Comments of the North American Section of the Society for Conservation Biology on Proposed Rule to Delist the Yellowstone Grizzly Bear Population (70 Fed. Reg. 69854-69884)

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The Society for Conservation Biology (SCB) has among its purposes facilitating the incorporation of conservation science into policy, including management of endangered species. The SCB is organized into Regional Sections, which represent geographic regions and disciplines around the globe. The largest of these Sections is the North American Section, representing the United States, Canada, and Greenland. Because the proposed rule to delist the Yellowstone grizzly bear (*Ursus arctos*) population (70 Fed. Reg. 69854-69884) is relevant to larger issues involving implementation of the U.S. Endangered Species Act (ESA) of 1973 and development of species recovery targets and strategies in the U.S. and beyond, it is both appropriate and urgent for SCB's North America Section to produce a summary of conservation science relevant to the rule. In this report we review the biological and policy context of grizzly bear management within the Greater Yellowstone Ecosystem (GYE); identify problems with the proposed rule; and, finally, suggest an alternative approach to grizzly bear recovery that may better reflect current conservation science and legal mandates for endangered species recovery.

CONTEXT OF GRIZZLY BEAR DECLINE AND RECOVERY

In 1975 the grizzly bear in the lower 48 states was listed as a Threatened species under the ESA because of concerns about the status of the remaining bear populations and their habitat. Grizzly bears have been reduced to 1% of their former numbers in 1-2% of their former range south of Canada (Mattson and Merrill 2002). At the time of listing, the grizzly bear lived in the Yellowstone, Glacier (Northern Continental Divide), Cabinet-Yaak, Selkirks, North Cascades and San Juan ecosystems (USFWS 1982).

Most experts maintain that the grizzly bear would not have survived in the lower 48 states without the protective mechanisms afforded by the ESA (Mattson and Merrill 2002). These mechanisms had the effect of : 1) eliminating the legal hunting of grizzly bears; 2) reducing illegal hunting (poaching); 3) reducing concentrated food sources (e.g., garbage dumps)

and other attractants that led to human/bear conflicts that often resulted in grizzly bear deaths; 4) improving habitat management, especially of national forest roads under the ESA's "look before you leap" and "take" provisions; 5) reducing, on national forest lands, the number of domestic sheep, which had led to lethal control of bears; 6) reducing management-related deaths, since 'nuisance' bears were given another chance in most cases rather than being euthanized immediately; and, 7) improving public education about bear behavior and the importance of preventing grizzly bear attraction and behavioral reinforcement from human-associated food sources.

The population of grizzly bears in the GYE may have reached its all-time low in 1982, when an estimated 200 bears remained in the population (USFWS 1982). Today the population is estimated at 400-600 animals (Schwartz et al. 2005b). Population sizes elsewhere are less certain. The Glacier population numbers perhaps 400-600 bears. The Selkirk population is estimated at 25-35 bears. At 15-20 bears, the Cabinet-Yaak grizzly is on the brink of extinction, and the population is believed to be declining. The North Cascades grizzly bears are thought to number only around 5-10 animals, although no bears have been seen there in more than a decade. The last grizzly in the San Juan Mountains of Colorado was killed in 1979. In 1999 the U.S. Fish and Wildlife Service (USFWS) finalized a plan to reintroduce the grizzly bear to the Selway-Bitterroot region of Idaho, an ecosystem that could harbor perhaps 400-600 bears (Boyce and Waller 2003, Carroll 2005), and could serve as a vital link between Yellowstone and Canadian source populations. However, the reintroduction plan has been indefinitely postponed at the urging of the governor of Idaho and others.

The USFWS developed its first grizzly bear recovery plan in 1982 and a second plan in 1993 (USFWS 1982, 1993). In 1995, in response to a challenge by conservation organizations, a federal district court judge found the recovery plan deficient because of unreliable population measures, failure to address genetic questions and issues related to livestock, failure to justify its reliance on Canadian source populations, and failure to contain habitat-based criteria (903 F. Supp. 96 [DDC 1995]).

On November 19, 2005, the USFWS proposed that the Yellowstone population be designated a Distinct Population Segment (DPS) and also proposed to remove the Yellowstone Grizzly Bear population from Threatened status under the ESA. The decision would return management of the grizzly bear to the three states of Idaho, Montana, and Wyoming, which have

announced their intention to resume grizzly bear hunting. Federal land management agencies such as the U.S. Forest Service would retain a major role in management of grizzly bear habitat. Guidelines for restricting road building and development would exist on federal lands within the Primary Conservation Area (PCA, formerly the Designated Recovery Zone (RZ)). The PCA contains 66% of currently occupied range and about 86% of the current population of grizzly bears within the DPS (Schwartz et al. 2002, 2005b). By limiting such restrictions to the PCA, the proposed rule in effect asserts that this portion of the DPS constitutes a reserve of adequate size to maintain a self-sustaining population of grizzly bears in perpetuity with no significant risk of extinction, and that this criterion meets standards for recovery under the ESA. The decision is expected to be finalized by the end of 2006 or early 2007.

The proposed rule relies on continued monitoring of habitat and the population by the Interagency Grizzly Bear Study Team. Proposed monitoring and management plans following delisting would cost an additional $1.2 million per year in addition to current annual allocations for grizzly management. This additional level of funding has not yet been secured. Although the Conservation Strategy is clear regarding what variables will be monitored, it does not state what threshold values of these variables might trigger delisting

THE DEFINITION OF RECOVERY UNDER THE ESA

While the Endangered Species Act of 1973 was the third in a series of laws aimed at protecting imperiled species, it was the first to offer substantial protection to a species in danger of extinction throughout *all or a significant portion of its range*. By including the phrase "significant portion of its range," Congress signaled its intent that listed species should not simply be saved from extinction, but rather recovered so that populations inhabit relatively large areas of suitable habitat within their historic distribution. Previous delisting actions by the USFWS are consistent with this intent, as the fifteen taxa recovered since passage of the ESA were generally widely distributed at the time of delisting (Goble et al. 2005). When considering recovery of the flat-tailed horned lizard (*Phrynosoma mcallii*), the Ninth Circuit Court of Appeals (*Defenders of Wildlife v. Norton,* 258 F.3d 1136 [2001]) concluded that the text of the ESA and its subsequent application have been guided by the following observation by Aldo Leopold (Leopold 1966: 277): "There seems to be a tacit assumption that if grizzlies survive in Canada and Alaska, that is good enough. It is not good enough for me … Relegating grizzlies to

Alaska is about like relegating happiness to heaven; one may never get there." The ecological role of species in ecosystems, which is often especially strong for large carnivores, is another consideration that argues for recovery across a large portion of the original distribution of the species (Soulé et al. 2005).

Under the ESA a recovered species is one that no longer meets the definition of a threatened or endangered species: it is not in danger of extinction throughout all or a significant portion of its range and is not likely to become so in the foreseeable future (Vucetich et al. in press). Under this definition even a species successfully recovered to a significant portion of its range is not fully recovered if there exists other significant portions where it remains threatened or extirpated (Vucetich et al. in press). Two aspects of the definition of recovery should be considered in any delisting proposal: 1) the magnitude of foreseeable threats to viability and distribution, and 2) the geographic extent of significant portion of range. With respect to the first factor, the ESA directs that five threat categories be considered: 1) threat to habitat, 2) overutilization, 3) disease or predation, 4) inadequacy of existing regulatory mechanisms, and 5) other natural or manmade factors affecting existence. A rigorous evaluation of these threats can be conducted through a variety of methods, including formal population viability analysis (Beissinger and McCullough 2002), as discussed below. Indeed, in recent proposals such as the 2003 delisting rule for the gray wolf (*Canis lupus*)(USFWS 2003), the USFWS conflated the concepts of population viability and recovery. The claim that the ESA mandates only maintaining a species' viability (preventing extinction) rather than effecting recovery was first made in a 1986 revision to the regulations governing ESA enforcement (USDOI and USDOC 1986), but has been repeatedly rejected by the courts (Suckling and Taylor 2005). This distinction is especially important for species such as the wolf or grizzly bear that currently occupy a small portion of their historic range, because ESA mechanisms for maintaining viability primarily focus on "take" of individuals or occupied habitat, whereas ESA mechanisms for effecting recovery may also restrict the destruction of unoccupied but suitable habitat and call for proactive measures to promote population reestablishment (Suckling and Taylor 2005).

Although the concept of significant portion of range is not explicitly defined in the ESA, it is evident that Congress did not intend that range be construed as "current range." This misinterpretation would not only accept as a fait accompli the very factor (range reduction) that originally led to the listing of many species, but would also violate the plain intent of the 1973

act to not only prevent total extinction, but also regional extirpation. The proposed rule, by defining "range" as "the area within the DPS boundaries where viable populations of the species now exist" (70 FR 69886), and tautologically concluding that "the grizzly bear occupies all of its range within this DPS..." (70 FR 69886), is thus at odds with the intent of the ESA.

Vucetich et al. (in press) propose that "range" be defined as "historic range that is currently suitable or can be made suitable by removing or sufficiently mitigating threats to the species." In support of this definition the authors cite previous delisting actions that have recognized the relevance of historic range (e.g., Brown Pelicans (*Pelecanus occidentalis*) and gray whales (*Eschrichtius robustus*)). However, data on historic distribution is often incomplete. Even for habitat generalists such as the grizzly bear, outer range boundaries as known from historic accounts may encompass large areas where the species was not found historically (Mattson and Merrill 2002). Therefore, habitat models may be used to delineate the extent of suitable habitat, both with and without the effects of deleterious human impacts (Carroll et al. 2006). The extent of these two areas can then be compared to evaluate what, if any, habitat restoration may be necessary to restore the species to a large proportion of historic range.

The expectation that species would be restored to large areas of their historic range was buttressed when Congress defined the term "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature" (ESA section 3(15)). The policy of recognizing distinct population segments (DPS) allows for protective measures before large-scale declines occur that would necessitate listing a species or subspecies throughout its entire range (Fay and Nammack 1996). Congress anticipated that the DPS designation would be used "sparingly," and it may be assumed that such DPSs must further or at least not hinder the ESA's mandate for rangewide recovery of a species. Under current policy, to merit consideration as a DPS for listing purposes, a population must be discrete (substantially reproductively isolated from other conspecific population units) and significant (an important component in the evolutionary legacy of the species) (Fay and Nammack 1996). The guidelines are less clear for establishing DPSs solely to *delist* recovered populations of an otherwise still threatened species. In fact, some of the criteria for establishing a DPS as "listable", such as its significance, might argue against rapid delisting. Most DPS designations have been applied to anadromous fishes, which have genetic and geographic subunits that are relatively easily identified (Green 2005). It is more difficult to apply

the DPS policy to terrestrial species such as the grizzly bear that currently inhabit only a small portion of their historic range, as measures of either current or historic genetic similarity may not be good guides to the distinctness of restored populations in today's landscapes.

Green (2005) proposed that the conservation intent of the DPS policy could be accomplished more effectively by shifting focus away from identifying DPSs based primarily on uncertain taxonomic data. Instead, Green (2005) proposes a policy similar to that used by Canadian agencies, in which “designatable units” are identified based on both distinct conservation status and either 1) genetic distinctiveness, 2) range disjunction, or 3) occupation of unique biogeographic zones. This policy is in agreement with three widely-invoked guidelines for restoring threatened species; the principles of representation (establishing populations across the full array of potential habitats), resiliency (protecting populations large enough to remain viable), and redundancy (saving enough copies of those populations that some can be lost without a loss of the species)(Shaffer and Stein 2000). By broadening recovery criteria to encompass representation, these principles recognize that a single population may not represent species recovery, even if large enough to be relatively resilient to extinction. Thus, although the proposed GYE grizzly bear DPS does not meet current standards that require “sparing” use of the DPS designation, it would represent a valid management unit under a revised policy similar to that described in Green (2005). However, to be coherent, such a policy would first require a comprehensive evaluation of recovery potential, and establishment of recovery goals, in all biogeographic zones historically inhabited by grizzly bears.

DEFICIENCIES IN THE PROPOSED RULE

The Yellowstone grizzly bear delisting proposal shows parallels to other recent delisting proposals for wolves (USFWS 2003) that have been found to be at odds with legal precedent and conservation science. Like the grizzly bear, the gray wolf has increased in population and distribution in the contiguous U.S. since protection under the ESA in 1973. In response to the wolf’s improved conservation status, in April 2003 the USFWS published a reclassification rule that divided the lower 48 states into three DPS, retaining the experimental-nonessential population areas in the northern Rocky Mountains, but elsewhere downlisting the eastern and western gray wolf DPS from endangered to threatened and indicating that recovery objectives for both had been met. In 2005, however, two federal court rulings vacated and enjoined the

proposed rule on the basis, in part, that it lacked comprehensive consideration of the phrase "significant portion of range" and misapplied the DPS policy (*Defenders of Wildlife v. Norton*, Civ. 03-1348-JO [2005], *National Wildlife Federation v. Norton*, 03-CV-340 [2005]). Both of these shortcomings are also evident in the grizzly bear delisting proposal. We first review these fundamental inadequacies in the proposed rule's definition of recovery, and then review deficiencies in the rule's consideration of threats to the population.

1) FAILURE TO CONSIDER SIGNIFICANT PORTION OF RANGE

The proposed rule does not rigorously evaluate the extent of current grizzly bear distribution in comparison to suitable yet unoccupied habitat. Although the document delineates suitable habitat within the proposed Yellowstone DPS, it excludes areas based on current discretionary uses of public lands (e.g., current sheep allotments), thus giving such uses *a priori* primacy over endangered species recovery. This discrepancy is especially apparent in the southern portion of the GYE, where the document notes (70 FR 69870):

"There are large, contiguous blocks of sheep allotments in peripheral areas of the ecosystem in the Wyoming Salt River and Wind River Mountain Ranges on the Bridger-Teton and the Targhee National Forests (Figure 1, above). This spatial distribution of sheep allotments on the periphery of suitable habitat results in areas of high mortality risk to bears within these allotments and a few small, isolated patches or strips of suitable habitat adjacent to or within sheep allotments. These strips and patches of land possess higher mortality risks for grizzly bears because of their enclosure by and proximity to areas of high mortality risk. ...Due to the negative edge effects of this distribution of sheep allotments on the periphery of grizzly range, our analysis did not classify linear strips and isolated patches of habitat as suitable habitat."

Based on its restrictive definition, the proposed rule concludes that only 24% of the DPS is suitable habitat. It does not compare the extent of this area to historic range within the DPS or evaluate the adequacy of currently suitable habitat in meeting the ESA's recovery goals.

In contrast, an approach consistent with the ESA's language and conservation science would likely require continuation of the current relatively protective regulations within the PCA (current recovery zone (RZ)) in order to maintain grizzly bear source habitat at least in its current quality, as well as improved efforts outside the PCA to alleviate current high mortality rates experienced by bears colonizing peripheral sink habitat. These steps would support continued range expansion and allow bears to colonize and inhabit all significant areas of suitable habitat

within the DPS. Several studies (see below) have documented the potential importance of connectivity outside the proposed Yellowstone DPS, especially westward to central Idaho. Enhancing occupancy of this connective habitat is necessary to facilitate natural recolonization of central Idaho's abundant habitat, and once a central Idaho population is established, to enhance genetic exchange between semi-isolated populations in central Idaho and the GYE. Nevertheless, the habitat protection measures necessary to insure functional connectivity were not analyzed substantively in the document, which instead states that the cancellation of the proposed Idaho reintroduction effort renders connectivity issues irrelevant (70 FR 69864). In actuality, lack of restoration efforts in central Idaho should impose more rigorous and precautionary standards for delisting extant populations; they certainly increase the importance of potential natural recolonization by bears dispersing from the GYE. The proposed rule states that grizzly bears have never been documented to move between the three northern Rockies recovery areas during the last three decades (70 FR 69864). Although restoring natural dispersal corridors for the grizzly bear is more challenging than for more vagile species such the wolf, this finding attests more to the current conservation plight of the species than to the lack of importance of connectivity in insuring full recovery.

2) MISAPPLICATION OF DPS POLICY

Advances in conservation science since the passage of the ESA have provided a better understanding of the factors, such as inter-population connectivity, necessary for long-term viability of populations (Breitenmoser et al. 2001). For example, a key element of the Northwest Forest Plan, designed to facilitate recovery of the Threatened Northern Spotted Owl (*Strix occidentalis caurina*), was the recognition that the viability of any particular owl sub-population was dependent on the successful establishment of territories by dispersing individuals, and hence on the size and connectivity of habitat patches across the landscape (Noon and McKelvey 1996). The issue of connectivity is one example of how management decisions such as delisting proposals that affect a particular DPS should also take into account the broader rangewide context for recovery. For example, even infrequent dispersal between DPSs may be important for initial recolonization and subsequent genetic interchange. In regard to the criteria for identifying DPS, USFWS policy states that "the standard for discreteness [is not] rigid or absolute...[but] allows for some limited interchange among population segments considered to be discrete, so

that loss of an interstitial population could well have consequences for gene flow and demographic stability of a species as a whole."

Ideally, DPS-level delisting proposals would thus be tiered to a rigorous evaluation of suitable habitat, threats to viability, and opportunities for recovery throughout historic range. Unfortunately, the existing grizzly bear recovery plan pre-dates many of the significant recent developments in conservation science that facilitate such analyses, and thus lacks substantive evaluation of such issues (USFWS 1982, 1993). For example, the plan sets no recovery goals for the southwestern U.S., where large areas of potentially suitable habitat exist (Carroll 2005). Due in part to the lack of such a comprehensive rangewide analysis, the Yellowstone DPS delisting proposal lacks consideration of the role of the DPS within the larger recovery strategy. By its nature as the southernmost extant grizzly bear population, the GYE might be expected to play a major role at facilitating restoration of a functional grizzly bear metapopulation in the western U.S. In addition, the Yellowstone population benefits from a large proportion of the GYE being represented in national park, wilderness, or other public lands with high potential to support grizzly bears. The ESA mandate for recovery to a considerable proportion of historic range implies that, in order to meet this goal rangewide, grizzly bears should be recovered across the extent of regions with highly suitable habitat, such as the GYE, in order to compensate for problems in regions within historic range where most habitat has been degraded through human land use and where human impacts on bear habitat are thus less easily reversible.

The proposed rule’s minimal definition of suitable habitat within the GYE and generally non-precautionary strategy toward threats to viability essentially guarantee that, even if the GYE population itself remains viable, no grizzly bears will disperse to adjacent areas outside the DPS. Delisting within the GYE may therefore preclude recovery in adjacent regions. As the DPS policy states, "loss of an interstitial population could well have consequences for gene flow and demographic stability of a species as a whole." Rather than consider Yellowstone delisting as part of a broader strategy for recovery, the current proposal seeks to prematurely downgrade protection for the population with the largest potential role in rangewide recovery. The argument that delisting will enhance rangewide recovery by redirecting resources to other recovery areas is specious, since the same political figures promoting Yellowstone delisting have blocked reintroduction of grizzly bears to central Idaho and thus would be unlikely to support effective recovery efforts outside the GYE.

Even though grizzly bears are currently managed as a federally listed Threatened species, human-associated mortality is the dominant source of grizzly bear mortality throughout the GYE (Knight et al. 1988). Human-caused mortality are especially high on the southern and eastern edges of their distribution in the GYE (Johnson et al. 2004). If continued growth and expansion of the population is to occur, it will be in peripheral areas with the high potential for mortality associated with poaching, livestock depredation, and conflicts with hunters and other recreationists. Because of their continued dependence on restrictive land use and management regulations to sustain expansion into these areas, grizzly bears may be a prototypical "conservation-reliant" species (Scott et al. 2005). Therefore it is inappropriate to expect that ESA protection is merely a short-term "emergency room" for such species (Goble et al. 2005). Given the continuing threats, consistent under-funding of essential recovery actions, and the fact that life history constrains recovery for grizzly bear to decades or longer, it can be expected that they would take more than 30 years to rebound from 150 years of decline. ESA protection for conservation-reliant species should be seen as the first stage in a longer term commitment by federal and state agencies to coordinate precautionary management measures (Scott et al. 2005). Conservation of such species thus requires a long-term perspective on threats to both viability and distribution. This perspective is lacking in the proposed rule, which instead relies on potential relisting of the Yellowstone population if future threats result in population decline.

3) INADEQUATE CONSIDERATION OF LONG-TERM THREATS

In a review of goals contained in recovery plans for threatened and endangered species, Gerber and Hatch (2002) found a lack of consistent standards and widespread inadequacy and lack of rigor. This was especially true in early recovery plans that pre-date much current research on population viability. The goal set forth in the 1982 grizzly bear recovery plan was a population of 37 females with cubs, based on a 6-yr moving average (USFWS 1982). This recovery goal was found to be inadequate by the courts (903 F. Supp. 96 [DDC 1995]). In the subsequent settlement agreement (Fund for Animals 1997), the USFWS agreed to establish habitat-based recovery criteria prior to publishing any proposed rule to delist any grizzly bear population. Nevertheless, although draft habitat-based criteria have been issued (USFWS 2002), they have not yet been finalized, and appear inadequate in several respects as detailed below. New standards for setting mortality thresholds, as well as Forest Service guidelines for managing grizzly bear habitat, also currently exist only in draft form, making evaluation of their impact on

recovery difficult. Thus, although the recovery goals set forth in the 1982 and 1993 recovery plans have been met (with the exception of levels for female mortality), the Yellowstone grizzly bear population does not yet meet current scientific and legal standards for recovery.

A) Factors affecting demographic rates: the role of population viability analysis

The 1993 grizzly bear recovery plan directed that a population viability analysis (PVA) be conducted (Boyce et al. 2001). PVAs make use of a diverse set of tools that attempt to quantitatively integrate knowledge of factors affecting a population's persistence (Beissinger and McCullough 2002). However, their utility to managers may be limited by sensitivity of results to alternate model structures and poorly known parameters. This is well illustrated by the contrasting conclusions emerging from different PVAs regarding viability of GYE grizzly bear populations, which largely result from unstated assumptions regarding trends in habitat quality. Boyce et al. (2001) summarize commonalities and shortcomings of various PVA models applied to grizzly bears. They conclude that several non-spatial demographic models predict low probability of extinction for the GYE population, but that the relevance of such PVAs is limited because they are not linked to habitat data, but may instead implicitly assume constant habitat conditions.

The current recovery plan and proposed delisting rule define recovery as maintaining demographically-robust populations (preventing extinction) over a relatively short time frame. Thus, demographic analyses cited in the delisting proposal focus on short-term projections of current demographic rates (e.g., Harris et al. 2005). However, even in the limited context of such models, the estimation of population growth rate in Harris et al. (2005) is of limited utility for recovery planning, as the models used inadequately considered the manner in which birth and death rates are structured within the population (e.g., effects of whitebark pine on death rates and recruitment) and the effect of flow among the subpopulations. Grizzly bears in the GYE show significant fluctuations in annual mortality rates. For example, the level of bear-human conflicts and resultant bear mortality vary significantly, depending on whether whitebark pine seed cones are abundant in remote, high-altitude areas (Mattson et al. 1991). Such environmental stochasticity, expressed as high interannual variation in mortality rates, significantly increases extinction risk for small populations (Lande 1995).

Whether or not they meet standards for short-term viability, current recovery plan goals demonstrably fail to meet standards for recovery of evolutionarily-robust populations over longer

time horizons. For example, Lande (1995) recommends genetically effective population sizes of greater than 5,000 (i.e., which translates to a census population of approximately 20,000 for grizzly bears; Allendorf et al. 1991) to avoid accumulation of deleterious mutations with resultant adverse effects on viability. These latter standards would require that a larger area of suitable but unoccupied habitat be reoccupied by bears, and thus are at odds with the delisting proposal's minimal definition of suitable habitat. Although the ESA pre-dates modern population viability analysis, the ESA mandate for geographically-widespread recovery also buttresses recovered populations from long-term demographic and genetic threats to viability. A population recovered to all but insignificant portions of its range would by implication be large in numbers, even for species such as grizzly bear that often occur at low densities. A metapopulation consisting of thousands to tens of thousands of grizzly bears would be much more likely to persist over centuries than would an isolated population of less than one thousand such as currently inhabits the Greater Yellowstone Ecoregion. Recovery of a large, geographically-widespread metapopulation also is a form of "spreading of risk" (Den Boer 1968), buffering the species from the effects of widespread threats such as disease, climate change, and invasive species. The genetic effective population size of the Yellowstone population is currently only 13-65 (Paetkau et al. 1997), well below the level of 500-5000 recommended for preventing genetic impoverishment (Lande 1995). In addition, the Yellowstone grizzly bear population has been isolated for more than seventy years. Because of concerns about the loss of genetic diversity, the USFWS has stated that it will continue to monitor the genetic make-up of the Yellowstone grizzly population, and will relocate two bears every ten years to address genetic concerns. However, the ESA mandates recovery of self-sustaining wild populations where feasible, rather than dependence on chronic augmentation or other intensive management to address genetic concerns.

The effects of environmental stochasticity and genetic factors can be effectively analyzed by many non-spatial PVAs. Nevertheless, as Boyce et al. (2001) conclude, such "chance events are not as serious a concern for the future of grizzly bears in the Rocky Mountains as the deterministic erosion of habitats for the species associated with human development and resource extraction." As the GYE grizzly bear population has expanded in the last two decades, it has increasingly encountered habitat conditions in its range periphery that differ from those typical of its initial expansion within the protected core area. At the same time, habitat quality is

changing throughout the GYE. Under these dynamic conditions, non-spatial analysis of past demographic trends cannot be expected to predict future population trajectories. Boyce et al. (2001) thus call for a habitat-based PVA, for example using individual-based models. Advocates of delisting have largely ignored this conclusion, instead taking out of context Boyce et al. (2001)'s PVA results predicting low extinction probability.

The analyses in Schwartz et al. (2005a) are to some extent habitat-based in that they model spatial structure within the GYE population based on three zones: park, non-park recovery zone, and areas outside the recovery zone. They assume that any difference in population growth rate among the zones is attributable to differences in their management regimes. An alternate hypothesis is that these zones roughly correlate with intrinsically different physical conditions that have little to do with federal management regimes, especially moving from inside to outside the recovery area, but rather are related to such factors as road densities, human population densities, and distribution of private property, factors that are more difficult to ameliorate than are particular management regimes. A comprehensive spatial analysis of grizzly bear survival rates within the GYE supported Schwartz et al. (2005a)'s conclusion regarding enhanced survival within the park, but found that other factors such as road and trail density and distance to settlement were also strongly correlated with survival rates (Johnson et al. 2004). This suggests that the ability of managers to intervene when necessary to reverse any future population declines may be limited, as many aspects of landscape-scale habitat degradation in the GYE (e.g., exurban growth) will be difficult to mitigate.

Several recent studies have begun to address the issue of habitat-based PVA. Past cumulative effects models have addressed habitat but lacked a rigorous statistical framework (Boyce et al. 2001). This was remedied by recent survival analyses (Johnson et al. 2004), laying the groundwork for future spatial PVAs. The individual-based modeling of Noss et al. (2002) linked grizzly bear demography to data on GYE habitat trends via conceptual models, and predicted that suitable habitat, though currently extensive beyond the PCA, would, lacking additional habitat protections, increasingly shrink to the inner core of park and adjacent wilderness areas. This conclusion is not surprising given that the GYE has one of the highest human population growth rates in the U.S., due in part to immigration of people attracted by the region's scenic and recreational values (Hansen et al. 2002).

B) Threats to habitat and food resources

In a 1995 ruling, the 1993 recovery plan goals, and their exclusive focus on population numbers, were found to be inadequate in their consideration of the species' habitat needs, and incapable of "assessing the habitat of a larger, recovered population, let alone threatened habitat destruction" (903 F. Supp. 96 (DDC 1995)). Because they require differing responses by managers, threats to habitat are appropriately divided into 1) land-use trends such as exurban development and road-building that remove suitable habitat, and 2) temporal fluctuations and long-term declines in food resources (e.g., due to invasive species) within otherwise protected habitat.

Grizzly bears are omnivorous and feed opportunistically on nearly one hundred different plant species (Knight et al. 1982) as well as insects, fish, and animal prey. Plant foods vary greatly from year to year in terms of nutritional value and abundance. To forage efficiently, grizzly bears travel extensively throughout their home ranges seeking different foods at different times of the year; home ranges are often extended when accustomed foods are not adequate, and bears explore new territory to find alternatives (Craighead et al. 1995). Grizzly bears in the GYE feed heavily on four key foods (Mattson et al. 1991). Whitebark pine (*Pinus albicaulis*), the keystone food source, is declining in many portions of the Yellowstone area due to mountain pine beetles, white pine blister rust, and global warming (Mattson et al. 1992a, 1992b). Yellowstone cutthroat trout (*Oncorhynchus clarki*) have been reduced due to the introduction of lake trout (*Salvelinus namaycush*) in Yellowstone Lake (Reinhart et al. 2001). Army cutworm moths (*Euxoa auxiliaris*) may suffer declines due to increases in predators, parasites, disease, or climatic variation; in addition a variety of pesticides are prescribed to control the larvae in alfalfa and wheat fields (Hein et al 1996, Kansas State 2005a, 2005b). Ungulate populations may be reduced by disease or various management practices. Uncertainty as to the continued abundance and distribution of these key bear foods, and the natural range of variation in these and other foods, demands large areas for adaptive response. Changes in these food sources will likely be exacerbated by global warming. This uncertainty suggests a more precautionary approach to management of the Yellowstone bear population than is evident in the delisting proposal.

C) Reliance on inadequate regulatory mechanisms by state fish and wildlife agencies and federal agencies

Most current and potential grizzly bear habitat in the GYE outside of Yellowstone National Park lies on lands administered by the U.S. Forest Service. Therefore, to a large degree, the delisting proposal defers to draft National Forest guidelines on management of grizzly bear habitat. On National Forest lands within the PCA, these plans generally mandate no net loss of habitat, rather than seeking habitat improvement, e.g., by reducing road densities. However, even these guidelines will not apply in the zone outside the PCA, which contains 34% of the DPS's occupied range (Schwartz et al. 2002, 2005b) and substantial suitable yet unoccupied habitat, including connective habitat to central Idaho.

On USFS lands inside and outside the PCA, consultation with USFWS would not occur with the grizzly bear delisted. The grizzly bear would, however, be listed as a Forest Service sensitive species throughout its range in the GYE. Draft USFS guidelines state that land management activities would be managed so as not to contribute to a trend for listing or loss of viability for the grizzly bear, and that there would be no impacts to sensitive species without an analysis of the significance of adverse effects on the population or its habitat. In addition, the Forest Service would cooperate in maintaining at least 500 bears as identified in the conservation strategy and with state wildlife agencies in attaining desired population goals above this level. Nevertheless, under recent revisions to National Forest Management Act (NFMA) regulations, these directives are guidelines rather than enforceable standards and thus do not constitute "regulatory mechanisms" under the ESA (Oregon Natural Resources Council v. Daley, 6 F. Supp. 2d 1139, 1155 (D. Or. 1998)(see also comments by SCB-North America on NFMA revisions (available at www.conservationbiology.org)).

Outside the PCA, existing long-term secure habitat (Management Category 1 areas) would remain, but existing road densities and land management activities would preclude many areas from being effectively occupied by grizzly bears. The guidelines under the environmental baseline provide no direction for areas outside the PCA. The preferred alternative, however, includes direction to use food storage orders, maintain the productivity of the four key grizzly bear foods, and resolve chronic livestock conflicts outside the PCA. In addition, changes in secure habitat in those areas outside the PCA that are determined by the states to be biologically suitable and socially acceptable for grizzly bear occupancy will be monitored and changes

evaluated in annual monitoring reviews by the Yellowstone Grizzly Coordinating Committee. Again, these management directives have no method of enforcing compliance. Without improvement in habitat on federal lands, there will be no means of mitigating future habitat loss in other jurisdictions such as private and state land. Projected exurban growth and oil and gas development in these latter areas will impact the periphery of grizzly bear range by increasing the deleterious effects of sink habitat (Noss et al. 2002).

The proposed rule also relies on mechanisms established in state management plans. The State of Wyoming has stated a management goal of 500 or more grizzly bears in the ecosystem. The Wyoming Grizzly Bear Data Analysis Unit considers a larger area than that within the PCA. "While the allowable human caused mortality threshold for the Wyoming segment of this population will be determined through a coordinated management system, Wyoming will have the latitude to determine where to apply the mortality. The Department will have the ability to direct human caused mortality to the areas it deems appropriate. The only constraint will be that the Department cannot exceed the overall human caused mortality threshold for the state." Moody et al. (2005). Although this is a laudable approach, it is not a method of enforcing compliance with the management goal.

Idaho has a management goal "to maintain grizzly bear distribution and occupancy within the PCA and to keep mortalities at low levels. This management direction will allow for the grizzly bear population to occupy some limited areas outside of the PCA." There is no method of enforcing compliance. In Montana the stated goal is "to manage for a recovered grizzly bear population in southwestern Montana and to provide for a continuing expansion of that population into areas that are biologically suitable and socially acceptable." Although the areas in Montana deemed socially acceptable are much larger than in either Wyoming or Idaho, there is still no method of enforcing compliance.

Schwartz et. al. (2005a) concluded that "actions and impacts of private land development and agency responsiveness in and adjacent to grizzly bear habitats to address bear-human conflicts on private lands will, to a large degree, determine continuing success of the recovery process." Agency response on federal lands outside national parks will depend upon local management discretion following National Forest Management Act guidelines. Agency response on state lands in Wyoming and Idaho will strive to maintain low densities where conflicts may occur and allow hunting of all bears leaving the Recovery Zone.

With population size and mortality thresholds set as leniently as they are in the Recovery Plan, the outcome of these management practices will, under the current political climate, be an isolated reserve within the PCA beyond which grizzlies will likely be removed if they venture into habitat in Idaho or Wyoming. Importantly, because individual grizzly bears often range widely, a substantial proportion of those bears inhabiting the PCA will occasionally venture outside that zone (Knight et al. 1988) and be exposed to high mortality risk. If the carrying capacity of the PCA drops, grizzlies will be able to expand successfully only into habitat in Montana. Given the magnitude of expected fluctuations in demographic and environmental factors, management of grizzlies after delisting does not ensure sufficient habitat beyond the PCA to act as a buffer for potential fluctuations in carrying capacity within the PCA.

OPERATIONALIZING THE ESA'S DEFINITION OF RECOVERY: AN ALTERNATIVE STRATEGY

A grizzly bear recovery strategy that was consistent with current conservation science and ESA mandates would take a fundamentally different approach from the proposed rule in its development of overall recovery goals and consideration of long-term threats to viability. Addressing the ESA's concept of significant portion of range would require rigorous evaluation of suitable yet unoccupied habitat throughout the species' historic distribution. Such an analysis has already been initiated in several studies, from which commonalities emerge regarding priorities for restoration. Analyses based on least-cost path models suggest the feasibility of restoring functioning linkages between the Yellowstone grizzly bear population and a restored central Idaho population (Walker and Craighead 1997). Analyses based on static habitat suitability models also identified large areas of suitable yet currently unoccupied habitat in the GYE and central Idaho, with a potential population size of 1,000-4,000 bears in the northern Rockies (Merrill et al. 1999). Carroll (2005) used a spatially-explicit population model, PATCH, to evaluate recovery potential for grizzly bears in the western U.S., a similar methodology to that used for the gray wolf (Carroll et al. 2006). The study found that 51% of the western U.S. had sufficient food resources to support territorial grizzly bears. The proportion of that "suitable" habitat likely (> 50% probability) to be occupied by grizzly bears was 23% under current conditions. The potential size of the grizzly bear population in the western U.S. was predicted to be close to 5300 under current conditions (assuming that total adult population was four times the number of adult female territory holders). Idaho, Montana, and Wyoming were predicted to

have the highest potential carrying capacity for grizzly bears, followed by Utah, Arizona, and Washington. The largest distinct population centers of grizzly bears could inhabit the Greater Yellowstone Ecosystem (GYE) and central Idaho. The most important areas for maintaining connectivity between grizzly bear populations were predicted to be between central Idaho and both the GYE and northwestern Montana, and connections along the arc of mountainous habitat extending southward from the GYE to the Blue Range.

The population estimates from the models reported here are far more ambitious than current recovery goals, yet are at least an order of magnitude lower than historic population estimates, and should thus fall within the range of reasonable options considered in recovery planning. To clarify the debate over recovery goals, suitable habitat might be divided into three categories: 1) areas that can be occupied despite current human impacts and anticipated habitat loss; 2) areas that are unlikely to support grizzly bears even with substantial habitat restoration or policy change; and 3) intermediate areas where long-term recovery might require proactive conservation measures (e.g., road removal and restriction of sheep grazing)(Carroll et al. 2006).

In their efforts to restore imperiled species and ecosystems, planners must be both ambitious and realistic. Inadequacy and lack of rigor in current ESA recovery plan goals (Gerber and Hatch 2002) are due in part to a shifting baseline effect (Jackson et al. 2001) that limits the "realistic" range of goals from considering the historic extent of suitable habitat. Leonard et al. (2005) concluded, based on genetic analysis, "restoration goals for grey wolves in the western US include far less area and target vastly lower population sizes than existed historically." Similarly, historic accounts suggest that 50,000 to 100,000 grizzly bears inhabited the western contiguous U.S. at the time of European settlement (Craighead et al. 1995), with about 10,000 in California alone (Storer and Tevis 1955). Approximately 50,000 were estimated remaining by 1800 (USFWS 1993). This suggests that grizzly bears may have once strongly influenced ecosystem function across a broad area of the western U.S.

Although the bulk of the ESA addresses the recovery of individual species, Congress also included language mandating the conservation of ecosystems upon which listed species depend—this was, in fact, the first stated goal of the Act. Hence, some researchers have proposed an additional guideline for recovery planning, the principle of ecological effectiveness (Soulé et al. 2005). An ecologically effective population contains enough individuals with a wide enough geographic distribution to re-establish a species' role in its ecosystem. The argument for

re-establishing ecologically effective populations is most persuasive in the case of the grizzly bear and other "keystone" species, which strongly influence ecosystem function through interspecific interactions such as predation. For example, grizzly bear predation has reduced the ability of moose to concentrate browsing on preferred species such as aspen (*Populus tremuloides*), leading to recovery of riparian vegetation and associated species (Berger 1999).

Ecological effectiveness is an ambitious guiding principle for recovery, as it speaks to abundance as well as distribution (Soulé et al. 2005). Unlike the concept of "significant portion of range," ecological effectiveness is only implicitly mandated by the ESA's charge to conserve the ecosystems upon which endangered species depend. Although the role of grizzly bears as keystone species presents a particularly strong argument for restoration of ecologically effective populations, conservation science has increasingly highlighted the high proportion of threatened species that may strongly influence ecosystem function (Soulé et al. 2005).

The controversy over delisting of Yellowstone grizzly bears thus has broader relevance to the debate over minimalistic versus ambitious implementation of species and ecosystem restoration goals. A policy that limits large carnivores and other species with rigorous habitat needs to minimal recovery areas where populations must be sustained by intensive intervention is consistent with a broader and insidious effort to slow the listing of truly imperiled species and designation of critical habitat (Suckling and Taylor 2005). Such policies, however, are entirely inconsistent with both the ESA's mandate and conservation science's awareness of the high value to humankind of the services arising from functioning ecosystems (Daily 1997).

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