May 17, 2024

To: US Forest Service, Boise National Forest

Re: Southwest Idaho Landscape Resilience Project

Objection filed Electronically to:
https://cara.fs2c.usda.gov/Public/CommentInput?Project=61880

Filed by: Yellowstone to Uintas Connection, Alliance for the Wild Rockies, Native Ecosystems Council.

The Southwest Idaho Landscape Resilience project is flawed by not addressing the cumulative effects of livestock grazing, roads and human activity on forest and riparian health, and carbon storage. A full EIS is needed to adequately address on ground conditions resulting from past timber harvest, fuel treatments, vegetation management combined with the effects of livestock grazing and browsing on aspen, denuding forest understory, promoting weeds, and degrading riparian areas.

The attached reviews were prepared by Dr. John Carter of the Yellowstone to Uintas Connection. These provide insight into some of the realities on the ground and the failure of the Forest Service to do an integrated and holistic analysis of its past actions on current forest stand condition, understory plant communities, and riparian areas.

The Aspen – Review of Literature Regarding Vegetation Treatments, Conifer Invasion and Browsing, 2012 provides a full understanding of the values of aspen, how they regenerate, effects of prescribed fire, livestock and wildlife grazing on recruitment, fire and conifer forests, and provides an annotated bibliography.

The Comments to the President's Climate Task Force Regarding the January 27, 2021 Executive Order on Tackling the Climate Crisis and Development of Guidelines for Determining Protected Areas provides in depth review of climate issues as related to forest management and livestock grazing that, as currently conducted are in direct opposition to the goals of the EO. It addresses forest management and carbon sequestration, wildlife corridors, provides examples of forest degradation by livestock, and reviews:

1. Livestock Grazing and Carbon Storage

2. Livestock Grazing and Biodiversity
3. Forests and Carbon Storage
4. Wildfire and Species Effects
5. Wildfire and Insect Outbreaks
6. Fire Suppression and Fuel Buildup
7. Summaries of Issues Around Fire
8. Road Densities and Effects
9. Off Road Vehicles and Carbon Emissions

These topics are not addressed in the EA and Draft Decision.

Respectfully,

Dated: July 6, 2021

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Aspen – Review of Literature
Regarding Vegetation Treatments, Conifer Invasion and Browsing

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Current Status and Values of Aspen

Aspen ecosystems provide a variety of important values. These include water yields, rich biodiversity, luxuriant undergrowth, excellent watershed protection, aesthetics, recreation, favored wildlife habitat for big-game and non-game species, valuable livestock forage and wood fiber (Bartos and Campbell 1998b). They point out that bird diversity and density was greater in aspen stands than in conifer forests and that bird species diversity increased as the size of aspen stands increased. Plant species occurrences in aspen understory (about 30 species) are double those of conifer forests. During the past 125 years aspen in the six National Forests in Utah have declined from 2.1 million acres to 800,000 acres, or a loss of 60% of the aspen community. Across Utah as a whole, of about 2.9 million acres of forested areas containing aspen, only 1.4 million acres now have aspen as the dominant tree type. These changes have been due to livestock grazing, wildlife use and a reduction in fires (Bartos and Campbell, 1998a, 1998b). In the Wasatch Mountains, 1/3 or more of the seral aspen communities have been replaced by spruce-fir with increased dominance of subalpine fir. An estimated 75 – 80 percent of the aspen is now in mid-age, mature and old-age condition. High levels of grazing in this type in the past have resulted in reduced fuels to carry fire and changed species composition and dominance (USDA 2001). Mueggler (1989) indicated that as much as one-third of the aspen communities in the region are believed to be relatively stable, occupying sites remote from or unsuited for conifers. The presence of both even-aged and uneven-aged stands also suggests that under some conditions, aspen can persist as a stable, self-perpetuating community in the absence of periodic disturbances like fire or clearcutting to stimulate sucker generation.

Gifford et al (1984) showed through measuring water transport in aspen and subalpine fir that replacement of aspen by subalpine fir deprives the watershed and streams of significant water, through increased water use by fir when compared to aspen. Bartos and Campbell (1998b) used this research to calculate the potential water loss from conversion of aspen to conifer in Utah forests. For every 1,000 acres of aspen converted to conifer, between 250 and 500 acre-feet of water is transpired and not available for streamflow or undergrowth production. They estimate that the loss of nearly 1.5 million acres of aspen experienced during the past 125 years in Utah has resulted in a loss of between 375,000 and 750,000 acre-feet per year.

Bartos and Campbell (1998b) also calculated the reduction of herbaceous understory vegetation based on the loss of 1.5 million acres of aspen in Utah. Using production figures of 1,500 lb/acre for aspen understory vegetation and 200 lb/acre for conifer, they calculated a loss of 975,000 tons of herbaceous vegetation per year.

Aspen Regeneration Mechanism

Aspen regenerate from seeds as well as suckers that arise from root meristems. McDonough (1979) studied the ability of seeds from healthy and deteriorating aspen clones to germinate under a variety of temperature and moisture conditions. The average mature aspen generates about 1.6 million seeds per year. Tests determined that nearly 100% of seeds can germinate, whether from healthy or deteriorating clones. At higher temperatures, germination success declined sharply. The same was true for water stress, as less water becomes available, germination success declines. The implications of this research are that exposed, dry soil conditions are not favorable to germination of seed, but under favorable environmental conditions, natural seeding and establishment might be sufficient to provide the benefits of reproduction by seed. Schier (1976) noted that under existing environmental conditions, aspen seldom reproduces from seed. The principal method of aspen regeneration is by growth of suckers from root meristems.

Schier (1975) described the dynamics of sucker production as governed by apical dominance, a phenomenon whereby the transport of the hormone, auxin, from above-ground stems to the root system inhibits hormones (cytokinins) in the root system that stimulate sucker growth. When disturbance of the stems reduces the flow of auxins, the cytokinins can initiate the regenerative process. However, when aboveground stems weaken and die, the root system dies back due to a lack of photosynthate being furnished to the roots. Residual stems maintain auxin levels in the smaller root system and inhibition continues. Reduced vigor of the clone makes it susceptible to disease and insect attack and unless some roots and aboveground stems survive to provide carbohydrates, the clone will die out. Major disturbances such as logging or fire that kills most stems in a short period of time stimulate abundant sucker production because the rapid death of stems eliminates apical dominance while the root system is still capable of producing suckers. Incidences of leaf blight have also been observed to stimulate sucker production. He also notes that regeneration problems are caused through browsing by livestock, wildlife and competing vegetation. Mueggler (1989) noted that even deteriorating clones are not doomed as evidenced by the existence of multi-aged aspen communities and the development of scattered root suckers under existing stands, with more forming as the old canopy breaks up. This does not assure success if the suckers are unable to grow due to browsing animals. Schier (1976) suggests that sucker regeneration is proportional to above-ground disturbance, citing examples from clearcut studies where the number of suckers generated is proportional to the number of stems removed.

The number of suckers produced varies. Mueggler (1989) studied 713 aspen-dominated plots in National Forests in Utah, Idaho and western Wyoming. Of these, 19% contained less than 200 suckers/acre, 50% contained less than 800 suckers per acre and 27% contained over 2000 suckers per acre. Sucker production was positively correlated with herbaceous understory vegetation and negatively correlated with stand age. In a study of clones in the Logan Canyon, Utah area, Schier and Campbell (1980) found that healthy clones contained 1,100 suckers per acre, while in deteriorating clones there were 500 suckers per acre.

Aspen Communities and Prescribed Burning

Bartos and Mueggler (1979) looked at an area on the Gros Ventre elk winter range where prescribed fire was used to improve forage production in aspen and sagebrush habitats and to stimulate aspen regeneration. Herbaceous vegetation production on the unburned control varied between 716 and 909 lbs/acre over the four years of measurement. In moderate intensity burn areas, vegetation production decreased from the pre-burn level of 558 lbs/acre to 356 lbs/acre the year following the burn, then rebounded the second post-burn year to 1167 lbs/acre. The high intensity burn area declined from a pre-burn level of 718 lbs/acre to 191 lbs/acre the first year following the burn and then 1,504 lbs/acre the second year. Before burning, annuals provided about 10% of the understory vegetation. After burning this increased to 35% on the moderate intensity burn and 60% on the high intensity burn. Annuals retained dominance in the burn areas for the three-year post-burn duration of the study. On a large burn area several miles from the study plots, combined deer and cattle use did not seem to hamper successful re-establishment of aspen. But the study did not take into account the slope and distance to water to account for livestock impacts, (Holechek et al, 1998). The study did indicate that normal deer populations and appreciable elk browsing did not prevent establishment of a new aspen stand. They also found that over the four-year study period in control, moderate intensity burn and high intensity burn areas, sucker numbers in the control varied between about 4,000/acre and 8,000/acre. In the moderate intensity burn area, sucker numbers ranged from 10,926/acre the first year post-burn, to 26,710/acre the second year and declined to 12,417/acre the third year. In the high intensity burn area, sucker numbers were 12,141/acre the first year post-burn and remained at that level through the third year.

Schier and Campbell (1978) studied clones following clearcutting and burning in the Gros Ventre Range in Wyoming. Sucker generation one year following clearcutting ranged from 22,000 to 77,000 stems per acre. Following burning, sucker numbers ranged from 14,000 to 45,000 stems per acre. It should be noted that, according to Krebill (1972) somewhere between 2,000 and 5,000 elk are fed at winter feeding stations in the Gros Ventre study area. Cattle are also grazed there.

In a study of aspen and understory vegetation relating to prescribed burning in the Gros Ventre, Bartos et al (1994) documented that undergrowth vegetation production was dominated by forbs before and after the treatments. Before burning forbs were 66%, grasses 21% and shrubs 13%. For the burn areas, forbs increased rapidly during the first three years to a range of 82% to 94% of production. The greatest portion of this increase was from fireweed. This represented a doubling of initial biomass for the treatments, while the control area experienced a 25% increase during the same period. At the end of 12 years, total biomass in the treated areas was not significantly different from the control (see figure in Appendix I). In addition, in the treated areas, the percent grasses were 20% or less and shrubs 5% or less which were about half the values for the control and pretreatment measures. Livestock grazing pressure during the study may have distorted the observed production values, especially for grasses.

Bartos et al (1994) continued earlier work in the Gros Ventre Range in Wyoming to evaluate changes following prescribed fire in aspen. Ten clones, nine of which were burned and one unburned control were monitored for sucker numbers and understory vegetation for a twelve year period following burning. Sucker stems <2m in height were 3,440/acre pre-burn, 7,537 three years following the burn and declined to 2,084/acre twelve years after the burn. The low intensity burn areas began with 1,618/acre and increased to 7,174/acre two years after the burn, then declined to 614/acre twelve years after the burn. The moderate intensity burn areas contained 2,412 suckers/acre prior to burning, 12,421/acre two years after burning and 750/acre twelve years after burning. The high intensity burn areas contained 3,406 suckers/acre prior to burning, 14,754/acre two years after burning and 971/acre twelve years after burning. All areas declined in sucker numbers, but the unburned control contained more than double the number of suckers after twelve years when compared to all burned areas. While cattle grazed the area throughout the study period, they seldom appeared to use the suckers. Large numbers of elk are fed in the study area during the winter and Krebill (1972) and were indicated to browse the aspen heavily. Bartos et al (1994) conclude that in this case, fire treatment may have hastened the demise of the aspen.

Wambolt et al (2001) studied the recovery of big sagebrush communities following burning in south-western Montana. The study was conducted because these communities are burned with the goal of increasing productivity of understory plants or big sagebrush. They looked at 13 paired burned and unburned sites. They noted that these communities were estimated to occupy 60 million acres in the west in 1960, but that due to their low preference as forage by cattle, millions of hectares had been treated to reduce sagebrush and increase herbaceous production. However, these treatments have eliminated the sagebrush without the expected increases in herbaceous production. Where herbaceous production has increased following sagebrush reductions, it has been accompanied by changes in grazing management or other treatments. They cite the paradox that land managers often state objectives of increasing productivity of big sagebrush through prescribed fire when the same practice was used in the past to eliminate sagebrush, while claiming all the values of a mature sagebrush community as their rationale. Numerous cited studies found that big sagebrush recovery took long periods, sometimes as long or longer than 30 years. Heavy browsing was seen to extend this period by suppressing recovery. They surveyed sites that were burned up to 32 years earlier for canopy cover, plant density, and production of winter forage. Their results showed sagebrush canopy was significantly less on burned sites than unburned controls, some burns resulting in the near elimination of sagebrush. Green rabbitbrush increased in cover on burn sites. Total perennial grass cover across all sites was not different between burned and unburned areas. Perennial forb canopy cover response was similar. No clear short- or long-term benefit for grasses or forbs could be identified, while the shrubs used by wildlife were suppressed by burning.

Mueggler (1994) looked at paired plots at the Great Basin Experiment Station on the Wasatch Plateau in Central Utah to determine changes in stand characteristics between thinned and unthinned aspen plots. Thinning was done to remove dead, depressed and intermediate trees. In each case, after 63 years, thinned plots had more trees per acre than unthinned plots. In all cases, the total number of trees on the plots had declined significantly, whether thinned or not. No information was given on the presence of livestock or other browsing animals.

Effects of Browsing

In a study by Krebill (1972) in the Gros Ventre elk winter range, 100 plots were surveyed in the 3000+ acres of aspen occurring there. In areas close to winter elk feeding grounds, obviously deteriorating aspen clones demonstrated symptoms of browsing, highlining and barking. Across all sample locations, the mean number of trees was 466 per acre of which 42% were less than 6" DBH. Aspen sprouts were present at 653/acre, with most showing evidence of being browsed down to <2' each year. An annual mortality was calculated at 3.6% per year compared to 1% in Colorado and 2.7% in Utah's Ephraim Canyon. These rates were two to four times higher than those found in New York. Occurrence of sagebrush and <u>Balsamorhiza sagittata</u> in aspen understory along with conifer saplings indicated a sign of browsing disclimax.

Mueggler and Bartos (1977) studied two exclosures on the Beaver Mountain Plateau in the Fishlake National Forest in Utah. These exclosures were approximately 100 x 200 feet and were designed to exclude all ungulates, exclude livestock but allow access to deer, and an outside area subject to combined use. A portion of each control was clearcut to study the effect of cutting on regeneration. A history of the area showed that deer were abundant in 1865 when Beaver County was first settled. Then heavy stocking with sheep and cattle, which overgrazed the range, coupled with unrestricted hunting resulted in a decline in deer numbers to a low in about 1910. Beaver Mountain was placed under National Forest Administration in 1906 and better regulation of forage use coupled with enforcement of hunting regulations in 1913 allowed deer numbers to increase. By 1926, heavy use of aspen suckers and palatable shrubs was attributed to high populations of deer and by 1934 aspen regeneration was poor over large areas. Overuse of the livestock summer range was a serious problem by the early 1930's. Cattle and sheep as well as deer were considered too numerous. Proposed reductions in livestock were protested by ranchers who claimed the deer were too numerous and responsible for depleted forage. Livestock have continued to graze the area. They found that understory vegetation in ungrazed plots increased to over 10 times the amount of shrubs (rose and snowberry) when compared to plots grazed by both cattle and deer and 3 times that in plots grazed by deer only. Overall herbage production was greatest on areas closed to cattle, but not to deer. [*These reports attest to the fact that declines in aspen were related to the combined pressure of livestock and competition for the deer, although before livestock were introduced, these problems apparently did not occur*].

Very few of the aspen suckers that arose between 1905 and 1934 become trees. Sucker occurrence on the combined use plots which continued to be grazed by cattle and wildlife ranged between 1,200 and 12,000 per acre, but few survived to reach 5.1 cm (dbh) 41 years later. Clearcutting stimulated sucker production in ungrazed plots to levels 19 to 26 times greater than those in uncut plots that were not grazed. After 8 years, however, numbers surviving were similar between cut and uncut plots that were not grazed. Deer use in the plots reduced sucker numbers to between 3% and 10% of the ungrazed plots and after 5 years, the plots contained no suckers or saplings. [*The removal of forage by livestock grazing outside the exclosure and the attraction of abundant food within the exclosure no doubt increased the focus of deer within the exclosure.*]

Bartos and Campbell (1998a) provided photographic documentation of the effects of livestock preventing aspen regeneration using fenceline contrasts of a previously burned and logged area which in the presence of livestock is barren and not regenerating. Across the fence where livestock, but not wildlife are excluded, dense regeneration is evident.

Kay and Bartos (2000) studied existing exclosures on the Dixie and Fishlake National Forests that had been constructed between the 1930's and 1970's to determine the effects of livestock and wildlife on aspen regeneration and associated vegetation. These were of three part construction to provide total exclusion, exclude livestock only and allow combined use by livestock and wildlife. Aspen within all total exclusion areas successfully regenerated without the influence of fire or other disturbance. Aspen subject to browsing by deer either failed to regenerate or regenerated at stem densities of 1,010 stems/acre compared to 1,810 stems/acre in total exclusion areas. On combined use plots, most aspen failed to regenerate or did so at low densities of 409 stems/acre. They concluded that there was no evidence that climatic variation affected aspen regeneration. The observed differences were due to varied histories of ungulate herbivory. They also monitored understory herbaceous vegetation. They found that herbivory by ungulates altered understory vegetation. Utilization by deer reduced shrubs and tall palatable forbs and favored growth of grasses, while combined use by livestock and deer reduced native grasses and promoted introduced species and bare soil.

Kay (2001) reported the results of studies of hundreds of aspen clones in the Shoshone, Simpson Park, Diamond, Desatoya and Roberts Mountains on BLM lands in central Nevada. Aspen in these areas are found to be in poor condition and many stands have not successfully regenerated in 100 years or more.

No evidence of elk presence was found in or near any of the stands, so elk were not contributors to the problem. Forest succession was not a problem as conifer invasion had not taken place in the communities studied. Other than pinyon pine, conifers were absent from the study area. Kay observes that where aspen in central Nevada has been protected from grazing, aspen has maintained its position in the vegetation community and, in fact, has actually replaced sagebrush, contrary to the opinion of some that say sagebrush naturally replaces aspen. He cites other exclosure studies that have found that aspen stands have expanded and eliminated sagebrush. [*A recent study on BLM lands in Rich County, Utah showed that in areas where livestock were excluded adjacent to riparian area, the riparian areas were expanding and invading sagebrush in uplands were senescing and being replaced by grasses and forbs in the absence of livestock (Carter and Chard, 2001)*]. Exclosure studies have also suggested that climate has little impact on aspen in central Nevada. Aspen inside exclosures regenerated without fire or other disturbance while aspen in adjacent, unprotected areas did not. Numerous papers are cited that demonstrate that climatic variation does not account for observed declines in aspen.

Fire exclusion was examined. It is noted that BLM has suppressed fires for a long period and none of the study areas contained evidence of fires with few exceptions. In fact, only a few out of the hundreds of clones studied had experienced fire during the past 20 years. Aspen age data suggest that few aspen stands in central Nevada have burned during the past 100 years. He points out that while the burned stands did regenerate, in all cases where aspen were protected from grazing, aspen regenerated. So, whle fire can benefit the species, aspen declines cannot be attributed to absence of fire.

Exclosure data indicated that herbivory has had a major influence on aspen stem dynamics and understory composition in central Nevada. Most herbivory was from livestock. Pellet counts were used and showed that 59.3% were from domestic sheep, 40.2% from cattle and 0.4% from deer. Exclosures that exclude cattle but not deer including canyons closed to livestock had all aspen stands that regenerated. When fallen trees blocked livestock access, aspen were able to regenerate in the protected spaces. Reductions in livestock numbers also resulted in aspen regeneration. Distance to water and slope were also factors that related to aspen regeneration or the lack of regeneration. Cattle use is generally related to distance from water and slope. Steeper slopes or areas further from water receive less use. Aspen stands further from water and on steeper slopes were in better condition than those nearer water or on more gentle slopes, again indicating that grazing by livestock was the operative factor causing declining health of aspen clones. While Kay cites other research indicating that wildlife have impacts on aspen regeneration, he states that in all cases where aspen is protected, it successfully regenerates and formed multi-aged stands without fire or other disturbance. He concludes by saying, “The single, stem-aged stands seen in central Nevada and found throughout the West are not a biological attribute of aspen, but a result of excessive ungulate herbivory. … In central Nevada, however, domestic livestock are the predominate ungulate herbivore."

Fire and Conifer Forests

Belsky and Blumenthal (1997) reviewed the literature for the effects of livestock grazing on forest soils and stand dynamics in the Interior West. Pre-settlement, these mature trees were maintained at low densities through competitive exclusion of tree seedlings by dense understory grasses and thinning of understory trees by frequent low-intensity ground fires. These fires were ignited by lightning and Native Americans and were fueled by grasses, forbs, low shrubs and pine needles. They were cool, slow burning and non-lethal to larger fire-tolerant trees with their thick bark such as Douglas fir. Seedling and saplings of ponderosa pine and other species suffered high mortality during these fires. Mean fire return intervals of these low-intensity fires were 5 – 12 years across the west, ranging from 4-5 years in the Southwest, and in the northern Rockies 5-20 years in ponderosa pine stands and 15-30 years in mixed conifer stands.

On drier sites at low elevations and on south facing slopes, the forests were dominated by widely dispersed ponderosa pine. On north-facing slopes, wetter sites and sites at mid-elevations, forests were dominated by Douglas fir, western larch, grand fir and white fir. These mature forests were altered periodically by intense fire, causing them to be opened up and replaced by ponderosa pine and western larch, which were maintained for long periods by low-intensity ground fires that eliminated the more fire-sensitive fir seedlings. At higher elevations, mature forests were dominated by subalpine fir and mountain hemlock.

As settlement of the West occurred, forest changes occurred including increases in tree density, insect and disease, fuel buildup and increased fire intensity. Early authors have suggested these changes began shortly after livestock were introduced into these areas. "As the numbers of livestock increased the biomass and vigor of the grasses and sedges they grazed declined.." This reduced the competitive dominance of the understory and allowed more tree seedlings to become established, thus generating thickets of saplings and pole-sized trees. Livestock reduced the frequency of surface fire by consuming the herbaceous vegetation which would otherwise have become a source of fine fuels. Agency fire suppression efforts have increased these densities. Fuel loads in some forest areas have increased by 10 times during the suppression period.

Case studies are provided that show differences in fire history and vegetation between areas grazed by livestock and ungrazed areas. These studies show that grazing reduced the herbaceous understory and caused the generation of dense crops of tree seedlings, while the ungrazed forest areas contained widely-spaced trees and low numbers of tree seedlings and healthy understory grasses. Tree recruitment corresponded to the level of grazing pressure, declining as grazing was reduced and when grazing was eliminated, recruitment returned to pre-grazing levels. Livestock were found to substantially reduce vegetative cover of herbaceous vegetation, especially native grasses which reduced plant litter and ground cover and increased soil compaction. These factors lead to decreased water infiltration, increased erosion and resulting water stress, and tree mortality during dry periods. These all combined to contribute to increased fire intensity in western forest.

In its study of *"Western National Forests. A Cohesive Strategy is Needed to Address Catastrophic Wildfire Threats."* GAO (1999) agreed with Belsky and Blumenthal (1997), recognizing the role of livestock and fire suppression in the decline in forest health including increased incidence and areas of damage by insects and disease as well as large increases in noxious weeds. In their report, they provide a map showing the areas of the west in which forests experienced frequent fires. None of these areas occurred in Northern Utah (see Appendix I). They also point out that in forests at higher elevations in more moist environments dominated by lodgepole pine, fires historically occurred at 40 to 200 year intervals which killed nearly all the trees in the stand.

Wadleigh and Jenkins (1996) studied the fire history in the T.W. Daniels Experimental Forest in the Logan Ranger District, northern Utah. They state up front that, "Absence of natural fire in wildland ecosystems, due to removal of fine fuels by livestock, reduction in Native American ignitions, and a suppression policy instituted in the early 1900's has led to extensive alterations in natural vegetative succession patterns." They cited literature for fire return intervals in spruce-fir of 50 to 130 years and in Colorado subalpine fir forests of around 200 years. Comparing pre-settlement (1700 – 1855) to settlement (1856 – 1900) and suppression periods (1910 to the present), they studied fire scars to determine a fire history of the T.W. Daniel Forest.

Presettlement fire intervals for spruce-fir produced no evidence for fire for the 155 year period. Lodgepole pine had a mean fire return interval of 39 years pre-settlement, while no fire evidence was found in aspen during that period. During the settlement period, fires from sheepherders and loggers increased the fire frequency radically with the overall area experiencing an average fire return interval of 4.9 years. During the suppression period, no fires were documented. It should be noted that a fire did occur from a hunter in the T.W. Daniels Forest ca 1987 and that area is still barren and lifeless with little or no re-establishment of herbaceous vegetation due to livestock grazing (personal observation, Dr. John Carter).

Management

The GAO report points out that the Forest Service lacks a cohesive strategy for addressing the problem of reducing fuels and this will result in large areas of the West remaining susceptible to catastrophic wildfires after 2015 and current plans to spend $12 billion to reduce fuels are carried out. Nearly a quarter of the currently designated high hazard areas will not be addressed due to agency procedures that reward managers for the highest number of acres treated, not necessarily treating those areas with the highest hazard while costs of doing so continue to escalate. Forest Service Officials reviewing the GAO report concurred with its conclusions. In 1995 the Forest Service announced its intention to refocus its fire management program to reducing accumulated fuels and in 1998 announced that it was prioritizing funds appropriated for fuels reduction to focus on high-risk urban interface areas, areas adjacent to and within wilderness areas and lower costs of suppressing wildfires by restoring and maintaining fire-adapted ecosystems. In 1998, Congress authorized the Joint Fire Science Program to develop consistent information on accumulated fuels and ways to reduce them.

They recommend the Forest Service develop a cohesive strategy for reducing and maintaining accumulated fuels on national forests of the interior West at acceptable levels. That strategy should include specific steps for acquiring data and assessing performance, reconciling fuel reduction strategies with other objectives and changing contracting procedures to better accomplish fuel reduction goals.

Bartos and Campbell (1998a) provide five risk factors for aspen dominated landscapes. These include (1) conifer cover >25%, (2) aspen canopy cover <40%, (3) dominated by aspen trees >100 years of age, (4) <500 stems per acres between 5 and 15 feet tall and (5) sagebrush cover >10%.

Mueggler (1989) provides a management model for addressing aspen deterioration. This model is reproduced in Appendix I. It is an iterative process that addresses important factors such as the presence of and growth status of conifers, age and condition of aspen stands, status of grazing or browsing. It provides a logic to follow for determining proper management which includes eliminating livestock.

Conclusion

It is a fact that livestock have altered forest stands and their understories in the interior West. The most recent studies have clearly shown that aspen stands in the Interior West are deteriorating and most are affected by the presence of livestock - not climate, fire or wildlife. This is recognized by scientists working for the Forest Service, Bureau of Land Management, the Government Accounting Office and the Forest Service itself. The evidence is clear, while fire suppression has played a role in some areas, the role of livestock cannot be ignored. It is also a fact that fire is not necessary for aspen regeneration as the research has shown. Further, documentation provided by GAO, Forest Service Scientists and others have shown that livestock create condition favoring establishment of conifers by eliminating understory herbaceous vegetation which suppresses establishment of conifers through competition. This dynamic is true in aspen as well. So, while conifer invasion is a threat, the underlying causes of this succession are livestock and perhaps, fire. Forest Scientists have provided management guidelines that in every case call for controlling browsing.

The GAO has documented that in northern Utah, the fire frequency is long and our forests are not in the high hazard category. Research in the area has documented that aspen seldom burn. The GAO has also recognized and Forest Service officials acknowledged that the current management system in place in the Forest Service provides incentives to engage in fuel reduction projects based on acres treated, not in the areas of highest hazard. This is based on funding mechanisms that establish priorities that are not based on ecological or forest health needs, but management incentives.

Annotated References Cited

Bartos, Dale L., James K. Brown and Gordon D. Booth. 1994. Twelve Years Biomass Response in Aspen Communities Following Fire. Journal of Range Management 47:79-83.

This study continued earlier work on Breakneck Ridge in the Gros Ventre Range in northwestern Wyoming to evaluate changes in vegetation following a prescribed fire in aspen. Plots were located in 10 aspen clones, nine of which burned with one unburned control. Sucker (stems <2m height) densities in the control ranged from 8,500/ha initially to a maximum of 18625/ha after three years and declined to 5,150 after 12 yeaars. The low intensity burn area contained 4,000/ha prior to burning. This increased to a maximum of 17,727 two years following burning and declined to 1,518 at 12 years after burning. The moderate intensity burn contained 5962/ha prior to burning, increased to 30,692 two years after burning and declined to 1,854/ha 12 years following the burn. The high intensity burn contained 8,417 suckers/ha prior to burning, increased to 36,458 two years after burning and declined to 2,400/ha 12 years following burning. The burned areas declined in sucker numbers from 29% to 38% after 12 years, while the control declined 39%. The authors attributed the decline in control area numbers due to elk browsing due to its location in close proximity to the burn area. The results of this study reflected similar results cited where sucker numbers declined below pre-burn levels, but biomass was higher.

While cattle grazed the area three out of four years, the area did not seem overly impacted by this grazing and the cattle seldom appeared to use the suckers. The original objective of producing more suckers than the elk could suppress was not realized [remember 2,000 to 5,000 elk use the elk winter range and are fed here]. In this case, fire treatment may have hastened the demise of the aspen. Other prescribed burns in the area were considered successful, but were not as heavily browsed by elk.

Undergrowth vegetation production was dominated by forbs before and after the treatments. Before burning forbs were 66%, grasses 21% and shrubs 13%. For the burn areas, forb increased rapidly during the first three years to a range of 82% to 94% of production. The greatest portion of this increase was from fireweed. This represented a doubling of initial biomass for the treatments, while the control area experienced a 25% increase during the same period. At the end of 12 years, total biomass in the treated areas was not significantly different from the control. In addition, in the treated areas, the percent grasses were 20% or less and shrubs 5% or less which were about half the values for the control and pretreatment measures. Livestock grazing pressure during the study may have distorted the observed production values, especially for grasses. Figure 1 showing the trend in understory vegetation is shown below.

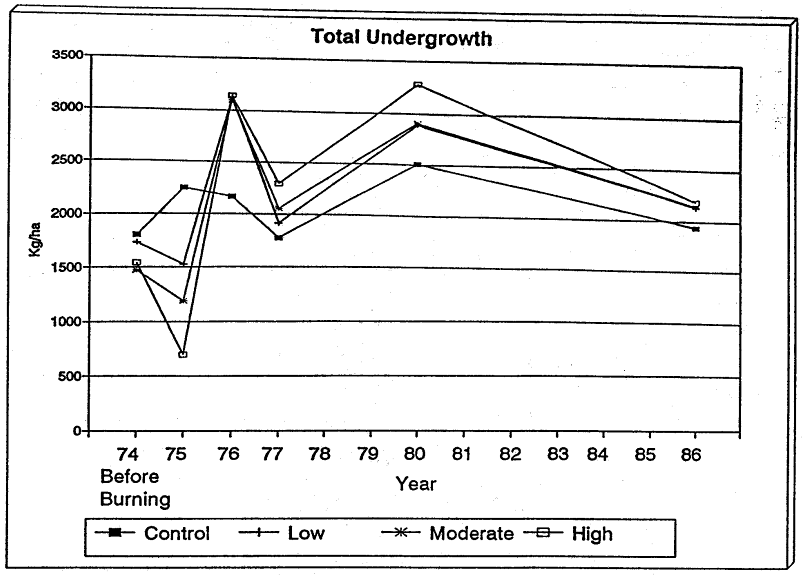


Fig. 1. Total undergrowth production for sampled years during a 12-year time span following burning in 1974 at 3 burn severities.

Shrubs were harmed by burning and did not regain pre-burn production levels even after 12 years. Burn severity did not significant. Snowberry production was reduced to half or less of pre-burn levels, for the high severity and moderate severity burns it was as low as 20% of pre-burn levels. Wild rose and aspen suckers were producing about the same as preburn levels, except at the high intensity burn site which was about half for the aspen.

The authors "question the continued use of fire to regenerate aspen stands that are subjected to heavy ungulate use. Such action could speed the elimination of aspen stands under these conditions."

Bartos, Dale L. and Robert B. Campbell, Jr. 1998a. Decline of Quaking Aspen in the Interior West – Examples from Utah. Rangelands 20(1):17-24.

Bartos and Campbell analyzed distribution of aspen in Utah National Forests. They found that of 2,100,000 acres that contained aspen, most has been converted to conifer and sagebrush, leaving 800,000 acres today. This represents a 60% decline in aspen cover across the six National Forests in Utah. They attribute loss of aspen to a combination of successional factors, fire suppression and long-term overuse by ungulates. [overuse by ungulates didn't occur prior to introduction of livestock, otherwise the larger extent of aspen documented wouldn't have occurred in the first place.] They state' "Changes in the abundance of aspen dominated landscapes have occurred over the past 125+ years partly as a result of livestock grazing, wildlife use and a reduction in fires. The historical fire regime was altered in the mid-1800's after European settlement. Fire exclusion resulted from a combination of excessive grazing, timbering, and people extinguishing wildland fires. Grazing removed the fine fuels which generally carried the fires."

For every 1,000 acres of aspen that convert to conifer, between 250 and 500 acre-feet of water is transpired and not available for streamflow or undergrowth production and an estimated 500 to

1,000 tons of undergrowth biomass is not produced. Further, numbers and kinds of plants and animals in the area decline appreciably. They provide five risk factors for aspen dominated landscapes. These are: (1) conifer cover >25%, (2) aspen canopy cover <40%, (3) dominated by aspen trees > 100 years of age, (4) aspen regeneration <500 stems per acre (5 – 15 feet tall), or (5) sagebrush cover >10%. They present photographic evidence of livestock preventing regeneration of aspen in fenceline contrast photos which show previously burned and logged area that in the presence of livestock is barren and not regenerating, but in the area where livestock are excluded, dense regeneration is evident. They state, "Actions (treatments) to induce suckering must not be initiated until excessive browsing is controlled."

Bartos, Dale L. and Robert B.Campbell, Jr. 1998b. Water Depletion and Other Ecosystem Values Forfeited When Conifer Forests Displace Aspen Communities. Proceedings of American Water Resources Association Specialty Converence, Rangeland Management and Water Resources. American Water Resources Association, Herndon, Virginia TPS-98-1. 474 p.

Application of transpiration rate studies for aspen and conifer trees provided a basis for estimating the water losses due to replacement of aspen with conifer. A statewide survey of all Utah woodlands revealed that about 2.9 million acres of forested habitat have aspen present, but only about 1.4 million acres of these are dominated by aspen. The remainder are classified as conifer forests.

The authors point out the various ecosystem values of aspen including important water yields, rich biodiversity, luxuriant undergrowth, excellent watershed protection, aesthetics, recreation, favored wildlife habitat for big-game and non-game species, valuable livestock forage and wood fiber. These aspen systems have been affected in a major way by fire control and livestock grazing. A fire history study indicates that during the 400 years prior to settlement, fire-free cycles ranged between 20 and 60 years, increasing as elevations increased. They predict that if these conditions continue, most aspen will be replaced by conifers, sagebrush or other shrub communities. Treatment alternatives mentioned include fire, cutting, fencing, spraying, ripping and chaining. They caution, however, that treatments must be pursued with caution, especially due to excessive animal pressure. Clones that are burned and then repeatedly browsed usually only hasten their demise. Therefore, treatments to induce suckering must not be initiated before relief from excessive browsing is obtained.

Various studies cited show declines of aspen due to grazing and fire suppression of near 50 % during the recent past. This includes a 50% decline in Utah since settlement, 47% in the Beaverhead National Forest Gravelly Range in Montana during a 45-year period between 1947 – 1992 and others which indicate similar patterns of decline across the West. Aspen clones that are suggested to have persisted on the same sites since the Pleistocene have been eliminated in the last 150 years.

Using figures from research by Gifford et al (1984) of 2.83 inches of water lost when fir forests replace aspen and 7.32 inches lost when spruce replaced aspen, the authors calculated that 250 to 500 acre-feet of water/1,000 acres was lost through transpiration annually, depending on the conifer species replacing aspen. Since about 1.5 million acres of aspen have been converted to conifers in Utah, this translates to an annual loss of water for streamflow and plant production of 375,000 to 750,000 acre-feet per year.

Using figures for undergrowth production in aspen (1,500 lb/ac) as opposed to conifer forest (200 lb/ac), a difference of approximately 1,300 lb/acre, this calculates to a loss of understory vegetation of 975,000 tons of herbaceous production per year.

Several authors cited have shown that aspen has biodiversity second only to riparian areas. Bird diversity and density was greater in aspen than conifers and bird species diversity increased as the size of aspen stands increased. Plant species occurrences in aspen understory (approx. 30) are nearly double those of conifer forests.

Bartos, Dale L. and Walter F. Mueggler. 1979. Influence of Fire on Vegetation Production in the Aspen Ecosystem in Western Wyoming. North American Elk Ecology, Behavior and Management. Mark S. Boyce and Larry Dl. Hayden-Wing eds. University of Wyoming, Laramie, Wyo.

One hundred and sixty hectares of aspen and 300 ha of adjacent sagebrush-grass vegetation on the Gros Ventre elk winter range were burned to improve forage production and rejuvenate the decadent aspen. Due to variations in fuel load and moisture, the burn was uneven, with high intensity and medium intensity burns. These areas were monitored prior to and for three years following the burn. Data were collected for forage production and aspen regeneration.

Total understory production on the control area varied during the four years of measurement, but changes were not significant, ranging between 1,770 kg/ha and 2,246 kg/ha. The moderate intensity burn decreased from 1,379 kg/ha pre-burn to 880 kg/ha the first year following the burn and then rebounded to 2,885 kg/ha the second year. The High intensity burn decreased even more the year following the burn. It decreased from 1,776 kg/ha before to 473 kg/ha after, but then increased to 3,717 kg/ha two years after the burn. Before burning, annuals composed about 10% of understory vegetation. On the moderate intensity burn this increased to 35% the first post-burn year and 60% on the high intensity burn. The annuals retained dominace during the three-year monitoring period.

Aspen sucker numbers in the control area ranged between 10,000 and 20,000 during the 4-year period. Most were less than 1 meter high and were suppressed by a combination of elk browsing and the aspen overstory [note: it is mentioned that high levels of cattle grazing affected understory production in 1997 – this may indicate that elk were not the only factor suppressing aspen, certainly other studies by the authors have documented cattle impacts on aspen regeneration]. Initial high numbers of suckers produced on the moderate intensity burn were 27,000/ha the first year, 66,000/ha the second year, but declined to 30,000 the third year. On the high intensity burn, sucker numbers reached 30,000 during the second year and remained at that level the following year. After three years, both the moderate and high intensity burns resulted in about 30,000 suckers/ha.

Belsky, A. Joy and Dana M. Blumenthal. 1997. Effects of Livestock Grazing on Stand Dynamics and Soils in Upland Forests of the Interior West. Conservation Biology 11(2):315-327.

This review article investigates the causes and effects of fire history in ponderosa pine and mixed conifer forests of the interior west. It points out that these forests were historically widely-spaced fire tolerant trees underlain by grass and that recent "forest health" problems characterized by dense stands of fire sensitive and disease susceptible trees have been mainly laid at the feet of fire suppression and selective logging of fire-tolerant trees while a third factor, livestock grazing, is seldom discussed.

The authors cite literature as early as the 1920's that suggested livestock played a role in altering these forests. Their review of livestock grazing effects focuses on literature for the "more arid low and mid-elevation forests of the western interior United States, which include forests from Washington south to New Mexico and from the Rocky Mountains west to the eastern Cascade-Sierra Nevada Range."

In presettlement times these forests were composed of widely spaced trees growing in even-aged and uneven aged stands with understories of grasses, forbs and shrubs. On drier sites at low elevations and south facing slopes, the forests were dominated by widely dispersed ponderosa pine. On north-facing slopes, wetter sites and sites at mid-elevation were dominated by Douglas fir, western larch, grand fir and white fir. These mature forests were altered periodically by intense fire, causing them to be opened up and replaced by ponderosa pine and western larch which were maintained for long periods by low-intensity ground fires that eliminated the more fire-sensitive fir seedlings. At higher elevations, mature forests were dominated by subalpine fir and mountain hemlock.

Pre-settlement, these mature trees were maintained at low densities by competitive exclusion of tree seedlings by dense understory grasses and thinning of understory trees by frequent low-intensity ground fires. These fires were ignited by lightning and Native Americans and were fueled by grasses, forbs, low shrubs and pine needles. They were cool, slow burning and non-lethal to larger fire-tolerant trees with their thick bark such as Douglas fir. Seedling and saplings of ponderosa pine and other species suffered high mortality during these fires. Mean fire return intervals of these low-intensity fires were 5 – 12 years across the west, ranging from 4-5 years in the Southwest, and in the northern Rockies 5-20 years in ponderosa pine stands and 15-30 years in mixed conifer stands.

As settlement of the West occurred, forest changes occurred including increases in tree density, insect and disease, fuel buildup and increased fire intensity. Early authors have suggested these changes began shortly after livestock were introduced into these areas. "As the numbers of livestock increased the biomass and vigor of the grasses and sedges they grazed declined.." This reduced the competitive dominance of the understory and allowed more tree seedlings to become established, thus generating thickets of saplings and pole-sized trees. Livestock reduced the frequency of surface fire by consuming the herbaceous vegetation which would otherwise have become a source of fine fuels.

These effects combined with Agency fire prevention efforts increased densities of trees. These more dense, shadier forests allowed establishment of more shade-tolerant and fire-sensitive species such as Douglas fir and white fir. As a consequence, forests shifted from fire-tolerant species such as ponderosa pine to fire-sensitive species. During dry periods, these densely spaced young and larger trees became stressed for water and increasingly susceptible to a variety of insect and disease infestations. Higher tree densities have led to more frequent and widespread disease outbreaks. As mortality increases, fuel loads increase. Examples of forests where fuel loads have increased by a factor of 10 during the fire suppression period are given.

Four case studies on grazed and ungrazed forest stands provide further insight into the effects of livestock grazing on stand dynamics. Isolated plateaus in central Washington were studied. One had never been grazed by livestock, the other had been grazed for 40 years. Neither had ever been logged. The ungrazed forests were covered with open, park-like ponderosa pine and mixed conifer forest. There was low tree regeneration and thick, lush grasses in the understory. The grazed forests had sparse grass understory and 8000 ponderosa pine, Douglas fir and western larch saplings and seedling per hectare. Since neither area had burned in 125 years and except for livestock grazing, other conditions were similar. Another case study in Utah compared two adjacent mesas, one of which was grazed and the other ungrazed. This study showed an increase in tree recruitment of 10 times greater on the grazed mesa compared to the ungrazed mesa. Tree recruitment on the grazed mesa corresponded to livestock grazing pressure, with the highest recruitment occurring during the heaviest period of grazing. As grazing was reduced, tree recruitment declined and when grazing was eliminated, tree recruitment returned to the low rates that occurred prior to grazing. Because fire had not occurred to thin the stands on the ungrazed mesa, the vigorous understory vegetation was determined to be the factor inhibiting tree recruitment.

The authors cite exclosure studies in these forests demonstrating that livestock substantially reduce vegetative cover of herbaceous vegetation, especially native grasses. This reduced plant litter and ground cover and associated soil compaction which decreases water infiltration, increases erosion rates and destabilizes soils and nutrient cycles. This leads to increased water stress and tree mortality during dry periods contributing to increased fire intensity in western forests.

Carter, John G., Brandon Chard and Julie Chard. 2000. Analysis of Ground Cover in Forest Openings in the Bear Hodges Analysis Area. Willow Creek Ecology, Inc. Mendon, Utah.

Carter, John G and Brandon Chard. 2001. An Assessment of Upland and Riparian Condition for Rich County, Utah BLM Lands. Western Watersheds Project Utah. Mendon, Utah.

GAO. 1999. Western National Forests. A Cohesive Strategy is Needed to Address Catastrophic Wildfire Threats. Report to the Subcommittee on Forests and Forest Health, Committee on Resources, House of Representatives. United States General Accounting Office GAO/RCED-99-65

GAO recognizes that the National Forest of the western United States have become much more dense, with fewer large trees and many more tightly spaced small trees and underbrush. They state that tree stands in the interior West differed from those found elsewhere due to the dry climate and varied elevations. In this region, frequent, low-intensity ground fires removed undergrowth and smaller trees from these areas. In recent years, changes in tree stand density, greater percentage of fire-tolerant species, overall species composition, insect and disease have led to concerns over forest health and the ability of the Forest Service to meet its mission of multiple use of recreation, rangeland, timber, watersheds, water flows, wilderness, wildlife and fish and protection of the lands' undiminished ability to produce these uses for future generations.

The Forest Service has estimated 39 million acres are at high risk of catastrophic wildfire due to fire suppression efforts which have allowed accumulations of high fuel levels. In 1997 it announced a goal of improving forest health through monitoring, increasing the number of acres on which fuels are reduced and restructured its budget to provide funds for those efforts. Congress authorized and funded a multi-year effort to better assess problems and solutions.

GAO provides maps of "frequent fire interval" forests which occurred at the warmer, lower elevations with fire return intervals of 5 to 30 years before settlement. These frequent fires kept the forests clear of undergrowth by consuming largely grasses and undergrowth. The figure showing these areas is reproduced on the following page. In the cooler, more moist forests at higher elevations which are generally dominated by lodgepole pine, fires historically occurred at 40 to 200 year intervals which killed nearly all the trees due to the more dense stands.

GAO points out that because the Forest Service lacks a cohesive strategy for addressing barriers to improving health of the national forests by reducing fuels, efforts may leave large areas of the West still susceptible to uncontrollable wildfire after 2015. Some of these barriers are that prescribed fires may get out of control, smoke produced can cause significant air pollution, and mechanical methods have institutional problems. These include a lack of contracting mechanisms that allow removal of timber with little commercial value and incentives focus on areas and acreage that may not present the highest fire hazards. Others are the costs which have risen as more fuels have accumulated and fires have increased in intensity. These costs have increased 70% in seven years to $661 million annually. Forest Service officials agree that the increased fire suppression efforts will not be successful and that large, intense wildfires are generally impossible for fire fighters to stop.

In 1997, the Forest Service adopted recommendations to increase the number of acres on which fuels are reduced to 3 million annually by 2005 to run until 2015. This will fall 10 million acres short of the estimated 39 million high hazard acres. The Joint Fire Science Program was authorized by Congress in 1998 to develop consistent information on accumulated fuels and ways to reduce them. This process will take up to 10 years and that is added to time required to modify Forest Plans to incorporate changes.

The Environmental Protection Agency and Forest Service are involved in a 3-year experiment to reconcile controlled burning and air quality standards. Mechanical harvesting has adverse effects on wildlife habitat and water quality in many areas which makes large-scale timber harvest infeasible. However, because the timber sale program provides funds for other activity, commercially valuable lands may be harvested while less commercially valuable lands with greater fire hazards may not be addressed. "Currently, managers are rewarded for the number of acres on which they reduce fuels, not for reducing fuels on the lands with the highest fire hazards."

GAO estimates that the cost of reducing fuels on the 39 million at-risk acres could be $12 billion between now and 2015. Forest Service officials agreed with a 1997 obseravtion by the Secretary of the Interior that efforts to reduce fuels will have to be repeated three to five times over several decades. They recommend the Forest Service develop a cohesive strategy for reducing and maintaining accumulated fuels on national forests of the interior West at acceptable levels. That strategy should include specific steps for acquiring data and assessing performance, reconciling fuel reduction strategies with other objectives and changing contracting procedures to better accomplish fuel reduction goals.

In 1997, the Forest Service identified a goal of achieving healthy and sustainable ecosystems throught conserving and restoring ecosystem structures. A specific objective was restoring or protecting the ecological conditions of forested ecosystems to maintain their components and their capacity for self-renewal. Forest Service scientists believe that a useful method of assessing forest health is comparison with the historical range of variability. "Examining the historical range of variability of a forest's tree stands is believed to be an especially useful starting point for analyzing the forest's overall health and functioning because (1) tree stands are the defining biological structures of forested versus other kinds of ecosystems and (2) the conditions of these structures greatly determine the capacity of a forest not only to produce timber, but also to maintain soils, watershed conditions, wildlife and fish habitats.

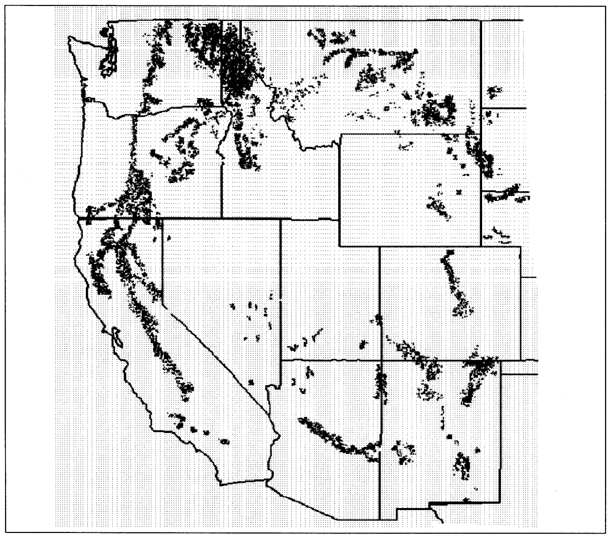
The Forest Service cites increased density of stands, accumulations of dead materials on the ground as important symptoms of poor health. Examples are given where tree stand density has increased over 50% of national forest lands with levels of increase in stems of over 15 times in the past century. Numerous figures are cited regarding increased incidence and areas of damage by insects and disease as well as large increases in noxious weeds. GAO summarizes the causes of these problems as due to extensive livestock grazing beginning in the 1800's which eliminated much of the grass that historically carried fire through the forest's undergrowth, timber harvest practices of selective logging larger trees or clearcutting and increases in nonnative plants, insects and diseases. These factors generally changed the forest's ecologies and the primary factors compounding the damage was fire suppression.

According to the Fish and Wildlife Service, of the 146 threatened, endangered, or rare plant species found in these states for which there is conclusive evidence on fire effects, 135 species benefit from wildfire or are found in fire-adapted ecosystems.

According to the Forest Service, virtually all of the 39 million acres of the lands threatened by uncontrollable, catastrophic wildfire are located in the lower-elevation, frequent fire forests of the interior West historically dominated by ponderosa pine. "These forests are particularly susceptible to such fires because, as stated in a 1995 internal agency report, far more cycles of fire (up to 10) were suppressed in these forests than in the higher elevation, lodgepole-dominated forests – where generally only one or no fire cycle was suppressed." Areas experts outside the Forest Service have identified as at medium or high risk were also shown. Those at medium risk are included because additional fuels can accumulate so over time they become high risk.

In 1995, the Forest Service announced its intention to refocus its fire management program to reducing accumulated fuels. In fiscal 1998 it announced that funds appropriated for reducing fuels would be prioritized to protect high-risk urban interface areas subject to frequent fires, areas adjacent to and within wilderness areas and lower expected long-term costs of suppressing wildfires by restoring and maintaining fire adapted ecosystems. Several reports have been issued

Figure 1.2: Location of Frequent Fire Forests in the Interior West



by the Forest Service to address forest health and reduction of fuels.

The Joint Fire Science Program previously mentioned called for the Forest Service and Interior Department to conduct research and analysis to better understand the location and extent of problems with accumulated fuels, effects on other resources of different approaches to reducing these fuels, relative cost-effectiveness of these approaches, interagency approaches to monitoring and reporting efforts to reduce fuels.

Gifford, Gerald F., William Humphries and Richard A. Jaynes. 1984. A Preliminary Quantification of the Impacts of Aspen to Conifer Succession on Water Yields – II. Modeling Results. Water Resources Bulletin. American Water Resources Association (20)2:181-186.

Using heat pulse velocity techniques, water losses from aspen and subalpine fir were measured in replicated trees for one year. These data were used to modify the plant activity index and crop coefficient within the ASPCON model. Results of modeling indicated net losses to streamflow when aspen were replaced by subalpine fir. The losses were nearly three times greater for subalpine fir than for aspen.

Holechek, Jerry L., Rex D. Pieper and Carlton H. Herbel. 1998. Range Management Principles and Practices. Prentice Hall, 542 p

This range management text provides detailed information regarding the use of areas at various distance from water and on different slopes by livestock.

Kay, Charles E. 2001. The Condition and Trend of Aspen Communities on BLM Administered Lands in Central Nevada – with Recommendations for Management. Final Report to Battle Mountain Field Office, Bureau of Land Management. Battle Mountain, Nevada.

This report summarizes field studies in the Shoshone, Simpson Park, Diamond, Desatoya and Roberts Mountains on BLM lands in central Nevada. Aspen in these areas are found to be in poor condition and many stands have not successfully regenerated in 100 years or more.

No evidence of elk presence was found in or near any of the stands, so elk were not contributors to the problem. Forest succession was not a problem as conifer invasion had not taken place in the communities studied. Other than pinyon pine, conifers were absent from the study area. Kay observes that where aspen in central Nevada has been protected from grazing, aspen has maintained its position in the vegetation community and, in fact, has actually replaced sagebrush, contrary to the opinion of some that say sagebrush naturally replaces aspen. He cites other exclosure studies that have found that aspen stands have expanded and eliminated sagebrush.

Exclosure studies have also suggested that climate has little impact on aspen in central Nevada. Aspen inside exclosures regenerated without fire or other disturbance while aspen in adjacent, unprotected areas did not. Numerous papers are cited that demonstrate that climatic variation does not account for observed declines in aspen.

Fire exclusion was examined. It is noted that BLM has suppressed fires for a long period and none of the study areas contained evidence of fires with few exceptions. In fact, only a few out of the hundreds of clones studied had experienced fire during the past 20 years. Aspen age data suggest that few aspen stands in central Nevada have burned during the past 100 years. He points out that while the burned stands did regenerate, in all cases where aspen were protected from grazing, aspen regenerated. So, whle fire can benefit the species, aspen declines cannot be attributed to absence of fire.

Exclosure data indicated that herbivory hah a major influence on aspen stem dynamics and understory composition in central Nevada. Most herbivory was from livestock. Pellet counts were used and showed that 59.3% were from domestic sheep, 40.2% from cattle and 0.4% from deer. Exclosures that exclude cattle but not deer including canyons closed to livestock had all aspen stands that regenerated. When fallen trees blocked livestock access, aspen were able to regenerate in the protected spaces. Reductions in livestock numbers also resulted in aspen regeneration.

Distance to water and slope were also factors that related to aspen regeneration or the lack of regeneration. Cattle use is generally related to distance from water and slope. Steeper slopes or areas further from water receive less use. Aspen stands further from water and on steeper slopes were in better condition than those nearer water or on more gentle slopes, again indicating that grazing by livestock was the operative factor causing declining health of aspen clones.

While Kay cites other research indicating that wildlife have impacts on aspen regeneration, he states that in all cases where aspen is protected, it successfully regenerates and formed multi-aged stands without fire or other disturbance. He concludes by saying, "The single, stem-aged stands seen in central Nevada and found throughout the West are not a biological attribute of aspen, but a result of excessive ungulate herbivory. … In central Nevada, however, domestic livestock are the predominate ungulate herbivore."

Kay, Charles E. and Dale L. Bartos. 2000. Ungulate Herbivory on Utah Aspen; Assessment of Long-term Exclosures. Journal of Range Management 53:145-153.

Krebill, R.G. 1972. Mortality of Aspen on the Gros Ventre Elk Winter Range. USDA Forest Service Research Paper INT-129. Intermountain Forest and Range Experiment Station, Ogden, Utah.

The 84,000 acre Gros Ventre elk winter range in the Teton National Forest was thought to contain between 2,000 and 5,000 elk, which were fed at supplemental feeding stations during winter.   Obviously deteriorating aspen stands coupled with signs of elk damage from browsing, highlining and barking occurred in areas close to winter feeding grounds. [*The study did not emphasize cattle grazing, but in one casual mention near the end of the paper was mentioned along with elk, deer, moose, rodents as causing browsing damage. This lack of attention to livestock is found in many papers that find big-game as culprits without addressing the competition effect of livestock which decrease available forage for wildlife and cause wildlife to excessively browse areas which may not have been historically over browsed*.]

100 sample plots were placed in the 3,330 acres of aspen so that one plot was in each 33.3 acres. Stand and understory data were collected. The majority of trees were in the 80 – 120 year class (71%). Across all sample locations, the mean number of live trees were 466.4 per acre, dead trees 336.8 per acre and those that died in the current year 17.1 per acre. Of the live trees, 42% were less than 6" DBH, 55% between 6.1" and 12" and 2% greater than 12.1". Aspen sprouts were not included in the populations figures, but were present at 653/acre. Most showed indications of being browsed down to less than 2 feet in height annually. An annual mortality of 3.6% per year was calculated, indicating that aspen populations would decline by 2/3 in 30 years. Ranges of mortality cited were 1% per year in Colorado and 2.7% per year in Utah's Ephraim Canyon. These rates are two to four times higher than those found in similar studies in New York. [*It could be suggested that the absence of livestock grazing in aspen in New York might account for some of the differences.*] Occurrence of sagebrush and Balsomorhiza sagittata in aspen understory along with conifer saplings indicated a state of browsing disclimax. Fungi and insects were diagnosed as the major cause of death of mature trees and were suggested to invade trees injured by elk.

McDonough, W.T. 1979. Quaking Aspen – Seed Germination and Early Seedling Growth. USDA Forest Service Intermountain Forest and Range Experiment Station. Ogden, Utah.

Suckering of aspen for regeneration has been widely studied, but propagation of aspen by seed has been considered of minor importance. Reproduction of seed has many important attributes including assuring genetic variability, widespread dissemination and new colonization by wind dispersal. Yearly seed production of mature trees is estimated at 1.6 million. Seed capsules were collected from two healthy and two deteriorating aspen clones in Logan Canyon in the Wasatch National Forest to study the effects of differences in ability to germinate under varying environmental conditions.

Germination tests at a range of temperatures revealed between 80 and 100% of seeds were able to germinate. These numbers declined as temperatures reached around 30º C and became very low at 40º C. There were no significant differences between healthy and deteriorating clones. Germination success declined under increasing water stress, ranging from 97% success at a water potential of –0.6 bars to 0% at –7.7 bars. The implications of this regard the effects of direct solar insolation on dark soil surfaces and the raising of soil temperatures above atmospheric and limit seedling establishment. Soil drying under these conditions would increase water stress and also lower germination success and ability of shoots to grow.

Because of the exacting requirements for germination and growth, the author suggests that seeding as a management tool might be too difficult and expensive and have doubtful value. It is suggested that under favorable weather and site conditions, natural seeding and establishment might be sufficient to provide the benefits of reproduction by seed.

Mueggler, Walter F. 1989. Age Distribution and Reproduction of Intermountain Aspen Stands. Western Journal of Applied Forestry 4(2):41-45.

Stand age and sucker reproduction was measured in 713 aspen-dominated forest plots on nine National Forests in Utah, SE Idaho and western Wyoming. Ninety-five percent were dominated by mature or over-mature trees. Approximately one-third of the pure stands, not invaded by conifers, may experience regeneration problems because they contain less than 500 suckers per acre.

Aspen woodlands are important for wildlife, fuelwood, flakewood, scenic beauty and summer range for livestock.

Aspen is a clonal species that regenerates almost exclusively from root suckers. It usually reproduces vigorously following fire. This method of reproduction gives it an advantage over conifers, which rely on seed for reestablishment. Aspen is a relatively short-lived and shade-intolerant species that rapidly declines in abundance as conifers regain dominance in the overstory. Because of the reduced incidence of fire, many of these even-aged aspen stands are gradually reverting to conifer dominance.

As much as one-third of the aspen groves and woodlands in the region are believed to be relatively stable communities that occupy sites unsuited for conifers or remote from a conifer seed source. The presence of both even-aged and uneven aged stands in these areas suggests that under some conditions, aspen can persist as a "stable self-perpetuating woodland community without the need for periodic disturbances like fire or clearcutting to stimulate sucker regeneration."

Stand age distribution data from the sites sampled showed that 78% of the stands contained dominant trees older than 80 years. 22% contained dominant trees younger than 80 years. Aspen reproduction data showed 19% with less than 200 suckers per acre, half with fewer than 800 suckers per acre, while 27% contained greater than 2000 suckers per acre. Sucker production was weakly, but positively correlated with herbaceous understory vegetation and negatively correlated with stand age. Aspen reproduction percentiles for all National Forest sites in the study were 33% contained 1482 suckers, 50% contained 812 suckers and 66% contained 412 suckers.

Sixty-two percent of the stands sampled were in the 80 to 120 year age class and only 2% over 160 years. In this and previous studies, only 2 of more than 1500 trees measured were more than 200 years old. Mueggler concluded that western aspen matures at between 60 and 80 years and deteriorates rapidly after about 120 years.

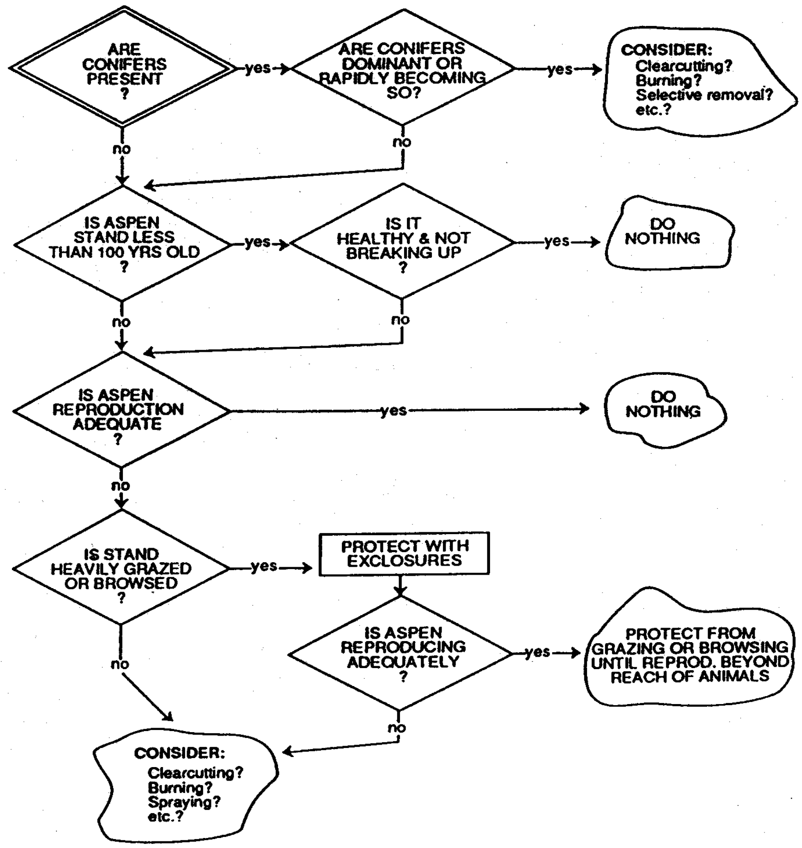
Mueggler states, "This does not necessarily mean, however, that the stands dominated by rapidly deteriorating trees will lose their identity as aspen-dominated communities. This is amply demonstrated by the existence of multi-age aspen communities. Scattered root suckers develop under existing stands, and more are frequently formed as the old canopy gradually breaks up. These suckers have the demonstrated potential to gradually replace a deteriorating even-aged canopy with a multiaged replacement stand."

Mueggler concludes that if while not definitive, the number of suckers in an aging stand in the absence of conifer invasion may indicate the ability of the stand to replace itself. If conifers are invading, the number of aspen suckers is irrelevant and unless wildfire or management activities intervene, the conifers will suppress the aspen. If conifers are not invading, the stand has potential for natural replacement.

While the number of suckers required for stand replacement is not well defined, numbers can far exceed mature tree stocking requirements of 400 to 600 per acre. Other researchers have reported 4,000 to 60,000 suckers per acre following burning, while clearcutting increased has suckers from 930 per acre to 17,800 per acre in northern Utah and as much as 31,000 to 50,000 per acre. These numbers decline rapidly due to disease, browsing and snow breakage is high, reducing numbers to less than 10,000 per acre after periods of a few years.

Based on their analysis, the authors conclude that at least a third of mature and overmature aspen stands in the Intermountain Region which are not being replaced by conifers may also have regeneration problems without some type of management intervention such as burning, clearcutting, herbicide spraying or some other mangement action to alter the control of apical dominance over sucker production. They note, however, that an abundance of suckers does not ensure successful regeneration of the stand if the suckers are unable to grow due to browsing animals, particularly sheep, but also cattle and wildlife.

Management recommendations include two major considerations, the status of aspen to conifer succession and the status of aspen regeneration in deteriorating stands. If the stand is threatened by conifers, the conifers must be reduced by burning, clearcutting or selective removal. If



conifer invasion is not an issue, then conditions must be promoted to encourage growth of the suckers needed to replace the aging trees. They note that burning is not always an option due to the inability of stands to carry a fire. A decision model is provided and included here. In mature stands over 100 years old, if aspen regeneration is inadequate, or less than about 500 suckers per acre, the first question to ask is whether the failure of reproduction is due to browsing or some other cause inherent to the clone. Exclosures are recommended to make this determination. If, after several years, vigorous sucker production is taking place, then the entire clone needs protection from browsing. If suckers are not produced, then other options such as clearcutting, burning or herbicides should be considered.
The figure is reproduced from Mueggler (1989).

Mueggler, Walter F. 1994. Sixty years of Change in Tree Numbers and Basal Area in Central Utah Aspen Stands. USDA Forest Service Intermountain Research Station Research Paper INT-RP-478.

Paired plots of aspen in three locations at the Great Basin Experiment Station on the Wasatch Plateau in Central Utah were measured over 64 years to determine changes in stand characteristics in thinned and unthinned plots. No information was given on the presence or absence of livestock during this time. Thinning consisted of removing dead, depressed and intermediate trees. Results are shown in the following table.

Stand Name	No. Trees/acre at Beginning Age	No. Trees/acre at End of Study (63 years)
Willow Creek Unthinned	2,220 @ 40 years	164 @ 104 years
Willow Creek Thinned	1,458 @ 40 years	282 @104 years
Dusterberg Hill Unthinned	1,037 @ 70 years	54 @ 133 years
Dusterberg Hill Thinned	656 @ 70 years	190 @ 133 years
Potato Patch Unthinned	3,007 @ 50 years	259 @ 113 years
Potato Patch Thinned	1,378 @ 50 years	313 @ 113 years

In each case, thinned stands had more trees per acre than unthinned stands after the 63 year period. Other data collected showed that basal area of the stand peaks around 80 years and declines appreciably by age 100. Stands thinned from below (removing smaller trees) will contain more, but smaller stems at maturity and greater total basal area than those not thinned. Removing 33% of the intermediate and suppressed aspen in the 40-year old Willow Creek Stand resulted in 1.75 times more aspen at age 104 than if thinning had not occurred. At Dusterberg Hill, 47% of the trees were removed at age 70 and the thinned stand at age 133 contained 3.5 times more aspen than the unthinned plot. The Potato Patch stand which was succeeding to white fir at the time of thinning, was thinned at about the same rate as Dusterberg Hill, yet at age 113, there were only slightly more aspen than in the paired unthinned stand.

Mueggler, W.F. and D.L. Bartos. 1977. Grindstone Flat and Big Flat Exclosures – a 41-Year Record of Changes in Clearcut Aspen Communities. USDA Forest Service Research Paper INT-195. Intermountain Forest and Ragne Experiment Station, Ogden, Utah.

This study was conducted on the Beaver Mountain plateau on the Fishlake National Forest in Utah. A history provided shows that deer were abundant in 1865 when Beaver County was first settled. Then the ranges were heavily stocked with sheep and cattle, which overgrazed the range and that factor coupled with unrestricted hunting resulted in a decline in deer numbers to a low in about 1910. Beaver Mountain was placed under National Forest Administration in 1906 and better regulation of forage coupled with enforcement of hunting regulations in 1913 allowed deer numbers to increase. By 1926, heavy use of aspen suckers and palatable shrubs was attributed to high populations of deer and by 1934 aspen regeneration was poor over large areas. Overuse of the livestock summer range was a serious problem by the early 1930's. Cattle and sheep as well as deer were considered too numerous. Proposed reductions in livestock were protested by ranchers who claimed the deer were too numerous and responsible for depleted forage. [*These reports attest to the fact that declines in aspen were related to the combined pressure of livestock and deer, although before livestock numbers were introduced these problems apparently weren't reported*]. This resulted in establishment of study plots in aspen to evaluate the relative effects of deer and cattle grazing on aspen and forage production. Two study plots consisting of small exclosures (30 x 60 m) to exclude all ungulates, a similar one to exclude livestock, but not deer and an adjacent area open to both deer and cattle was monitored. Three-fourths of each exclosure were clearcut to allow measurement of successional change after cutting. Livestock have continued to graze the area during the study period.

Aging of aspen in the study plots indicates that very few aspen were able to escape browsing and become trees from suckers that arose between 1905 and 1934. Sucker occurrence on the uncut plots under use by deer and cattle was persistent over the years, ranging between 3,000/ha and 30,000/ha. Few of those survived to reach the 5.1cm DBH size class by 1975 (41 years later). Clearcutting stimulated sucker production in ungrazed plots to levels 19 to 26 times greater than those in uncut and ungrazed plots. After 8 years numbers surviving were similar between cut and uncut plots that were not grazed. Deer use in the plots reduced sucker numbers to 3% and 10% of the numbers in the ungrazed plots. After 5 years, neither plot contained suckers or saplings. In uncut portions of the plots, suckers continued to occur but were suppressed by browsing. In the cut portions, suckers were present for only a few years after cutting, apparently because the heavily browsed suckers were not able to keep the root system alive.

Effects on understory vegetation after 41 years included an increase to over 10 times the amount of shrubs (rose and snowberry) in the ungrazed exclosures compared to the area grazed by both deer and cattle and over 3 times that grazed by deer. Cattle use hampered total forb production, but deer use did not. Overall production of herbage was greatest on areas closed to cattle, but grazed by deer.

A large burn covering 600 hectares a few miles from the study plots had abundant aspen suckers offer hundreds of hectares. Combined deer and cattle use did not appear to inhibit successful re-establishment of the aspen stands. Several studies cited indicated that management of livestock is essential for regeneration of aspen following burning or clearcutting. These studies also indicated that normal deer populations and appreciable elk browsing did not prevent establishment of a new aspen stand. The authors suggest treating areas of sufficient size to generate sufficient aspen suckers to overcome browsing pressure. They also suggest that smaller areas might fail even if livestock are excluded for 5 to 10 years due to deer being attracted to the available forage.

Schier, George A. 1975. Deterioration of Aspen Clones in the Middle Rocky Mountains. USDA Forest Service Research Paper INT-170.

When fire and other major disturbances are excluded from the environment, aspen clone ramets become mature in 80 to 100 years and then show a rapid decline in vigor with increased susceptibility to disease and insects with age. This study was designed to investigate the ability of overmature aspen to generate suckers and account for the scarcity of regeneration in deteriorating clones compared to the abundant reproduction occurring following logging or fire.

Five deteriorating clones were located and paired with adjacent healthy ones. The location was in the Wasatch National Forest in northern Utah. Deteriorating clones were determined by low densities of living ramets and large numbers of dead stems. Absence of conifers was an important characteristic. Sucker reproduction was measured on 10 m^2 circular plots. In addition, root samples were taken from both types of sites and planted in controlled greenhouse conditions to determine ability to generate suckers. Schier (1975) defined a healthy aspen clone as one having a stem density at least 75% that of fully stocked clones of the same age on similar sites.

A deteriorating clone is characterized by low density of living trees and a large number of dead stems and low density of suckers in the absence of conifers or suppression caused by browsing.

Schier (1975) documented the number of suckers in healthy clones at between 930 and 2,900 per acre while deteriorating clones had 159 to 441 suckers per acre. The authors conclude that stands with less than 500 suckers per acre may have regenerative problems, while those with over 1,000 per acre have the potential to replace themselves.

Basal area of deteriorating clones ranged from 6 to 30% of healthy ones. They were visually distinguishable from healthy clones, being shorter and having poorer form than stems in healthy stands. Excavations during root collections showed that root systems in deteriorating clones were limited in extent, occurring near the isolated living stems. Dead roots were numerous, indicating they were declining in extent. "Even if all suckers in the deteriorating clones escape mortality and develop into mature trees, only a few small areas have the potential for reaching full stocking." Mean density of sucker reproduction was 5260 suckers/ha and 2360 clumps/ha in healthy clones while in deteriorating clones, mean densities were 767 suckers/ha and 528 clumps/ha. Rooting experiments showed no significant difference in ability of the deteriorating and healthy clones to regenerate.

Schier suggested auxin transported from above ground plant parts to the roots inhibits sucker generation. When this auxin supply is inhibited, a hormonal imbalance occurs that enables other hormones such as cytokinins to initiate regenerative processes. When above ground stems weaken and die, the root system dies back due to a lack of photosynthate being furnished to the roots. Residual stems maintain auxin levels in the smaller root system and sucker inhibition continues. Reduced vigor of the clone makes it susceptible to disease and insect attack and unless some roots and above ground stems survive to produce carbohydrates, the clone will die out. Disturbances such as damage to roots by browsing animals, insect and disease and environmental changes can cause shifts in hormones and trigger sucker generation. Schier suggests that differences in genotype susceptibility to disturbances or environmental change may explain why deteriorating and healthy clones occur side by side. He points out that abundant sucker production following major disturbance such as logging or fire that kills most stems within a short time demonstrates that regeneration is usually no problem because the rapid death of stems eliminates apical dominance while the original root system is still capable of producing suckers. He provides examples sucker regeneration under diseased mature trees as a result of leaf blight (Marssonina populi) or insect attacks.

Scheir notes that management to stimulate suckering in deteriorating clones by killing stems using methods such as clearcutting, herbicide spraying or burning. He also notes that important regeneration problems are caused by livestock, wildlife and competing vegetation. Heavy browsing can totally suppress regeneration and speed up succession to conifer or shrub types.

Schier, George A. 1976. Physiological and Environmental Factors Controlling Vegetative Regeneration of Aspen. In: Utilization and marketing as tools for aspen management in the Rocky Mountains. Proceedings of the Symposium p. 20-23. Also USDA Forest Service General Technical Report RM-29, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

This paper reviews the factors important to aspen regeneration. It recognizes the importance of aspen and the importance of root suckering as a regeneration mechanism. It notes that under existing environmental conditions in the Rocky Mountains, aspen rarely reproduces from seed. Several papers are cited that provide evidence that the transport of auxin from aboveground parts to roots suppresses the generation of suckers which arise from meristems on the root system. This is known as apical dominance. As long as the transport of auxin to maintained, suppression continues. Interference with the auxin supply by cutting, burning, girdling or defoliation decreases the auxin concentration in roots, initiating suckers. This effect appears proportional to the aboveground disturbance. Examples of logging in which clearcuts generate the highest numbers of suckers and the number of suckers generated is proportional to the number of stems removed.

"Sucker formation does not require anything as drastic as logging or fire. This is evident from the occurrence of thousands of shoot primordial and numerous suckers in various stages of development on the roots of relatively undisturbed aspen clones … . Elongating suckers also produce auxins which can inhibit initiation of additional suckers. Carbohydrate reserves provide the energy for growth of suckers following the hormonal imbalance that initiates suckering. The density of regeneration is related to the levels of reserves. More energy is required to reach the soil surface from deeper roots, therefore more reserves would be needed for deeper rooted clones as opposed to shallow rooted clones. Repeated destruction of new suckers by burning, cutting, spraying or heavy grazing can exhaust carbohydrate reserves and cause a drastic reduction in sucker production … . Defoliation by insects can deplete root reserves and reduce the amount of regeneration when aspen are cut."

Schier, George A. and Robert B. Campbell. 1978. Aspen Sucker Regeneration Following Burning and Clearcutting on Two Sites in the Rocky Mountains.

Data was collected from four clones each in a controlled burn area on Breakneck Ricge in the Gros Ventre Wyoming and four clearcut areas in the Chicken Creek Watershed of the Davis County Experimental Watershed in Utah. One year following clearcutting, sucker densities ranged from 22,000 to 77,000 stems per hectare. In the controlled burn areas, sucker density ranged between 14,000 to 45,000 stems per hectare. Observations of parent roots and suckers were made to determine differences in root and sucker characteristics as well as browsing impacts. Depth of parent roots producing suckers ranged from 0 to 28 cm. Differences in root depth were observed in both areas that were significant at the 1% level. These differences were suspected to be either genetic or due to site factors including soil characteristis or temperature. Significantly more suckers arose from deep roots on areas where burn intensity was high as opposed to those where it was low, probably due to shallow roots being killed. Although it was postulated that reduction of litter or darkening of the soil surface could have inhibited growth due to higher temperatures as well.

The ability of suckers to establish independent root systems was observed by adventitious roots forming on the shoots and new lateral roots on the parent roots near the suckers. At both sites, there were significant clonal differences in the ability to produce new roots. However, the formation of lateral roots on parent roots near suckers was only significant at the Chicken Creek sites. At the Gros Ventre sites, formation of adventitious roots occurred on between 44% and 74% of suckers with a mean of 65.5%. New lateral roots formed on 37.5% of the sucker locations. At the Chicken Creek sites, adventitious roots formed on between 14 dn 78% of suckers with a mean of 50.5 locations forming new lateral roots on parent roots.

"The condition of the clonal root system is of considerable importance in aspen management because suckers not only are initiated on parent roots but are dependent on them for a period of time afterwards. Shallow rooted clones must be given special consideration because the roots are vulnerable to logging damage. The best time to stimulate suckering by cutting and controlled burning is during ages when clones are making rapid growth. Vigorous clones have abundant small roots and these roots have a high sucker producing capacity. Once regeneration is established, thinning and other treatments that stimulate sucker growth can be used to encourage the development of independent root systems."

Schier, George A. and Robert B. Campbell. 1980. Variation Among Healthy and Deteriorating Aspen Clones. USDA Forest Service Research Paper INT-264.

The authors note that site quality is probably a major factor contributing to the timing and rate of decline of an aspen genotype. Ramets of a clone will probably start deteriorating on a poor site earlier than on a good one. Research from the Lake States was cited which has documented that environmental variables have a significant effect on aspen longevity. The research presented was to determine if there are inherent differences between healthy and deteriorating clones in morphology and capacity for vegetative propagation and if site quality is a factor contributing to deterioration of aspen clones. To test these questions, ten healthy and ten deteriorating clones were examined in the Logan Canyon area of the Wasatch National Forest. Clones were described according to stand characteristics. Environmental variables including physiographic features (slope, aspect, etc.) and soils were analyzed. Root segments were collected for sucker generation ability under controlled greenhouse conditions and suckers were also collected to evaluate the formation of adventitious roots. Sucker cuttings generated from collected roots were grown in controlled conditions in a greenhouse until two years old, then transplanted into a common garden where growth characteristics were observed over a ten year period.

The stand characteristics varied between healthy and deteriorating clones. Healthy clones were younger at an average of 66 years, while deteriorating clones were older at 98.3 years. This reflects the presence of younger age classes in the healthy clones. DBH and total height in healthy clones were 12.98 cm and 14.83 meters, respectively. Deteriorating clones had DBH of 7.1 cm and 8.87 m. Numbers of living stems per ha were 2,735 in healthy clones and 1244 in deteriorating clones. Dead stems per ha were 388 and 535 in healthy and deteriorating clones, respectively, while basal area was 39.04 m^2/ha and 5.04 m^2/ha. High variation between the number of suckers in healthy clones made the difference in numbers of suckers between healthy and deteriorating clones non-significant (healthy clones varied between 1000/ha to 21000/ha, as number of clumps – not stems).

Root suckering tests showed no significant difference between the ability of healthy and deteriorating clones to produce suckers or in sucker growth. ANOVA did show that clone and date were factors affecting ability to sucker or grow. Survival tests of rooted sucker cuttings showed that over 90% survived after two years with no significant difference between healthy and deteriorating clones. Environmental variables that differed between healthy and deteriorating clones were the mean phosphorous concentration and percent silt in the upper soil layer was greater for healthy clones. Since percent silt is an indicator of water-holding capacity of the soil, this indicates that soil water conditions are better in healthy clones.

The authors conclude that to determine whether a clone is deteriorating, evidence of high mortality should be present. Poor stocking is not sufficient evidence because some sites may support relatively few stems and low root density. Poor stocking may also be genotypic. “In other words, inherent characterisitics of a clone, such as the ability to regenerate itself, the pattern of root development, and the ability of suckers to develop independent root systems, could all affect the population structure of clones.”

USDA. 2001. Draft Environmental Impact Statement Wasatch-Cache National Forest. United States Department of Agriculture. Forest Service. Intermountain Region. Wasatch-Cache National Forest, Salt Lake City, Utah.

Draft EIS supporting the proposed revision to the Wastatch-Cache National Forest Plan.

Wambolt, C.L., K.S. Walhof and M.R. Frisina. 2001. Recovery of Big Sagebrush Communities After Burning in South-western Montana. Journal of Environmental Management. 61:243-252.

Because big sagebrush communities are burned with the goal of increasing productivity of understory plants or big sagebrush, this study tested whether those goals were reached on 13 paired burned and unburned sites in southwestern Montana. Big sagebrush communities were estimated to occupy approximately 60 million acres in the west in 1960. Significant reductions in these populations have occurred by burning, herbicides and other methods of removal since then due primarily to its low preference for forage by cattle. This reduction has been negative for many native wildlife species, including the sage grouse. Burning and other treatments have eliminated millions of hectares of this habitat, without the expected increases in herbaceous production. “Where herbaceous production has increased following sagebrush reduction, the cause of the increase is often difficult to determine. In general, changes in grazing management or other improvements accompany the sagebrush treatments.”

The authors cite the paradox that land managers often state objectives of increasing productivity of big sagebrush through prescribed fire when the same practice was used in the past to eliminate sagebrush, while claiming all the values of a mature sagebrush community as their rationale. Numerous cited studies found that big sagebrush recovery took long periods, sometimes as long as 30 years. Heavy browsing was seen to extend this period by suppressing recovery. Sites that were burned up to 32 seasons prior to the study were surveyed for canopy cover, plant density, production of winter forage using a strenuous statistical design.

Overall comparisons showed sagebrush canopy was significantly less on burned sites than unburned controls. Some burns nearly eliminated sagebrush, resulting in levels of 1% to 13% of controls after 9 and 16 years, respectively. On one site big sagebrush was eliminated while its paired control site almost doubled in 15 years. One site did not differ significantly in canopy cover, although the control contained greater cover after 32 growing seasons. Green rabbitbrush was benefited by burning, experiencing increases in cover. Bitterbrush canopy cover decreased on burn areas compared to controls. Heavy browsing affected both controls and treatments and the authors suggest that the loss of bitterbrush in the burns caused heavier browsing of the untreated areas.

Sagebrush density was significantly reduced by burning at all sites compared to controls. Seven of ten sites had more juvenile sagebrush than the burned areas, while the reverse was true for one burned site that occurred on a slope. Significantly more winter forage was produced by big sagebrush in the unburned sites than in the burned sites. This was true even at the oldest site after 32 seasons. Site and temporal variables had no significant correlation to canopy cover or density.

Total perennial grass cover across all sites was not different between burned and unburned areas. Even after 32 years, there was no significant difference. Perennial forb canopy cover response was similar. This research was stated to confirm earlier studies that non-sprouting shrubs like big sagebrush can take longer than 30 years to re-establish to pre-burn condition. No clear short or long term benefit to grasses or forbs could be discerned, while the shrubs used by wildlife are suppressed by burning. The authors conclude that the opportunity to increase livestock forage through prescribed burning of sagebrush communities under similar environmental conditions are minimal.

"Land managers should include all the effects of burning in their decision-making. Burning has often been prescribed for big sagebrush communities without concern for long-term monitoring for potential environmental impacts."

Wadleigh, Linda and Michael J. Jenkins. 1996. Fire Frequency and the Vegetative Mosaic of a Spruce-Fir Forest in Northern Utah. Great Basin Naturalist 56(1):28-37.

This paper analyzes causes and effects of forest health problems in the T.W. Daniel Experimental Forest managed by Utah State University. The authors state up front that, "Absence of natural fire in wildland ecosystems, due to removal of fine fuels by livestock, reduction in Native American ignitions, and a suppression policy instituted in the early 1900's has led to extensive alterations in natural vegetative succession patterns."

Photo evidence from as early as the 1870's showed that early stages of forest succession were more common than they are today. The evidence is that the absence of fire has contributed to a marked alteration of natural vegetation mosaics by favoring woody species such as shrubs and trees over grasses. Fire return intervals of 50 to 130 years were estimated for spruce-fir habitats with subalpine fir forests in Colorado with an interval of around 200 years. In lower elevation aspen and lodgepole pine forests, fire return frequency was higher.

Wadleigh and Jenkins studied the fire history in the T.W. Daniels Forest to determine if the existing vegetative mosaic is correlated with the fire history of the study area. They studied fire occurrence during presettlement (1700 – 1855), settlement (1856 – 1909) and suppression (1910 to present) eras. Overstory ages were 63 to 284 years in lodgepole pine, 106 years in aspen, 188 years in subalpine fir and 193 years in Engelmann spruce.

Across the entire study area, a fire occurred on average about every 18 years. The fire interval was shortest in lodgepole pine and longest in aspen. Results are tabulated below.

Mean Fire Return Interval

Forest Type	Presettlement 1700 – 1855	Settlement 1856 – 1909	Suppression 1910 to Present	Total 289 Years
Overall Study Area	39 (1 – 122)[1]	4.9 (1 - 30)	79[2]	18.1
Spruce – Fir	--	9 (1 – 30)	79[2]	41.3
Lodgepole Pine	39 (12 – 122)	6 (1 – 17)	--	22.2
Aspen	156[3]	13.5 (4 – 16)	--	57.8

1. Numbers in parentheses are length of intervals from which the mean is calculated. Dashes indicate no evidence of fire during period. 2. No fires occurred. 3. No evidence of fire during pre-settlement, but since oldest aspen was 106, it is assumed longer than 106 years.

It is noted that stands dominated by subalpine fir are a later successional stage and that where stands have sustained recent extensive fires, subalpine fir dominance is less. Subalpine fir is, however, a component of regeneration following those fires. Fire frequencies have declined during the suppression era which has favored the establishment of Englemann spruce and subalpine fir. Once subalpine fir ovetops other species, it is not easily replaced, requiring fire, insects, disease or logging.

The size and number of fires was related to the heaviest use period. In 1880, the census indicated that between 1% and 10% of the timbered area of Cache County burned. Heavy grazing reduced fine fuel loads, but use by loggers and sheepherders increased the sources of ignition. A report by an early forester in 1906 stated that ¾ of the area that would later become the Wasatch-Cache NF burned over in the last 20 years. "probably due to careless sheepherders". During the suppression period, fire frequency decreased due to Forest Service efforts and a large reduction in grazing which lessened ignition hazards (from herders).

Fire hazard in lodgepole pine is highest following a fire when standing dead snags and remaining ground fuels from the previous fire and when crowns of tolerant understory species reach into the crowns of mature lodgepole, creating a ladder effect. During the period between 1877 and 1903, several non-lethal fires occurred in lodgepole pine stands due to available fuel.

The lack of fire in the T.W. Daniel Forest during the last 80 years has allowed succession to proceed toward a subalpine fir climax. Earlier periods with more frequent fires favored lodgepole pine. "The continued lack of disturbance will allow the more tolerant species of subalpine fire and Engelmann spruce to overtop the intolerant lodgepole pine and aspen. Eventually the area will lose its diverse appearance and will be similar to that in areas where fire disturbance is less frequent."

Comments to the President's Climate Task Force Regarding the January 27, 2021 Executive Order on Tackling the Climate Crisis and Development of Guidelines for Determining Protected Areas.

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These comments are submitted on behalf of 501c3 environmental organizations and individuals listed in the cover letter. These are science-based organizations and individuals working on National Forest and public lands issues. Here, we focus on these Forest issues and the need for the Executive Branch to ensure the Forest Service and other public lands management agencies are addressing the management needed to ensure our National Forests and these public lands are **conserving and restoring** wildlife habitat, migration corridors and ensuring maximum carbon sequestration. These elements are essential in arriving at net-zero emissions by 2050 by conserving our lands, waters, oceans and biodiversity and protecting 30 percent of our lands and waters by 2030. This reflects the mission of the January 27, 2021 Executive Order on Tackling the Climate Crisis. [1]

Our National Forests, National Parks, Wildlife Refuges, National Monuments, and Bureau of Land Management (BLM) managed lands do not meet sufficient criteria to be deemed "protected" as they are subject to many damaging practices. These practices include, but are not limited to logging, thinning, prescribed fire, sagebrush and juniper removal, excessive road density and off-road vehicle use, livestock grazing and other extractive uses, all of which exacerbate climate change by depleting carbon stocks or by their emissions of carbon.

These comments review the proposition of "conservation" or "protection" in the context of Climate by providing a closer look at National Forest management. This is illustrated by examples of a wildlife corridor and lands managed by the Forest Service showing the effects of past and ongoing management with recommendations for what management meets the intent of "conservation" or "protection". Mere administrative boundaries do not comprise protection. It is what happens within those boundaries that matters.

Our public lands such as National Forests, BLM-managed lands, National Parks, Wildlife Refuges, and National Monuments encompass about 30% of our land base. Since these are under Federal management, maximizing protection on these lands to achieve the goals of the Executive Order would be a logical approach with efficiencies of scale as uniform principles could guide their management going forward.

[1] Biden, J. 2021. Executive Order on Tackling the Climate Crisis at Home and Abroad. January 27, 2021

The Executive Order

On January 27, 2021, President Biden signed the Executive Order on Tackling the Climate Crisis at Home and Abroad. One aspect of that Order directed the Interior Department to formulate steps to achieve the President's commitment to conserve at least 30% each of our lands and waters by 2030. The Interior Department issued a press release describing this process in more detail and referenced a U.S. Geological Survey (USGS) report that only 12% of lands in the continental U.S. are permanently protected.[2] The USGS protected area database is available online.[3] Even those lands given the highest status of current protection such as wilderness areas and national parks are still subject to activities that degrade them from being truly protected. For example, livestock grazing continues in over a quarter of the 52 million acres of wilderness areas in the lower forty-eight states in the U.S.[4] In Yellowstone National Park, each day during winter, hundreds of snowmobiles pollute and cause disturbance.[5]

Our National Forests, Bureau of Land Management (BLM) managed lands, and State managed lands are further down the list and remain far from protected, being in the third of four levels of protection, the fourth level being no protection at all. According to the January 27, 2021 Executive Order, the Secretary of the Interior shall submit a report within 90 days proposing guidelines for determining whether lands and waters qualify for conservation. The USGS report stresses analyzing and setting aside migration corridors for species (both plants and animals) to prevent their extinction from the effects of climate change.

In 2010, the Forest Service produced a National Roadmap for Responding to Climate Change.[6] This roadmap provides guidance to the agency to: (1) Assess vulnerability of species and ecosystems to climate change, (2) Restore resilience, (3) Promote carbon sequestration, and (4) Connect habitats, restore important corridors for fish and wildlife, decrease fragmentation and remove impediments to species migration. These guidelines are suited to the current goals of the Executive Order.

As advocates for restoring wildlife corridors and wildlife habitats, we have continued to insist that the Forest Service analyze these corridors, their associated habitats, and their ability to function for the species of interest, whether it be deer, elk, Canada lynx, wolverine, grizzly bears or others. This entails use of the quantitative, science-based habitat criteria required for these species and comparing this to the current habitat conditions in the corridor or lands of interest. Then, the agency must adjust management to meet these conditions, such as reducing

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[2] U.S. Department of Interior. 2021. Fact Sheet: President Biden to Take Action to Uphold Commitment to Restore Balance on Public Lands and Waters, Invest in Clean Energy Future. January 27, 2021.

[3] U.S. Geological Survey. 2021. GAP Analysis Project PAD - US Data Overview.

[4] Wilderness Watch. 2019. The Cattle Compromise: Livestock Grazing's Damaging Effect on Wilderness and the Way Toward a Livestock - Free Wilderness System. Missoula, MT.

[5] U.S. Department of Interior. 2021. Visiting Yellowstone in Winter. National Park Service. https://www.nps.gov/yell/planyourvisit/visiting-yellowstone-in-winter.htm

[6] USDA Forest Service. 2010. National Roadmap for Responding to Climate Change.

road density, timber projects, livestock grazing and other actions that fragment and degrade these habitats. To date, the Forest Service has ignored our request as pipelines, mines, timber and "forest health" or "restoration" projects continue to expand their footprint, while roads, noise and activity from off road vehicles are pervasive. In the West, livestock grazing is adversely affecting most of our National Forest and BLM managed lands.

Impacts of Forest Management on Carbon Sequestration

See Attachment 1 for a brief review of literature that provides insight into the activities occurring in our National Forests and public lands that are in opposition to the goals of the Executive Order. Some of the major points from that review are summarized here.

Livestock globally produce an estimated 14% of total greenhouse gas emissions. The review points out that livestock grazing is occurring on vast areas of our Western National Forests (103 million acres) and BLM lands (165 million acres). Aside from the environmental degradation leading to loss of biodiversity and productivity, it is causing a loss of carbon storage in watersheds, plants and soils.

Road densities are extremely high and at levels many times that which provides wildlife security. Roads, both legal and illegal, fragment the Forests and wildlife corridors. Off-road vehicles (OHVs) such as ATVs and snowmobiles using roads or groomed trails, or traveling cross-country generate high levels of emissions. For example, OHVs in California annually emit more than 230,000 metric tons of carbon dioxide into the atmosphere. Their emissions are 118 times greater per mile than modern automobiles. Another example, that of fossil fuels consumed by snowmobiles and transporting them in Montana each year releases 192 million pounds of carbon dioxide into the atmosphere per year.

The forests in the lower 48 states are estimated to sequester 460 teragrams[7] of carbon per year while losses from disturbance are 191 teragrams per year. This loss is mostly from timber harvest which reduces the estimated carbon sink of US forests by 42%. Losses from insects and other causes are minimal. Carbon losses from forest treatment projects (logging, thinning) may exceed those from wildfire because most of the carbon mass remains on site unburned during fire. Studies at large spatial and temporal scales suggest that there is a low likelihood of high-severity wildfire events interacting with treated forests, negating any expected benefit from fuels reduction. Further, forests with higher levels of protection such as in wilderness areas had lower severity fires even though they are considered to have the highest levels of biomass and fuel loads.

In the past two years, in the Yellowstone to Uintas Connection, the wildlife corridor in SE Idaho and NE Utah, we have seen over 2,000,000 acres of "restoration" projects aimed at addressing the problems the Forest Service identifies as adversely affecting these Forests. They describe the problem as a departure from natural regimes of vegetation characteristics and fire frequency.

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[7] 1 teragram = 2,204,622,621 pounds

These departures are attributed to past fire suppression, timber harvest, drought, and livestock grazing. Generally, the stated purpose of these proposed projects is to improve big game habitat, reduce conifer encroachment in aspen and manage hazardous fuel accumulations.[8] [9]

None of these projects propose to halt or reduce the activities that they claim to be causing these departures from historic or natural conditions, or that affect wildlife. They do not propose to limit timber harvest. They do not propose to terminate or reduce livestock grazing. They do not propose to close and restore roads to a natural state to achieve security habitat and connectivity for wildlife. They also do not acknowledge the inability of fuels treatments to moderate severe fires as these are climate driven events. They do not propose to limit their logging, thinning and fuels reductions to areas immediately around structures as the science recommends, but instead propose to treat millions of acres remote from structures. A recent article pointed out that this "Active Forest Management" or "Restoration" is a ruse to promote logging and deflect around the science.[10] In that article, the author cites a 2018 letter to Congress from more than 200 scientists refuting the current proposed solutions to wildfire such as forest thinning. Thinning, by removing large trees opens the canopy, leads to drying of the understory, and increases fire spread by increased wind velocity and increased flammability of understory vegetation. It also reduces carbon stored in the forests.

These activities currently occurring on our National Forests are perpetuated by misinformation, rather than science and are counter to the goals of the Executive Order. The example below illustrates one wildlife corridor and the damage to habitats and carbon storage from livestock grazing and other activities occurring on the National Forests comprising that corridor.

The Yellowstone to Uintas Connection

The Yellowstone to Uintas Connection is the high elevation wildlife corridor in southwest Wyoming, southeast Idaho and northeast Utah connecting the Greater Yellowstone Ecosystem and Northern Rockies to the High Uintas Wilderness and Southern Rockies. The Corridor includes portions of several National Forests, including the Ashley, Bridger-Teton, Caribou-Targhee, and Uinta-Wasatch-Cache. It is a critical link in the larger Regionally Significant Wildlife Corridor designated by the Forest Service.[11] In the past, Canada lynx, wolverine, grizzly bears, and other wildlife used this corridor and the associated core areas such as the High Uintas Wilderness. Today, these animals are absent from much of this former range.

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[8] USDA Forest Service. 2020. Caribou Prescribed Fire Restoration Project. Scoping Proposed Action. Caribou-Targhee National Forest.

[9] USDA Forest Service. 2020. Targhee Prescribed Fire Restoration Project. Scoping Proposed Action. Caribou-Targhee National Forest.

[10] Wuerthner, G. 2021. The Active Forest Management Scam. Counterpunch March 18, 2021.

[11] USDA Forest Service. 2003. Regionally Significant Wildlife Corridor. Wasatch-Cache National Forest 2003 Revised Forest Plan and Final Environmental Impact Statement.

The Yellowstone to Uintas Connection is fragmented, degraded, and made non-functional for these animals and other native wildlife by a variety of human activities. Road densities exceed levels these animals can tolerate. Roads fragment the habitat and intrude even into areas designated as Inventoried Roadless Areas (IRA). In Idaho, these IRAs are divided into prescriptions that allow extractive uses and are degraded by user-created roads, timber harvest, and sold off or traded for mining facilities. [12] Phosphate mines and mountain top removal, pipelines, roads, transmission lines, and timber harvest further fragment and destroy the habitat.[13]

Noise and disturbance from mining, recreational vehicles such as ATVs, dirt bikes and side by sides drown out natures' sounds in spring, summer and fall while in winter, groomed snowmobile trails dissect the mountains. Thus enabled, snowmobilers leave no place secure from their noise and disturbance as they "high mark" remote slopes, many carry guns to kill wolves, coyotes and other carnivores, or "coyote whack", a term used to describe chasing down and running over coyotes with their machines. They can scout a hundred miles of groomed trails in a day looking for mountain lion tracks so they can turn their dogs loose, chase down and tree the lion and kill it. An example is the Caribou National Forest in Idaho where 97% of the Forest is open to snowmobiles, including IRAs.[14]

Finally, the habitat degradation and fragmentation is made complete by the livestock grazing the Forest Service permits across the landscape. Entire Forests in the West are divided into grazing allotments with fences, water troughs, pipelines, herders with guns to kill any bear, wolf, coyote or other carnivore they see "harassing" livestock. States are also doing their best to eliminate carnivores. For example, Idaho is now proposing no limits on killing mountain lions.[15]

The Forest Service does not address the activities fragmenting the corridor. At best, they will claim that animals will travel around the periphery of a project and use other habitat.[16] That other habitat is not analyzed for its functionality for any species whether it is deer, elk, sage grouse, lynx. wolverine or others. Population data is not kept current, so impacts are not documented.

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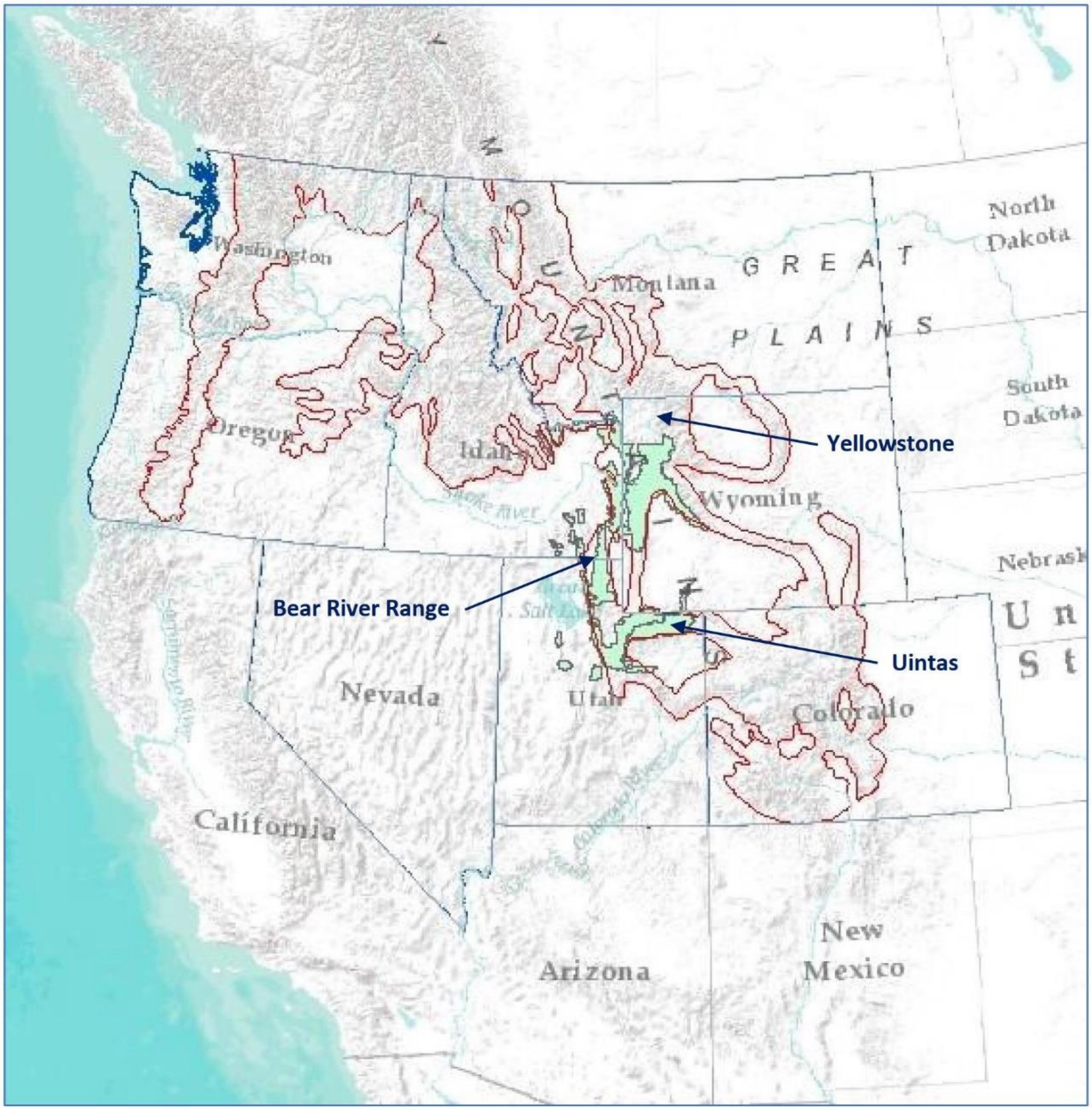
[12] USDA Forest Service. 2008. Roadless Area Conservation National Forest System Lands in Idaho. Final Environmental Impact Statement Appendix C - Idaho Roadless Areas.
[13] Carter, J. 2019. Surface Mining in the Yellowstone to Uintas Connection: What About Wildlife? Counterpunch April 5, 2019.
[14] USDA Forest Service. 2003. Final Environmental Impact Statement for the Caribou National Forest Revised Forest Plan. Volume IV.
[15] Idaho Department of Fish and Game. 2021. Big Game Season Setting.
[16] U.S. Department of Interior and USDA Forest Service. 2019. Final Environmental Impact Statement Proposed Dairy Syncline Mine and Reclamation Plan. Bureau of Land Management and Forest Service. Pocatello, ID.



Regionally Significant Wildlife Corridor (red outline)
Yellowstone to Uintas Connection (green fill)*
***Includes (north to south) Bridger-Teton, Caribou-Targhee, Uinta-Wasatch-Cache and Ashley National Forests. Map by John Carter.**

The Bear River Range

The Bear River Range in the Caribou-Targhee and Wasatch-Cache National Forests in SE Idaho and NE Utah is a critical part of the Yellowstone to Uintas Connection. It is the place where the last grizzly bear, Old Ephraim, was killed in 1923 near Logan, Utah. You will not find grizzly bears here today.[17]

The Bear River Range also has all the problems with habitat fragmentation by roads and extractive uses described above for the corridor overall. Even the Caribou National Forest Revised Forest Plan in its FEIS (referenced above) admitted that road densities are excessive in the Bear River Range, yet they do not address this problem, instead they expand roads with each additional project, while user-created roads and trails continue to proliferate.

Aspen stands in the Bear River Range have lost their understory vegetation, soils are bare and weeds increasing in these cattle and sheep grazed aspen stands. The stand in the lower photo is being lost with only a handful of trees left. Photos by John Carter.

We have studied the Bear River Range over the decades as it was where we first became aware of the ecological damage inflicted by livestock (sheep and cattle) permitted to graze on our National Forests. The Forest Service deflects around the damage due to political pressure and inherent conflicts.[18] [19] They conflate livestock with elk and deer by using the term, "ungulates" to describe them while it is the cattle and sheep

[17] Arave, L. Old Ephraim: Utah's most legendary bear. Standard-Examiner. Ogden, Utah. July 16, 2015.
[18] Hudak, M. 2013. Western Turf Wars The Politics of Public Lands Ranching. Biome Books, Binghamton, New York. 416p
[19] Keetcham, C. 2019. This Land: How Cowboys, Capitalism, and Corruption are Ruining the American West. Viking Press, New York. 432 p.

that are the major consumers of plants and browsers of aspen shoots.[20] Streams with barren banks are polluted with E. coli, sediment, and manure. Aspen stands lack recruitment, their understories are reduced to bare dirt and they eventually die off, or they are dominated by conifers as the grazing promotes accelerated conifer recruitment by eliminating the grasses, flowers and aspen that would provide ground cover and competition for conifer seedlings.

Aspen stand on Kiesha's Preserve in the Bear River Range, where livestock have been excluded. This stand has complete ground cover, a healthy herbaceous plant community and is regenerating after livestock were removed years earlier. Photo by John Carter.

Beginning in the 1980's and in the years since, we have documented the problems in this mountain range and its habitat from livestock grazing and logging. In the 1990's the Forest Service was assessing conditions in Region 4 National Forests, which includes the Bear River Range. At the time, they acknowledged that vegetation and habitat had suffered large departures from potential conditions for aspen, conifer, sagebrush/grasslands, riparian and wetland areas. They found livestock grazing and past timber harvest were a fundamental cause leading to these departures, yet we saw no effort to address these causes as these practices have continued. As a result, we began to characterize and report on the impacts.[21]

Using the Forest Service characteristics that defined healthy vegetation communities such as forest structural stages and understory plant communities, in 2001 we assessed 310 locations in livestock-accessible areas in the Idaho portion of the Bear River Range. These were generally within one mile of water sources and in areas with less than 30% slope, considered "capable" for livestock. At each location we applied Forest Service criteria for Proper Functioning Condition (PFC) of the plant communities and habitats. Of these, only 53, or 17% were properly functioning.

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[20] Ratner, J.R., E.M. Molvar, T.K. Meek, and J.G. Carter. 2019. What's eating the Pando Clone? Two weeks of cattle grazing decimates the understory of Pando and adjacent aspen groves. Hailey, ID: Western Watersheds Project, 33 pp.

[21] Chard, B., Chard, J., and J. Carter. 2002. Assessment of Habitat Conditions Bear River Range Caribou National Forest, Idaho.

Upper and right photos of a grazed riparian area in the Bear River Range - soils are barren, there is no stream shading from shrubs or trees, only weeds survive, and the streambed is covered in sediment. At left is a recovering riparian area on Kiesha's Preserve in the Bear River Range where livestock were removed years earlier. This stream has a complete cover of grasses and flowers, clean substrate and shading from trees and shrubs. Upper photos by Brandon Chard. Lower photo by John Carter.

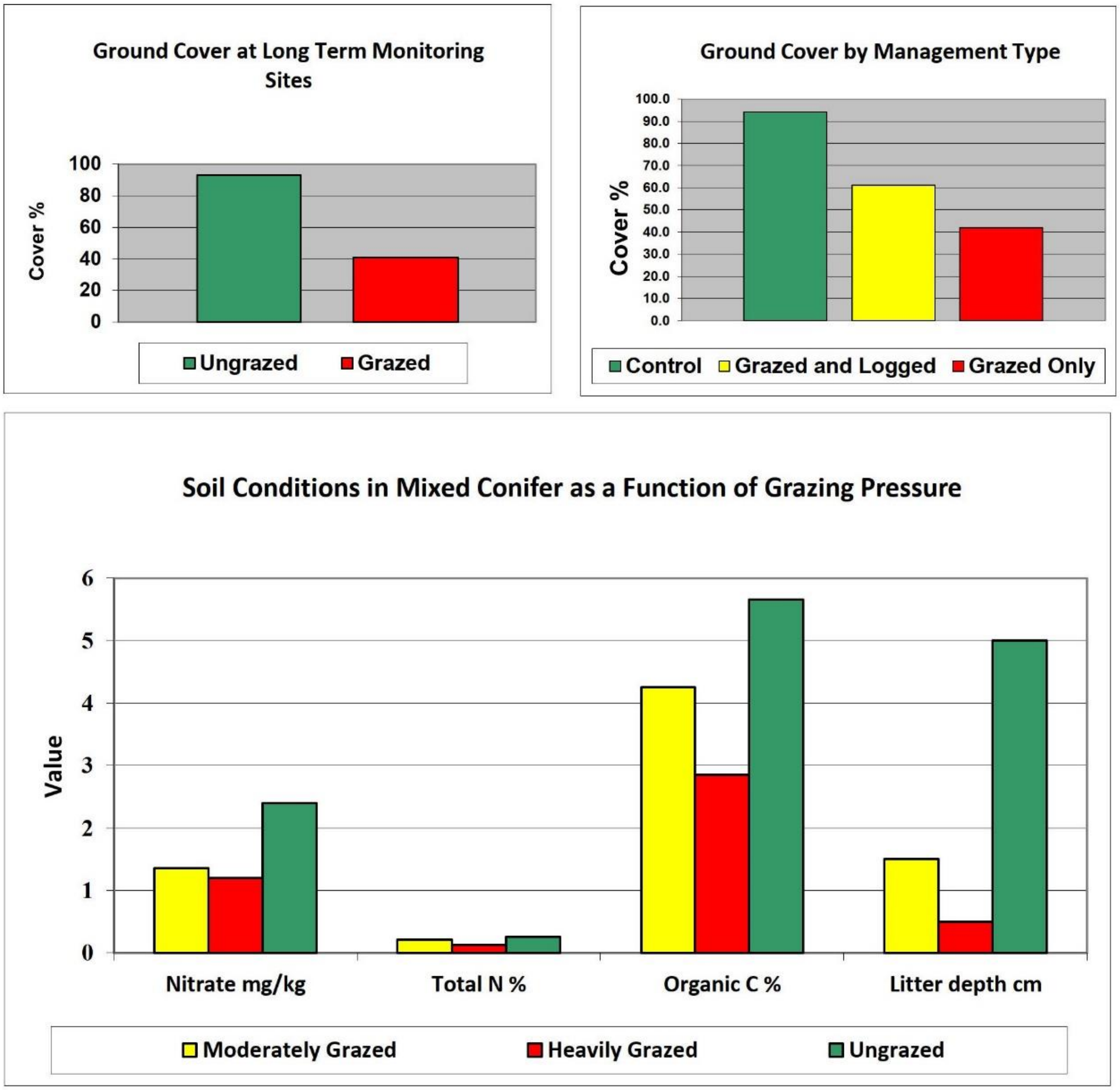
Results of Bear River Range PFC Assessments

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 habitat structure and ground cover (vegetation, litter, rocks, mosses) at 55 locations in forest openings in sagebrush/grasslands and tall forb communities, finding that bare soil was dominant, averaging over 50%. Potential ground cover is over 90% and in most habitats near 100%. In the Utah portion of the Bear River Range, we conducted additional surveys over time. We compared ground cover in locations grazed by livestock and protected areas that were not grazed by livestock. Ground cover was less than 50% in those areas grazed by cattle or sheep. When we grouped the sites by management type, forested areas that were logged and grazed had only 60% ground cover, while forest openings in sagebrush/grassland were lowest at 40% ground cover. Ground cover in un-grazed controls was over 90%. In the logged and grazed areas, woody debris made up the difference. This loss of ground cover has implications for watersheds in that greater bare soil leads to accelerated erosion, loss of infiltration and ground water recharge, more rapid runoff and flooding, and stream flow depletion in summer. With these losses come reductions in stored carbon.

These allotments all contained large numbers of stock ponds and water troughs for livestock, a proposition the Forest Service promotes time after time as a solution to overgrazing, rather than reducing stocking rates. In one allotment alone, there were 130 stock ponds and water troughs, and these are the degraded conditions we found. These water developments for livestock did not improve conditions, but instead spread the degradation to areas that might have been spared. We looked further at the impacts of these water sources by sampling areas at different distances from the water source, finding that sites closer to water were more heavily grazed (less ground cover) and had lower soil carbon, nitrogen and reduced litter depth when compared to sites with lesser or no grazing. The grazed sites also had lost most of the mycorrhizal fungi layer which is fundamental to nutrient cycling.[22]

[22] Carter, J., Chard, B., and J. Chard. 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.



Bear River Range - Ground Cover and Soil Properties at Grazed and Ungrazed Sites. Charts by John Carter.

Conclusions and Recommendations

As pointed out in Attachment 1, 103 million acres of National Forests in the West are grazed by livestock. Even if active forest management (logging, thinning, prescribed fire) could provide a benefit relating to reduced intensity of wildfires, the costs to wildlife habitat and carbon storage are large. The benefits are also negated if livestock remain and continue to destroy the aspen communities, denude and pollute watersheds, streams and springs, and create thickets of conifer saplings. Livestock are grossly overstocked across the public lands in the West. For example, a recent paper demonstrated that stocking rates in the High Uintas Wilderness would need to be reduced by over 90% to be sustainable and minimize environmental damage.[23] In our experience, this is typical across the West.

The Forest Service continues business as usual and is budget-driven to propose projects such as the 2,000,000 acres of prescribed fire restoration projects in the Yellowstone to Uintas Connection corridor because they can fit into the wildfire program.[24] Across the country, logging and thinning continue to be a major emphasis.[25] This fire-driven set of priorities must change if we are to "protect" and restore these lands for the purposes of the Executive Order.

The Forest Service and other agencies such as the Bureau of Land Management must recognize the contribution of timber harvest and livestock grazing to loss of carbon storage in plant communities and soils, increased carbon emissions, degradation of wildlife habitat and loss of biodiversity. It is important to eliminate from consideration as "protected" those lands that are grazed by livestock due to their negative effects on these goals. Agencies must delineate, protect and restore wildlife migration corridors. Snowmobile access must be limited and excluded from areas needed for sensitive wildlife species such as Canada lynx, grizzly bears, and wolverine. These agencies must act to reduce road density with its associated motorized recreation and carbon pollution, and greatly reduce or eliminate livestock grazing thru permit action and mechanisms such as voluntary permit retirement and buyouts. In addition, a reduction in commercial timber sales, a diameter limit on logging, protection and restoration of old growth, and a banning of politically derived timber mandates are steps to take to maximize carbon storage and biodiversity. Until this happens, Forest Service and other Public Lands will remain in the lowest protection status while continuing to exacerbate climate change by loss of carbon storage and increases in carbon pollution, accompanied by ongoing losses in biodiversity.

An example of a proposal that would protect 23,000,000 acres in the Northern Rockies is the Northern Rockies Ecosystem Protection Act (NREPA). This Act has been introduced in Congress and would protect all the remaining roadless lands in the Northern Rockies. The purpose of the Act is "To designate certain National Forest System lands and certain public lands under the jurisdiction of the Secretary of the Interior in the States of Idaho, Montana, Oregon, Washington, and Wyoming as wilderness, wild and scenic rivers, wildland recovery areas, and biological connecting corridors, and for other purposes."[26] It would designate current

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[23] 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

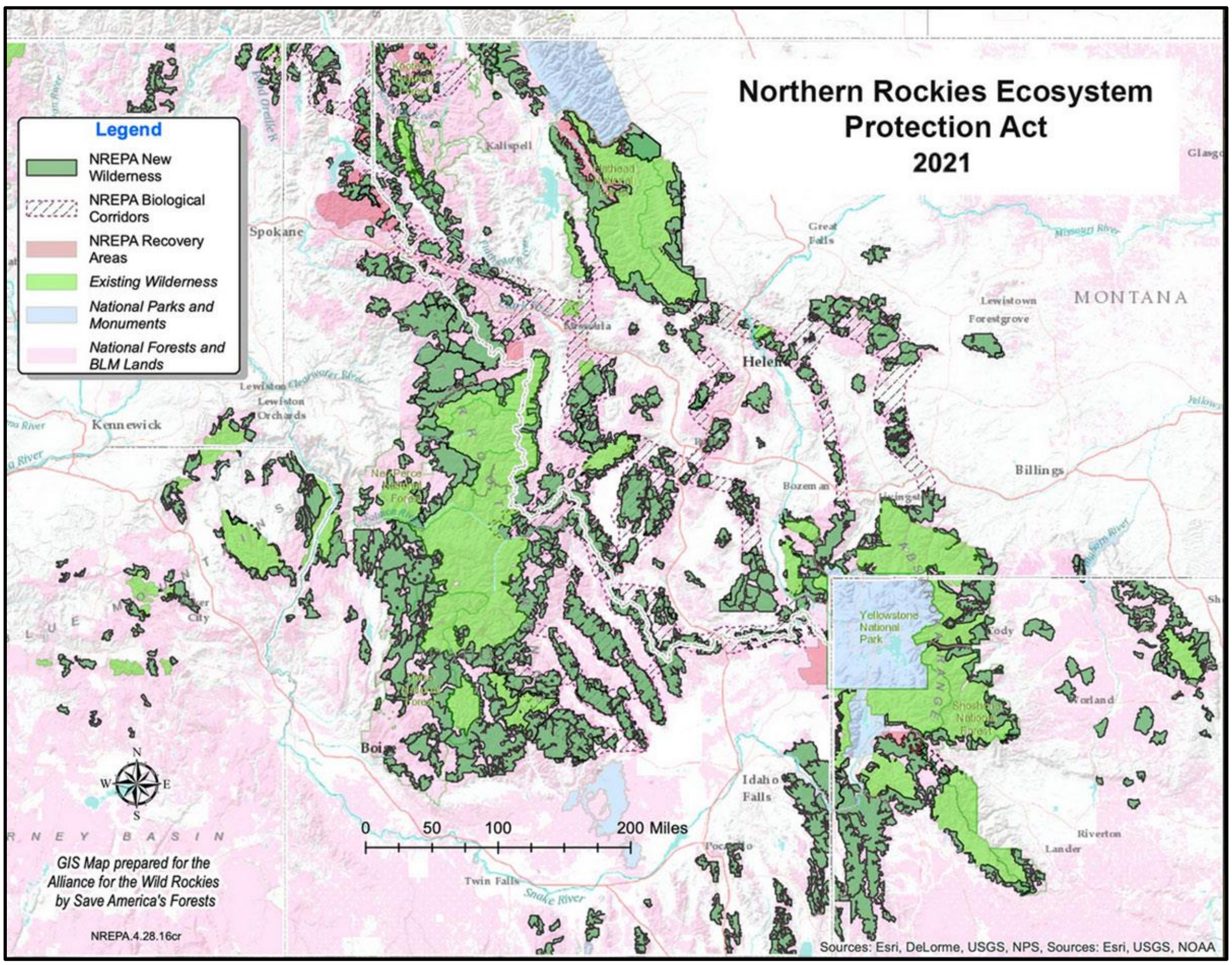
[24] USDA Forest Service. 2020. FY 2021 Budget Justification.

[25] Mounger, D. 2021. Restoration, Resiliency, and Regeneration Follies n the Central Hardwood Region. Tennesee Heartwood. Powerpoint Presentation. https://app.box.com/s/fpyn1q5l68im45e0jguwv62ftzmz9d17

[26] https://www.congress.gov/bill/117th-congress/house-bill/1755

Inventoried Roadless Areas as wilderness and protect 1,800 miles of rivers under the Wild and Scenic Rivers Act. It would remove thousands of miles of roads used for past logging and other purposes that fragment the landscape and restore natural conditions.[27]

NREPA would partially meet the goals of the Executive Order and Forest Service Roadmap for Climate Change to provide for protection, restoration, carbon sequestration, biodiversity and habitat connectivity. Expanding this to include reductions in livestock grazing, timber harvest and vegetation manipulations across the 103 million acres of National Forest and 165 million acres of BLM managed land in the West would begin to restore the native plant communities, watersheds, streams and wetlands, and wildlife habitat to their potential natural condition. Along with this, a necessary step is removal of livestock infrastructure such as fences that fragment habitat and water diversions that dry up streams and springs. Halting the killing/removal of native sagebrush and junipers to benefit livestock would allow species such as sage grouse and migrant birds to begin recovery.



Map of the extent of lands proposed in the Northern Rockies Ecosystem Protection Act in Idaho, Montana, Wyoming, Washington and Oregon. Map provided by the Alliance for the Wild Rockies.

Attachment 1

This summary of pertinent literature is intended to provide context to the issues addressed in the accompanying comments to the Climate Task Force on protecting 30% of the lands and waters by 2030 as outlined in the January 27, 2021 Executive Order on Tackling the Climate Crisis. Topics covered include:

1. Livestock Grazing and Carbon Storage
2. Livestock Grazing and Biodiversity
3. Forests and Carbon Storage
4. Wildfire and Species Effects
5. Wildfire and Insect Outbreaks
6. Fire Suppression and Fuel Buildup
7. Summaries of Issues Around Fire
8. Road Densities and Effects
9. Off Road Vehicles and Carbon Emissions

Livestock Grazing and Carbon Storage

A goal of the January 27, 2021 Executive Order is to determine the characteristics of "protected" or "conserved" lands for the purpose of reducing or reversing carbon loss for mitigating climate change, providing species protections for biodiversity, and restoring biological corridors. Corridors are essential to effect climate-induced animal or plant migration. It is important to eliminate from consideration those lands that are grazed by livestock due to their negative effects on these goals.

The Intergovernmental Panel on Climate Change (IPCC) released its special report on climate change in August 2019.[1] That report noted that, "reducing deforestation and forest degradation rates represents one of the most effective and robust options for climate change mitigation, with large mitigation benefits globally." The Food and Agriculture Organization (FAO) estimated total global emissions of greenhouse gases (GHG) from livestock are 7.1 Gigatons of CO2 equivalent, or 14.5% of all human related GHG emissions. An estimated 44% of these emissions are methane, 29% Nitrous Oxide, and 27% carbon dioxide. This is 5% of global anthropogenic CO2 emissions, 44% of methane emissions, and 53% of nitrous oxide emissions.[2] In a prior

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[1] IPCC. 2019. Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. https://www.ipcc.ch/report/srccl/. Accessed 11/23/2019.

[2] Gerber, P.J., Steinfeld, H., Henderson, B., Mottet, A., Opio, C., Dijkman, J., Falcucci, A. & Tempio, G. 2013. Tackling climate change through livestock – A global assessment of emissions and mitigation opportunities. Food and Agriculture Organization of the United Nations (FAO), Rome. http://www.fao.org/news/story/en/item/197623/icode/ Accessed 03/28/2021.

study, FAO estimated the GHG emissions from livestock production was more than that of all transportation and industry sources. [3]

Three times as much carbon resides in soil organic matter as in the atmosphere, 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. [4] [5] Long term intensive agriculture can significantly deplete soil organic carbon and past livestock grazing in the United States has led to such losses. [6] [7] [8] The United Nations Convention to Combat Desertification has estimated that 73 percent of livestock-grazed lands worldwide have suffered soil degradation.[9]

The literature regarding grazing effects upon carbon storage varies, in part because diverse ecosystems may respond differently to grazing animals. For instance, livestock grazing was found to significantly reduce carbon storage on Australian grazed lands while destocking currently grazed shrublands resulted in net carbon storage. [10] 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.[11] In a study of livestock grazing effects in the Wasatch Cache National Forest in NE Utah, there were declines in soil carbon and nitrogen in livestock grazed areas compared to ungrazed areas. As grazing intensity increased, ground cover, plant litter, soil organic carbon and nitrogen decreased. [12] Analysis of livestock grazing in the High Uintas Wilderness demonstrated that the Forest Service grossly overstocked this

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[3] Steinfeld H., Gerber, P., Wassentaar, T., Castel, V., Rosales, M. & de Haan, C. 2006. Livestock's long shadow. Rome, Italy. Food and Agriculture Organization of the United Nations. 407 p.

[4] Almaras, R. R., H. H. Schomberg, and C. L. Douglas. 2000. Soil organic carbon sequestration potential of adopting conservation tillage in U.S. croplands. Journal of Soil and Water Conservation 55:365-373.

[5] Grace, J., San Jose, J., Meir, P., Miranda, H. and Montes, R. 2006. Productivity and carbon fluxes of tropical savannas. Journal of Biogeography 33: 387–400.

[6] Benbi, D. K. and J. S. Brar. 2009. A 25-year record of carbon sequestration and soil properties in intensive agriculture. Agronomy for Sustainable Development 29:257-265.

[7] Follett, R. F., J. M. Kimble, and R. Lal [eds.]. 2001. The potential of U.S. grazing lands to sequester carbon and mitigate the greenhouse effect. Boca Raton, FL, USA: Lewis Publishers. 457p.

[8] eely, C., S. Bunning, and A. Wilkes. 2009. Review of evidence on drylands pastoral systems and climate change: Implications and opportunities for mitigation and adaptation. Rome, Italy: Food and Agriculture Organization of the United Nations. Land and Water Discussion Paper 8. 48 p.

[9] Gabathuler E., H. Liniger, C. Hauert, and M. Giger. 2009. Benefits of sustainable land management. Bern, Switzerland: World Overview of Conservation Approaches and Technologies, Center for Development and Environment, University of Bern. 15 p.

[10] Daryanto, S. D.J. Eldridge, and H.L. Throop. 2013. Managing semi-arid woodlands for carbon storage: Grazing and shrub effects on above and belowground carbon. Agriculture, Ecosystems and Environment 169:1– 11.

[11] Fernandez, D.P., J.C. Neff and R.L. Reynolds. 2008. Biogeochemical and ecological impacts of livestock grazing in semi-arid southeastern Utah, USA. Journal of Arid Environments 72: 777–791.

[12] Carter, J., B.Chard and J.Chard. 2011. Moderating livestock grazing effects on plant productivity, carbon and nitrogen storage. In: Monaco, T.A. et al. [eds.]. Proceedings of the 17th Wildland Shrub Symposium: 18-20 May 2010: Logan, UT, USA. p191-205.

Upper - Lake in High Uintas Wilderness grazed by livestock leading to barren, eroding soil, loss of vegetation and rapid filling of the lake with sediment. Lower - Stream and wetlands in an ungrazed watershed in the High Uintas Wilderness have complete soil cover, and a healthy and productive vegetation community. Photos by John Carter

160,410 acre area by including areas that are not capable for grazing livestock, such as steep slopes, forested areas and highly erodible soils. When current forage production, current forage consumption rates for livestock and a conservative utilization factor were used to determine the amount of forage that could be allocated to livestock, it was determined that the stocking rate should be reduced by over 90% to be sustainable.[13]

Livestock Grazing and Biodiversity

In 16 western states in the US, 165 million acres on Bureau of Land Management-managed land (94%) and 103 million acres of Forest Service-managed land are grazed by livestock. Seventy percent of the western US is grazed by livestock. This includes these BLM and Forest Service managed areas as well as wildlife refuges, wilderness areas, national monuments and national parks. These grazed lands have suffered severe impacts leading to loss of biodiversity, lowered population numbers of species, disrupted ecosystem function and altered terrestrial and aquatic habitats.[14] The resulting simplified plant communities with the associated loss of vegetation mosaics negatively affect pollinators, birds, small mammals, amphibians, wild ungulates, and other native wildlife, as well as rare species such as Western sage-grouse.[15] A meta-analysis of 109 global studies that looked at the response of animals or plants to livestock grazing relative to livestock exclusion showed that "Across all animals, livestock exclusion increased abundance and diversity, but these effects were greatest for trophic levels directly dependent on plants, such as herbivores and pollinators.[16] Other studies have documented increased riparian songbird abundance after livestock exclusion.[17] [18] Overall biodiversity increased under long term rest from livestock grazing.[19] [20]

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[13] 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

[14] Fleischner, T. 1994. Ecological costs of livestock grazing in western North America. Conservation Biology 8(3):629-644.

[15] Beschta, R.L., D.L. Donahue, .A. DellaSala, J.J. Rhodes, J.R. Karr, M.H. O'Brien, T.L. Fleischner, and C.D. Williams. 2012. Adapting to climate change on western public lands: addressing the ecological effects of domestic, wild, and feral ungulates. Environmental Management DOI 10.1007/s00267-012-9964-9. 18p.

[16] Filazzola,A., Brwn, C., Dettlaff, M.A., Batbaatar, A., Grenke,J.,Bao, T., Heida, I.P., and Cahill, J.F. 2020. The effects of livestock grazing on biodivesity are multi-trophic: a meta-analysis. Ecology Letters 23:1298 - 1309. doi: 10.1111/ele.13527

[17] Dobkin, D. S., A. C. Rich, and W. H. Pyle. 1998. Habitat and avifaunal recovery from livestock grazing in a riparian meadow system of the northwestern Great Basin. Conservation Biology 12: 209-221.

[18] Earnst, S.L., Ballard, J.A., Dobkin, D.S., 2005, Riparian songbird abundance a decade after cattle removal on Hart Mountain and Sheldon National Wildlife Refuges In: Ralph, C.J., Rich, T. [eds.], Proceedings of the Third International Partners in Flight Conference; Albany, CA, USA. US Department of Agriculture. Forest Service, General Technical Report PSW-GTR-191. p. 550-558.

[19] Bock, C.E., J.H. Bock, W.R. Penney, and V.M. Hawthorne. 1984. Responses of birds, rodents, and vegetation to livestock exclosure in a semidesert grassland site. Journal of Range Management 37:239-242

[20] Brady, W.W., M.R. Stromberg, E.F. Aldon, C.D. Bonham, and S.H. Henry. 1989. Response of a semidesert grassland to 16 years of rest from grazing. Journal of Range Management 42:284-288.

Forests and Carbon Storage

Forests currently capture and store approximately 25% of global anthropogenic carbon emissions. Forests in the lower 48 states sequester 460 ± 48 Teragrams (Tg) of carbon per year, while losses from disturbance average 191 ± 10 Tg carbon per year. Carbon loss in the southern US was 105 ± 6 Tg with 92% from harvest and 5% from wind damage. Carbon loss in the western US was 44 ± 3 Tg with 66% due to harvest, 15% from fire, and 13% from insect damage. Carbon loss in the northern US was 41 ± 2 Tg with 86% from harvest, 9% from insect damage, and 3% from land conversion. Taken together, these disturbances reduced the estimated potential carbon sink of US forests by 42%.[21] Life cycle analyses of fuel reduction treatments including removal of woody biomass, combustion of fuel in logging machinery, transport, burning of slash, milling energy use, and other factors lead to the conclusion that over the long term, carbon losses from treatment projects may exceed those from wildfire because most of the carbon mass remains on site unburned during fire. The authors further noted that, "Studies at large spatial and temporal scales suggest that there is a low likelihood of high-severity wildfire events interacting with treated forests, negating any expected benefit from fuels reduction."[22]

A USDA study estimated soil organic carbon in relatively undisturbed secondary forests in the Rocky Mountain Region is 71,571 lbs/acre. Estimated carbon in dead organic matter above the mineral soil horizon in lodgepole pine forest in the Rocky Mountain Region is 13,411 lb/acre. Average storage of carbon by Forest ecosystem component for the Rocky Mountain Region is 148,190 lb/acre for Idaho with trees (60,961 lb/acre), soil (64,417 lb/acre), forest floor (21,735 lb/acre) and understory (1,077 lb/acre). Annual average carbon accumulation in live trees for Idaho is 1,112 lb/acre/year. [23] The Proceedings of the American Society of Mining and Reclamation reported that, "Soil organic matter (OM) is drastically reduced by various processes (erosion, leaching, decomposition, dilution through soil horizon mixing etc.) typically associated with topsoil salvage prior to surface mining activities. Of these processes, loss of physical protection of OM through the breaking up of soil aggregation can result in up to 65% of soil carbon (C) reductions."[24] This has implications for timber harvest, or other activities that disturb and disrupt the soil.

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[21] Harris, N.L., Hagen, S.C., Saatchi, S.S. et al. Attribution of net carbon change by disturbance type across forest lands of the conterminous United States. Carbon Balance Manage 11, 24 (2016). https://doi.org/10.1186/s13021-016-0066-5

[22] Restaino, J.C. and D.L. Peterson. 2013. Wildfire and fuel treatments effects on forest carbon dynamics in the western United States. Forest Ecology and Management 303:46-60.

[23] Birdsey, R. A. Carbon Storage and Accumulation in United States Forest Ecosystems. USDA Forest Service General Technical Report WO-59.

[24] Wick et al. 2008. Soil aggregate and aggregate associated carbon recovery in short-term stockpiles. Proceedings America Society of Mining and Reclamation, 2008 pp 1389-1412. DOI: 10.21000/JASMR08011389

Both fuel treatments and wildfire remove carbon from forests. In mature ponderosa pine forests, for example, protecting one unit of carbon from wildfire combustion came at a cost of removing three units of carbon with treatments. "The reason for this is simple: the efficacy of fuel reduction treatments in reducing future wildfire emissions comes in large part by removing or combusting surface fuels ahead of time. Furthermore, because removing fine canopy fuels (i.e. leaves and twigs) practically necessitates removing the branches and boles to which they are attached, conventional fuel-reduction treatments usually remove more carbon from a forest stand than would a wildfire burning in an untreated stand." The analysis showed that thinning and other fuel treatments to reduce high-severity fire, although considered to keep carbon sequestered, do not do so. High carbon losses came from treatments while only small losses were associated with high-severity fire. These were similar to the losses with low-severity fire that treatments are meant to encourage.[25]

Wildfire and Species Effects

More species (48% of the community) reached peak abundance at moderate-high-severity-fire locations than at low-severity fire (8%), silvicultural management (16%), or undisturbed (13%) locations. Total community abundance was highest in undisturbed dense forests as well as in the first few years after silvicultural management and lowest in the first few years after moderate-high-severity fire, then abundance in all types of disturbed habitats was similar by 10 years after disturbance. Even though the total community abundance was relatively low in moderate-high-severity-fire habitats, species diversity was the highest. Moderate-high-severity fire supported a unique portion of the avian community, while low-severity fire and silvicultural management were relatively similar.[26]

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[25] Campbell, J.L., Harmon, M.E., and S.R. Mitchell. 2012. Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions? Frontiers in Ecology and Environment 10(2):83-90. doi:10.1890/110057.

[26] Roberts, L.J.; Burnett, R.; Fogg, A. Fire and Mechanical Forest Management Treatments Support Different Portions of the Bird Community in Fire-Suppressed Forests. Forests 2021, 12, 150. https://doi.org/10.3390/f12020150

Clearcuts in the Helena NF (upper) and Gallatin NF (lower) result in habitat fragmentation and loss of carbon storage. Photos by George Wuerthner.

Thinning projects in the Deschutes NF result in soil disturbance, loss of habitat and loss of carbon storage. Photos by George Wuerthner.

Old growth mixed conifer forests in the Caribou NF have habitat structure, healthy and diverse understory habitat and provide maximum carbon storage.

Photos by John Carter

Wildfire and Insect Outbreaks

An analysis of 2766 large wildfires that burned in the west during the 2003 - 2012 period was carried out to determine the influence of mountain pine beetle outbreaks on fire behavior and area burned. Approximately 12% of these fires intersected prior beetle outbreaks and burned in those areas for only about 4 days. Daily area burned for high-extreme fire behavior in large fires burning for long periods in landscapes affected by mountain pine beetles was not related to beetle activity, but was due to warm, dry and windy conditions.[27] A study of the effects of spruce beetle on fire activity in Colorado found no effect of pre-fire beetle activity on fire severity. Both bark beetle outbreaks and wildfires have increased due to climate variability while topography, weather conditions and pre-outbreak basal area exerted a stronger effect on fire severity.[28] Review of treatments (tree harvest and prescribed burning, among other actions) for mountain pine beetle control found that overall, they had little to no impact on mountain pine beetle. Controls that had not been logged or thinned had more trees killed by beetles, but in the end, contained more residual mature trees than did thinned stands.[29]

Fire Suppression and Fuel Buildup

Fire suppression and the associated fuel buildup is often blamed for the larger wildfires in recent years. The solution proposed nearly always is for more logging and thinning, or fuel treatments. But this does not apply to most fires and plant communities in the West. For example, about half the 20,000,000 acres burned in California in 2020 were in chapparal or grassland, not forests, while about 35% were in conifer forests. There is also a difference in fire intervals depending on whether the forest is a dry conifer forest. These make up only about 4% of forest types in western Montana and northern Idaho and are subject to more frequent fire return intervals on the order of decades. The higher elevation conifer forests have much longer fire return intervals of 200 - 300 years. Large fires are the result of drought, high temperatures, low humidity and wind.[30] An analysis of 1500 fires affecting Ponderosa and Jeffrey Pine and mixed conifer western forests found that "forests with higher levels of protection had lower

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[27] Hart, Sarah J.; Preston, Daniel L. 2020. Fire weather drives daily area burned and observations of fire behavior in mountain pine beetle affected landscapes. Environmental Research Letters 15(5):054007.
[28] Robert A Andrus, Thomas T Veblen, Brian J Harvey, Sarah J Hart. 2016. Fire severity unaffected by spruce beetle outbreak in spruce-fir forests in southwestern Colorado. Ecol Appl;26(3):700-11. Doi: 10.1890/15-1121.
[29] Six, D.L., Biber,E., and Long, E. 2014. Management for mountain pine beetle outbreak suppression: Does relevant science support current policy? Forests 5:103-133. doi:10.3390/f5010103
[30] Wuerthner, G. 2021. Fire Suppression Hyperbole. The Wildlife News, March 1, 2021. https://www.thewildlifenews.com/2021/03/01/fire-suppression-hyperbole/

severity fire even though they are considered to have the highest levels of biomass and fuel loads.[31]

Summaries of Issues Around Fire

The Firefighters United for Safety, Ethics and Ecology have summarized the issues surrounding fires, logging, fuels treatments, carbon storage and climate change. Some of their points are that: (1) most forests are fire-adapted and renewed by fire; (2) more acres burned in the past than today; (3) logging targets commercially valuable trees for harvest and these trees have the least influence on fire spread; (4) logging does not address fuels such as small diameter ladder and surface fuels; (5) past logging has made the forest more flammable than the original forest cover; (6) firefighting efforts are irrelevant against large or high-intensity fires burning under severe conditions; (7) firefighters are most effective in suppressing small, low-intensity fires that should not be suppressed; (8) only 15% of total carbon from a tree is preserved in wood products while most enters the atmosphere from logging and milling and these losses are greater than from wildfires; (9) most carbon is stored in large tree boles or soils and most severe wildfires do not completely consume large tree boles or deep layers of organic soils; (10) areas closest to communities have the legacy of logging and fire exclusion and these areas pose the greatest fire risk and fuel hazards. They conclude that "attempts to fire-proof the forest through landscape-scale logging or mechanized firefighting are essentially geoengineering schemes that would fundamentally alter forest ecosystems, ultimately put them at greater risk of destruction, and further accelerate global heating."[32]

A recent book has addressed the value of large trees using Oregon Eastside Forests as an example.[33] The values of large trees include: (1) forest raptors, woodpeckers, songbirds, bats, and other small mammals depend on large trees to nest, forage, overwinter, roost, and den; (2) large trees provide shelter and microclimates for countless invertebrates, epiphytes, herpetofauna, and rare plants; (3) large trees in riparian areas provide stream-side shading and, when they fall into streams, hiding cover for aquatic species; (4) large trees store the accumulation of decades to centuries of atmospheric carbon helping to reduce adverse consequences of global overheating; (5) large trees are essential to nutrient cycling, soil stabilization, and below-ground processes that develop as they mature; (6) large trees remain in short supply due to a legacy of logging; (7) when logged, large trees release most (up to two-thirds) of their stored carbon to the atmosphere (contributing to global overheating) and their emitted carbon takes decades to centuries to recover, if ever. A current article also reviews the

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[31] Bradley, C.M., Hanson, C.T., and DellaSala, D.A. 2016. Does increased forest protection correspond to higher fire severity in frequent fire forests in the western United States? Ecosphere 7(10)/e01492. https://doi.org/10.1002/ecs2.1492

[32] Ingalsbee, T. 2020. Incendiary rhetoric: climate change, wildfire, and ecological fire management. Firefighters United for Safety, Ethics & Ecology. 24 p. https://fusee.org/fusee/incendiary-rhetoric

[33] DellaSala, D.A. and Baker, W.L. 2020. Large Trees: Oregon's Bio-Cultural Legacy Essential to Wildlife, Clean Water, and Carbon Storage. https://oregonwild.org/sites/default/files/pdf-files/Large%20Trees%20Report%20resize.pdf

value of large trees for carbon storage and notes that live and dead trees and forest soil hold the equivalent of 80% of all the carbon currently in Earth's atmosphere.[34] They point out that in mature and old forests in Oregon: "Big trees, with trunks more than 21 inches in diameter, make up just 3% of these forests but store 42% of the above-ground carbon. Globally, a 2018 study found that the largest-diameter 1% of trees hold half of all the carbon stored in the world's forests." This validates the need to protect and restore mature and old-growth forests for their value in carbon storage.

Another article regarding fire in California addressed these and similar points, citing supporting science.[35] Some of these are that: (1) there is not an unnatural excess of fires in forests today, in fact, there is less than in the past; (2) current fires are mostly low to moderate intensity in western US forests; (3) those forests that have remained without fire the longest have mostly low to moderate intensity fire; (4) high intensity fires do not destroy wildlife habitat, but create "snag forest" which is comparable to old growth forest in terms of native biodiversity and wildlife abundance; (5) human-caused climate change increases temperatures and influences wildland fire; (6) today's forests are not unnaturally dense and overgrown, there are more small trees and fewer medium and large trees, less overall biomass and therefore less carbon stored; (7) recent large fires are not unusual and occurred prior to modern fire suppression; (8) drought and native bark beetles do not make forests unhealthy, during drought, bark beetles selectively kill the weakest and least climate adapted trees leaving the better adapted ones to survive and reproduce, while bird and small mammal species increase in numbers because snags provide excellent wildlife habitat; (9) logging reduces the cooling shade of forest canopy, creating hotter and drier conditions and leaves behind "kindling-like slash debris, and spreads combustible weeds; (10) Field studies of large fires find only about 11% of forest carbon is consumed and only 3% of the carbon is from trees. Vigorous post-fire regrowth absorbs huge amounts of CO_2 from the atmosphere, resulting in an overall net decrease in atmospheric carbon a decade after fire; and (11) landscape scale prescribed burning would cause at least a ten-fold increase in smoke emissions relative to current fire levels; (12) prescribed burns do not stop wildland fire when it occurs but can alter intensity, while the short-term benefit lasts only about 10 - 20 years so would have to be repeated every 10- 20 years.

In a review[36] of wildland fuel treatments in the interior forests of the US, the following points were made:

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[34] Law, B. and Moomaw, W. 2021. Curb climate change the easy way: Don't cut down big trees. Phys.Org April 7, 2021. https://phys.org/news/2021-04-curb-climate-easy-dont-big.html

[35] Hanson, C. 2019. Common Myths about Forests and Fire. In: A New Direction for California Wildfire Policy - Working from the Home Outward. Leonardo DeCaprio Foundation.

[36] Reinhardt, E.D., Keane, R.E., Calkin, D.E., and J.D. Cohen. 2008. Objectives and considerations for wildland fuel treatment in forested ecosystems of the interior western United States. Forest Ecology and Management. 256:1997-2006. https://app.box.com/s/loj3dqgz37akelxs18thq0qpkplmk533

(1) "Treating fuels to reduce fire occurrence, fire size, or amount of burned area is ultimately both futile and counter-productive" because most acreage burned is under extreme conditions which make suppression ineffective. If, due to treatments, moderate intensity fires are suppressed this leads to most acres burning under extreme conditions. Reducing burned area would not be desirable as large fires were common prior to European settlement and many western plant species are adapted to large, severe wildfires. Large fires generally have many areas lightly to moderately burned. Any fire "could offer a unique opportunity to restore fire to historically fire-dominated landscapes and thereby reduce fuels and subsequent effects."

(2) Reducing fuel hazard is not the same as ecosystem restoration. Treatments such as mastication and thinning may leave stand conditions that do not mimic historical conditions. Mastication breaks, chips, grinds canopy and surface woody material into a "compressed fuel bed" while thinning that removes fire-adapted species and leaves shade tolerant species do not mimic historical conditions. "Fire itself can best establish dynamic landscape mosaics that maintain ecological integrity."

(3) Thinning for fire hazard reduction should concentrate on the smaller understory trees to "reduce vertical continuity between surface fuels and the forest canopy." Thinning can increase surface fire behavior, for example, it increases surface wind speed and results in solar radiation and drying of the forest floor creating drier surface fuels.

(4) Fuel treatments are transient. Prescribed fire creates tree mortality with snag fall contributing to fuel loads, tree crowns expand to fill voids, trees continue to drop litter. Trees cut for harvest or killed by fire contribute limbs to the forest floor, increasing fuel loadings. Up to seven treatments may be needed to "return the area to acceptable conditions that mimic some historical range."

(5) Fire was historically more complex and everchanging than commonly believed and cannot be mimicked by prescribed burning. The low-severity model that is being pushed as "restoration" is no longer widely accepted by scientists. Prescribed fires do not have the variability of past wildfires, and thus can cannot mimic them.

(6) Commercial Thinning and Prescribed out of season burning have negative ecological impacts. Out of season burning coincides with nesting season for birds. Smoke may drive them from their nest, possibly even kill nestlings, etc. Ground nesters will be most impacted.

(7) The probability that a fire will encounter a fuel treatment of any kind is low.

Another review questions current policy and whether it is based on science. Lack of monitoring of post treatment effects leaves questions as to the efficacy of treatments. "While the use of timber harvests is generally accepted as an effective approach to controlling bark beetles during outbreaks, there has been a dearth of monitoring to assess outcomes, and failures are often not reported. Additionally, few studies have focused on how these treatments affect forest structure and function over the long term, or our forests' ability to adapt to climate change. Despite this, there is a widespread belief in the policy arena that timber harvesting is an effective and necessary tool to address beetle infestations. That belief has led to numerous proposals for, and enactment of, significant changes in federal environmental laws to encourage more timber harvests for beetle control."[37]

Analysis of fire severity patterns in western ponderosa pine and mixed conifer forests showed that " that the traditional reference conditions of low-severity fire regimes are inaccurate for most forests of western North America. Instead, most forests appear to have been characterized by mixed-severity fire that included ecologically significant amounts of weather-driven, high-severity fire." "Biota in these forests are also dependent on the resources made available by higher-severity fire. Diverse forests in different stages of succession, with a high proportion in relatively young stages, occurred prior to fire exclusion. Over the past century, successional diversity created by fire decreased. Our findings suggest that ecological management goals that incorporate successional diversity created by fire may support characteristic biodiversity, whereas current attempts to 'restore'' forests to open, low-severity fire conditions may not align with historical reference conditions in most ponderosa pine and mixed-conifer forests of western North America."[38]

Analysis of fuel treatments and fire occurrence in the western US Forest Service managed lands determined that fuel treatments have a probability of 2.0 - 7.9% of encountering moderate or high-severity fire in a 20-year period of reduced fuels (estimated time frame for return of fuels to prior levels or the "window of effective fuel reduction").[39]

In an Open Letter to Decision Makers Concerning Wildfires in the West, 215 scientists and Forest advocates expressed their concerns about ongoing proposals to expand logging on public land in response to recent increases in wildfire in the West.[40] They called for science-based solutions to maintain biologically diverse fire-dependent ecosystems while reducing risks to communities and firefighters. Today, less acres burn than in the past, but since the 1980s, the fire season has become longer and the number of wildfires has increased, while temperatures have risen and snowpack decreased, and the fire season has increased from five to seven

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[37] Six, D.L., Biber, E., and E.L. Esposito. 2014. Management for mountain pine beetle outbreak suppression: does relevant science support current policy?. Forests 5(1):103-133. DOI: 10.3390/f5010103. https://app.box.com/s/4y9y70lbqyza4xnn56a9764abhyr92h8

[38] Odion DC, Hanson CT, Arsenault A, Baker WL, DellaSala DA, et al. (2014) Examining Historical and Current Mixed-Severity Fire Regimes in Ponderosa Pine and Mixed-Conifer Forests of Western North America. PLoS ONE 9(2): e87852. doi:10.1371/journal.pone.0087852.

[39]Rhodes, J.J. and Baker, W.L. 2008. Fire probability, fuel treatment effectiveness and ecological tradeoffs in
western U.S. public forests. The Open Forest Science Journal 1: 1-7. https://app.box.com/s/s3dqfmgcxizw0pkrva56ott43qphhjya

[40] Geos Institute. 2018. Open Letter to Decision Makers Concerning Wildfires in the West. Geos Institute, Ashland, Oregon. https://wildfiretoday.com/2018/09/22/217-scientists-sign-letter-opposing-logging-as-a-response-to-wildfires/

months. This is attributed in part to climate change. They make several points about forest management, including; (1) thinning is ineffective in extreme fire weather; (2) post-disturbance salvage logging reduces forest resilience and can increase fire hazards; (3) wilderness and other protected areas are not especially fire prone; (4) fires burned more severely in previously logged areas, while in wilderness, parks and roadless areas, they burned "in natural fire mosaic patterns of low, moderate, and high severity" which maintained resilient forests.

Road Densities and Effects

Big Game security areas are defined as an area of cover over 0.5 miles from an open motorized route and over 250 acres.[41] These areas are important for limiting disturbance and hunting vulnerability to big game animals, but also provide benefits to other animals as well. Higher road densities correspond to lower security for wildlife.

There have been numerous publications on the benefits of roadless areas and the negative effects of roads regarding noise pollution and wildlife. Roads increasingly provide vehicle access into more and more remote areas, forcing sensitive species to be eliminated or greatly reduced especially when the cumulative impacts from livestock, oil, gas and mineral exploration and development are included. Roads and groomed trails provide increased access that can be used in summer and winter to damage environmental resources and displace or disrupt wildlife. Motorized vehicles, OHV/ATVs and snowmobiles, with their ability to travel large distances cross-country, often have negative environmental impacts whether the trail is open, closed, or user created. The ecological effects of roads and/or mechanized use include erosion, air and water pollution, spread of invasive weeds, avoidance of road or machine-affected areas by wildlife, and habitat fragmentation.[42, 43]

Roads, human activity, and noise fragment habitats by breaking large areas into smaller areas. These smaller areas no longer retain their original functions and begin losing the ability to

[41] USDA Forest Service. 2003. Final Environmental Impact Statement for the Caribou National Forest Revised Forest Plan. Volume IV.

[42] T. W. Clark, P. C. Paquet, and A. P. Curlee. 1996. Large Carnivore Conservation in the Rocky Mountains of the United States and Canada," Conservation Biology 10: 936–939.

[43] Trombulak, S. C. & C. A. Frissell. 2000. The ecological effects of roads on terrestrial and aquatic communities: a review. Conservation Biology 14:18-30

support many species, especially those that are wide-ranging.[44, 45, 46, 47] Roads have been shown to have thresholds of density above which species begin to decline or be eliminated. This has been reported to generally be 1 mile per square mile, with effects to some large mammals such as bears at a road density of 0.5 miles/square mile.[48, 49] The importance of roadless areas was documented for both small (1,000-5,000 acres) and large (>5,000 acres) roadless areas under consideration in the Clinton Roadless Area Draft Environmental Impact Statement (DEIS).[50] A press release at the same time noted that this roadless area rule would protect 58.5 million acres, or nearly one-third of America's national forests.[51] That DEIS contained an alternative 4 that would "Prohibit road construction, reconstruction and all timber harvest within unroaded portions of Inventoried Roadless Areas".

Researchers, including those with the Forest Service, have documented the benefits of roadless areas and the negative effects of roads and OHV/ATVs on wildlife.[52] [53] Twenty-five percent of elk exhibited a flight response to ATVs that were 1 km or 0.6 miles away. [54] Elk select summer

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44 D. A. Saunders, R. J. Hobbs, and C. R. Margules. 1991."Biological Consequences of Ecosystem Fragmentation: A Review," Conservation Biology 5 (1991): 18-32.

45 Hitt, N.P. and C.A. Frissell. 1999. Wilderness in a landscape context: a quantitative approach to ranking Aquatic Diversity Areas in western Montana. Presented at the Wilderness Science Conference, Missoula, MT, May 23-27, 1999.

46 J. R. Strittholt and D. A. DellaSala, Importance of Roadless Areas in Biodiversity Conservation in Forested Ecosystems: A Case Study-Klamath-Siskiyou Ecoregion, U.S.A. 2001. Conservation Biology 15 (6): 1742-1754.

47 G. E. Heilman, Jr., J. R. Strittholt, N. C. Slosser, and D. A. DellaSala. 2002. Forest Fragmentation of the Conterminous United States: Assessing Forest Intactness Through Road Density and Spatial Characteristics. Bioscience 52 (5): 411-422.

48 R. P. Thiel. 1985. Relationship Between Road Densities and Wolf Habitat Suitability in Wisconsin. American Midland Naturalist 113: 404-407.

49 L. D. Mech, S. H. Fritts, G. L. Radde, and W. J. Paul. 1988. Wolf Distribution and Road Density in Minnesota. Wildlife Society Bulletin 16: 85-87.

50 USDA Forest Service. 2000. Forest Service Roadless Area Conservation Draft Environmental Impact Statement. Volume 1. Washington Office. 504p.

51 The White House. 2001. President Clinton: Strong Action to Preserve America's Forests. January 5,2001 press release. https://clintonwhitehouse5.archives.gov/WH/new/html/Fri_Jan_5_151122_2001.html Accessed April 2, 2021.

52 Gilbert, Barrie K. 2003. Motorized Access on Montana's Rocky Mountain Front. A Synthesis of Scientific Literature and Recommendations for use in Revision of the Travel Plan for the Rocky Mountain Division.

53 Canfield, J.D., L.J. Lyon, J.M. Hillis, and M.J. Thomposn. 1999. Ungulates. Pages 6.1-6.25 in G. J oslin and H. Youmans, coordinators. Effects of recreation on . Rocky Mountain Wildlife: A Review for Montana. Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society. 307pp.

54 Wisdom, M. J., H. K. Preisler, N. J. Cimon, B. K. Johnson. 2004. Effects of Off-Road Recreation on Mule Deer and Elk. Transactions of the North American Wildlife and Natural Resource Conference 69: in press.

range with low road densities and abandon summer range early when in areas easily accessible to motorized use.[55] [56]

Off Road Vehicles and Carbon Emissions

Off road vehicles such as ATVs, dirt bikes, UTVs and snowmobiles are used in our National Forests and public lands. The impacts of these machines include noise, damage to soils and vegetation, accelerated erosion, and displacement of wildlife.[57] An analysis[58] of the carbon footprint of off-road vehicles in California determined that:

(1) 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.

(2) Off-road vehicles emit considerably more pollution than automobiles. According to the 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.

(3) 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[59] provides data on the amount of fossil fuel being consumed by snowmobiles in Montana, from which one can calculate the carbon footprint. The study found 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. 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

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https://www.researchgate.net/publication/228447373_Effects_of_Off-Road_Recreation_on_Mule_Deer_and_Elk.

[55] Stubblefield C.H., Vierling Kt.T., and MA. Rumble. 2006. Landscape-Scale Attributes of Elk Centers of Activity in the Central Black Hills of South Dakota. Journal of Wildlife Management. 70(4): 1060—1069.

[56] Grigg, J. 2006. Gradients of predation risk affect distribution and migration of a large herbivore. Master Thesis, Montana State University, Bozeman.

[57] Wuerthner, G. 2007. Thrillcraft. Foundations for Deep Ecology. 312p.

[58] Kassar, C. and P. 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.

[59] 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.

per gallon of gas (diesel pickups spew 22 pounds per gallon) and snowmobiling releases 192 million pounds (96 thousand tons) of climate-warming CO2 per year into the atmosphere.

These are only two states, but these examples provide an indication of the large contribution of these machines to greenhouse gases if extrapolated for the Nation as a whole. Reducing road density and the area of National Forests and public lands open to their use could have the effect of reducing these emissions.