A Critical Analysis

2023 Biological Opinion Regarding Effects of the Lolo National Forest Plan on Grizzly Bears

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A Critical Analysis of the March 10, 2023, Biological Opinion on Effects of the Lolo National Forest Plan on Grizzly Bears

David J. Mattson, Ph.D.

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What follows is my critical analysis of the Biological Opinion (hereafter BiOp) issued by the U.S. Fish and Wildlife Service (hereafter the Service) on March 10, 2023, regarding likely effects of continued implementation of the 1986 Lolo National Forest Plan on grizzly bears (U.S. Fish & Wildlife Service 2023). This partially amended plan promulgated nearly 40 years ago is in the process of being revised. The BiOp addresses how continued implementation of the 1986 Forest Plan for the next 10 years will likely affect grizzly bears.

Although the Service determined that "the action" (i.e., continued implementation) "may affect, likely to adversely affect" grizzly bears, its remedy merely consisted of an incidental take permit contingent on the Lolo National Forest (hereafter the Forest) not degrading existing levels of security temporarily or permanently more than 1-5%. In effect, the Service's BiOp allowed for perpetuation of business as usual for as much as a decade, without any provisions requiring restoration of patently deficient habitat security for grizzly bears during this period.

As I detail below, the Service's analysis of likely effects of the action on individual bears and prospects for recovery of the species in the contiguous United States is comprehensively flawed. More to the point, the Service systematically understates or underestimates likely harm. This is accomplished through neglect of best available science, misrepresentations of current conditions, specious claims, tortuous and otherwise flawed logic, and inattention to the precautionary principle.

I conclude that the "proposed action" (continued implementation of the 1986 Forest Plan) will cause considerable harm, not only to a significant number of individual grizzly bears, but also prospects for recovery of the species in the contiguous United States. I end by describing the several realistic opportunities for meaningful restoration of habitat security in the action area (i.e., Lolo NF).

My analysis is organized by broad topical categories under which specific failings of the Service's BiOp are addressed, with topics sequenced according to a nested hierarchy of considerations, including: current status and trend of extant populations; adequacy of recovery criteria and determinations; implications for importance of the action area to meaningful recovery; current deficiencies in habitat security and other habitat conditions within the action area; likely harm of current conditions to grizzly bears; the extent to which bears will likely be exposed to human-associated hazards; and prospects for restoration.

1. Population Status and Trend

1.1. *The Service Overstates Status and Trend of NCDE Grizzly Bears*

The Service invokes Costello & Roberts (2022) in several places (BiOp:6, 88 & 93) to assert that the Northern Continental Divide (NCDE) grizzly bear population is growing at a rate of 2.3% per annum and currently numbers 1,163 animals. Aside from problems associated with ignoring uncertainty of both growth rate and population size estimates and the absurdity of reporting population size to a precision of single digits, the weight of available evidence strongly suggests that both estimates are inflated, as is the Service's conclusions regarding status and trend of the NCDE population.

Several weighty problems compromise methods used by Costello et al. (2016a) and Costello & Roberts (2022) to calculate current population trajectory and size. For one, the data used by Costello et al. (2016) to estimate a growth rate of 2.3% were collected during 2004-2013. None of the data collected since then have been incorporated into a revised growth rate, which means that the estimate of 2.3% is 16.5 years old and offers no information about recent growth of the NCDE population. More certainly, there is no credible scientific basis for uncritically projecting population size 11 years beyond any supporting data.

Perhaps even more important, the available evidence suggests not only that annual growth of the NCDE population was <2.3% during 2010-2013, but also that current growth is close to 0% (stasis). Mace et al. (2012) estimated that the NCDE population was growing at 3% annually during 2004-2009. Costello et al. (2016a) consolidated data used by Mace et al. (2012) with data collected during 2010-2013 to estimate that annual population growth during 2004-2013 was 2.3%, 0.7% less than during 2004-2009. Axiomatically, population growth during 2010-2013 must have been lower than during 2004-2009 for this reduction to have occurred.

An algebraic calculation can be used to estimate growth rate for 2010-2013 by weighting data collected during 2004-2009 and 2010-2013 in an equation in which population growth rates for 2004-2009 (3.1%) and 2004-2013 (2.3%) are known[1]. The result is an estimated growth rate for the 2010-2013 period of 1.4% per annum, roughly half the 3% growth rate estimated for 2004-2009.

There is, moreover, good reason to conclude that growth of the NCDE population has been closer to 0% per annum since 2018 largely because of an approximate 43% increase in annual death rates of independent female bears, from an average 4.9% during 2004-2013 and 4.8% during 2014-2017, to an average 7% during 2018-2021 (Costello et al. 2016a; Costello & Roberts 2016, 2017, 2018, 2019, 2020, 2021, 2022). Costello et al. (2016a) demonstrated that, absent any compensatory changes in other vital rates, population trajectory would approximate 0% per annum (stasis) if annual deaths of independent females approached 7%, as has been the case during 2018-2021.

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[1] Calculating growth rate ($\lambda 2$) for 2010-2013 entails solving the equation ($\lambda 1$ * p1) + ($\lambda 2$ * p2) = $\lambda 1{:}2$, where $\lambda 1$ is growth rate for 2004-2009, $\lambda 2$ is growth rate for 2010-2013, $\lambda 1{:}2$ is growth rate for 2004-2013, p1 is the proportion of analyzed data collected during 2004-2009, and p2 is proportion of analyzed data collected during 2010-2013. When populated, this equation is (1.031 * 0.56) + ($\lambda 2$ * 0.44) = 1.023, where $\lambda 2$ is the unknown. Solving the equation yields $\lambda 2$ = 1.014 (i.e., 1.4% per annum population growth).

More to the point, there has likely been no increase in size of the NCDE grizzly bear population during the past 5 plus years.

These more plausible estimates of population growth rate for 2004-2009, 2010-2017, and 2018-2021 can be used to produce credible point estimates of population size for the end year of each period assuming a beginning population of around 765 bears during 2004 (Kendall et al. 2009); i.e., 889 in 2009, 994 in 2017, and 994 (<1,000) in 2021.

An additional consideration introduces even more cause for conservatism. Populations estimated for 2017 and 2021 were distributed outside as well as inside the NCDE Demographic Monitoring Area (DMA or Zone 1 plus Recovery Zone). Costello et al. (2016a) estimated that areas occupied by bears outside the DMA accounted for roughly 28% of the total. Assuming that bear densities in these peripheral areas have been and continue to be roughly ½ densities within the DMA, approximately 140 of the total 994 bears have occupied peripheral areas, leaving a population of roughly 854 bears inside the DMA. This number is only 54 bears more than the minimum goal for the NCDE DMA (Costello et al. 2016a, Northern Continental Divide Ecosystem Subcommittee 2019) and only 90 more than the number of bears present in the DMA 20 years ago (e.g., Kendall et al. 2009), tantamount to a trivially small annual growth rate of 0.8% since 2004.

At face value, this small rate of increase for grizzly bears inside the NCDE DMA raises the question of why grizzly bears have continued to disperse into and colonize peripheral areas such as the Lolo NF. There is a well-substantiated answer to this question that contradicts assertions made by the Service in the Lolo NF BiOp linking dispersal ineluctably to high population growth rates. Swenson et al. (1998), Kojola & Laitala (2000), Støen et al. (2006), Roy et al. (2012), and Moore et al. (2014) have all documented a phenomenon variously called pre-saturation, inverse density-dependent, or negative density-dependent dispersal among brown and black bears. Put simply, this phenomenon can result in high rates of dispersal independent of any substantial increases in bear densities in a core population or result in selective dispersal by adolescent bears into peripheral areas even when core densities are declining.

As a bottom line, status of the NCDE grizzly bear population is more precarious than claimed by the Service in its Lolo NF BiOp, which throws into relief the prospective importance of the Lolo NF to assuring long-term resilience of the NCDE population. This conclusion contradicts the Service's dismissal of Lolo NF as an important landscape for recovering grizzly bears in the NCDE.

1.2. *The Service Misrepresents the Status of Cabinet Mountains Grizzly Bears*

The Service cites Kasworm et al. (2022a) as a basis for stating that the Cabinet-Yaak (CYE) grizzly bear population is increasing at a rate of 1.9% per annum, and that status of this population has improved considerably during the last decade. The Service also asserts that the 'population' is currently comprised of 60-65 bears. These statements misrepresent or otherwise obfuscate status and trend of the grizzly bear population in the Cabinet Mountains, which is of greatest relevance to management of bears and habitat on the Lolo NF, including Management Unit (BMU) 22 of the CYE Recovery Area and adjacent areas on the Forest.

The Cabinet Mountains portion of the CYE Recovery Area is contiguous with the Lolo NF and occupied by a grizzly bear population that is largely isolated from grizzlies elsewhere, including the Yaak portion of the CYE (Kasworm et al. 2022a). This isolation alone debars any statements about status and trend of bears in the totality of the CYE. More to the point, 95% of the survival data and 85% of the reproductive data used to estimate a 1.9% annual growth rate were obtained from bears occupying the Yaak region (Kasworm et al. 2022a). Not only did this estimate not account for the trend of bears in the Cabinet Mountains, it also failed to account for bears involved in conflicts with humans (Kasworm et al. 2022a). All of this precludes application of an estimated 1.9% population growth rate to bears in the Cabinet Mountains.

The Cabinet population is highly vulnerable not only because of its isolation but also its very small size. This small size catalyzed a long-standing augmentation effort that likely prevented extirpation of this population (Kasworm et al. 2022a), but otherwise resulted in minimal demonstrable success. An increase in size of the Cabinet Mountains grizzly bear population over a 30+ year period by roughly 10 bears from an estimated 15 bears in the mid-1980s to an estimated 22-24 in the mid-2010s is no doubt attributable to augmentation efforts (Kendall et al. 2016, Kasworm et al. 2022a). However, since the mid-2010s, there is little or no indication that the population has increased (Kasworm et al. 2022a).

The perpetually perilous status of the Cabinet Mountains grizzly bear population signals that more needs to be done to aid recovery efforts. Human-related conflicts and human-caused mortality inside and out of the Recovery Area clearly need to be reduced. The area within which habitat security for grizzly bears is prioritized also needs to be increased. This unambiguously implicates the Lolo NF as a critical component of recovery efforts for the Cabinet Mountains bear population, not only because of its adjacency, but also because the Cabinet portion of the CYE Recovery Area is plagued by deleterious edge effects arising from its attenuated shape (e.g., Mattson & Merrill 2002). In keeping with Forestwide Management Direction Goal A.7 and Standard E.24, the Lolo NF has a critical role to play in recovering the Cabinet Mountain grizzly bear population through actions that substantially increase habitat security for grizzly bears in areas adjacent to the CYE Recovery Area.

2. Recovery and Long-Term Viability

2.1. *The Service Conflates Achievement of Recovery Goals with Long-Term Population Viability*

The Service emphasizes throughout the Lolo NF BiOp that all recovery criteria in the NCDE have been met and, moreover, that meeting these criteria within the NCDE and CYE Recovery Areas *de facto* equates to 'recovery' (e.g., BiOp:6). This is accompanied by several invocations of the 1993 Recovery Plan as a basis for asserting what could be considered a tautology: "Recovery zones are areas adequate for managing and promoting the recovery and survival of grizzly bear populations" (BiOp:16, 54).

These claims are deficient largely because Recovery Area delineations are a historical and political artifact, have no relation to substantive reckonings of population viability, and are at variance with the current scientific consensus regarding what's needed to assure a high probability of population persistence over meaningful periods of time.

Of relevance to the first point, Recovery Area boundaries for the CYE, NCDE, and Greater Yellowstone (GYE) Ecosystems – first roughly delineated in the 1982 Recovery Plan and subsequently codified in the 1993 Recovery Plan – are highly correlated with the estimated distribution of these populations in 1979, roughly 45 years ago (U.S. Fish & Wildlife Service 1982; Figure 1). None of the populations listed under the ESA in 1975 as threatened were close to being recovered a mere four years later in 1979. Logically, any Recovery Area boundaries drawn to coincide with populations that were patently threatened – as happened in 1982 – were not likely to include the requisites for meaningful recovery. Although it is intrinsically difficult to assess motivations, I can attest from personal experience that delineations of Recovery Areas were, in fact, a consequence of political expediency and not a result of biological assessments that carefully considered even the crude state of scientific knowledge in the 1980s and 1990s.

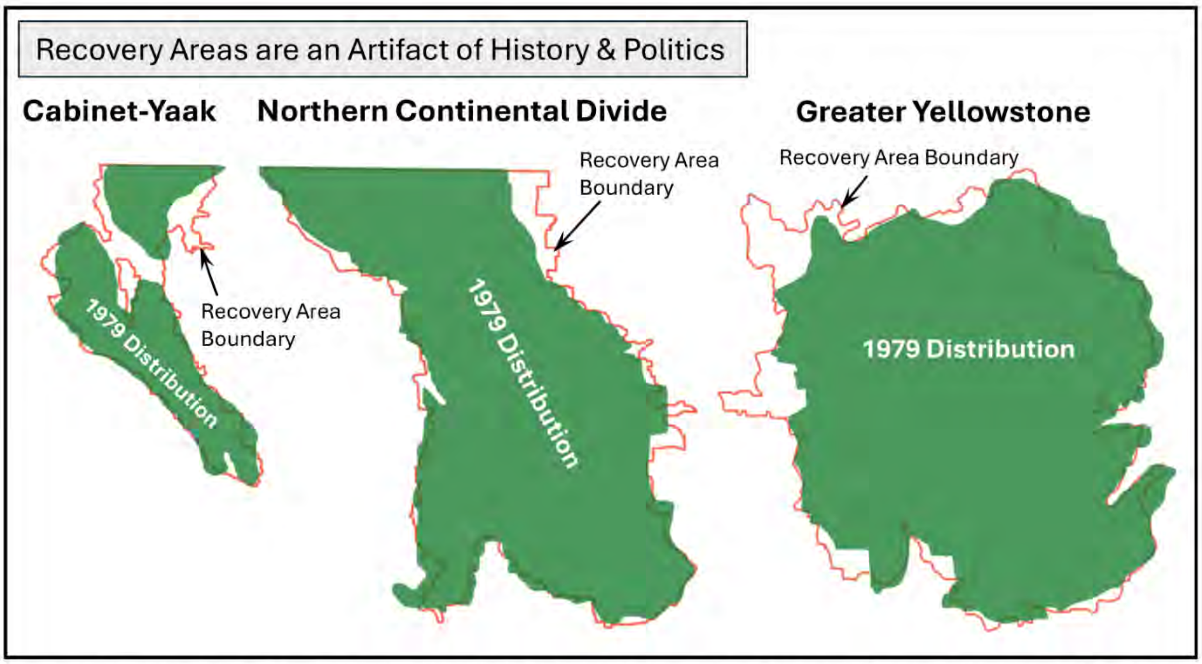

Figure 1. These maps show the estimated distributions of grizzly bear populations in the Northern U.S. Rocky Mountains *circa* 1979 superimposed on Recovery Area boundaries specified in the 1993 Grizzly Bear Recovery Plan. The correlation is almost exact, suggesting that RA boundaries merely codified where managers assumed grizzly bears were present four years after they were listed as threatened under the ESA. Distributions are from U.S. Fish & Wildlife Service (1982) and Recovery Area boundaries are from https://igbconline.org/.

Again, based on personal experience both developing recovery criteria and delineating a geospatial framework for management, I can attest to the fact that once Recovery Area boundaries were drawn, they merely were infilled with BMU boundaries that were then the basis for spatial reckonings of occupancy by reproductive females with no explicit relationship to population viability or known numbers and densities of bears (e.g., Weaver et al. 1986, Mattson & Knight 1991, Dixon 1997). At best, most recovery criteria were crude rules of thumb that reflected the state of scientific knowledge in the 1990s.

More to the point, current Recovery Area/Zone boundaries and recovery criteria have no relationship to requisites for long-term population viability (e.g., Mattson & Knight 1991). The Service's invocations of Recovery Area boundaries and criteria in the Lolo NF BiOp as a basis for asserting that populations in the GYE and NCDE have meaningfully recovered have little intrinsic scientific credibility, especially when reckoned against the current scientific consensus (see 3.2). As such, the Service's dismissal of areas outside Recovery Zones or the NInemile DCA on the Lolo NF as important to recovering grizzly bears in the contiguous U.S. lacks credibility.

2.2. *According to the Best Available Science the NCDE and CYE Populations are Not Recovered*

Grizzly bear numbers in the contiguous United States total to little more than 2,000 animals, with approximately one-half of them confined to the isolated GYE bear population (e.g., Van Manen et al. 2023). The approximately 120 bears occupying the Selkirk (SE) and CYE ecosystems are also semi-isolated from grizzly bear populations elsewhere because of low rates of immigration and emigration (Kasworm et al. 2022a, 2022b). This fragmented distribution intrinsically confounds meaningful recovery efforts that entail assurances of long-term viability (Proctor et al. 2012), with these efforts further compromised by comparatively small numbers in any given bear population, including the NCDE and GYE.

Of relevance, the current scientific consensus holds that 40 generations is an appropriate time span for reckoning risks to genetic viability (Reed et al. 2003, Traill et al, 2007, O'Grady et al. 2008). In the case of grizzly bears, 40 generations equates to roughly 400 years (e.g., Shaffer & Samson 1985, Shafer 2022). This time span has been used by researchers as a basis for estimating minimum sizes of populations needed to assure long-term viability (MVPs) based on theoretical calculations, historical observations, and population viability simulations. Based on these investigations, geneticists estimate that interbreeding populations of species such as grizzly bears need number around 3,700 animals, with estimates ranging from 1,850 to 10,000 (Lande 1995, Lynch & Lande 1998, Miller & Waits 2003, Reed et al. 2003, Brook et al. 2006, Sinclair et al. 2006, Traill et al. 2007, Puranen-Li et al. 2014). Grizzly bears in the contiguous U.S. collectively do not meet this numerical criterion – much less our two largest populations in the NCDE and GYE. More certainly, the small populations of grizzly bears in the SE and CYE fall far short of even the meagerest historical criteria for reckoning population viability (e.g., Shaffer & Samson 1985, Suchy et al. 1985, Shafer 2022).

These viability-based benchmarks have clear implications for key interstitial landscapes such as those encompassed by the Lolo NF, including highlighting a role in establishing connectivity that allows for an interbreeding population of approximately 3,000 bears in the contiguous United States.

2.3. *The Service Disregards Importance of the Lolo NF to Achieving Meaningful Recovery*

The Service acknowledges that continued implementation of the 1986 Lolo NF Plan would not limit road access or other infrastructure on the Forest outside the Ninemile DCA, NCDE Zone 1, and CYE BMU 22 (i.e., in extralimital areas), and that this lack of security would be "…at a level substantially less than is likely needed to successfully support a female grizzly bear with cubs" (BiOp:16).

Although this admission is accompanied by numerous assertions regarding the presumed capacity of this severely impaired landscape to support "some" transient or dispersing bears, the Service fails to credit the potential importance of extralimital areas on the Lolo NF to recovery of grizzly bears in the contiguous U.S. The Service furthermore confirms that any measures to increase security for grizzly bears are discretionary, while insinuating that the Lolo NF's extralimital landscape is expendable for purposes of grizzly bear recovery.

The Service's dismissal of this landscape on the Forest is at odds with not only the current marginal or impaired status of grizzly bears in the NCDE and Cabinet portion of the CYE Recovery Zone (Section 2), but also the inadequacy of current recovery criteria (Section 2.1) and the best available science regarding requisites of long-term population viability (Section 2.2). The nominal status of NCDE grizzly bears and perilous status of bears in the Cabinet Mountains; the largely arbitrary nature of recovery areas and criteria; and the imperative for a freely interbreeding population of between 2,000 and 4,000 bears throws into relief the potentially critical role of extralimital lands on the Lolo NF in providing connectivity among extant or nascent grizzly bear populations in the CYE, NCDE, and Bitterroot (BE) ecosystem. When connected, these ecosystems, together with the GYE, hold the promise of supporting the requisite 2,000-4,000 grizzly bears needed to achieve meaningful recovery (Mattson 2021a).

Several researchers have identified habitat in extralimital areas of the Lolo NF that potentially provide connectivity among the NCDE, CYE, and BE – variously referred to as corridors, linkage zones, dispersal areas, or connectivity pathways (Figure 2; Sandstrom 1996, Walker & Craighead 1997, Servheen et al. 2001, Proctor et al. 2015, Sells et al. 2023). Servheen et al. (2001) and Proctor et al. (2015) identified areas in western portions of the Lolo NF that are either contiguous with or proximal to the current CYE Recovery Zone (i.e., the Prospect, St. Regis North, St. Regis South, Dy Eddy, and Lynch Cr.-Clark Fork GBAUs). Sandstrom (1996) delineated the Ninemile, Clark Fork, Evro Hill, and Swan-Clearwater linkage zones (LZs) comprising a template for connectivity between the NCDE and the BE, largely through central portions of the Lolo NF. Although his Ninemile and Evro Hill LZs were foundational to establishing the Ninemile DCA and designing the Highway 93 "Peoples Way", his vision of a comprehensive system remained unfulfilled when the Service failed to provide the Clark Fork LZ south of Interstate 90 the status of a Demographic Connectivity Area. Finally, farthest east, Walker & Craighead (1997) modeled wildlife corridors between the NCDE and BE that provided an uncanny match to subsequent verified locations of grizzly bears (Figure 3).

In toto, this corpus of research prospectively encompasses the entirety of the Lolo NF in a design for connecting the NCDE, CYE, and BE, again with the potential for achieving meaningful recovery of grizzly bears in the contiguous U.S. Even so, this prospect is hedged by the all-important proviso that fulfillment will require substantial restoration of habitat security for grizzly bears on the Forest (see Sections 3 and 6).

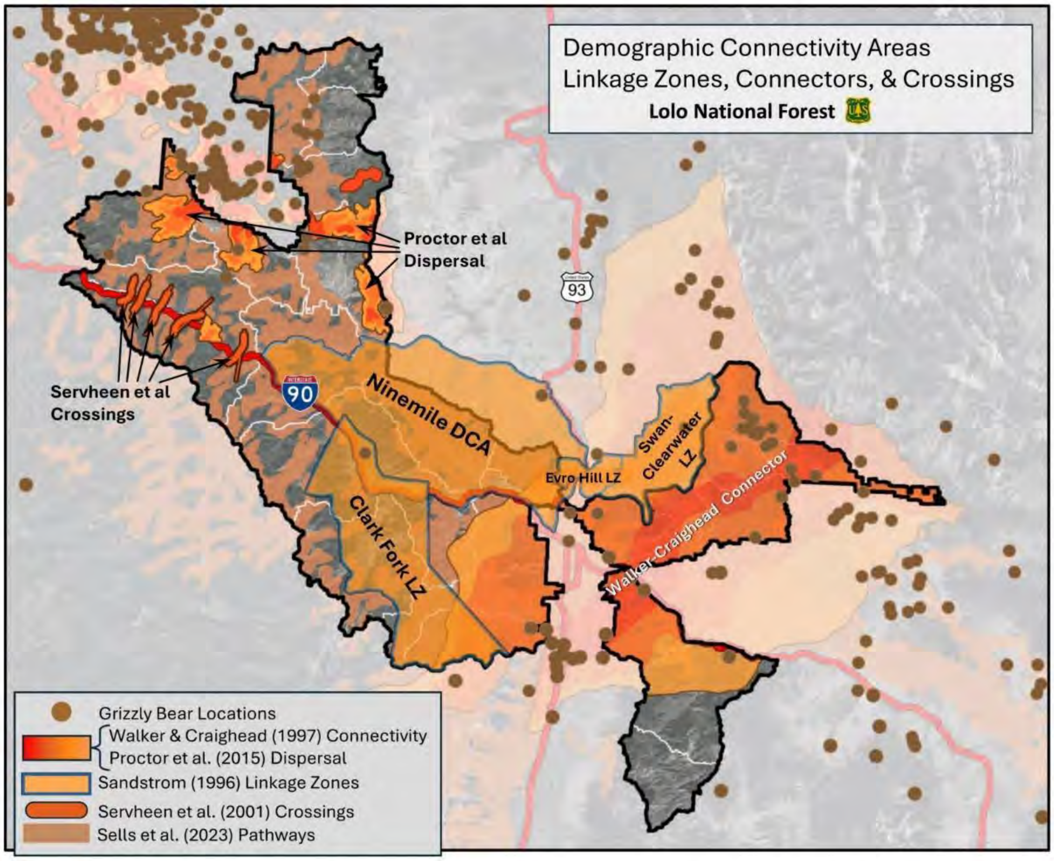

Figure 2. This map shows areas modeled by various researchers as having potential for supporting dispersing or resident grizzly bears in interstitial areas between the Cabinet-Yaak (CYE), Northern Continental Divide (NCDE), and Bitterroot (BE) ecosystems, highlighting areas on the Lolo National Forest. Modeled linkage Zones, Connectors, or Pathways are shown in shades of orange. Documented locations of grizzly bears in an near the Lolo NF are shown as brown dots. Linkage Zones identified by Sandstrom (1996) are denoted by 'LZ'. Areas where Walker & Craighead (1997) modeled a high probability of connectivity are shown in shades or orange, with darker orange denoting higher probabilities. Areas modeled by Proctor et al. (2015) as having a high probability of dispersal by grizzly bears from the CYE are likewise shown in shades of orange. The somewhat uninformative areas modeled as connectivity pathways by Sells et al. (2023) are shown in dusky orange in the background. Locations modeled by Servheen et al. (2001) as being good candidates for locations of crossing structures along Interstate-90 are also shown. Notice how the connectivity areas modeled by Walker & Craighead (1997) encompass most documented locations of grizzly bears in or near eastern portions of the Lolo NF.

3. *In Situ* Risk, Hazards, and Security

3.1. *The Service Describes but Then Dismisses the Importance of Adequate Security*

The Service devotes considerable space in the BiOp to reviewing the contingent effects of roads on grizzly bears (BiOp:42-43), the importance of sizeable well-distributed patches of secure habitat (BiOp:11, 43-44), and derivative standards applied to management of grizzly bear habitat in NCDE Zone 1, CYE BMU 22, and the Ninemile DCA (BiOp:12-13, 16, 55). Several noteworthy observations are included in these reviews, including the proven efficacy of security areas >1,000-5,100 acres in size; the related importance of maintaining security levels at >55-67% within a given BMU; and the extent to which traffic levels, visual screening, arrangement of road networks, and juxtaposition of roads with productive habitat configure the impacts of any given road on grizzly bears.

For unexplained reasons, the Service then proceeds to largely disregard these reviews of relevant scientific literature by asserting that "even small patches" (i.e., ~10 acres) of secure habitat have "some value" (e.g., BiOp:10, 11) while also largely ignoring the extent to which traffic levels on extant or planned road systems as well as placement of these road systems relative to productive habitat and visual screening affect habitat security levels in NCDE Zone 1, CYE BMU 22, and the Ninemile DCA. The Service also variously reports that road densities within these areas are 1.1, 1.3, and 1.5 miles/mile^2 while also asserting that the last two densities are compatible with a management standard or goal of 1.1 mile/mile^2 – all without attempting to reconcile these seemingly contradictory claims (BiOp:16, 55).

Insofar as meaningfully sized security areas are concerned, there is no evidence that areas <1,000 acres are particularly efficacious for grizzly bears. Conversely, available research shows that patches averaging 2,340 acres and ranging in size from 1,000 and 5,100 acres are plausibly the minimum required to provide appreciable benefit for grizzly bears engaged in daily foraging activities (Schleyer et al. 1984, Haroldson & Mattson 1985, Mace & Manley 1992, Mattson 1993, Wakkinen & Kasworm 1997, Gibeau et al. 2001, Schwartz et al. 2010, Costello et al. 2023). Patch sizes any smaller than this would require that most grizzly bears spend an appreciable part of a given day within the 500-m hazard zone of roads, defeating the purpose of minimizing exposure to human-related threats.

Even assuming there are security benefits attributable to patches <1,000 acres in size, another confounding issue relates to how these small patches are placed relative to patches >2,340-2,500 acres in size that provide more demonstrable security benefits for bears. Of relevance, the Service implies that bears moving away from large secure patches will be sprinting in a directional manner from one postage-sized 'secure' area to another, regardless of the intervening distance or an individual bear's experience with a specific landscape (see Figure 3). This is implausible. Logically, the farther the intervening distance and the less an individual bear's knowledge of a specific landscape, the more time the focal bear will be exposed to road-associated hazards. Absent any accounting for these factors, the value of small, isolated patches will be unduly inflated while risks to naïve bears will be inappropriately discounted.

More concretely, including patches <2,340 or even <1,000 acres in size in calculations of BMU/GBAU-specific habitat security – without regard for placement – predictably inflates estimates while simultaneously introducing vagaries arising from differences in patch size and distribution that confound reckonings of causation between putative security levels and metrics used to monitor grizzly bear population status in different BMU/GBAUs.

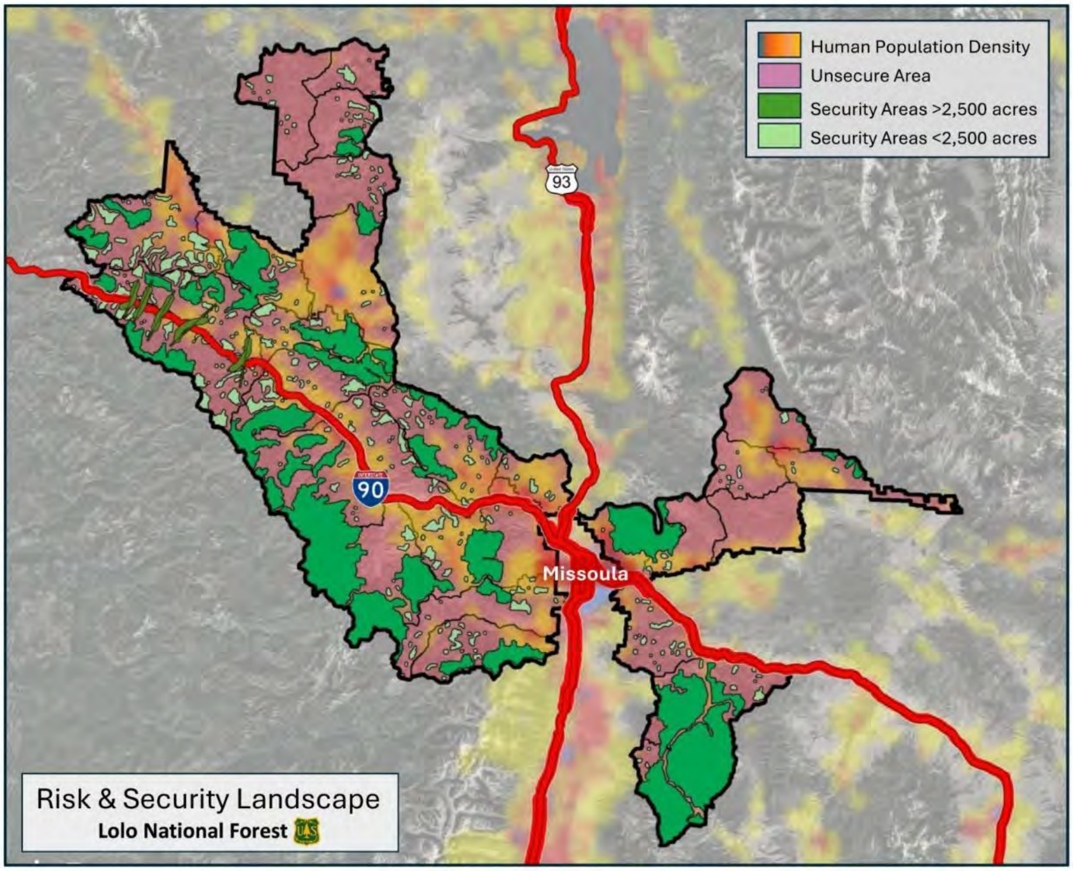

Figure 3. This map shows security areas on the Lolo National Forest superimposed on risk features such as major highways (US 93 and I-90) and human population densities. Security areas >2,500 acres in size are shown in dark green; areas less than this size are shown in light green (Appendix 1, U.S. Forest Service 2022). Relative traffic volumes on US93 and I-90 are denoted by the thickness of the red buffer along each (Montana Department of Transportation, 2022 Annual Average Traffic Statistics). Relative human population density is shown in shades of blue (>800 people/mile^2) grading to red, orange, and yellow (2-20 people/mile^2), with blue denoting urbanized areas and yellow relatively sparsely populated rural areas (Montana State Library, Geographic Information). Boundaries of Grizzly Bear Analysis Units (GBAUs) on the Lolo NF are shown as thin black lines (Appendix 1, U.S. Forest Service 2022). Areas of greatest contiguous habitat security are concentrated along the southern boundary of the Lolo NF, adjacent to Idaho, as well as in the northern Sapphire Mountains.

3.2. *The Service Fails to Acknowledge the Relationship Between Managing Cumulative Effects and BMU/GBAU Security Levels*

Bear Management Units (BMUs) were expressly conceptualized and delineated as a means of managing cumulative effects at scales that minimized hazards for individual grizzly bears – not simply as a means of calculating habitat security (Christiansen 1986, Weaver et al. 1986, Mattson & Knight 1991, Dixon 1997). The adopted scale comported with the approximate sizes of annual or life ranges for independent-aged female bears. Thresholds were developed at this scale with the goal of ensuring a high likelihood that individual bears would survive human-associated hazards embedded in each BMU (Mattson & Knight 1991, Dixon 1997). Over time, these thresholds have been reduced to simplistic reckonings based on percentages of core secure habitat and areas impacted by >1 mile/mile^2 and >2 miles/mile^2 road densities. The key point here is that management of security levels in BMUs is expressly linked to management of cumulative effects and informed by whether levels of security provide a high probability of survival for affected grizzly bears.

The Service does not expressly acknowledge the link between managing cumulative effects and levels of security in BMUs and GBAUs or risk-informed security thresholds anywhere in the Lolo NF BiOp. As a derivative - except for one pointed reference (BiOp:16) – the Service divorces calculations of GBAU security from any systematic appraisal of how subpar security levels (i.e., embedded cumulative human impacts) might affect likelihood of survival for affected grizzly bears.

Instead, the Service claims that substantially deficient BMUs/GBAUs allow for "some level of connectivity/impacts" (BiOp:16, 17, 47, 98, 100); that "some females are able to adapt" (BiOp:20, 43, 60, 81); or that bears "may occur"/"may result"/"may be adversely affected"/"may be able to" (BiOp:43, 45, 59, 77, 82, 87, 93, 104) – all without attempting to specify the likelihood that bears will survive, be harmed, or successfully disperse at any given intrinsically unmeasurable increment of "some" or "may." Nor does the Service then relate these likelihoods to attainment of outcomes such as supporting resident bears or allowing for levels of dispersal needed to achieve meaningful recovery. The Service also fails to relate its claims to reckonings of cumulative effects associated with deficient security levels. Instead, the sheer number of specious claims by the Service bespeaks argument through repetition rather than the judicious invocation of evidence.

As a bottom line – and as the Service acknowledges – few areas outside NCDE Zone 1, CYE BMU 22, or the Ninemile DCA provide enough secure habitat for a female to successfully reproduce and rear offspring that will not only disperse, but also replace her in the female reproductive cohort. Absent requisite security levels, there is little likelihood that extralimital areas on the Forest will be able to support colonizing female grizzly bears and thereby help realize not only connectivity between the NCDE, CYE, and BE, but also meaningful recovery of grizzly bears in the contiguous U.S.

3.3. *The Service Fails to Meaningfully Acknowledge Implications of Pervasively Inadequate Habitat Security on the Lolo NF*

Deficient levels of security in GBAUs outside NCDE Zone 1, CYE BMU 22, and the Ninemile DCA lend weight to the conclusions of Section 3.2. The box-and-whisker diagrams in Figure 4 compare security levels for Lolo NF's extralimital GBAUs with security levels for BMUs and BMU Subunits in the GYE, NCDE, SE, and CYE along with a thumbnail of population status in each of these ecosystems. The contrast is not subtle. Median security of Lolo GBAUs is 14%, roughly 6-times less than median security levels of BMUs in the GYE and NCDE and 4-times less than median security levels of BMUs in the SE and CYE. This extreme comparative deficiency suggests that few colonizing grizzly bears will survive long enough to reproduce and replace themselves on most of the Lolo NF, especially in light of the fact that security standards and thresholds in the GYE, NCDE, SE, and CYE were expressly developed with the intent of sustaining and recovering resident grizzly bear populations.

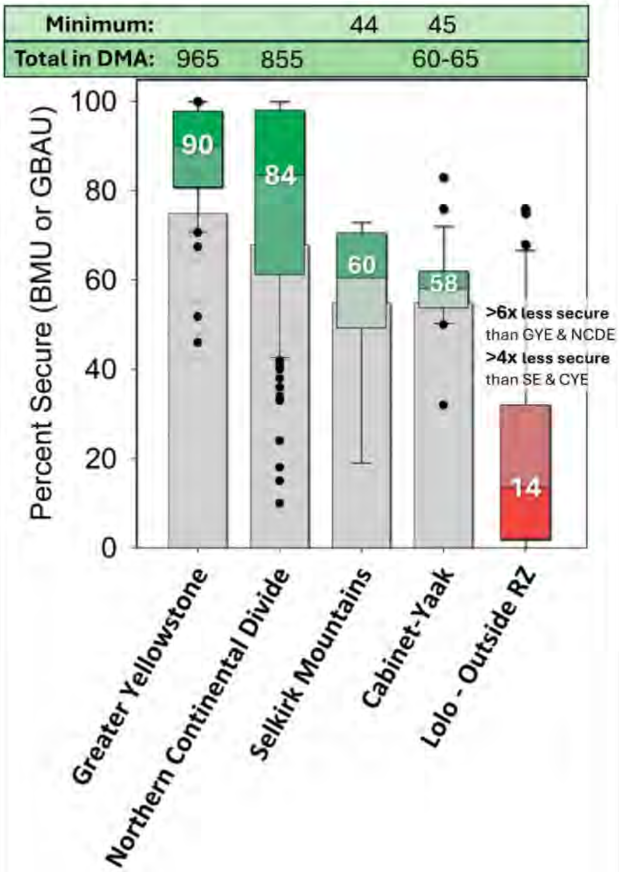

Figure 4. These bar charts show median and interquartile ranges of habitat security for Bear Management Units (BMUs) or BMU Subunits in grizzly bear Recovery Areas of the Northern U.S. Rocky Mountains, together with security standards for each ecosystem as gray bars. The boxes in each box-and-whisker diagram bound the interquartile interval; the brackets bound 95% intervals; and the dots denote outliers. Median security levels are shown for BMUs in each Recovery Area, ranging from 58% in the Cabinet-Yaak (CYE) to 90% in the Greater Yellowstone (GYE). The same information for Grizzly Bear Analysis Units (GBAUs) on the Lolo National Forest outside designated Recovery Areas is shown in the box-and-whisker diagram farthest right. Notice that median security levels here are 14%, >6-times less secure than in the GYE and >4-times less secure than in the CYE. A summary of estimated population sizes for each Ecosystem is given in the green boxes at top, with estimated minimums shown in the light green box and estimated totals shown in the dark green box. Security calculations are from Northern Continental Divide Ecosystem Subcommittee (2016), Kasworm et al. (2022a, 2022b), U.S Forest Service (2022), and Van Manen et al. (2022). Estimated population sizes are from Kasworm et al. (2022a, 2022b), Van Manen et al. (2023), and my calculations in Section 1.1.

This point is driven home by differences in status of grizzly bear populations in the various Recovery Areas and the extent to which these differences correlate with median security levels. The two ecosystems with between 800 and 1,000 bears (GYE and NCDE) – roughly twice the probable number at time of listing – have median security levels of 90 and 85%, respectively. The two ecosystems with nearer 60 bears (SE and CYE) – amounting to perhaps one or two dozen more than at the time of listing – have median security levels of only 60 and 58%, respectively. One can reasonably assume that if the SE and CYE grizzly bear populations are still critically imperiled (see Section 2.2), then the plight of most female grizzly bears attempting to permanently occupy the Lolo NF will be bleak.

Because the Lolo NF occupies a geographic position critical to realizing not only connectivity between the NCDE, CYE, and BE but also achieving meaningful population viability and recovery for grizzly bears in the contiguous U.S. (Section 2.3), there is clearly a need for targeted and substantial restoration of habitat security on the Forest if this potential is to be fulfilled (see Section 6). Absent this kind of restoration, the Forest will likely continue to function as a population sink that takes a toll on source populations in the NCDE (Mattson 2019) without substantially contributing to establishment of a freely interbreeding meta-population of grizzly bears in the contiguous U.S.

3.4. *The Service Disregards the Importance of Survival While Inflating the Importance of Displacement*

The Service makes only passing reference to the effects of Forest management on survival of grizzly bears (e.g., BiOp:16) while at the same time belaboring the phenomenon of bears being potentially displaced from roads or other human activities (e.g., BiOp:17, 31, 59, 82). As a preface, 'displacement' is only one way that bears, as individuals, respond behaviorally to humans or human facilities. Bears also 'avoid' threatening landscape features – as a more enduring aspect of learned individual behavior – and 'under-utilize' (e.g., collectively select against) areas near human infrastructure as an aggregate phenomenon entrained by both transmitted as well as individual learning (Mattson 2021b). These distinctions are relevant because they differentiate the varied ways that bears in aggregate and as individuals can be behaviorally impacted by people. Displacement is an immediate behavioral response; avoidance is a more enduring learned individual reaction; and under-use is an aggregated population level response.

More importantly, individual bears can exhibit remarkably vagarious reactions to people and human infrastructure based on levels of tolerance or intolerance for both (Mattson 2021b). By contrast, human-related hazards are embedded in a landscape, with risk of fatal outcomes predictably mounting for bears as their level of exposure increases – as when they more frequently encounter roads or highways and potentially lethal interactions with people. This mounting likelihood of death and related decline in likelihood that bears will be present has been demonstrated repeatedly in a wide variety of circumstances and settings (Merrill et al. 1999; Mattson & Merrill 2004; Nielsen et al. 2004; Schwartz et al. 2010; Boulanger & Stenhouse 2014; Lamb et al. 2018, 2020; Parsons et al. 2021, 2022), conciliant with the fact that nearly all non-collision human-caused grizzly bear deaths occur within 500-1000 m of secondary (e.g., forest) roads (Dood et al. 1985; Aune & Kasworm 1989; Nagy & Gunson 1990; Mattson et al. 1996; Benn & Herrrero 2002; Wakkinen & Kasworm 2004; Boulanger & Stenhouse 2014, McLellan 2015; Kasworm et al. 2022a, 2022b).

As a bottom line, displacement and avoidance, as individual phenomena, can vary among bears and circumstances in landscapes such as those on the Lolo NF. By contrast, the hazards associated with presence of roads and people are much less fungible, with mounting likelihood of lethal outcomes for bears the greater their exposure to these hazards. As important, levels of security reckoned as cumulative human hazards within the bounds of BMUs and GBAUs (see Section 3.1) are a reasonable way of accounting for the likelihood that grizzly bears will prematurely die, with that likelihood predictably mounting to unsustainable levels when secure areas comprise <55-75% of a bear's home range (see Section 3.2). Of relevance, the Service does not adequately address this reality in either its evaluation of action impacts or prescription of remedies for the Lolo NF.

3.5. *The Service Unduly Discounts the Role of USFS Roads in Governing Landscape Hazards*

The Service makes several disingenuous claims on page 45 of the BiOp, specifically that none of the proximal causes of grizzly bear deaths (e.g., self-defense, defense of property, poaching, mistaken identification) are part of "the proposed action" because the Forest cannot directly control them. The Service further asserts that because "it is unknown as to when or where such mortality may occur [*sic*]" the Forest is further relieved of any responsibility or accountability for these lethal effects on a listed species.

There are several logical, legal, and factual fallacies to these claims. Among them is an obvious one: but for the presence of roads, most human-caused grizzly bear deaths would not occur, regardless of the direct cause (see Section 3.4). There is an inescapable causal link between the presence of Forest roads and human-caused grizzly bear deaths, which alone obviates any dismissal by the Service of culpability on the part of Lolo NF managers who are accountable for effects arising from more than 9,000 miles of motorized routes on the Forest, including >3,000 miles that are not officially part of the Forest System (e.g., in 'undetermined' status; Lolo National Forest [2015]). The inconvenient fact that roads lead directly to bear deaths is the basis for a legal mandate that established habitat-based recovery criteria (*Fund for Animals v. Babbitt* (1995), 903 F. Supp. 96) and the related management edifice that limits areas impacted by high road densities and establishes minimum habitat security levels for grizzly bears.

The claim that Forest managers are further spared accountability for road-related grizzly bear deaths because it is "unknown…when or where [they] may occur" is specious at best. No one ever knows with certainty when or where a bear will be present or what the related outcomes will be – including death. Management to reduce risk is intrinsically based on likelihoods, probabilities, and (ideally) statistical relations. As described in Sections 3.1-3.4, above, all the available albeit inherently probabilistic evidence unambiguously depicts a causal link between on-going and prospective actions that facilitate mechanized human access on the Forest and risk that grizzly bears will die.

3.6. *The Service Understates Risks to Male Bears, Dispersers, and 'Transients'*

The Service makes several claims regarding effects of the proposed action on male, subadult, and 'transient' bears, all of which are dismissive of harm to these individuals as well as to recovery prospects. More specifically, the Service claims that because male, subadult, and transient bears are "highly mobile," their behavioral patterns will not be significantly impacted (BiOp:43); that displacement of these types of bears will be insignificant (BiOp:60); leading to culminating claims such as "we do not expect any effects to individual grizzly bears [sic]" ([my emphasis], BiOp:99) and "we do not anticipate any take of subadult or male grizzly bears" or "take of grizzly bears that are transients" ([my emphasis], BiOp:104).

Not only do these claims fail the standards of deductive reasoning, they also defy a large body of evidence conclusively showing that wide-ranging bears, including subadults and adult males, have, of all bears, the greatest per capita chances of being killed by humans, and are consequentially at greater risk of dying than females of any age largely because of predictably greater movement-related exposure to humans and human infrastructure. Males in particular are also more likely to engage in behaviors that magnify this risk.

Axiomatically, bears that move more often over longer distances will be more likely to encounter geospatially fixed hazards such as roads, especially if road networks are dense, as typifies most areas on the Lolo NF. Of relevance, average home range sizes of adult males, subadult males, and subadult females are 4-times, 2.8-times, and 1.2-times larger, respectively, compared to average homes ranges adult females. Males also move correspondingly longer distances within their home ranges (Craighead 1976, Ballard et al. 1982, Blanchard & Knight 1991, Mace & Waller 1997, Dahle & Swenson 2003, Dahle et al. 2006, Mace & Roberts 2011, Bjornlie et al. 2014, Graham & Stenhouse 2014, Joly et al. 2022, Kasworm et al. 2022a, Costello et al. 2023). These greater movements inescapably engender greater odds of encountering human-related hazards if secure areas are small relative to average daily movements – again, as typifies most of the Lolo NF. Wide-ranging movement magnifies rather than minimizes risk.

Not surprisingly, the larger range sizes and greater mobility of adult and subadult males correlate with average annual numbers of deaths, almost all of which are attributable to human causes. Death rates of subadult male, adult male, and subadult female bears average 3.2-times, 2.2-times, and 1.8-times higher, respectively, than those of adult females, meaning that these classes of bears are roughly 2-3-times more likely to be killed by people during any given year (Eberhardt et al. 1994, Wielgus et al. 1994, Hovey & McLellan 1996, Miller 1997, Mace & Waller 1998, McLellan et al. 1999, Sellers et al. 1999, McLoughlin et al. 2003, Wakkinen & Kasworm 2004, Garshelis et al. 2005, Kovach et al. 2006, Schwartz et al. 2006, Costello et al. 2016a). This pattern holds without exception across study areas.

As a corollary, relative to their average proportions in northern Rockies grizzly bear populations, subadult male, adult male, and subadult female bears are 9.8-times, 2.6-times, and 2.1-times more likely, respectively, than adult females to be killed or captured because of conflicts with humans (McLellan et al. 1999; Mace & Chilton 2009; Mace & Roberts 2011, 2012a, 2012b, 2013, 2014, 2015; Costello & Roberts 2016, 2017, 2018, 2019, 2020, 2021; Kasworm et al. 2022a, 2022b).

All of this puts the lie to claims made by the Service in its Lolo NF BiOp regarding risks of the proposed action to wider-ranging or ‘transient’ bears. These bears are, in fact, at considerable risk of being harmed or affected by humans, especially compared to adult females. Greater mobility does not engender any sort of immunity from hazards posed by humans or human infrastructure. In fact, the opposite is true.

4. Habitat, Foods, and Competition

4.1. *The Service Conflates Omnivory and Adaptability with Indifference to Foods and Habitats*

The Service invokes the fact that grizzly bears are "habitat generalists and opportunistic omnivores" as a basis for then claiming that grizzlies will be unaffected by climate change or human disturbance (BiOp:35, 76) and, moreover, that because certain bears are "highly mobile," they will readily find "food and shelter" regardless of human impacts (BiOp:43). These claims rest on the tacit assumption that all foods and habitats are equal and that, because of this equivalence, grizzly bears are indifferent to food or habitat quality. Hence, according to the Service, grizzly bears can readily substitute one food or habitat patch for another in the face of human intrusion and habitat degradation.

Other than the self-evident truth that grizzly bears are omnivorous and adaptable, this is yet another instance where the Service's claims and inuendo are at odds with most research regarding bear foods, habitats, and behavior.

Insofar as foods are concerned, there are orders-of-magnitude differences in energetic and nutritional values to bears, ranging from relatively undigestible foliage and insects to highly digestible tissue from fish and ungulates, with roots and fruit in between (e.g., Mattson et al. 2004). This variation in nutritional value together with the architecture and local abundance of foods has a definitive effect on foraging behaviors, food preferences, and, ultimately, composition of bear diets (e.g., Bacon & Burghardt 1983, Welch et al. 1997, Rode & Robbins 2000, Rode et al. 2001, Robbins et al. 2007, Coogan et al. 2014, Erlenbach et al. 2014, Costello et al. 2016b). Subject to constraints of nutrient optimization, grizzly bears unequivocally seek out high-value foods if available.

This pursuit of abundant high-quality food is manifest in an equally large corpus of research showing that grizzly bears have a strong tendency to select habitats and patches that are more productive and yield greater amounts of high-quality food. A sampler of this research from the northern Rockies, inclusive of the Lolo NF, includes Waller & Mace (1997), McLellan & Hovey (2001a), Apps et al. (2004), Lamb et al. (2018), Mace et al. (1997, 1999), Sells et al. (2022), and Proctor et al. (2023). Subject to constraints imposed by the need for security from conspecifics, grizzly bears unambiguously seek out and preferentially select productive habitats.

The well-documented tendency of bears to seek out and consume high quality foods in resource rich patches can lead to the equally well-documented phenomenon of ecological traps (Nielsen et al. 2006, Falucci et al. 2009, Northrup et al. 2012, Lamb et al. 2017, Penteriani et al. 2018). In simplest terms, an ecological trap occurs when and where food-rich habitats chronically attract bears into situations where they are exposed to unsustainable human hazards. This can occur regardless of bear densities when naïve bears venture into unfamiliar environs, as would typify adolescent bears dispersing into the Lolo NF.

Although grizzly bears tend to avoid humans and human infrastructure, they also routinely seek out productive habitats, often regardless of nearness to human infrastructure. Resources such as food usually come with compelling proximal cues whereas hazards are often attended by diffuse cues that manifest too late to benefit an affected animal. This perverse dynamic can exacerbate hazards for bears especially when human infrastructure is located in seasonally important habitats such as riparian areas or valley bottoms. Despite the Service's cursory acknowledgment of this consideration (BiOp:40-43), there is no evidence that it affected the Service's subsequent judgments regarding potential harm from perpetuating existing conditions in the action area.

4.2. *The Service Overlooks the Importance of Competition with Black Bears*

The Service asserts in several places that because grizzly bears are rare or occur at only low densities on the Lolo NF there will be little competition for food, thereby allowing the few resident or colonizing bears free access to food and habitat while avoiding human infrastructure (BiOp:60, 82). As I describe in Section 4.1, this assertion is *prima facie* problematic at best and fallacious at worst.

However, an additional proviso pertains to local impacts of black bears – another adaptable omnivore that exploits most of the foods consumed by grizzly bears. In fact, in areas where both species subsist primarily on foliage and fruit, dietary overlap can be nearly complete (Mattson et al. 2005). Exacerbating this nascent competition, black bears have been shown to be at an advantage over grizzly bears when exploiting dispersed foods such as grasses, clover, huckleberries, and serviceberries (Welch et al. 1997, Rode et al. 2001), which sets the stage for high densities of black bears adversely affecting grizzly bears through attrition of shared foods in shared habitats (e.g., Stetz et al. 2014).

Black bears in the northern Rockies exist at densities sufficient to translate this potentiality into a reality, especially for younger grizzly bears dispersing into unfamiliar areas, as would typify adolescents and 'transients' moving into or through the Lolo NF. Black bear densities average >5x higher than grizzly bear densities in areas where they are conspecific, including the northern Rockies (Aune 1994; Mowat et al. 2005; Kendall et al. 2008; Stetz et al. 2014; Kasworm et al. 2022a, 2022b). This ratio is an even more exaggerated 8:1 when contrasting densities of grizzly bears in areas serving as a source of dispersers (Kendall et al. 2009, 2016; Kasworm et al. 2022a) and black bear densities in and near the Lolo NF (Mace & Chilton-Radandt 2011).

As a bottom line, it is reasonable to expect that competition with black bears on the Lolo NF will constrain access to foods and habitats for dispersing/colonizing grizzly bears (e.g., Mattson et al. 2005, Stetz et al. 2014) – in the process exacerbating negative impacts of the existing road infrastructure on grizzly bears attempting to establish residency.

4.3. *The Service Understates Likely Impact of Overstory Removal during the Next 5-10 Years*

The Service assessed prospective effects of the Lolo NF's timber harvest and mechanical fuel treatment programs on grizzly bears on pages 29-31 of the BiOp, concluding that site- and project-specific effects would range from "minimal disturbance to significant displacement" (BiOp:31; but see Section 3.4 for my critique of undue emphasis on displacement versus survival). Curiously, although the Service reported a per annum figure of acres harvested or otherwise mechanically treated during 2018-2020 (totaling 34,630 acres); summarized acreage burned by wildfires during 2017-2021 (344,972 acres); and noted that this acreage would likely increase due to effects of climate change, the Service failed to address the cumulative effects of this vegetation modification which have been and will likely continue to be substantial.

Put another way, roughly 80,500 acres of Forest jurisdiction have been affected by some degree of natural or human-caused disturbance each year for approximately the last five years, with much of this disturbance resulting in overstory removal and mortality of woody understory plants. The Service, moreover, acknowledges that this acreage will likely increase in the future (BiOp:29-30). A simple calculation shows that this could amount to >400,000 acres during the next 5 years alone, >18% of the action area. This non-trivial percentage would accrue on top of the approximate 18% affected during the previous five years, totally roughly 36% of the Forest during a 10-year period spanning 2017-2027.

Although the Service belabors the proximal effects of human activities associated with mechanical treatments and fire control with an emphasis on potential short-term displacement of bears, it fails to address the longer-lasting effects of overstory removal or understory modification by fire, cutblocks, and other vegetation treatments on grizzly bears. Of relevance to fruit availability, several research projects have shown that abundance of huckleberries and buffaloberries is reduced to virtually nil immediately after wildfires and doesn't peak until around 10-30 years after removal of fruit-producing stems by either fire or mechanical treatment (Miller 1977; Martin 1979, 1983; Noble 1985; Hamer 1996; Nielsen et al. 2004b; Barber et al. 2016; Denny & Nielsen 2017; Bateman & Nielsen 2020; Proctor et al. 2023). More concretely, this means that potentially 100% of areas supporting high densities of either or both fruit-bearing species are out of production for grizzly bears 10 years after disturbances that remove ground and overstory vegetation. This prospective loss of fruit biomass is further exacerbated by the fact that grizzly bears commonly avoid cutblocks for more than one-decade after human disturbances associated with mechanical treatments if harvested areas continue to be accessed by roads (Colton et al. 2021).

The implications of these patterns are clear. Continuation of business as usual under the 1986 Lolo NF plan and its amendments will likely have widespread albeit transient negative effects on grizzly bears through continued vegetation conversion, with road access and timber harvest being the factors most amenable to management, especially for mitigating effects attributable to ever-increasing wildfires.

5. Presence, Occupancy and Exposure

5.1. *The Service Overstates Detection of Bears that are Present or Have Been Killed*

Throughout the BiOp the Service asserts that there have been few *verified* locations of grizzly bears on most of the Lolo NF (BiOp:8, 59) and that very few bears will be or have been exposed to adverse effects of human activities and infrastructure in the action area (BiOp:61, 68, 82). The Service even goes so far as to assert that no bears will be harmed by embedded human-related hazards if "grizzly bears are not present" or an area is "lacking grizzly bear use" (BiOp:20, 61, 99, 104). These statements are made in awkward juxtaposition with an acknowledgement on page 8 that "grizzly bears may be present throughout most of the Forest…ranging from high likelihood in some areas…to very low likelihood or transient use in others."

There are several logical, evidentiary, and risk-related problems with these statements. For one, the Service requires that presence rather than absence of bears be proven, which is antithetical to premises of the ESA's precautionary mandate and guaranteed to increase the rate of type II errors (i.e., erroneously concluding that no bears are exposed to hazards when, in fact, some are), resulting in unintended harm to bears in the action area (see Shrader-Frechette 1991, Shrader-Frechette & McCoy 1993). For another, the Service's assertions fail to account for prospective syndromes where hazards associated with existing human infrastructure and activities in the action area *prevent* bears from being present in the first place – a phenomenon almost certain to go undetected by managers or researchers absent intensive radio-tracking of bears on or near the Lolo NF.

This last point leads to a pervasive evidentiary problem that compromises the Service's claims about absence or rarity of grizzly bears in the action area. Costello et al. (2016a), Costello & Roberts (2022), and Kasworm et al. (2022a) make clear that efforts to capture and then radio-track grizzly bears are largely confined to the NCDE DMA and CYE Recovery Zone, respectively. A dearth of capture efforts in extralimital areas of the Lolo NF (i.e., outside NCDE Zone 1 and the CYE Recovery Area) is consequently guaranteed to provide scant information on movements of grizzly bears in this area, and consequently little insight into exposure and resulting harm to bears from human-related hazards. However, even with capture efforts comparable to those in demographic monitoring areas, radio-monitored adolescent and adult grizzly bears on the Lolo NF would probably comprise little more than the 10-11% currently being monitored in the NCDE DMA (e.g., Costello & Roberts 2018, 2019, 2020, 2021, 2022) – which is a sparse sample size under the best of circumstances.

A relative scarcity of closely monitored grizzly bears predictably means that managers and researchers will detect only a small percentage of grizzly bears using an area, including those that consequently died. Estimating this percentage is intrinsically difficult, especially for populations of bears where there are few if any radio-marked animals – as on the Lolo NF. Even so, several researchers have either made estimates or provided data that can be employed for the purpose, focusing on likelihoods that bear deaths would be detected absent any radio-monitoring (e.g., Mace & Chilton 2007, 2009; Mace & Roberts 2011, 2012a, 2012b, 2013, 3014, 2015; Costello et al. 2016a; McLellan et al. 2018; Lamb et al. 2020; Kasworm et al. 2022a, 2022b). The average of these estimates suggests that only 36% of grizzly bear deaths attributable to poaching, malicious killing, unknown human causes, or illegal defense of life-and-property are reported by the public independent of detection through radio-monitoring[2]. The harmonic mean is lower yet, approximately 26%.

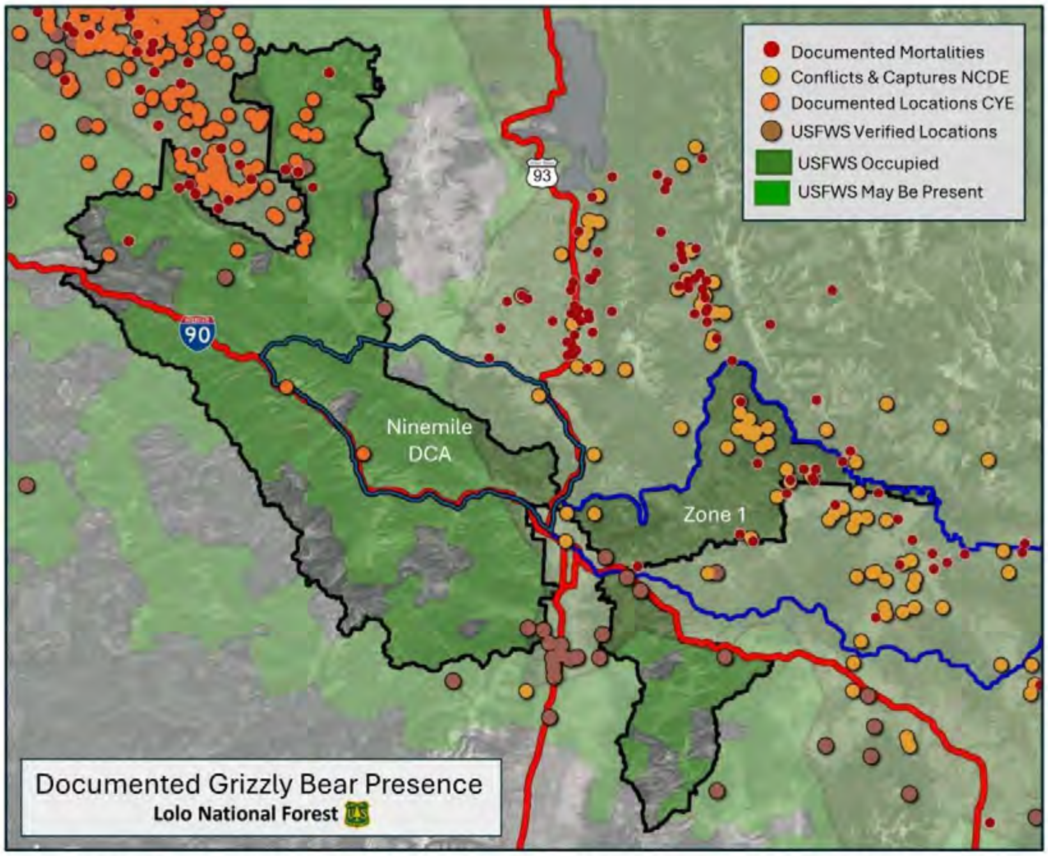

Figure 5. This map shows the extent of documented or estimated presence, occurrence, and distribution for grizzly bears in and near the Lolo National Forest. Documented occurrences are shown as dots, including mortalities (red), verified locations in and near the Cabinet-Yaak Ecosystem (orange), captures and conflicts in and near Zone 1 of the Northern Continental Divide Ecosystem (NCDE; dusky orange), and verified outliers (brown). Areas where the U.S. Fish & Wildlife Service has determined that grizzly bears 'may be present' are shown in light green; areas estimated to be 'occupied' in dark green (U.S. Fish & Wildlife Service 2022). Data sources for verified locations are Costello et al. (2016), Costello & Roberts (2017, 2018, 2019, 2020, 2021, 2022), Kasworm et al. (2022a), and Sells et al. (2023). Boundaries of the Ninemile Demographic Connectivity Area (DCA) and Zone 1 of the NCDE are shown in blue. Major highways (US 93 and I-90) are shown as red lines.

[2] Most of these estimates are based on comparing the proportional causes of deaths for radio-marked bears, with fates that are more likely to be known, with proportional causes of death for bears reported by all observers, including the general public. One approach to estimating fractions of unreported bear deaths involves adjusting proportional contributions of causes for all reported deaths to sum to 1 after first adjusting these proportions account for the fact that some causes (i.e., management removals, capture-related mortality, and even vehicle collisions) are almost certain to be reported. This adjustment 'corrects' for under-reporting among other causes with lower apparent detection rates.

As a bottom line, there are probably three to four times as many grizzly bears present in the action area as indicated by verified locations, and thus three to four times as many bears exposed to hazards associated with the proposed action than asserted by the Service. This potential level of grizzly bear activity comports with the current extent of areas where bears 'may be present' on the Lolo NF (U.S. Fish & Wildlife Service 2022; Figure 5) as well as verified locations of grizzly bears in adjacent areas where bears are more closely monitored (Figure 6; locational data for verified observations, conflicts, mortalities, and captures from Costello et al. [2016], Costello & Roberts [2017, 2018, 2019, 2020, 2021, 2022], and Kasworm et al.[2022a]).

The Service's claims that very few grizzly bears will be harmed by the proposed action are consequentially unreliable and unjustified. This holds even more so for assertions that *no* grizzly bears will be present and prospectively harmed in many areas of the Forest.

5.2. *The Service Underestimates Likelihood of Occupancy During Next 5-10 Years*

The Service claims in several places that either very few or no female grizzly bears are present in the action area or that the process of colonization by females will proceed so slowly that significant or otherwise consequential harm to this cohort is not foreseeable (BiOp:8, 59, 60, 61, 82, 90, 91, 98, 100, 104). In an inexplicable turn of logic, the Service also asserts that because female grizzly bears are rare, not *all* roads at *all* times will adversely affect *all* female bears – and conversely that *some* females will find refuge from *some* roads at *some* times.

These claims by the Service are spurious simply because they offer no insight into whether prospective impacts to *some* female bears at *some* times in *some* places exceed a biologically meaningful threshold or are in violation of the ESA. They moreover fail to address the question of whether the proposed action significantly impairs processes such as dispersal or colonization by females that would otherwise occur at a higher rate and thereby more readily fulfill the need (or desirability) for demographic connectivity between the NCDE, BE, or CYE (e.g., BiOp:32; see Section 2).

Available research suggests, moreover, that *absent* substantial impacts associated with the Lolo NF's existing infrastructure and associated human activities, dispersal by bears of both sexes would likely encompass all or most of the Lolo NF during the proposed action. Subadult male and female brown or grizzly bears disperse an average of 48 km and 14 km from natal ranges, respectively (McLellan & Hovey 2001; Proctor et al. 2004, 2012; Støen et al. 2006; Zedrosser et al. 2007; Norman & Spong 2015; Lamb et al. 2020; Karamandilis et al. 2021; Hansen et al. 2023). Average *maximum* recorded dispersal distances for each sex are 198 and 72 km, which comports with male bears being documented well into the BE and an adolescent female being documented on the doorstep of this ecosystem (BiOp:60). More concretely, a single dispersal event could take a subadult female half-way across the Lolo NF, consistent with research showing that brown and grizzly bear populations potentially expand at rates of 1.5-2 km per year, amounting to 15-20 km during a 10-year period (Jurina & Adamič 2008, Bader & Sieracki 2024).

These kinds of dispersal and colonization rates have the potential to expose more females than credited by the Service to harm resulting from a patently deficient security situation in the action area (see Section 3). This, in turn, casts doubt on the Service's statements regarding levels of adverse effects on females and, more indirectly, achievement of meaningful recovery associated with female colonization of the Lolo NF (see Section 2).

5.3. *The Service's Analysis is Inadequate and Consistently Understates Effects of the Action on Individual Bears, the Lower-48 Population, and Prospects for Recovery*

The Service systematically and comprehensively understates prospective harm of the proposed action not only to individual bears but also prospects for meaningfully recovering grizzly bears in the contiguous United States:

- The Service overstates status of populations contiguous with the Lolo NF, leading not only to an inflated prospectus for these populations, but also devaluation of the Forest as a contributor to recovery of grizzly bears in designated Recovery Areas (Section 1).
- The Service furthermore overstates the adequacy of recovery criteria and existing Recovery Areas for achieving long-term viability of listed grizzly bears, thereby allowing the Service to discount the Forest as prospectively vital connective habitat between the NCDE, CYE, and BE (Section 2).
- The Service compounds these inadequacies by essentially disregarding patently deficient levels of habitat security on most of the Lolo NF as a basis for then rationalizing the perpetuation of a hazardous and prospectively lethal landscape for most bears likely to venture here (Section 3).
- The Service is likewise dismissive of impacts arising from potentially adverse changes to bear habitat as well as impeachable for neglecting the best available science regarding bear foods and behaviors as an apparent basis for then overstating the ability of bears to simultaneously avoid hazards and find life-sustaining resources on the Forest (Section 4).
- Finally, the Service underestimates the number of grizzly bears likely to be harmed by the proposed action as a basis for then not only dissembling, but also producing an unrealistically low estimate of prospective take (Section 5).

These inadequacies render the Service's Surrogate Measures (BiOp:109-112) deficient if not meaningless as a basis for determining and monitoring likely 'incidental take' of grizzly bears on the Lolo NF. All these surrogate measures are premised on insufficient recovery goals, overly optimistic representations of grizzly bear population status, the presumed expendable nature of extralimital areas on the Lolo NF, the related permissibility of perpetuating deficient levels of habitat security, and a capricious assessment of harm potentially visited upon bears exposed to existing conditions.

In short, most of the Service's assertions related to prospective incidental take are arbitrary, including the contention that a temporary or permanent 1-5% decrease in secure habitat from an already deficient median of 15% (Figure 5) results in an acceptable level of harm to an acceptable number of bears. These assertions are a recipe for perpetuating an already lethal and otherwise hazardous environment for grizzly bears in an area that has the potential to play an important role in establishing demographic connectivity between the NCDE, CYE, and BE and thereby contributing to meaningful recovery of grizzly bears in the contiguous U.S.

Rather than posing minimal likely harm to individual grizzly bears as well as 'the listed entity as a whole', the Service's sanctioning of the Lolo NF 1986 Forest Plan and associated amendments will likely impose substantial harm on a significant number of individual bears, with derivative negative effects on prospects for recovering grizzly bears in the contiguous United States.

6. Imperative and Prospects for Restoration

6.1. *The Lolo NF and Service Have a Duty to Promote Recovery*

The Endangered Species Act and Forest Goal 7 mandate that the Service and Lolo NF promote recovery of grizzly bears. Given current or 'baseline' conditions on the Forest (as per Section 3), this duty logically translates into an imperative to restore habitat security for grizzly bears. Although restoration of this kind potentially has numerous facets, the most straight-forward elements covered by Forest Service authorities pertain to mechanical or other vegetation treatments and management of human infrastructure, notably roads and permanent recreational developments. Ideally, this sort of restoration would build on extant secure areas through road decommissioning or closures, as well as redesign of road networks. Restoration would also ideally focus on areas previously identified as ripe with potential for fostering connectivity among Recovery Areas and prospectively host to bears dispersing from extant source areas (see Figure 2).

6.2. *Lolo NF Contains Areas with Potential for Restoration to Promote Recovery*

Most of the Lolo NF is encompassed by areas that have been modeled as potential linkage zones or connectivity pathways (Figure 2). However, there are three parts of the Forest that stand out as priority candidates for the initiation of efforts to restore grizzly bear habitat security. The first is in the far west, adjacent to the CYE Recovery Area and BMU 22; the second is in middle portions coincident with the Ninemile DCA and Clark Fork Linkage Zone; and the third is in the east aligned with NCDE Zone 1 and areas across the Clark Fork and Bitterroot Valleys to the south and southwest.

Figures 6a and 6b highlight GBAUs adjacent to the CYE Recovery Zone. Existing secure habitat is shaded green, with patches >2,500 shown darkest green. Likely dispersal areas modeled by Proctor et al. (2015) are shown as a gradient of orange; the Ninemile DCA as a more uniform shade of the same; and areas identified by Servheen et al. (2001) as candidate for locating structures to facilitate crossing Interstate 90 as lines superimposed on more sinuous configurations aligned with drainages.

When combined, this information highlights several GBAUs in the west with prospects for building upon existing networks of secure habitat or dispersal areas. These notably include Prospect, Dry Eddy, and St. Regis North and South, which, when combined, are contiguous between the CYE and forest lands to the south in Idaho providing connectivity with the BE. Farther east, several large patches of secure habitat offer prospects centered on the Keystone and Dry Cold GBAUs, although considerable restoration would be needed to realize this potential in southwestern portions of Keystone adjacent to I-90.

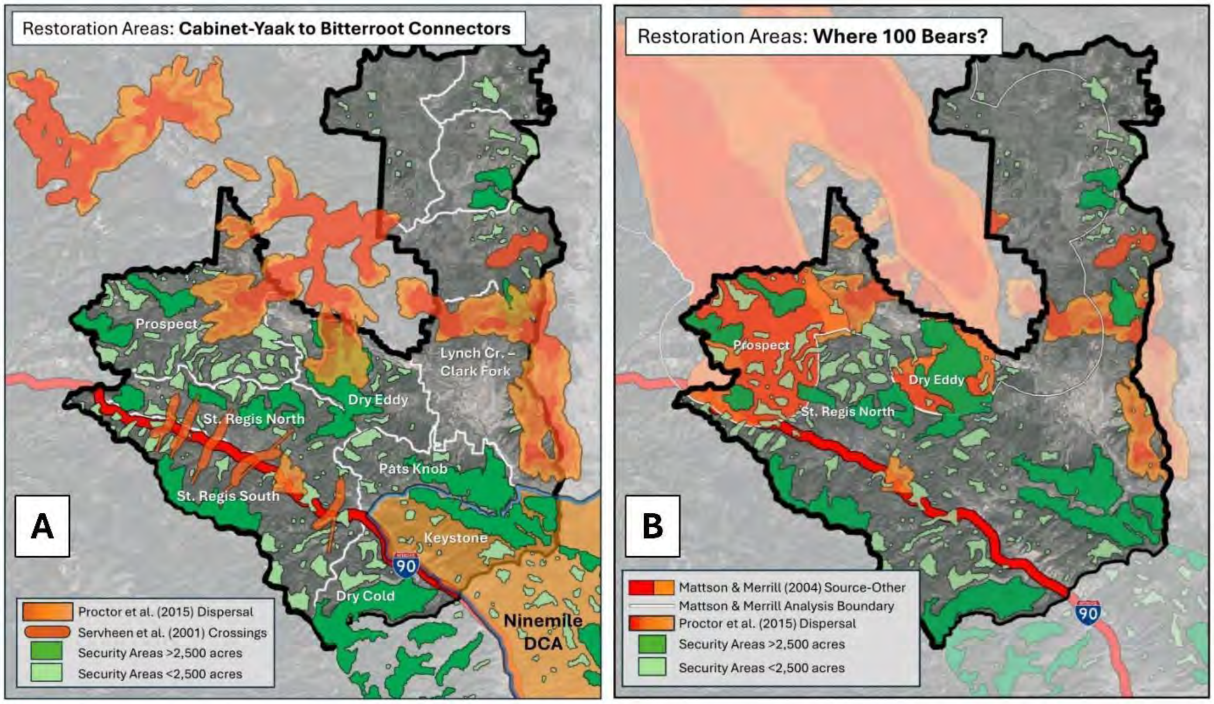

Figure 6. These maps feature Grizzly Bear Analysis Units (GBAUs) in western portions of the Lolo National Forest where there is potential to build on existing security areas to promote connectivity between the Cabinet-Yaak Ecosystem (CYE) and areas in Idaho to the south contiguous with the Bitterroot Ecosystem (BE). Existing security areas are shown in shades of green, with those >2,500 acres in size shown as dark green and those that are smaller shown as light green (Appendix 1, U.S. Forest Service 2022). Areas in (A) modeled by Proctor et al. (2015) as having high potential to support grizzly bears dispersing from the CYE are shown in shades of orange. Areas in (B) modeled by Mattson & Merrill (2004) as having high and intermediate potential for supporting some of the 100 bears needed to achieve recovery in the CYE are shown in dark and medium orange, respectively. Areas identified by Servheen et al. (2001) as prospective locations for structures facilitating passage across Interstate 90 are also shown in (A) as dark orange lines. GBAU boundaries are shown in white. GBAUs potentially playing a key role in establishing connectivity and candidates for restoration activity are labeled.

Figure 6b lends weight to the potential importance of areas farthest west. This figure features the Dry Eddy, Prospect, and St. Regis North GBAUs. Portions of these Analysis Units were identified by Mattson & Merrill (2004) as candidates for sustaining some of the 100 bears needed to achieve the population goal for recovery in the CYE. Although the analysis by Mattson & Merrill (2004) was geospatially truncated short of including the entire Lolo NF, their results nonetheless highlight a prospectively key role for this Forest in recovering imperiled bears in the Cabinet Mountains portion of the CYE.

Figure 7 similarly illustrates prospects in central and eastern portions of the Lolo NF. Although areas in the Ninemile, Trout East and West, Fish Creek, and Lolo North and South GBAUs encompass large patches of secure habitat and coincide with the Ninemile DCA and Clark Fork Linkage Zone (Sandstrom 1996), considerable effort would be needed to build bridges of secure habitat across the Clark Fork valley bottom where even small (<1,000 acres) patches are currently missing. This void is problematic, especially given that it coincides with the barrier posed by I-90.

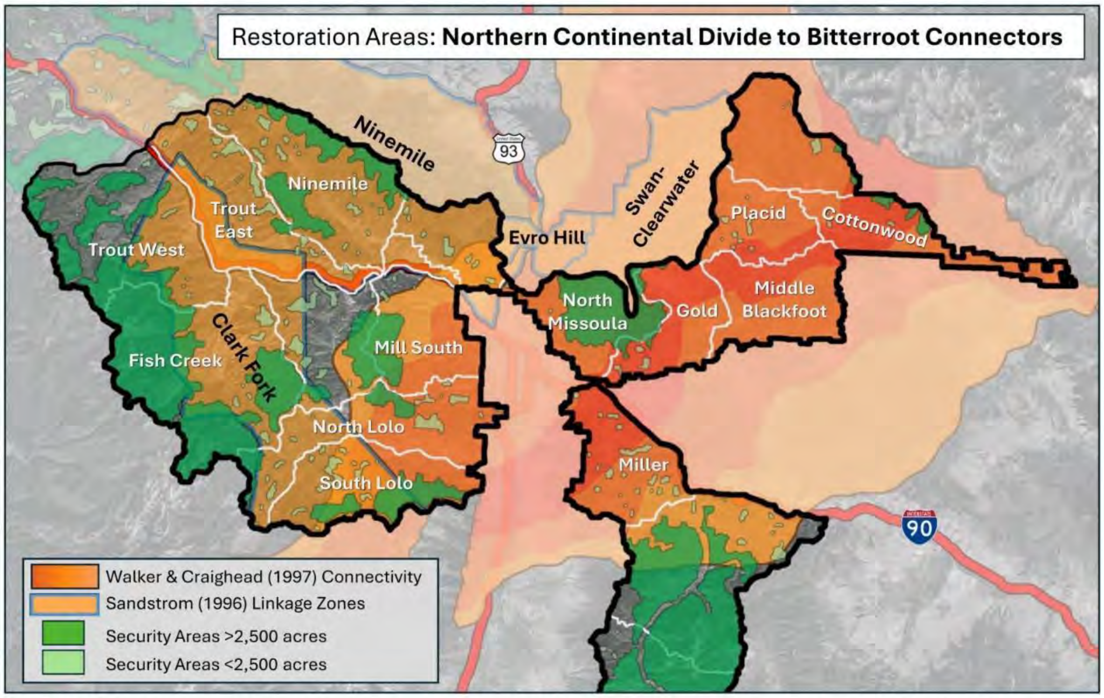

Figure 7. This map feature Grizzly Bear Analysis Units (GBAUs) in central and eastern portions of the Lolo National Forest where there is potential to build on existing security areas to promote connectivity between the Northern Continental Divide Ecosystem (NCDE) and the Bitterroot Ecosystem (BE). Existing security areas are shown in shades of green, with those >2,500 acres in size shown as dark green and those that are smaller shown as light green (Appendix 1, U.S. Forest Service 2022). Areas in modeled by Walker & Criaghead (1997) as having high potential to serve as connectors between the NCDE and BE are shown in shades of orange farthest east. Areas identified by Sandstron (1996) as potential Linkage Zones between the two ecosystems are shown in orange bounded by blue lines and labeled in black. GBAU boundaries are shown in white. GBAUs potentially playing a key role in establishing connectivity and candidates for restoration activity are also labeled.

Current evidence of dispersal and colonization together with early modeling by Walker & Craighead (1997; Figure 7) provide perhaps the greatest support for restoration opportunities connecting NCDE Zone 1 with not only the BE, but also large areas of secure habitat in the Sapphire Mountains, including the Welcome Creek Wilderness Area and Quigg Peak and Stony Mountain Roadless Areas which farther south connect with the Anaconda-Pintlar Wilderness Area. Although there are scant patches of secure habitat on Forest Service lands in much of NCDE Zone 1, most documented instances of extralimital grizzly bears occur here, prospectively attributable to security provided by Nature Conservancy Lands in the Gold and Middle Blackfoot GBAUs, as well as efforts under auspices of the Blackfoot Challenge to reduce human-bear conflicts on private lands in the Blackfoot Valley (Wilson et al. 2014, 2023). Regardless of contributions made by efforts on private lands, the map in Figure 8 makes clear that creation of patches of secure habitat in the Gold, North Missoula, and Miller GBAUs could pay big dividends by increasing odds that grizzly bears would successfully colonize the Sapphire, Long John, and Anaconda Mountain Ranges.

Potential exists for restoration of grizzly bear habitat security on the Lolo NF, with prospects of contributing to long-term recovery and conservation of grizzly bears in the contiguous United

States. However, the Forest will have few incentives to pursue substantive restoration activities if the Service provides little more than an apologia for the *status quo*, as with the Service's Lolo NF Plan Biological Opinion.

6.3. *Precedent: The Case of the Targhee National Forest*

Although restoration of adequate habitat security for grizzly bears in key areas of potential connectivity on the Lolo NF could be considered a daunting task, the success of restoration efforts on Idaho's Targhee National Forest during the 1990s and early 2000s demonstrates that such efforts can be undertaken and, moreover, achieve desired improvements in local status of grizzly bears. During the 1970s and 1980s a dense system of roads was constructed on the Targhee's Plateau BMU as a means of clearcutting roughly 40-60% of forest stands in this Unit. These pervasive human impacts coincided with a period of unsustainable grizzly bear mortality. As a result, no reproductive females and only a handful of grizzly bear sightings were documented in the Plateau and Henry's Lake BMUs during 1985-1995 (Targhee National Forest 1996). Core security levels at the end of this period were also low, in the range of 45-50%.

This deficient situation resulted in a Biological Opinion from the Service that, among other things, required that the Targhee Forest create security zones comprised of security areas >7,000 acres in size (U.S. Fish & Wildlife Service 1994). This was accompanied by standards that allowed for no greater than an average 0.6 mile/mile^2 of open roads and motorized trails in any given BMU (Targhee National Forest 1999), resulting in the decommissioning of 433 miles of roads on the Forest between 1999 and 2005 (U.S. Forest Service 2006).

These improvements in habitat security were unambiguously successful. Verified sightings of a female with young during any given year increased from 0 per year during 1985-1995 in the two affected BMUs, to 0.6-0.7 per year during 1995-2004, to >1 per year during 2017-2022 (Van Manen et al. 2023). All other indicators suggest that grizzly bears made a remarkable come-back during a 25-year period in this part of the GYE where previously deficient levels of habitat security and law enforcement had resulted in local near-extirpation of grizzly bears.

Although restoration efforts on the Targhee NF occurred in an area designated as part of the GYE Recovery Zone, it clearly signifies that substantial efforts of this sort can not only be undertaken, but also produce desired conservation outcomes. This lesson applies to the Lolo NF, although absent an authoritative signal from the Service in its current Biological Opinion requiring that restoration activities be undertaken, few if any likely will be – unlike in 1994 when the Service mandated in its Opinion on the Targhee National Forest Plan Revision that a substantial number of roads be decommissioned as means of achieving adequate habitat security for grizzly bears.

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