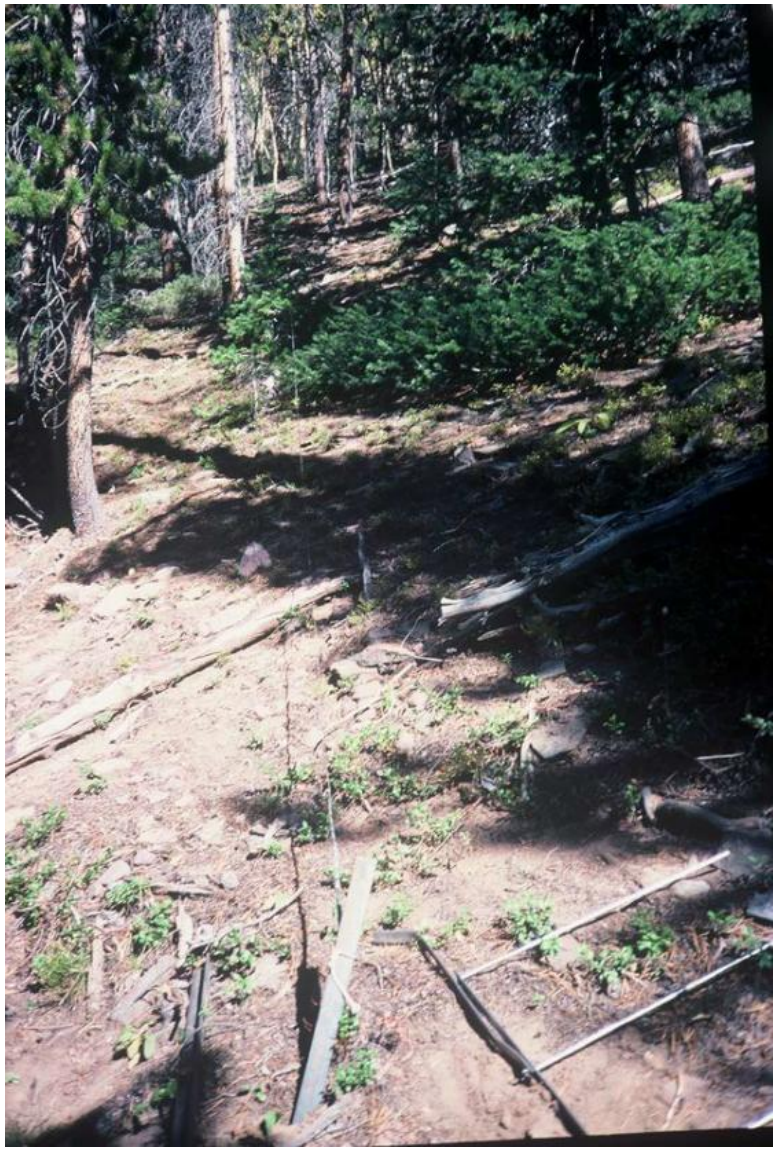




08-26B Forested as above. Site similar to 26A but more cover (p16).

Photos 9/24/1991





08-32C1 Wet meadow and stream with adjacent upland little vegetation. Stream banks are scoured even on this level reach. Note on p4 photos demonstrates grazing of sedges in the stream and on the right side of the stream. Notice little residual forage in adjacent upland. Also, sedges in the stream and stream lacks a defined channel and bank in this wetland reach.

Photo from 9/10/2014



08-32C2 Stream and adjacent meadow. Note on p1 “Downstream view of right fork of the split creek where riparian and mesic vegetation flanks the stream where it cuts through a dry debris fan. The raw bank at the left of the channel is likely aggravated by sheep use. Perhaps this is potential for the left fork if that fork remains supplied with a permanent source of water.” Goodrich calls this potential even while admitting sheep damage. Note adjacent uplands barren, trampled and grazed to dust and that is unnoticed.

Photos from 8/24/2014





08-32C2 contd. Here adjacent upland grazed to the ground.



08-32D Stream channel scoured. Lodgepole pine growing midstream indicates the channel has widened and moved. Note on p4 “The eroded appearance of the wide and shallow drainage might be attributed to sheep use in this area.” Then it is deflected by this statement, “However, the narrow channel seen in 8-32C1 with tall sedges covering the stream is less than 300 ft away.” But, this location is within a wet meadow area, not running through uplands as here. When 08-32C2 is also inspected, there is a deeper and narrower channel, likely steeper gradient and one side fortified by lodgepole pine.

Photo from 8/22/2014



08-33 Bald Mtn snowbed area. Notes p2 “The gully without vegetative cover on the sides is a function of the persistent snowbed. Vegetation is unable to establish and persist…”. Yet if one looks closer there is a cut turf area, evident downcutting of the channel, and also a slope with evident bare soil in the trees. Nothing is said about the effect of sheep grazing and trampling this sensitive and erodible area or grazing the plants which have barely begun growth.

Photos from 7/21/1999



08-47 Riparian stubble height location. Note the scoured stream banks and in lower photo the sheared area and broken turf on the right side that has no other explanation than sheep trampling while watering. Nothing is said regarding this.

Photos from 9/23/2003





18-08A Sheep Driveway Report 11/4/1993 conditions summary points intro letter. “To document conditions, ground cover was measured at three locations on the driveway, one site near but not on the driveway, and one late serai site that has not been grazed for over 15 years. Nested frequency was measured for all species on one driveway location as was depth of topsoil.”

Results were summarized in the intro letter as:

“To summarize our findings, ground cover, species composition, and depth of topsoil differ greatly on some portions of the sheep driveway when compared to the late seral site. Topsoil depth on the late serai site averaged over 11 inches while on the sheep driveway it was less than 2 inches.”

“While bare soil on the late seral site was approximately 0.5 percent, along the sheep driveway it ranged from 6.5 to 52.5 percent. When percent rock and pavement are added to those figures, there is approximately 7 percent for the late seral site and ranged from nearly 24 percent to over 86 percent along the sheep driveway.”

“Also of concern, existing national and regional standards that limit soil erosion and the loss of long term soil site productivity are being exceeded along most portions of the driveway; these same standards are being exceeded in many of the pastures as well.”

Report p1

“Alpine communities that represent near climax conditions in the Uinta Mountains (occurring on sites similar to those we sampled along the sheep driveway) are characterized by nearly 100 percent ground cover and are dominated by Kobresia myosuroides and/or Carex elynoides and are included in the Sedge-Grass Community described by Lewis (1970)”

“On unimpacted and low impact sites such as this area, cryptobiotic lichens are commonly present on the rock surface down to where the vegetation and/or litter covers the rock. Most rocks on this site had this appearance. On driveway sites, these lichens were often totally absent. Where present in minimal amounts, they often occurred at an elevated position several inches above the ground surface level.”

Report p6

“On unimpacted and low impact sites such as this area, cryptobiotic lichens are commonly present on the rock surface down to where the vegetation and/or litter covers the rock. Most rocks on this site had this appearance. On driveway sites, these lichens were often totally absent. Where present in minimal amounts, they often occurred at an elevated position several inches above the ground surface level

“Similarities/were seen in the reddish colored sandy ancLgravelly'soils observed at or near the ground surface on sites 1/5 and 4 and in the subsoil horizons at sites 3 and 6: The data collected in this study and previous soil mapping work suggests that all these sites had thick humus enriched "topsoil" horizons at one time, and that accelerated erosion has in effect converted sites 1/5 and 4 to a poorer condition.”

Pedestaling, broken sod and land subsidence leading to rill erosion above Hessie Lake





18-53 Red Knob Area East Fork Blacks Fork. This is the path of the East Fork Driveway. Their focus is on the more mesic vegetated strip with the erosion path shown. What is missing is a mention of the steep, erodible bordering slopes that are also subject to the sheep grazing and trampling.

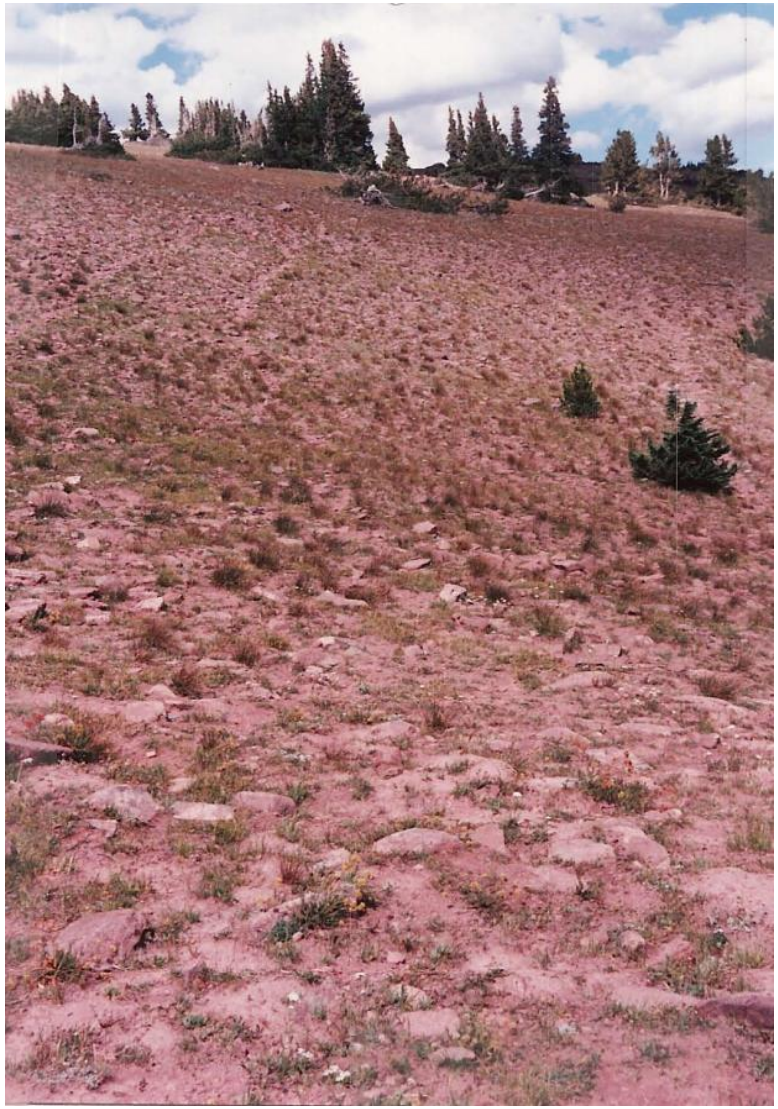
Photos from 8/8/2007





19-09 Hillside to Flat Top p21 in 1972 noted as a “fragile soil area” Hessie Lake – Henry’s Lake slope leading to Flat Top Mtn. The photos below illustrate trailing damage and bare soil, but also that these slopes have potential for full vegetation cover. Slopes such as these are grazed and trailed throughout the project and adjacent allotments. This year was noted as a drought year. Notes from 9/5/2014 blame snow, gophers for bare soil and low productivity but not erodibility and sheep grazing/trampling. No ground cover data but it is substantial bare soil.

Photos from 9/6/1995





19-10 Sheep driveway entering Hessie Lake drainage. Note deep gully with broken turf at the edge, but some vegetation growing on the banks even in this erodible soil. Previous file indicated 95 as a drought year. The photo from 20002 taken in early July, the 1995 photo in September, so if any change it is difficult to determine. However, this shows that the impairment remains and is a degradation to wilderness and ecosystem function

Photos upper from 9/6/95 lower from 7/9/2002





19-11 Sheep driveway entering Hessie Lake drainage on slope off Flat Top Mtn. Note erosion and barren soils extending up into the forested area. This can be observed throughout these allotments. Note on p3 that gully appears to be deepening and narrowing..this indicates it is still downcutting and a permanent impairment as long as sheep continue to use the area.

Photos from 9/6/1995 upper and 9/5/2014 lower.





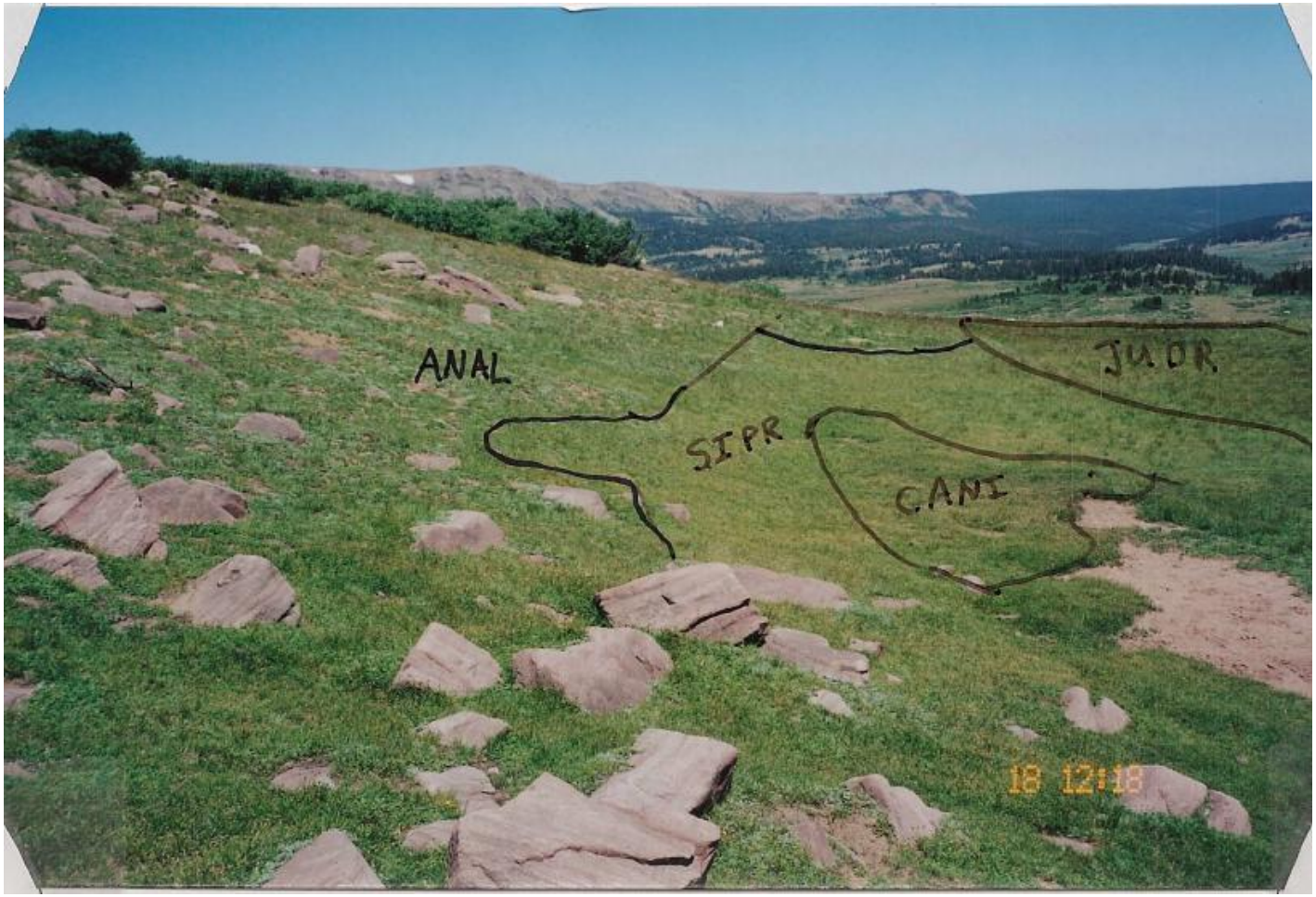
19-32A Upper Henry's Fork basin. Note on p9 "This shows the open soil, gravel and rock covered surface around a snowbed with the snowbed still persisting as of 18 August (area 2). The barren soil is a function of a growing season too short to support more than a few plants. The center of the snowbed can be expected to be devoid of plants inmost years. The area marked as "1" is a snowbed where the snow has all melted as of 19 Aug. 1999. Snowmelt can be expected to vary with different years. However, persistence of snow here is sufficient to greatly suppress establishment and growth of plants." Yet, sheep are driven and grazed throughout this basin with no apparent cosideration of the short grazing season and effect of defoliation and trampling on plant growth and cover.

Photo from 8/18/1999


4
5
6
18 9:46

19-32D Snowbed area. Note on p5 “These photos form a horizontal panorama that displays a sequence of alpine snowbed communities. To the left and on the leeward slope is a communities dominated by the gray-colored alpine pussytoes (ANAL) where plant cover is suppressed by late persisting snow cover. Just below this is a sibbaldia community (SIPR) where plant cover is more fully developed. Below this and on the flat or concave bottom is a black alpine sedge community (CANI) where the ground is irrigated through much of the growing season by snow-melt from the slope above. Also on the flat or concave bottom, a Drummond rush conununity is developed in an area where a deep snowbed commonly develops, but where the snowbed is less persistent.” This does not appear to be on a driveway, but is in the upper basin slopes.

Photo from 8/19/1999


ANAL
JUDR
SIPR
CANI

20-5 Upper Henry's Fork near the Gunsight Pass Trail. Notes dominance by Spruce wormwood which according to the Fire Information system is a weed https://www.fs.usda.gov/database/feis/plants/forb/artabs/all.html Unpalatable for horses and cattle but used by sheep.Note that vegetation is growing on the talus and fan but less so in the direct debris flow areas off the outcrops. Gopher activity is implicated in the 16.5% bare soil, but the productivity of the site shows that activity is less than in areas with more disturbance.

Photo from 8/19/1999


a
b

20-05B Upper Henry's Fork near Gunsight Pass trail. Note from p1 "This vertical panorama shows the bedrock and talus slope with abundant Precambrian Shale and the outwash alluvium of fans on bench-lands below the steep slope. The outwash material contains shale materials. This material is highly selected by pocket gophers." Yet the photo shows vegetation cover, indicating that there is potential for near complete ground cover in the absence of sheep generating soil compaction that stimulates visible gopher activity.

Photos from 8/14/2003





2025 Annual Operating Intructions notes

- East Fork Blacks Fork – JRB 1350 Ewe/Lambs. Shows trailing plan to trail into Ottoson, Hessie, Oweep, Painter, Yellowstone, Tungsten. Shows Sims Sheep Co in Driveway plan. No rested pasture. All used or trailed.
- Hessie Lake -Henry's Fork – JRB 1400 Ewe/Lambs. When the sheep trail into Red Castle drainage, do not use the main horse trail route. Instead trail the sheep in a contour fashion to the east of the main trail where they can gently drop down into the drainage. Also, when the sheep top out at the head of Hessie Lake drainage, do not trail sheep down into the drainage, but trail them to the south across Flat Top. No rested pastures. All used or trailed.
- Middle Fork Blacks Fork – Sims 1200 Ewe/Lambs. The meadow with the riparian protection fence in it (Unit 5): sheep may trail through, but no deliberate grazing is to occur. The gully system in Unit 3 should be avoided and trailed around. The old burn area in Unit 1 should also be avoided and trailed around. These areas are crossed hatched in red on your map. No rested pastures. All used or trailed.
- Ottoson Sheep – JRB 1500 dry (Name blacked out) but EFBF driveway plan shows JRB using the driveway to Ottoson and other Ashley allotments. Notes entering from WCNF trailing to Ottoson. Sheep will not enter the WCNF until they can be trailed over the passes (plural). What passes? Note bedgrounds with excessive bare soil excessively high and new locations used. All pastures grazed.
- Oweep Sheep – JRB 1400 Ewe/Lambs (name blacked out) but same as above JRB AOI drive to Oweep. Same note about trailing over passes. Maps show arrows for crossing. Notes loss of 56 Ewes/Lambs to predators in 2024. Our experience is they are left behind. All pastures grazed, but not mapped. Grazing fee $0.27 per AUM.

- Red Castle – Sims 1300 Ewe/Lambs. Please see the attached driveway trailing plan that gives details where the sheep are to overnight and noon along the Black Fork Driveway. The Red Castle herd is scheduled to overnight in North Big Meadow Pasture, and then to noon/overnight in Pasture 15. The sheep are to be contour trailed, east of the main horse trail, into and out of the Red Castle drainage. The same driveway pasture are to be used when trailing home in the fall. The sheep are not to trail through the North Big Meadow Pasture. The only exception to this is if there is no water in the South Big Meadow Pasture. Notes attached driveway plan, but no plan provided. No pastures rested. Map shows Unit 1 and 2 are across Bald Mtn, so trailing up and down steep slopes. Have to trail back across Units 3, 2, and 1 across Bald Mtn unless they are actually going out across Flat Top Mtn. Seems impossible to leave Unit 4 on 9/8 and trail out thru 3,2, and 1 by 9/9.
- Tungsten - Painter – JRB 1500 dry (Name blacked out) but JRB shown as the permittee trailing into here. Painter Basin allotment trailed on and off through Gunsight Pass. Tungsten allotment trail on and off via Smith's Fork Pass. Tungsten rested in 2025. Painter all pastures grazed.
- Gilbert Creek – JRB 1400 Ewe/Lambs. This is the 2022 AOI as Gilbert Rested in 2025. Strange that Tungsten has an AOI and is also rested. Note: Please see the attached driveway trailing plan that gives details where the sheep are to overnight and noon along the Black Fork Driveway. The Gilbert Peak herd is scheduled to overnight in pasture No. 13 and then to overnight in Pasture 22 at dark. When the sheep trail into Red Castle drainage, do not use the main horse trail route. Instead trail the sheep in a contour fashion to the east of the main trail where they can gently drop down into the drainage. Also, when the sheep top out at the head of Hessie Lake drainage, do not trail sheep down into the drainage, but trail them to the south across Flat Top. So they go out the EFBF, not the Henry's Fork? Shows Gilbert Peak being grazed.

Analysis of Driveway Locations

In our FOIAs (2014, 2015, 2025) we requested location data for all monitoring locations. In our prior comments we noted that many lacked coordinates. In our 2025 FOIA we requested monitoring points for the sheep driveway. Using the Driveway data from our 2014 FOIA Studies we received, there were 78 unique locations for which files were provided. From our 2025 FOIA request, we found only 36 sites listed with location data. These were along the Driveway in the Red Castle, Hessie Lake and Henry's Fork, and Gilbert Peak allotments. There were no points in the East Fork Blacks Fork Driveway corresponding to the points in the 2024 FOIA response.

Using ArcGIS pro we calculated the minimum, maximum and mean distance of these 36 Driveway points from the Driveway. The minimum distance was 5 feet, maximum distance was 1,868 feet, and the mean distance was 530 feet.

ATTACHMENT 8

FILED
United States Court of Appeals
Tenth Circuit

May 9, 2025

Christopher M. Wolpert
Clerk of Court

PUBLISH

UNITED STATES COURT OF APPEALS

FOR THE TENTH CIRCUIT

WILDEARTH GUARDIANS; WESTERN WATERSHEDS PROJECT,

Petitioners - Appellants,

v.

U.S. FOREST SERVICE, a federal agency of the United States Department of Agriculture,

Respondent - Appellee,

and

WAYNE BROWN; JERRY BROWN; THE COLORADO WOOL GROWERS ASSOCIATION; J. PAUL BROWN; COLORADO FARM BUREAU FEDERATION,

Intervenor Respondents - Appellees.

No. 24-1187

Appeal from the United States District Court
for the District of Colorado
(D.C. No. 1:19-CV-00208-DDD)

Lauren M. Rule, Advocates for the West, Portland, Oregon (Elizabeth H. Potter, Advocates for the West, Bend, Oregon, with her on the briefs), for Petitioners-Appellants.

Amy E. Collier, Environment and Natural Resources Division, U.S. Department of Justice, Washington, D.C. (Todd Kim, Assistant Attorney General, with her on the brief), for Respondent-Appellee.

Aaron Bruner, Western Resources Legal Center, Portland, Oregon, filed a brief for Intervenor Respondents-Appellees Wayne Brown, Jerry Brown, and Colorado Wool Growers Association.

Grady J. Block and Ivan L. London, Mountain States Legal Foundation, Lakewood, Colorado, filed a brief for Intervenor Respondents-Appellees J. Paul Brown and Colorado Farm Bureau Federation.

Before **HOLMES**, Chief Judge, **MURPHY**, and **McHUGH**, Circuit Judges.

McHUGH, Circuit Judge.

Petitioners-Appellants WildEarth Guardians and Western Watersheds Project ("Guardians") appeal the district court's denial of their Administrative Procedure Act ("APA") petition against Respondent-Appellee the United States Forest Service (the "USFS").[1] Guardians challenges an underlying USFS decision to open new domestic sheep grazing allotments (the "Wishbone Allotments") in the Rio Grande National Forest in Colorado. Guardians argues the allotments pose a high risk to local populations of Rocky Mountain bighorn sheep, which are vulnerable to catching diseases from domestic sheep.

The USFS's decision to open the Wishbone Allotments in the Rio Grande National Forest in 2017 followed two previous decisions in 2013 and 2015 to vacate larger grazing allotments which the USFS determined posed an unacceptable risk to bighorn sheep populations. Those decisions relied on the "risk of contact model"

[1] Intervenor Respondents-Appellees Wayne Brown, Jerry Brown, and the Colorado Wool Growers Association, along with J. Paul Brown and the Colorado Farm Bureau Federation, intervened in the case and have filed briefs on appeal.

("RCM"), a modeling tool the USFS uses to determine the likelihood a grazing allotment will risk domestic sheep coming into contact with bighorn sheep. In the previous decisions, the model's determination of a high risk of contact was determinative. But the USFS's 2017 decision authorizing the Wishbone Allotments eschewed the results of the risk of contact model—which again predicted a high risk of contact—and asserted that outside factors such as the geography of the allotments, the length of the bighorn sheep grazing season, and the use of best management practices by herders would mitigate the risk.

Guardians objected to the 2017 decision before the USFS, arguing that the use of local factors to change the result of the model was unsupported by data or scientific consensus. The USFS approved the Wishbone Allotments over Guardians' objection. Guardians next sued in federal district court under the APA and the National Environmental Protection Act ("NEPA"), contending the USFS's creation of the allotment was arbitrary and capricious. The district court determined the USFS did not violate NEPA. This appeal followed.

For the reasons explained below, we agree with Guardians that the USFS acted arbitrarily and capriciously in approving the Wishbone Allotments. We accordingly reverse the district court's decision denying Guardians' APA petition and remand to the district court to determine the appropriate remedy.

I. BACKGROUND

A. Rocky Mountain Bighorn Sheep

Rocky Mountain bighorn sheep "are an iconic species of the American West." App. Vol. III at 231. Colorado Parks and Wildlife ("CPW"), which manages wildlife in Colorado, has observed bighorn sheep "are among the most sought after watchable wildlife species in the state" and are also popular among hunters. App. Vol. II at 44. "[O]nce ubiquitous throughout the West," bighorn sheep populations declined dramatically in the nineteenth century due to overhunting, overgrazing, and disease. App. Vol. III at 231. Bighorn sheep remain vulnerable to this day, and so the species has been designated by the USFS as a "Sensitive Species on National Forest System lands" because "there is concern for the long-term viability and/or conservation status of bighorn sheep." App. Vol. III at 161. The sensitive-species designation requires all agency actions which have the potential to affect bighorn sheep conservation to be analyzed for their potential impact to bighorn sheep.

While bighorn sheep have faced habitat degradation due to "fire suppression, highways, livestock grazing, and human disturbance," the primary risk to their viability is respiratory disease, which they can catch from domestic sheep. *Id.* Indeed, the USFS has recognized disease is "the greatest concern for bighorn sheep population persistence [in] the Rio Grande National Forest." *Id.* One pathogen in particular, *Mycoplasma ovipneumoniae*, can be passed from domestic sheep to bighorn sheep if the species come into contact. While the pathogen does not affect domestic sheep, it can cause fatal respiratory diseases in bighorn sheep herds. Moreover, female bighorn sheep who survive

the disease pass it on to their lambs, leading to early mortality which, in turn, affects herd sizes. Poor lamb survival can persist for years or even decades after an initial die-off, preventing population recovery. Scientific research shows that contact between bighorn sheep and domestic sheep can lead to a "pronounced" die-off of bighorn sheep. App. Vol. III at 161.

The movements and behavior of bighorn and domestic sheep contribute to disease spread. The primary habitat area a bighorn herd occupies is called a "core herd home range," or CHHR. App. Vol. V at 140–41. In summer, herds move to additional areas beyond the CHHR known as "summer source habitat." App. Vol. III at 181–82. Individual sheep, typically rams, also move beyond the CHHR to disperse, find a mate, or explore, in movements known as "forays." App. Vol. V at 140–41. Bighorn sheep forays can be as far as twenty-one miles. At the same time, domestic sheep can stray from their bands and seek out bighorn sheep herds. The remote terrain of the national forests can make it difficult to find and remove stray domestic sheep. The combination of bighorn sheep forays and domestic sheep straying increases the risk of contact between the two species. This risk is heightened by the animals' natural attraction to each other.

B. Past Management Actions in the Rio Grande National Forest

The USFS manages forests for multiple uses, seeking to balance the use of the national forests for activities including recreation, hunting, conservation, and livestock grazing. The susceptibility of bighorn sheep to pneumonia has created tension between the USFS's two goals of managing domestic sheep grazing allotments while also protecting bighorn sheep populations. In the Rio Grande National Forest specifically,

there are several bighorn sheep herds that the USFS seeks to conserve alongside managing domestic sheep grazing allotments.

In proposing grazing allotments for domestic sheep on national forest land, the USFS uses the RCM to estimate the frequency of disease transmission to bighorn sheep caused by a domestic sheep grazing allotment. The USFS has recognized the RCM as the "best available science regarding potential disease transmission and resultant long-term viability of bighorn sheep herds." App. Vol. III at 40. The model uses telemetry data—which shows actual locations of bighorn sheep wearing radio telemetry collars—and habitat data to establish a bighorn sheep herd's CHHR. Based on the proximity of the CHHR and the probability of a foray, the model determines the number of times per year a bighorn sheep would contact the proposed domestic sheep grazing allotment, which in turn is used to predict how frequently disease transmission would occur. Those results are used to rate disease risk as low, moderate, or high. Under the model, any rate of disease transmission that occurs once every thirty-two years or less is considered a high risk to bighorn sheep herds. A rate of transmission between thirty-two and forty years is considered moderate.

The USFS has explained that in the Rio Grande National Forest, "four bighorn sheep herds are still experiencing lingering effects . . . of past disease events dating back to the mid 1990's." *Id.* at 184. "A conservative recovery rate based off of past localized disease events involving [Rio Grande National Forest] bighorn herds can potentially be considered to be a minimum of 32 years between disease events and possible eventual recovery," based on scientific literature documenting lengthy periods of poor lamb

survival following a massive die-off. *Id.* "[D]isease outbreaks of every 32 years or less would result in a bighorn sheep population that is being constantly exposed to ongoing disease transmission and resultant outbreaks," which would cause the Rio Grande National Forest bighorn populations to "likely be extirpated as a result of consistent exposure to disease." *Id.*

In 2013, the USFS began to assess the risk to bighorn sheep herds in the Rio Grande National Forest pursuant to a 2011 letter of direction from the USFS's Washington office urging regional USFS offices to conduct bighorn sheep viability analyses to meet the objective of maintaining or enhancing bighorn sheep populations. The USFS began by analyzing the Fisher-Ivy/Goose Lake ("FIG") grazing allotments in the Rio Grande National Forest. Using the RCM, each of seven pastures in the FIG Allotments were rated as high risk to the bighorn sheep. Four of the pastures directly overlapped CHHR, contributing to a high risk of contact. The remaining three pastures were located between 1, 1.5, and 2.5 miles away from the CHHR, within reach of bighorn ram forays: "[e]ven without direct overlap, high contact rates exist from the short foray distance to each pasture." *Id.* at 49.

Based on these results, the USFS converted the FIG Allotments to vacant status rather than allowing further grazing. The USFS explained that based on the RCM analysis, the FIG Allotments posed an unacceptably high risk of disease transmission to bighorn sheep. It also explained that "project design criteria"—management strategies

domestic sheep herders can use to keep their sheep separate from bighorn sheep[2]—would be insufficient standing alone to prevent contact. *Id.* at 62. The USFS administrator stated, "[u]ntil the science is available that shows that project design criteria[3] are effective in maintaining separation, I cannot use them as the sole basis for authorizing grazing, especially in the case of FIG, where direct overlap between the two species is occurring." *Id.*

C. The Proposed Wishbone Allotments

After vacating the FIG Allotments, in 2015, the USFS turned to an analysis of the Snow Mesa Allotments, a set of three allotments near four bighorn sheep herds in the Rio Grande National Forest. The USFS created a risk assessment using the RCM. The Snow Mesa Allotments were rated a high risk to the bighorn sheep herds, and the USFS promulgated a proposed action which would eliminate domestic grazing entirely on the Snow Mesa Allotments. Specifically, eliminating the Snow Mesa Allotments was "Alternative 1" of the proposed action. *Id.* at 165. The USFS also considered Alternative 2, which would have kept the allotments but added project design criteria to reduce

[2] Project design criteria include strategies such as requiring a minimum number of herders, requiring herders to notify the USFS before they move their herds, and requiring herders to "haze" any bighorn sheep they encounter to prevent contact. App. Vol. III at 221.

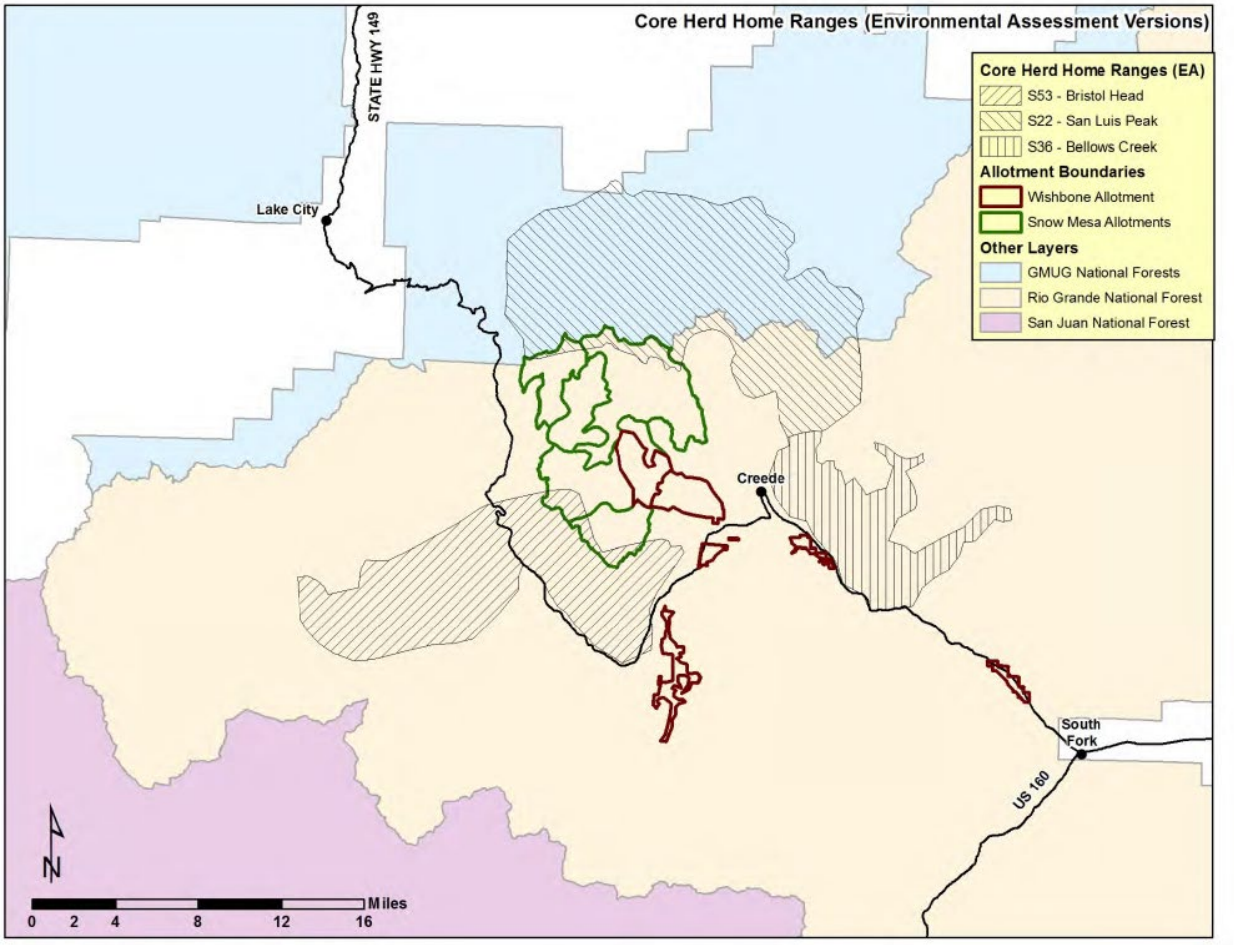
[3] In the administrative record and the parties' briefing, project design criteria are also referred to as "project design features" ("PDFs") or "best management practices" ("BMPs").

contact, and Alternative 3, which would have modified the allotment boundaries to exclude high-risk areas and implemented project design criteria.

In endorsing Alternative 1, the USFS relied on the RCM finding a high risk of contact. The USFS explained that only the "no grazing" alternative could result in "no risk of contact or potential for subsequent disease transmission," and would likewise result in the "highest" "probability of long-term herd persistence." *Id.* at 207. In rejecting Alternatives 2 and 3, which both relied on project design criteria to mitigate contact risk, the USFS explained "there is uncertainty about the effectiveness of project design criteria and it is unknown how much, if any, reduction might be expected in the contact probabilities produced by the Risk of Contact Tool from full and complete implementation of all project design criteria." *Id.* at 181. The USFS further observed that "the effectiveness of many of the project design criteria have not been fully tested or verified," and instructing permittees to follow the criteria for the most recent grazing season had led to "mixed results." *Id.* at 210. The USFS concluded that project design criteria "should not be relied upon solely to achieve effective separation, particularly in areas of close association." *Id.*

Rather than move forward with Alternative 1 in a final decision, in 2017, the USFS initiated a new proposed action which suggested another alternative for the Snow Mesa Allotments. What became known as Alternative 5 proposed creating a new set of

allotments, called the Wishbone Allotments, to replace the Snow Mesa allotments.[4] The Wishbone Allotments are located southeast of the Snow Mesa Allotments but partially overlap with them, as pictured below.



App. Vol. VI at 192. The largest pastures, which overlap with the old Snow Mesa Allotments, are called the Crystal and Shallow pastures. The smaller pastures, which are discontinuous, are partially bordered by Highway 149 and the Rio Grande River.

[4] Domestic sheep grazing permittees proposed Alternative 4, which suggested modified boundaries for the Snow Mesa allotments. It was considered but not studied in depth by the USFS.

In the draft Environmental Assessment ("EA") evaluating the proposed Wishbone Allotments, the USFS used the RCM to evaluate the risk of contact created by the Wishbone Allotments. The RCM concluded the risk of contact between bighorn sheep herds and the Wishbone Allotments was high. In reviewing the results of the RCM, the USFS recognized that "Bighorn can be expected to contact the allotment every year," and additionally, there would be "a disease transmission with potential subsequent bighorn mortality every 4 years," easily triggering the thirty-two year "high risk" threshold. App. Vol. IV at 116.

But this time, instead of rejecting the Wishbone Allotments for being rated high risk by the RCM, the USFS considered additional factors outside the model and downgraded the risk to moderate. Those additional factors—what Guardians refers to as "local factors"—included "project design criteria likely being more effective, topographical features serving as barriers, increased distance from CHHR, a lesser amount of overlap between suitable domestic sheep grazing acres and bighorn sheep habitat and less amount of bighorn sheep source summer habitat within the boundary of the Wishbone Allotment[s]." *Id.* at 118. The USFS had not previously used these local factors to change the result of the RCM.

Notably, the draft EA reiterated the analysis which proposed vacating the old Snow Mesa Allotments. In that analysis, the USFS again emphasized that project design criteria could not make Alternatives 2 or 3—which would keep the original Snow Mesa Allotments—viable. Specifically, the USFS stated that:

> For the past two grazing seasons (2014 and 2015), the allotment boundary configuration and design criteria for Alternative 3 have been tested through direction in the Snow Mesa Sheep Allotments . . . . Project design criteria regarding stray management and herd management have not been implemented successfully. This supports the [Western Association of Fish and Wildlife Agencies] guidelines that management practice should not be relied on solely to achieve separation.

Id. at 84. The USFS similarly stated it could not lower the risk rating for Alternative 3 based on project design criteria "because of uncertainty about the effectiveness." *Id.* at 91.

But in analyzing Alternative 5, the USFS acknowledged that the herds' CHHRs were physically close to the new allotments and would result in disease intervals of far less than thirty-two years: the San Luis Peak herd "every 4.6 years," Bristol Head herd "every 1.3 years," and Bellows Creek herd "every year." *Id.* at 115–16. This caused the RCM to predict a high risk of contact. But the USFS lowered the risk rating, explaining:

> [D]ue to an overall low amount of suitable source bighorn habitat in most pastures, existing topographical barriers such as the Rio Grande River, Highway 149 and several subdivisions, the likelihood of success of project design features is higher than that of any other grazing alternative. These factors will decrease the level of risk as displayed in the model to Moderate.

Id. at 116. The USFS lowered the rating despite acknowledging "a higher degree of uncertainty" as to these factors, including as to the effectiveness of natural barriers and project design criteria. *Id.* at 116–17; *see also id.* at 122 (stating effectiveness of project design criteria "have not been fully tested or verified").

The proposed action also included a brief discussion of preliminary data collected by CPW during a trial run of the Wishbone Allotments conducted in 2016 and 2017 but did not discuss whether that data undercut the USFS's assumptions about bighorn habitat

usage or movement. Specifically, the USFS had authorized existing Snow Mesa permittees Wayne and Jerry Brown (intervenors in this action) to use the Wishbone Allotments on a trial basis. As Guardians stated in an objection letter before the agency, the permittees violated the conditions both years. In 2017, fifty-six stray domestic sheep remained on or near the Wishbone pastures after grazing season ended. The draft EA, however, did not address how the permittees' noncompliance with grazing permits during the trial run supported the conclusion that project design criteria would be effective on the new allotments.

D. Objections and Final Action on Wishbone Allotments

The USFS received objections to the proposed action from several groups, including the conservation groups that initiated this action. Those objections faulted the USFS's conclusion that the Wishbone Allotments posed only a moderate risk based on factors outside the model, specifically arguing that using these factors to downgrade the risk rating was not supported by any scientific literature or data. For example, WildEarth Guardians argued the difference in how Alternative 3 and Alternative 5 were rated was "arbitrary" and lacked any "scientific basis," noting the disease interval figures for Alternative 5 were comparable to Alternative 3. *Id.* at 159–60. Western Watersheds noted that no scientific literature was cited for the proposition that roads, rivers, and homes could create natural barriers to bighorn sheep movement, and further emphasized that there was no evidence cited for the conclusion that project design criteria could be effective in achieving separation between bighorn and domestic sheep.

In responding to comments, the USFS addressed both objections from environmental groups concerned about Alternative 5 and from sheep herders concerned about the Snow Mesa Allotments being vacated. In defending the retirement of the Snow Mesa Allotments based on the RCM, the USFS asserted the RCM was the "[b]est [a]vailable [s]cience," *id.* at 205–06, and that "[i]nconsistency" in adhering to project design criteria made keeping the existing allotments a risk, *id.* at 239. But in defending the Wishbone Allotments, the USFS asserted that the RCM was "just one tool used to compare options and alternatives. . . . in conjunction with other specific and relevant information, based upon on-the-ground specifics." *Id.* at 279. The USFS emphasized that no single factor outweighed the model, but that the factors in tandem "improve[d] the ability to manage for separation." *Id.* at 281. The USFS did not identify any scientific studies or data to support supplanting the model's results with specific factors. *Id.* at 278–83.

Over these objections, in November 2017, the USFS released the Final EA for the Wishbone Allotments, reiterating its conclusion that local factors merited downgrading the RCM's risk from high to moderate. The USFS stated that authorizing the Wishbone Allotments "[m]ay [a]dversely [i]mpact [i]ndividual [bighorn sheep], but is not likely to result in a loss of viability in the planning area, nor cause a trend towards federal listing or a loss of species viability range wide." App. Vol. V at 75. The USFS explained that the proportion of bighorn sheep the RCM's default values used in analyzing foray possibilities are "expected to be greater than those associated with the Wishbone Allotment[s]" but also stated "[a]t this time however, there is not enough information

from local GPS collars to inform how this might be adjusted for this analysis." *Id.* The USFS also stated it could adjust the result because the grazing season was shorter than the six-month period the model used, and bighorn sheep are known to go to higher elevations in the summer. *Id.* And the USFS expected project design features would have the "best opportunity" to be successful in the Wishbone Allotments because moving the allotments from the "current high alpine landscape" in the Snow Mesa Allotments to more accessible and visible areas will "result in improved monitoring and management." *Id.* at 75–76. The USFS did not address the overlap between the Snow Mesa and Wishbone Allotments in so concluding. *See id.* Notably, the USFS found overlap between domestic sheep grazing areas and summer bighorn habitat between 37% and 92% contributed to a "high" risk rating for Alternatives 2 and 3, but a 34% overlap was acceptable for the Wishbone Allotments. *Id.* at 211–15.

In an objection to the Final EA, Guardians wrote that the EA did not analyze the potential impacts of lost and straying sheep—a known occurrence on the Snow Mesa Allotments—or the possibility of increased disease risk if bighorn sheep populations grew. Guardians further argued that the USFS had still not provided any scientific basis for the selection of risk thresholds or evidence supporting the assertion that topographical barriers could prevent contact. In particular, Guardians emphasized that the local factors did not provide "appropriate justification for the assertion that risks to herd viability are moderate when interspecies contact occurs at intervals of 8 years or less." App. Vol. VI at 6. Guardians also asserted that reliance on project design features, permittee compliance, and agency enforcement was arbitrary and capricious, because the evidence to date

showed permittees were not complying with their permits and the agency was not initiating enforcement actions.

Unmoved, the USFS released a Final Decision Notice and Finding of No Significant Impact ("DN/FONSI") in March 2018. The final decision vacated the Snow Mesa Allotments and authorized use of the Wishbone Allotments. The DN/FONSI reiterated the factors discussed in the Final EA to justify reducing the RCM's risk from high to moderate. It also concluded that the Wishbone Allotments would not have any significant environmental effects and that the USFS did not have to complete a more comprehensive Environmental Impact Statement ("EIS") before taking action.

In relying on local factors to adjust the RCM rating, the USFS explained:

> The [RCM] integrates the best available information regarding bighorn sheep populations and habitats to estimate risk of physical contact . . . . While the [RCM] provides a systematic way to assess relative risk of contact with an allotment among alternatives analyzed, its results should be interpreted in light of local conditions and knowledge. The specific factors considered in interpreting the [RCM] results for the analysis area were grazing season duration, amount of overlap between capable domestic sheep range and bighorn sheep summer source habitat outside the [CHHR], and the known bighorn sheep seasonal migration patterns, based on local radio-telemetry data. These factors tie directly to the ability to provide spatial and temporal separation between the species.

App. Vol. VI at 147.

The USFS next explained why it relied on the factors to downgrade the model. First, the USFS explained that because grazing permits would be approved for up to two and a half months—shorter than the six-month grazing season assumed by the model—and local observations indicated forays typically occurred in October, there would be "increase[d] temporal separation between the species" under this alternative. *Id.* at 147–

48. The USFS also concluded that because there was only a 34% overlap between bighorn sheep summer habitat and the domestic sheep range—a figure lower than some of the existing Snow Mesa Allotments but close to the 37% found too high in Alternative 3—there was sufficient spatial separation. The USFS acknowledged that "[t]his same process supposed a high risk of contact on the Snow Mesa . . . allotments" and that project design features "alone" would be "inadequate when there is spatial overlap between bighorn sheep and domestic sheep or the two species occur in close proximity," but that "in the proposed action's case, where allotment configuration provides a foundation of spatial and temporal separation, design features can help enhance that separation." *Id.* at 148.

In responding to specific objections to the Final EA, the USFS explained that while it identified several factors to justify lowering the risk of contact rating from high to moderate, no factor on its own was sufficient—rather, the factors in combination with the fragmented nature of the allotments were sufficient. The USFS identified no scientific support for altering the model results in this way; instead, it stated "several points of logic [] march[ed] the risk of contact from high towards moderate." *Id.* at 154. This included "[l]ocal knowledge" of migration patterns which show most bighorn sheep go to higher elevations in the summer, away from the allotments. *Id.* at 155. The USFS did acknowledge areas of likely overlap between the allotments and bighorn sheep habitat, but asserted project design features would mitigate this risk—again citing no data in support. Instead, the USFS reasoned that unlike the Snow Mesa Allotments, where "continuous, connected summer source habitat, extensive overlap between habitat and

capable range, [and] bighorn seasonal migration" combined with "limited opportunities for monitoring" suggested project design features would not be effective, project design features could be effective on the Wishbone Allotments. *Id.* at 156. The USFS did not address the overlapping areas between the old Snow Mesa Allotments and the new Wishbone Allotments in reaching this conclusion. *See id.* at 156, 192.

The USFS acknowledged that relying on design features "may seem counterintuitive because 49 strays and 7 carcasses were documented in 2017" during the trial run, but asserted "the contrast between the 2016 and 2017 seasons made it clear that the success in implementing these [project design features] relie[d] heavily on having sufficient manpower." *Id.* at 156. Therefore, the final decision required at least two herders to ensure "success" of the project design features. *Id.*

Finally, as to risk to the broader bighorn meta-populations, the USFS recounted the long history of domestic sheep grazing in the vicinity and stated that because current herd populations were still viable and the Wishbone Allotments were safer than the old Snow Mesa Allotments, approving the Wishbone Allotments would not be a high risk to the bighorn populations. The USFS did not address its earlier analysis recounting the large die-offs in the 1990s and the risk of "extirpation" that would be caused by a disease interval of thirty-two-years or less. *See* App. Vol. III at 184.

E. Supplemental Information Report (SIR)

Guardians learned that the USFS had not obtained any additional data from CPW concerning the Wishbone Allotments based on the trial runs before releasing its final decision notice. Guardians requested the data and obtained it from CPW in October 2018.

The USFS then requested the data and used it to re-run the RCM for the Wishbone Allotments. The USFS documented the new analysis in a Supplemental Information Report ("SIR") and concluded the new data did not require a full supplementary NEPA analysis.

The additional data showed that the CHHR of three of the herds was larger than previously thought, and that the CHHR of one of the herds was directly adjacent to two of the Wishbone pastures—Crystal and Shallow. The RCM again produced a high risk rating based on the new data. In the SIR, the USFS maintained that local factors lowered that risk to moderate. The USFS also acknowledged a report that two bighorn sheep were observed on the South River pasture of the Wishbone Allotments in July 2019—that is, during grazing season—but asserted this new information was an isolated incident and did not undercut any of its assumptions about the risk level. Specifically, the USFS explained that the July 2019 sighting was "insufficient in number of sheep and repeated occurrence to justify modifying CHHR to overlap the pasture boundary or to determine that the local factors that lowered the modeled risk of contact to moderate no longer apply." App. Vol. VI at 189. "The effectiveness of citizen monitoring and the ability to modify the rotation in response supports the agency's ability to manage for separation within the moderate risk environment." *Id.*

II. PROCEDURAL HISTORY

Guardians filed suit in the United States District Court for the District of Colorado in January 2019. The Wishbone permittees, Wayne Brown and Jerry Brown, moved to intervene in the case, along with the Colorado Woolgrowers Association, J. Paul Brown

(another permittee), and the Colorado Farm Bureau Federation. The district court allowed each party to intervene.

The USFS lodged the administrative record in June 2019. Summary judgment briefing was completed in July 2020. Nearly four years later, in March 2024, the district court issued an order and judgment denying Guardians' motion for summary judgment. This timely appeal followed.

III. STANDARD OF REVIEW

The APA provides the cause of action for a NEPA challenge. *See, e.g.*, *New Mexico Cattle Growers Ass'n v. U.S. Fish & Wildlife Serv.*, 248 F.3d 1277, 1281 (10th Cir. 2001). Our review of a district court's decision in an APA case is de novo. *Id.*

"As with other challenges arising under the APA, we review an agency's NEPA compliance to see whether it is 'arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law.'" *N.M. ex rel. Richardson v. Bureau of Land Mgmt.*, 565 F.3d 683, 704 (10th Cir. 2009) (quoting 5 U.S.C. § 706(2)(a)). "An agency's decision is arbitrary and capricious if the agency (1) entirely failed to consider an important aspect of the problem, (2) offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise, (3) failed to base its decision on consideration of the relevant factors, or (4) made a clear error of judgment." *Id.* (internal quotation marks omitted). In conducting this review, "[w]e also accord agency action a presumption of validity," recognizing "[t]he challenger bears the burden of persuasion to show that the

agency action is arbitrary and capricious." *Diné Citizens Against Ruining Our Env't v. Haaland*, 59 F.4th 1016, 1029 (10th Cir. 2023) (internal quotation marks omitted).

IV. ANALYSIS

Guardians raises three arguments on appeal, each arising under the APA and NEPA: *first*, the USFS violated NEPA in creating the Wishbone Allotments; *second*, the USFS violated NEPA by electing not to prepare an EIS before creating the Wishbone Allotments; and *third*, the USFS violated NEPA when it issued the SIR which determined a supplemental NEPA analysis was unnecessary. For the reasons explained below, we agree with Guardians that the USFS violated NEPA in creating the Wishbone Allotments by failing to take a hard look at the environmental impacts of the allotments. In failing to take a hard look, the USFS acted arbitrarily and capriciously and therefore violated NEPA. Because we agree with Guardians that the USFS violated NEPA in creating the Wishbone Allotments, we do not reach the EIS or SIR issues.

First, we discuss the applicable law. Next, we turn to Guardians' arguments as to why the creation of the Wishbone Allotments violated NEPA, and address each in turn. Finally, we conclude that remanding to the district court is the appropriate remedy.

A. Applicable Law

"NEPA specifically requires agencies to 'take a hard look at environmental consequences' of a proposed action." *Diné Citizens*, 59 F.4th at 1034 (quoting *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989)). "In doing so, the agencies must consider the direct, indirect, and cumulative environmental impacts of the proposed action." *Id.* "Direct effects are those 'caused by the action and occur[ring] at the same

time and place,' and indirect effects are 'caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable.'" *Id.* (quoting 40 C.F.R. § 1508.8). "A cumulative impact 'is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency . . . or person undertakes such actions.'" *Id.* (alteration in original) (quoting 40 C.F.R. § 1508.7).

"[W]hen assessing whether agencies took a 'hard look,' we are applying the APA standard of review, determining whether agencies' actions were 'arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law.'" *Id.* at 1034 n.7 (quoting 5 U.S.C. § 706(2)(A)).[5] As such, "an agency must examine[] the relevant data and articulate[] a rational connection between the facts found and the decision made." *Richardson*, 565 F.3d at 713 (alterations in original) (internal quotation marks omitted). "[W]e consider only the agency's reasoning at the time of decisionmaking, excluding post-hoc rationalization concocted by counsel in briefs or argument." *Id.* at 704. But we apply a "presumption of validity [] to the agency action and the burden of proof rests with the appellants who challenge such an action." *Id.* (quotation marks omitted). And we do not "decide the propriety of competing methodologies," but rather "determine simply whether the challenged method had a rational basis and took into consideration the relevant factors." *Silverton Snowmobile Club v. U.S. Forest Serv.*, 433 F.3d 772, 782

[5] As we have explained, "[w]e do not view 'hard look' as a requirement going beyond the APA standard of review or applying a heightened standard." *Diné Citizens Against Ruining Our Env't v. Haaland*, 59 F.4th 1016, 1034 n.7 (10th Cir. 2023) (internal quotation marks omitted).

(10th Cir. 2006) (quotation marks omitted). In short, "[t]he role of a federal court under NEPA is to review the . . . EA" and "ensure that the agency has adequately considered and disclosed the environmental impact of its actions." *Diné Citizens Against Ruining Our Env't v. Bernhardt*, 923 F.3d 831, 851 (10th Cir. 2019) (quotation marks omitted). "In conducting this review, we apply a rule of reason standard to determine whether claimed NEPA violations are merely flyspecks, or are significant enough to defeat the goals of informed decision making and informed public comment." *Id.* at 852 (internal quotation marks omitted).

Finally, "[i]t is axiomatic" that when an agency "materially" changes or "contradict[s]" previous findings, "the agency [] need[s] to provide a 'reasoned explanation' for the difference." *Cure Land, LLC v. U.S. Dep't of Agric.*, 833 F.3d 1223, 1232 (10th Cir. 2016) (quoting *F.C.C. v. Fox Television Stations, Inc.*, 556 U.S. 502, 515 (2009)). "[U]nexplained conflicting findings about the environmental impacts of a proposed agency action violate the APA." *Id.* (alteration in original) (quoting *Organized Vill. of Kake v. U.S. Dep't of Agric.*, 795 F.3d 956, 969 (9th Cir. 2015) (en banc)).

B. Application

Guardians argues the USFS failed to take a hard look at the environmental impacts to bighorn sheep herds in creating the Wishbone Allotments by (1) arbitrarily downgrading the RCM result from high to moderate using "local factors," (2) overstating the effectiveness of project design criteria, (3) failing to consider the cumulative environmental impacts to neighboring bighorn herds, and (4) by not using the best available science. Appellants' Br. at 22–41. The USFS, for its part, contends its decision

creating the Wishbone Allotments was "well-reasoned and thoroughly explained," and that Guardians' "disagreement with the agency's substantive and scientific conclusions" does not establish a NEPA violation. Appellee's Br. at 24–25. We address each argument in turn.

1. Local Factors

Guardians contends that by changing the RCM-calculated risk level from high to moderate based on "local factors" to justify creating the Wishbone Allotments, the USFS acted arbitrarily and capriciously. Appellants' Br. at 23. The "local factors" could not justify creating the Wishbone Allotments, Guardians argues, because they do not apply to the largest pastures in the allotments—Crystal and Shallow. *Id.* at 23–24.[6] Specifically,

[6] The USFS argues that Guardians waived this argument by failing to argue a pasture-by-pasture analysis was needed in its comments or objections to the EA before the agency or before the district court. Appellee's Br. at 25–27. In its reply brief, Guardians clarifies its argument is not that a pasture-by-pasture RCM analysis was needed. Rather, the argument was the same one made before the agency: that the moderate risk rating was unreasonable because it was "based on assumptions that were unsupported by scientific and factual evidence," which is illustrated on appeal by focusing on the Crystal and Shallow pastures. Reply Br. at 7.

We agree with Guardians that this argument was not forfeited because it was adequately raised below. In addressing a waiver argument, we consider whether Guardians made its objections before the agency with "reasonable specificity." 42 U.S.C. § 7607(d)(7)(B). We recognize that Guardians may refine its argument on appeal as long as its objection alerted the USFS to the general substance. *See WildEarth Guardians v. EPA*, 770 F.3d 919, 943 (10th Cir. 2014). After the USFS promulgated the EA proposing the creation of the Wishbone Allotments, Guardians objected by arguing, *inter alia*, that the Wishbone Allotments created a high risk of contact due to overlap between the Wishbone Allotments and summer bighorn range. *See* App. Vol. IV at 158–61; *see also* App. Vol. IV at 67–68, Vol. VI at 192 (maps illustrating that areas of overlap are on Crystal and Shallow pastures). Additionally, Guardians argued that the creation of the Wishbone Allotments relied on changing the RCM's output from high to moderate based on "local factors" that—as a general

Guardians argues the local factors are not rationally related to Crystal and Shallow pastures, which are contiguous, make up almost two-thirds of the grazing area in the Wishbone Allotments, are located on steep terrain far from any road, and overlap with the Snow Mesa Allotments which were vacated based on high risk of contact. *Id.* at 25–26. The USFS responds it reasonably analyzed the Wishbone Allotments as a whole (not just the Crystal and Shallow pastures) in its analysis of the local factors, and that its analysis substantiated the conclusion that local factors reduced the risk of contact between bighorn sheep and domestic sheep. Appellee's Br. at 25, 28.

We agree with Guardians that the USFS's reliance on local factors to change the model result was arbitrary and capricious. First, we explain why the use of local factors was, in itself, arbitrary and capricious. Next, we explain that even taking the "local factors" on their own terms, they do not provide support for the USFS's conclusion that the risk to bighorn sheep is moderate.

a. Choice of methodology

Before addressing the more granular arguments about the USFS's analysis of the local factors, we conclude that the USFS's stated rationale for relying on the local factors to supplant the result of the RCM was arbitrary and capricious.

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matter—were not supported by science or data indicating they could successfully separate the bighorn sheep from domestic herds. Therefore, Guardians made, with "reasonable specificity," 42 U.S.C. § 7607(d)(1)(B), the same argument before the agency as it refines on appeal. This was sufficient to alert the USFS to the substance of Guardians' argument on appeal, and thus the argument is not waived. *See WildEarth Guardians*, 770 F.3d at 943.

As a general rationale for using local factors, the USFS points to the risk of contact analysis for the Wishbone Allotments, which states the RCM should be used "in conjunction with other specific and relevant information if known, based upon on-the-ground specifics." *Id.* at 27 (citing App. Vol. V at 164). The USFS argues it therefore reasonably found local factors reduced the risk of contact on the Wishbone Allotments. *Id.* at 27–28. But the Final EA and the data it relied on does not provide that these additional factors should be used to *supplant* or modify the result of the RCM. Rather, the EA states only that the factors should be compared to the model result and then used to ultimately formulate a recommendation. *See* App Vol. V at 164.

Critically, the USFS does not identify any scientific support in the administrative record for the contention that the model's results can be *changed* using the local factors. Rather, it asserts only that "several points of logic [] march the risk of contact from high towards moderate by providing spatial separation." App. Vol. VI at 154. In particular, the USFS highlights the fragmented nature of the Wishbone Allotments and asserts "[i]t stands to reason that while it is possible for bighorn sheep to disperse across a fragmented landscape to encounter domestic sheep, it is not as likely as portrayed by the Risk of Contact tool." *Id.* But it cites no science or data in support of that "reason[ed]" conclusion. *See id.* Notably, the RCM predicted a high risk of contact and a disease interval of four years—much lower than thirty-two years necessary to earn a "high" rating. App. Vol. V at 214. The USFS asserts that the local factors can mitigate this predicted four-year disease interval but identifies *no* data or scientific studies showing that factors such as topography, project design features, or temporal separation can have

this effect—much less such a dramatic effect that the disease interval could be raised from four years to higher than thirty-two years. *See id.*

In fact, in the DN/FONSI, the USFS stated that no local factor on its own was sufficient to lower the predicted risk. *See* App. Vol. VI at 153. Rather, the USFS asserted it was the *combination* of local factors that decreased the risk from high to moderate. *See id.* at 152–53. This is so, the USFS asserts, even though evidence in the record suggests project design features have been ineffective, topographical features like roads and rivers pose no serious obstacle to the bighorn, and that bighorn sheep have moved close to the Wishbone Allotments during grazing season. *See* App. Vol. IV at 160 (Guardians noting bighorn sheep regularly cross highways and rivers according to data and literature and observing "[the EA] itself has a photo of bighorns running across Highway 149"); App. Vol. VI at 6 (Guardians noting CPW data showed bighorn sheep moved "within 1.5 miles" of a Wishbone pasture in 2017); *id.* at 156 (the USFS noting high number of domestic strays documented in 2017 despite attempt to implement project design features). Given this data and the lack of any countervailing scientific studies or data to the contrary in the record, the USFS's assertion that a combination of local factors could lower the RCM's predicted risk rating was arbitrary and capricious.

We found an agency's methodology similarly arbitrary and capricious in *Diné Citizens*, 59 F.4th at 1036–37. In that case, we held the Bureau of Land Management ("BLM") did not take the requisite "hard look" by failing to adequately consider the direct and indirect effects of greenhouse gas ("GHG") emissions from applications for permits to drill ("APDs") wells for oil and gas. *Id.* BLM had "included only the annual

GHG emissions from operating the wells, even though BLM assumed the wells would each have a twenty-year life span." *Id.* at 1035. During litigation, BLM provided a report that asserted it was "not possible to estimate the lifespan of an individual well," despite the fact BLM was able to assume twenty-year lifespans for downstream emissions. *Id.* In evaluating BLM's explanation for the gap in its methodology, we explained that "[w]hile we are deferential to the agency when it comes to the methodology the agency chooses to use, the agency's methodology must be rational—and not arbitrary or capricious." *Id.* at 1036. We held BLM's methodology was unreasonable because "it uses the emissions calculated for one year to represent the estimated direct and indirect emissions over a twenty-year period," despite being able to create a similar estimate for downstream emissions. *Id.* at 1037. Because BLM provided no explanation as to why it could not use a similar process to estimate direct emissions, we held its methodology was "inconsistent" and "unreasonabl[e]." *Id.*[7]

Similarly, we also held BLM had acted arbitrarily and capriciously in its analysis of health effects from certain pollutants. *Id.* at 1046. In an EA Addendum, BLM had recognized the poor health effects including cancer that could be caused by pollutants but did not determine the quantity of pollutants that would be released. *Id.* at 1047. Instead, it stated the levels "would be low relative to the distance from the source and would not

[7] In contrast, we rejected an argument that BLM acted arbitrarily and capriciously by using a hundred-year time horizon rather than a twenty-year horizon to calculate the global warming potential for GHGs, because the one-hundred-year method was supported by "high quality" and "accurate scientific analysis" in the record. *Diné Citizens*, 59 F.4th at 1039.

pose a risk to human health . . . because there would be no long-term exposure." *Id.* But this contradicted the method from its initial EAs, in which BLM determined the estimated emissions range for each APD. We held the assertion the effects would be short-term did not make sense given that "more than 3,000 similar wells [would] be drilled . . . over the next several years," which could cause long-term exposure. *Id.* Because BLM did not "include any analysis of the anticipated [] emissions from the construction of those wells over a period of years," it acted arbitrarily and capriciously by failing to take "the necessary hard look." *Id.*

Here too, the USFS asserted that the RCM analysis could be supplanted with the "local factors" without citing any data in support, and despite the administrative record contradicting its assertions. In particular, the USFS justified vacating the Snow Mesa Allotments—which partially overlap with the Wishbone Allotments—by emphasizing that the RCM was the "[b]est [a]vailable [s]cience," App. Vol. IV at 205–06, and that "inconsistency" in adhering to project design criteria militated in favor of vacating the allotments rather than accepting the "high" risk predicted by the model, *id.* at 239. But in the same breath, it asserted that it could "manage for separation" on the partially overlapping Wishbone Allotments using the local factors, failing to produce any data in support. *Id.* at 281. As in *Diné Citizens*, these assertions are arbitrary and capricious because they lack scientific support and are directly contradicted by the administrative record.

Finally, the break in logic between the USFS's decision to rely on the RCM results to vacate the Snow Mesa Allotments and its decision authorizing the Wishbone

Allotments *despite* the RCM results further indicates that the creation of the Wishbone Allotments was arbitrary and capricious. As we have stated, "unexplained conflicting findings about the environmental impacts of a proposed agency action violate the APA." *Cure Land, LLC*, 833 F.3d at 1232 (10th Cir. 2016) (alteration and citation omitted). Here, the USFS determined allotments with disease intervals between three and eight years and overlap between 37% and 92% with summer bighorn habitat was an unacceptably high risk, relying on the RCM. App. Vol. V at 210–13. But in the same decision, it determined that a four-year disease interval with 34% overlap was only a moderate risk by modifying the results of the model. *Id.* at 214–15. While the USFS provided an explanation for the difference—that the local factors supported modifying the RCM result—for the reasons discussed above, that explanation was not *reasoned*. That is, the explanation relies on no science or data, and in fact contradicts the data in the record about bighorn sheep movement and permittees' compliance with project design features. Accordingly, we hold the USFS acted arbitrarily and capriciously in relying on the local factors to supplant the RCM model result and approve the Wishbone Allotments. *See also W. Watersheds Project v. Vilsack*, No. 23-8081, 2024 WL 4589758, at *11–15 (10th Cir. Oct. 28, 2024) (unpublished) (holding agency acted arbitrarily and capriciously in approving plan amendment that failed to take a hard look at combined impacts of decreased acreage, density control, increased poisoning, and increased recreational shooting on prairie dog populations where previous analyses conclude the combined impacts of these factors could lead to "eradication" of the population and new

analysis failed to explain how the combined impacts were no longer considered an existential threat).[8]

b. Application of methodology

Even if we concluded it was not arbitrary and capricious for the USFS to use the local factors to downgrade the RCM model's result, we would still conclude that the USFS's argument fails on its own terms. That is, the USFS's conclusion that the local factors supported creating the Wishbone Allotments runs contrary to the evidence in the record and is therefore arbitrary and capricious.[9]

First, the USFS argues that because the Wishbone Allotments do not overlap with the CHHR for any bighorn sheep herd, a bighorn sheep could only contact the allotment through forays; and because forays generally occur in October, it was reasonable to downgrade the predicted risk to moderate. But a lengthy foray is not necessary to close the one-mile gap between some of the CHHRs and the Wishbone Allotments. *See* App. Vol. V at 147–48 (illustrating close distance between CHHRs and Wishbone Allotments);

[8] We cite unpublished cases for their persuasive value only and do not treat them as binding authority. *See United States v. Ellis*, 23 F.4th 1228, 1238 n.6 (10th Cir. 2022).

[9] The USFS argues Guardians does not cite any case requiring a pasture-by-pasture risk assessment, and that deference is owed to its determination an allotment-level analysis was sufficient. Appellee's Br. at 30. As Guardians argues in reply, it does not argue a pasture-by-pasture analysis is needed, but that "it was unreasonable to conclude the entire allotment was a moderate risk when the local factors the [USFS] relied upon do not apply to the two largest pastures." Reply Br. at 6. We agree an analysis of the Wishbone Allotments as a whole requires analysis of the Crystal and Shallow pastures, which overlap with the old Snow Mesa Allotments. *See* App. Vol. VI at 192.

id. at 178 (explaining distances of less than ten miles between CHHR and grazing allotments are considered high risk when combined with probability of forays). Moreover, the preliminary CPW telemetry data suggested the bighorn sheep were moving closer than expected to the Wishbone Allotments in the summer. *Id.* at 167–68 (noting preliminary data showed bighorn sheep overlapping the Snow Mesa Allotments); App. Vol. VI at 5–6 (noting this movement happened during the summer season). And again, the USFS cites no scientific literature or data to support modifying the model's prediction of high risk based on timing of forays despite relying on the model's conclusion for the Snow Mesa Allotments. Accordingly, the contention that the lack of direct overlap between CHHR and the Wishbone Allotments provides a reason to adjust the RCM model result is unsupported by the record.

Relatedly, the USFS argues that limited overlap between summer source habitat and the Wishbone Allotments (34%, as opposed to 70% for the vacated Snow Mesa Allotments) supports a lower contact risk. But in the Final EA, proposed allotments with overlap between 37% and 92% were given a high rating by the RCM and deemed too high risk to approve. The USFS provides no data as to why it can ignore a similar overlap percentage and an identical RCM result of high risk for the Wishbone Allotments.

Second, the USFS argues fragmentation of the Wishbone Allotments caused by the highway and river would reduce contact and merits lowering the risk rating. Even assuming that these topographical barriers can create separation—as discussed *supra*, the administrative record suggests roads and rivers pose no significant barrier to the bighorn sheep—as the map of the Wishbone Allotments reveals, the biggest pastures in the

Wishbone Allotments, Crystal and Shallow, are not protected by these barriers. While the USFS argues temporal gaps between bighorn sheep herds and domestic sheep on these two pastures will help create separation, CPW data showed at least one ram moving within a half-mile of the Shallow pasture during grazing season in July 2017. The USFS did not dispute that data in the Final EA or DN/FONSI, and on appeal points to no source in the administrative record for the contention that any temporal gaps are sufficiently wide to justify such a dramatic downgrade in the model's rating.

Finally, the USFS argues the RCM does not account for seasonal bighorn sheep movements, "which [are] fairly predictable each season and highly observable to managers." Appellee's Br. at 29. As for the Crystal and Shallow pastures in particular, the USFS argues that there are no known instances of bighorn directly entering the pastures, that topographic data showed the pastures were lower than the closest herd's CHHR, and that the herd would go to higher elevations only in the summer. The USFS also argues the additional telemetry data analyzed in the SIR supported relying on the local factors. Specifically, while acknowledging the new data showed one of the herd's CHHR "border[ing]" on the Crystal and Shallow pastures, there was no record of a bighorn sheep entering either pasture. Appellee's Br. at 31.

As to seasonal movements, the USFS does not address data in the record showing that a ram approached the Shallow pasture in July 2017, thereby undercutting its assumptions concerning herd movements. Moreover, the EA itself describes the herds as beginning the summer season in lower elevations and moving up toward the old Snow Mesa Allotments—movement that requires passing near the Crystal and Shallow

pastures. As to the additional telemetry data, as Guardians argues, we are generally limited in our review to information before the agency at the time of decision-making. *See Richardson*, 565 F.3d at 704; *CBD*, 72 F.4th at 1178. But even considering that data, it shows that bighorn sheep herds were moving *closer* to the Crystal and Shallow pastures than previously assumed, undercutting the USFS's argument about predictability. *See* App. Vol. VI at 193–98. Moreover, just because there was no record of a sheep directly entering either pasture does not suggest a lower risk—as discussed above, distances of ten miles or less are considered high risk due to the possibility of forays.

In short, analyzing the factors individually reveals there is no support in the record for the contention that there is a lower risk of contact between bighorn sheep and domestic sheep than the RCM predicts. Therefore, approving the Wishbone Allotments by relying on these "local factors" to supplant the RCM's risk analysis was arbitrary and capricious.

2. Project Design Criteria

Guardians argues the USFS also violated NEPA because its reliance on project design criteria to reduce the risk rating was unreasonable. Guardians stresses there is no support for the use of project design criteria because experts have refuted their effectiveness and the permittees on the Wishbone Allotments repeatedly violated permit terms. The USFS argues it reasonably relied on project design criteria in determining the risk of contact was moderate. The USFS emphasizes it understood that design criteria alone would not provide effective separation and was not the "sole reason" for the lower rating. Appellee's Br. at 34. Rather, because project design criteria were not the only

mechanism for separation in the Wishbone Allotments, it was reasonable to expect those criteria—in combination with other factors—to mitigate the risk of contact.

We agree with Guardians. As the administrative record amply demonstrates, there is no scientific support for the idea that project design criteria—alone or in combination with other factors—can successfully separate bighorn sheep from domestic sheep where the RCM predicts a high risk of contact. The record reveals only the apparent ineffectiveness of project design criteria and the USFS's skepticism that it can serve as the sole basis for authorizing grazing. *See, e.g.*, App. Vol. III at 62 ("Until the science is available that shows that project design criteria are effective in maintaining separation, I cannot use them as [the] sole basis for authorizing grazing."); App. Vol. III at 181, 210 (stating "there is uncertainty about the effectiveness of project design criteria and it is unknown how much, if any, reduction might be expected in the contact probabilities produced by the Risk of Contact Tool from full and complete implementation of all project design criteria" due to the lack of "testing or verifi[cation]" and uneven adoption by permittees); App. Vol. IV at 84 (noting that during trial use of Wishbone Allotments, "[p]roject design criteria regarding stray management and herd management have not been implemented successfully").

To be sure, the USFS argues that the Wishbone Allotments can be distinguished from these earlier pronouncements because project design criteria *in combination* with other features can successfully keep bighorn sheep separate from domestic sheep. But it identifies no science or data in the record supporting that conclusion. Instead, in relying on the combination of project design criteria and other features, the USFS asserted only

that "*several points of logic* [] march[ed] the risk of contact from high towards moderate," chiefly that bighorn sheep tend to move toward higher elevations in the summer and that "sufficient manpower" will improve the effectiveness of project design criteria. App. Vol. VI at 154, 156 (emphasis added). But these "points of logic" are directly contradicted by the available data, including the high number of domestic strays found during the 2017 trial season and the recognized areas of "overlap" between the bighorn summer habitat areas and the Wishbone Allotments. *Id.* at 154, 156. In the absence of any science or data suggesting that project design criteria could become effective in combination with other features such as spatial or temporal separation, the USFS's reliance on untethered "logic" alone is insufficient to satisfy NEPA's "hard look" requirement. *See Diné Citizens*, 59 F.4th at 1037 (holding agency failed to take a "hard look" where it failed to use a reasonable methodology and its explanation was "inconsistent with the record").

3. Cumulative Impacts

Guardians argues the USFS violated NEPA in creating the Wishbone Allotments for the additional reason that it failed to take a hard look at threats to bighorn sheep besides the three herds closest to the Wishbone Allotments. *Id.* at 39–40. Guardians argues that because bighorn sheep herds can interact with other herds from adjacent populations, and the CPW telemetry data confirmed interaction between the Wishbone-adjacent herds and other neighboring herds, failing to consider the impact the Wishbone Allotments could have on other bighorn sheep herds constituted a failure to take a hard look at all effects. *Id.* The USFS counters it took a sufficiently hard look at environmental

impacts of the proposed action. Appellee's Br. at 42.[10] As to the threat of the bighorn sheep herds closest to the Wishbone Allotments spreading disease to other herds, the USFS argues it considered this risk but ultimately concluded the risk was sufficiently attenuated due to the "series of events that must occur for [the] disease to spread." *Id.* at 43–44. The USFS also argues that it considered the cumulative impact of the Wishbone Allotments alongside other allotments. *Id.* at 45.

We agree the USFS failed to take a hard look at impacts to bighorn sheep herds beyond the herds closest to the Wishbone Allotments. On one hand, the Final EA recognizes that there are eleven distinct herds in the Rio Grande National Forest, beyond just the herds closest to the Wishbone Allotments, and that "disease outbreaks of every 32 years or less would result in a bighorn sheep population that, although potentially in the initial stages of recovery [from 1990s outbreaks], would be constantly exposed to ongoing disease transmission events and resultant outbreaks." App. Vol. V at 176. But in analyzing the disease risk to bighorn sheep in creating the Wishbone Allotments, the USFS analyzed only the risk to the three nearest herds, saying nothing about the

[10] The USFS also argues this argument was waived by Guardians because it was not presented before the agency. Appellee's Br. at 42–43. But as Guardians argues in reply, it raised the need to consider the Wishbone Allotments' impacts on the broader bighorn sheep population in comments before the agency. *See* App. Vol. V at 6 (objecting to the USFS's failure to consider impacts of Wishbone Allotments on neighboring herd); *see also id.* at 95–96 (another organization objecting to the USFS's failure to consider impacts to neighboring herds nearby the Wishbone Allotments). We agree that Guardians made, with "reasonable specificity," 42 U.S.C. § 7607(d)(1)(B), the same argument before the agency as it presses on appeal. *See WildEarth Guardians*, 770 F.3d at 943.

remaining eight. *Id.* at 206–09. And despite recognizing that between these three herds there was expected to be a disease transmission event as often as once every four years—far below the thirty-two-year threshold that merits a high rating under the RCM model—the USFS nonetheless downgraded the risk threshold to moderate based on the local factors. *Id.* at 208–09.

Not only does this analysis fail to justify the modification of the risk from high to moderate as discussed above, it also entirely fails to consider the impacts the Wishbone Allotments could have on the neighboring herds, despite being alerted to the problem through comments. This also violates NEPA. *See Utahns for Better Transp. v. U.S. Dep't of Transp.*, 305 F.3d 1152, 1180 (10th Cir. 2002) (holding agency violated NEPA by failing to assess impacts to neighboring species); *Diné Citizens*, 59 F.4th at 1040–44 (holding agency violated NEPA by failing to consider cumulative impacts where it "[did] not say anything about how the emissions will impact the environment" despite methods existing for conducting this analysis).

While "NEPA does not require the impossible" and does not require "the agency to employ a specific method for determining the effects of an agency action," it "does require agencies to consider whether the proposed agency action will have a significant impact on the environment and to use accurate science to do so." *Diné Citizens*, 59 F.4th at 1040 (quotation marks omitted). An agency acts arbitrarily and capriciously "by choosing not to address the cumulative impacts" of an action without explaining why. *Id.* at 1043. Here, the USFS did not address the cumulative impacts of the Wishbone Allotments on neighboring herds despite acknowledging the existence of those herds in

the EA as well as the high risk to their survival generated by a disease interval of thirty-two-years or less. *See* App. Vol. V at 206–09. Not considering the impact of the Wishbone Allotments on neighboring herds constitutes a failure to take a hard look and also violates NEPA.

4. Best Available Science

Finally, Guardians argues the USFS did not use the best available science in the EA of the Wishbone Allotments. Appellants' Br. at 36. Specifically, Guardians contends that by using only CPW's preliminary telemetry data and not requesting additional data before releasing a final decision, the USFS missed most of the relevant data before rendering its decision creating the Wishbone Allotments. *Id.* at 37–38. Guardians argues this violated NEPA because the telemetry data was critical for the USFS's decision-making process, especially given its reliance on the "local factors" including the bighorn sheep herds' summer movement patterns and foray timing. *Id.* at 38. The USFS, for its part, contends it did not have to postpone its decision until CPW finished the telemetry study because it considered "extensive" information about bighorn sheep movement in its decision, which provided adequate data to render its decision. Appellee's Br. at 37. We agree with the USFS.

In *Center for Biological Diversity v. U.S. Department of the Interior*, 72 F.4th 1166, 1171–72 (10th Cir. 2023) ("*CBD*"), we considered whether the Department of the Interior considered the best available science in approving a decision allowing the State of Utah to draw water from a contested source. The petitioners argued Interior failed to take a hard look at the effects of global warming on future water availability in the

contested sources, identifying three scientific studies that had not been included in the EA. *Id.* at 1179. Interior responded that by relying on hydrology data rather than the three identified studies, it provided a "reasoned explanation" sufficient to satisfy NEPA. *Id.* at 1180. We concluded the agency adequately explained its approach, holding its preference for a different methodology was "reasonably discernable from the record" even though the agency did not name or discuss the three studies. *Id.* We emphasized that the "choice of the best science" was in the agency's "prerogative[] to meet the chosen scale of analysis," noting our "[d]eference to the agency is especially strong where the challenged decisions involve technical or scientific matters within the agency's area of expertise." *Id.* at 1182 (internal quotation marks omitted).

Here too, we agree with the USFS that it did not have to wait for the full results from the CPW telemetry study. As in *CBD*, the USFS provided a reasoned explanation as to why it relied on the preliminary data, and the record clearly sets out the sources it did rely on, including the preliminary data. *See* App. Vol. V at 152–63 (discussing sources including CPW data, USFS monitoring, and historical records of bighorn populations); *id.* at 164–71 (discussing the interplay of these sources with the RCM tool). While we agree with Guardians that the USFS's overall approach—manually changing the RCM result despite what the preliminary CPW data showed—was arbitrary and capricious, the USFS was not required to wait for the full results from CPW before making a final decision. As Guardians admits, the USFS did discuss the preliminary data from this study in its EA, "adequately incorporat[ing] in its analysis" the available information about bighorn sheep movements. *CBD*, 72 F.4th at 1181.

Put simply, the USFS did not violate NEPA by not waiting for the *additional* telemetry data; as discussed above, it violated NEPA by ignoring the ramifications of the initial data. Because of the deference given to agencies in determining which methodologies and science to rely on, and because the USFS did use the data available to it, the USFS was not required under NEPA to wait for the full CPW study.

5. Conclusion

We agree with the USFS that it did not have to wait for the full results of the CPW study to have adequately considered the best available science. But we agree with Guardians that the USFS's reliance on the local factors and project design criteria to supplant the RCM result was arbitrary and capricious. We further agree with Guardians that the USFS failed to take a hard look at the cumulative impacts to neighboring bighorn sheep herds. Accordingly, we conclude that the USFS violated NEPA in creating the Wishbone Allotments.

V. REMEDY

Having determined that the DN/FONSI creating the Wishbone Allotments is unlawful, we must now determine the appropriate remedy.

This court has adopted a two-prong, fact-sensitive test for determining whether vacatur is the appropriate remedy for an APA violation: "(1) 'the seriousness of the [agency action's] deficiencies (and thus the extent of doubt whether the agency chose correctly)' and (2) 'the disruptive consequences of an interim change that may itself be changed.'" *Diné Citizens*, 59 F.4th at 1049 (quoting *Allied-Signal, Inc. v. U.S. Nuclear Regul. Comm'n*, 988 F.2d 146, 150–51 (D.C. Cir. 1993)). We have previously explained

that "[a]pplication of the *Allied-Signal* factors requires a fact-intensive inquiry that is typically left to the discretion of the district court." *Id.*

Guardians briefly argues on appeal that partial vacatur is the appropriate remedy. Appellants' Br. at 56; Reply Br. at 27. Guardians explains that the two permittees authorized to graze the Wishbone Allotments have not done so since 2020, so "vacating the decision would have little disruptive consequence." *Id.* (citing *Allied-Signal*, 988 F.2d at 150). In reply, Guardians clarifies partial vacatur is appropriate because no party has challenged the portion of the decision vacating the Snow Mesa Allotments. Reply Br. at 27. The USFS disagrees, asserting the district court should determine the remedy in the first instance. Appellee's Br. at 60 n.15; *see also* Br. of Intervenor Respondents-Appellees Jerry Brown, Wayne Brown, and Colo. Woolgrowers Ass'n at 27–28 (agreeing remand to the district court is appropriate remedy).[11]

Because the *Allied-Signal* factors were not considered by the district court, and because the parties do not provide any extensive discussion of the factors on appeal, we

[11] J. Paul Brown and the Colorado Farm Bureau, for their part, assert remand without vacatur to the agency is the appropriate remedy. *See* Br. of Intervenor Respondents-Appellees J. Paul Brown and Colo. Farm Bureau at 33–36.

remand to the district court with instructions to apply these factors in the first instance to determine the appropriate remedy.

VI. CONCLUSION

For the reasons explained above, the USFS's creation of the Wishbone Allotments violated NEPA. We REMAND to the district court to apply the *Allied-Signal* factors in the first instance to determine the appropriate remedy.

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RE: 24-1187, WildEarth Guardians, et al v. U.S. Forest Service, et al
Dist/Ag docket: 1:19-CV-00208-DDD

Dear Counsel:

Enclosed is a copy of the opinion of the court issued today in this matter. The court has entered judgment on the docket pursuant to Fed. R. App. P. Rule 36.

Pursuant to Fed. R. App. P. 40(d)(1), any petition for rehearing must be filed within 14 days after entry of judgment. Please note, however, that if the appeal is a civil case in which the United States or its officer or agency is a party, any petition for rehearing must be filed within 45 days after entry of judgment. Parties should consult both the Federal Rules and local rules of this court with regard to applicable standards and requirements. In particular, petitions for rehearing may not exceed 3900 words or 15 pages in length, and no answer is permitted unless the court enters an order requiring a response. *See* Fed. R. App. P. Rule 40 and 10th Cir. R. 40 for further information governing petitions for rehearing.

Please contact this office if you have questions.

Sincerely,



Christopher M. Wolpert
Clerk of Court

cc: Grady Block
Aaron E. Bruner
Amy Collier
Brian Gregg
Ivan L. London
Krystal-Rose Perez

CMW/lg