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PETITION TO LIST THE WHITE-TAILED PTARMIGAN, (*Lagopus leucura*) AS A THREATENED SPECIES UNDER THE ENDANGERED SPECIES ACT

August 24, 2010

CENTER FOR BIOLOGICAL DIVERSITY

PETITIONER

August 24, 2010

TO: Mr. Ken Salazar
Secretary of the Interior
18th and "C" Street, N.W.
Washington, D.C. 20240

Dear Secretary Salazar:

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. §1533(b), Section 553(3) of the Administrative Procedure Act, 5 U.S.C. § 553(e), and 50 C.F.R. §424.14(a), The Center for Biological Diversity hereby formally petitions the Secretary of the Interior, through the United States Fish and Wildlife Service ("FWS"), to list either the U.S. population or Rocky Mountains population of the white-tailed ptarmigan (*Lagopus leucura*) as a threatened species and to designate critical habitat concurrent with listing.

FWS has jurisdiction over this petition. This petition sets in motion a specific process, placing definite response requirements on FWS. Specifically, FWS must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. §1533(b)(3)(A). FWS must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id.* Petitioners need not demonstrate that listing *is* warranted, rather, petitioners must only present information demonstrating that such listing *may* be warranted. While petitioners believe that the best available science demonstrates that listing the white-tailed ptarmigan as threatened *is* in fact warranted, there can be no reasonable dispute that the available information indicates that listing the species as threatened *may* be warranted. As such, FWS must promptly make an initial finding on the petition and commence a status review as required by 16 U.S.C. § 1533(b)(3)(B).

PETITIONER:

The Center for Biological Diversity is a nonprofit conservation organization with 220,000 members and online activists dedicated to the protection of endangered species and wild places. http://www.biologicaldiversity.org

For the petitioners,

Noah Greenwald
Endangered Species Program Director
Center for Biological Diversity
P.O. Box 11374
Portland, OR 97211

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Introduction

Lagopus leucura, the white-tailed ptarmigan, is a high-alpine bird belonging to Grouse family. It is unique in that it is the only ptarmigan that occurs exclusively in North America. Its range spans from Alaska to isolated peaks in northern New Mexico. The white-tailed ptarmigan enjoys an extensive range in the arctic; however, within the continental United States their range is limited to isolated peaks including those in the Rocky Mountains and Cascade Mountains. The amount of separation between these populations is dramatic. Because white-tailed ptarmigan are not known to migrate great distances, the arctic population and the Rocky Mountain populations are separated both physically and genetically.

White-tailed ptarmigan thrive in forbiddingly cold climates. Their bodies and behaviors are highly specialized to exploit every detail of their environment. During both the winter and the summer, they don plumage that provides them natural camouflage. Their talons are feathered to act as snow-shoes. And, their metabolism is so remarkable that white-tailed ptarmigan continue to gain body mass throughout harsh alpine winters. The alpine areas they inhabit are harsh but this bird's resiliency is a product of the consistency of alpine weather. Warmer winter temperatures, warmer summer temperatures, changes in precipitation patterns and the movement of treeline upslope will cause white-tailed ptarmigan habitat to become unsuitable. A warming climate and the projected changes in alpine areas pose an imminent peril to the white-tailed ptarmigan.

White-tailed ptarmigan face many threats throughout their contiguous United States and Rocky Mountain range. Inadequately regulated recreation and a historical mismanagement of mining and grazing practices have degraded many areas of alpine habitat utilized by the ptarmigan and alpine habitats are slow to recover from anthropogenic disturbances. Though much damage to the alpine habitats of the ptarmigan has been done, climate change is the gravest threat to the contiguous United States population. Climatic warming not only promises to directly affect the white-tailed ptarmigan's breeding success and metabolic stability; warming will also exacerbate the ecological instabilities caused by previous habitat degradation.

The white-tailed ptarmigan is a prominent resident of its ecosystem. Because its success is intricately tied to the viability of alpine areas as a whole, white-tailed ptarmigan are excellent indicators of their ecosystem's overall health. Indeed, in ecosystems unduly damaged by human activities, white-tailed ptarmigan have suffered silent extirpation.

Because they are at home in harsh locales, they are unaccustomed to the presence of humans. Their behavior is consequently quite charismatic. Around humans, white-tailed ptarmigan are known for being approachable and unafraid. Their natural beauty and charm has made them popular with photographers and hunters treasure these birds for their extraordinary white winter plumage

This petition summarizes the natural history of the white-tailed ptarmigan, its population status, and the threats to this species' habitat and clearly demonstrates that, in the context of the ESA's five statutory listing factors, the U.S. Fish and Wildlife Service should list *Lagopus leucura* as Threatened.

I. Natural History and Ecology of the White-tailed Ptarmigan

A. Taxonomy

The white-tailed ptarmigan, *Lagopus leucura*, is a grouse of the Order Galliformes, Family Phasianidae, and subfamily Tetraoninae. There have been 5 subspecies designated of white-tailed ptarmigan. These include *Lagopus leucura altipetens* (southern white-tailed ptarmigan, the subspecies found in the United States Rocky Mountain region; Osgood 1901), *L. l. leucurus* (northern white-tailed ptarmigan; Wilson and Bonaparte 1831), *L. l. peninsularis,* (Kenai white-tailed ptarmigan; Chapman 1902), *L. L. saxatilis* (Vancouver white-tailed ptarmigan; Cowan 1939), and *L. l. rainierensis* (Mt. Rainier white-tailed ptarmigan; Taylor 1920). Conclusive comparative reports are lacking to confirm all of these designations and Braun et al. (1993) questioned the validity of them. However, they cited examinations of museum specimens to suggest that the 3 subspecies designations that reside further south resemble each other is size and color and that the 2 northern subspecies resemble each other, with marked physiological differences from the southern populations.

The white-tailed ptarmigan is most closely related to the rock ptarmigan and the willow ptarmigan, however, there is no evidence supporting hybridization between these species (Short 1967). Furthermore, there is no evidence supporting hybridization with blue grouse, the only other closely related species the ptarmigan is likely to come in contact with during the breeding season (Zwickel 1992).

B. Physical Description

The white-tailed ptarmigan is the smallest species of grouse. Adults typically grow to 30 to 34 cm in length and weigh 345 to 425 grams (May 1975, Braun et al. 1993). The white-tailed ptarmigan is distinguishable from other species of grouse by its perpetually white rectrices. The rest of the ptarmigan's plumage changes seasonally, from a predominately grayish brown during the summer to completely white during the winter (Braun et al. 1993). Both plumage patterns provide seasonally relevant camouflage in the ptarmigan's high-alpine environment. The white-tailed ptarmigan also exhibits feathers on its feet that serve as a sort of snowshoe (Höhn 1977). Sexual dimorphism is evident in the coloration of eye combs, breast feathers, and shading of plumage during the summer (Johnsgard 1973, Braun et al. 1993, Bent 1932).

C. Habitat

The white-tailed ptarmigan is found almost exclusively in alpine environments at or above treeline (Braun et al. 1993). The elevation of treeline is variable, depending on local moisture patterns, wind action and temperature fluctuations but occurs where limits of vascular plants' ability to withstand adverse seasonal conditions are reached. The few species of trees that are capable of growing in alpine environments are dwarfed versions of the same species at lower elevations (Zwinger and Willard 1972, Wardle 1974, Brown et al. 1978a, Billings 1979, Hoffman 2006). Alpine ecosystems are characterized by varied topography, soil type and slopes. They experience high winds, a short growing season, and intense solar radiation (Hoffman 2006). Alpine vegetation includes small patches of plant communities that consist of low-growing perennial forbs, graminoids, mosses, lichen, and dwarf shrubs (Braun 1969, Hoffman 2006).

Wintering habitat. The most important characteristics of white-tailed ptarmigan wintering habitat is the presence of willow (*salix* spp.) and soft snow to burrow in (Braun 1971, Braun et al. 1976). White-tailed ptarmigan tend to winter at the lowest elevation of their range, at or above treeline and occasionally in extreme weather conditions, below treeline (Braun et al. 1993). In general, ptarmigan prefer to winter in areas that are free of dense vegetation so that they have accessible escape routes from predators (Hoffman 2006).

In early winter, white-tailed ptarmigan typically feed above treeline on exposed slopes where willow are limited to less than 1 meter in height (Hoffman 2006). When they are not feeding, ptarmigan find shelter from strong winds on the leeside of conifers and ridges (Hoffman 2006). The snow on these exposed slopes tends to be shallow and have a hard crust making it unsuitable for burrowing into. White-tailed ptarmigan require soft snow in which to roost for insulation in the winter, at night and in especially cold conditions. Therefore, at dusk, they seek areas of deeper snow along treeline, in isolated basins, or in other more protected areas (Braun and Schmidt 1971, Braun et al. 1976).

Later in winter, white-tailed ptarmigan are more often found along treeline where snow has accumulated, covering more dense small shrubs and leaving only taller willows exposed. There is generally also soft snow accumulated at treeline for roosting.

Projections of changes in precipitation patterns in western mountains suggest an increase in precipitation falling as rain rather than snow (Mote et al. 2005, Knowles et al. 2006, Karl et al. 2009). More rain on snow events and the resulting melt conditions will limit the presence of soft snow that white-tailed ptarmigan depend on.

Breeding and nesting habitat. For breeding and nesting habitat, ptarmigan migrate to higher elevations that are free of snow by mid-May and where willow is a major component of the plant community (Choate 1963, Braun 1971, Herzog 1977, Frederick and Gutierrez 1992). White-tailed ptarmigan use predominantly rocky areas for nesting (Braun et al. 1993) and tend to build their nests directly adjacent to some type of cover. This cover is more often provided by rock than vegetation so that it provides protection from wind but is an open enough area to allow ptarmigan to flee from predators (Wiebe and Martin 1998). Nesting also requires relatively cool ambient air temperatures so that nesting hens do not overheat in nests that are exposed to the sun (Hoffman 2006).

In the Sierra Nevada, breeding success was found to be negatively correlated with high spring snow depths (Clarke and Johnson 1992). A study from 1982 to 1987 found spring snow depth to be highly variable, ranging from 50.8 to 424.2 cm. With higher snow depths, nesting success, chick survival, and brood success were reported to be depressed. Clarke and Johnson suggest that the correlation is potentially due to the influence of snow depth on the availability of resources such as nest sites, food and cover. When population and snow depth data were compared in the white-tailed ptarmigan's natural range in the Rocky Mountains, no correlation was found. This may be due to differences in wind action that allow for snow-free areas in the Rocky Mountains even when overall snow depth is high.

Summer and brood-rearing habitat. White-tailed ptarmigan migrate to their highest annual habitat for the summer and brood-rearing season (Hoffman 2006). Although ptarmigan typically return to the same summer areas each year, in areas damaged by heavy grazing, ptarmigan may move laterally or downhill in order to find suitable vegetation (Braun 1971). Additionally, traditional summering areas may be abandoned during especially dry years for areas with more moisture, which are often found at lower elevations (Hoffman 2006). Summer areas are characterized by a mix of rock fields and low-growing vegetation of *Carex* spp, Polygonum spp, *Trifolium* spp, and *Geum rossii*. Because ptarmigan are specialized for cold environments, they often seek areas of cooler temperatures when local temperatures are warm (Zerba and Morton 1983, Wiebe and Martin 1998). Ptarmigan remain in their summer habitat until the first severe snowstorm prompts a migration to lower elevations (Braun 1971).

Fall habitat. In the fall, white-tailed ptarmigan return to lower elevations at the upper edge of the willow community (Hoffman 2006). In early fall, they may move back and forth between high and low elevations, if snow up higher melts. By mid to late fall, ptarmigan are beginning to molt into their white winter plumage and prefer a patchwork of green vegetation and partial snow cover (Braun 1971, Hoffman 2006). They remain at this lower elevation into the winter season.

Conclusion. The white-tailed ptarmigan's range is naturally limited by its dependence on alpine habitat, which covers only a small portion of the landscape. Global warming will change the conditions of this environment as well as threatening the very presence of it, with the advancement of treeline upslope. The white-tailed ptarmigan is therefore especially sensitive to the effects of global warming. Other factors such as mining, recreation, and grazing will negatively affect the presence and quality of willow as well as other environmental factors that the white-tailed ptarmigan depends on in its limited alpine habitat.

D. Distribution

The white-tailed ptarmigan is the only species of ptarmigan exclusive to North America and the only species of ptarmigan present south of Canada (Aldrich 1963). The ptarmigan's primary range extends from southeastern Alaska, the Yukon, and the Northwest Territories southward, through British Columbia and the western border of Alberta, to northwestern Montana and the northern Cascade Mountains in Washington (Figure 1). Smaller populations are fragmented throughout suitable alpine environments in the Rocky Mountains of Montana, Colorado, and northern New Mexico. Reports of the species in Yellowstone National Park are likely erroneous. The white-tailed ptarmigan has been extirpated from Wyoming and areas in New Mexico (Ligon 1961, USDA 2003a,b).

Additionally, populations have been introduced into high-alpine habitats outside of the ptarmigan's historical range. Successful translocations include populations in the Sierra Nevada Mountains in California (Gaines 1988), Uinta Mountains in Utah (Braun et. al 1978), Pike's Peak in Colorado (Hoffman and Giesen 1983), as well as the Pecos Wilderness in New Mexico

(Braun et al. 1993). An ultimately unsuccessful translocation was attempted in the Wallowa Mountains in northeastern Oregon (Evanich 1980, Braun et al. 1993).

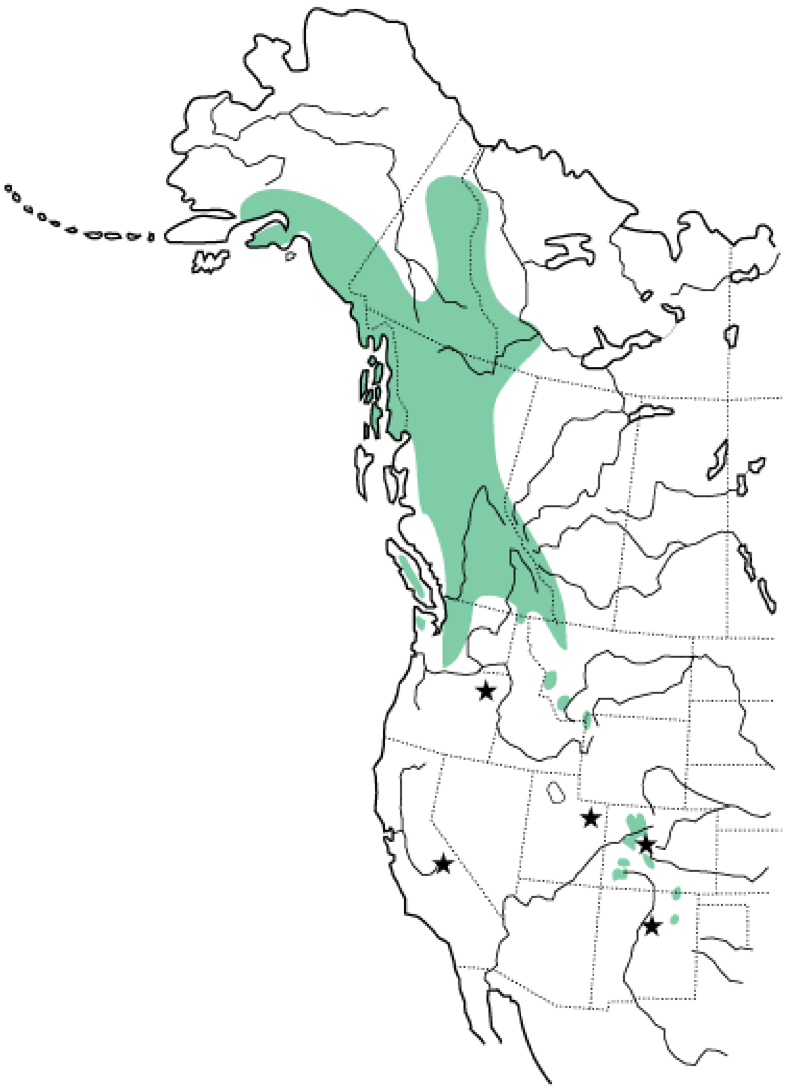


Figure 1. Distribution of White-tailed Ptarmigan: Known distribution of white-tailed Ptarmigan in North America. Stars show locations of introduced populations (Braun et al. 1993). Population in Yellowstone National Park likely based on erroneous sightings.

E. Breeding

Female white-tailed ptarmigan migrate, individually or in flocks, from their winter habitats into territories established by males. Males will often return to territories they occupied during the previous year. Territory selection favors older males (Schmidt 1969, 1988, Braun 1969, Braun and Rogers 1971). Breeding territory size varies by location and may increase as snow melts, making previously unusable areas available (Schmidt 1988, Braun et al. 1993).

The white-tailed ptarmigan's breeding behavior is predominately monogamous though some reports of polygyny exist (Wittenberger 1978, Braun and Rogers 1971, Schmidt 1988, Hannon and Martin 1996). Previously established pairs will often return to formerly occupied territories and pair formation typically occurs within a few days of a female's arrival (Hannon and Martin 1996). Upon the arrival of females, males will exhibit strutting, bowing, and chasing courtship behavior (Schmidt 1969, Braun et al. 1993). Often, when one member of an established pair dies, the living member will remain in their territory to be joined by another mate (Hannon and Martin 1996). Because sex ratios commonly favor females, it is extremely rare for a female to be unmated (Braun et al 1993).

The ptarmigan's nesting events respond to changes in day length but may occur earlier or later in response to premature or delayed snow melt (Braun and Rogers 1971, Giesen et al 1980). Nests are typically constructed in early to mid June using loose vegetation and feathers in bowl-like depressions in the ground (Giesen et al. 1980).

Females will typically lay at least one clutch, though renesting is not uncommon (Braun et al. 1993). However, females will only renest if the first clutch was abandoned or destroyed (Hoffman 2006). Initial clutch sizes typically range from four to eight eggs while renest clutch sizes range from two to six (Giesen et al. 1980, Braun et al. 1993). Females older than 2 years usually have relatively larger clutch sizes than younger females, in both initial and renest clutch size, and are more likely to renest (Wiebe and Martin 1998, Sandercock et al. 2005). The incubation period typically lasts 22-26 days (Giesen et al.1980, Braun et al. 1993, Martin et al. 1993). During incubation, males do not approach the nest and often stand watch. The female is solely responsible for maintaining and caring for the nest.

Males and unsuccessful females will proceed to summer habitat during the late phases of incubation and congregate in flocks (Braun 1969, Schmidt 1988). Soon after hatching, females lead their young away from the nesting area. Although movement often varies from year to year, the female will move her brood progressively toward summer habitats. Intermediary brood ranges are returned to each year and are located at slightly lower elevations than summer habitat. Once these broods have moved into shared summer habitat, multiple broods will combine to form larger flocks, occasionally joined by unsuccessful females. This mixing of broods and the subsequent migration to winter habitat results in the separation of broods from their mother, signaling the end of the incubation period (Braun 1969, Schmidt 1988).

F. Diet and Foraging

The white-tailed ptarmigan's spring and summer diet is composed primarily of *Salix* (willow), *Ranunculus,* and *Dryas.* In Alaska, white-tailed ptarmigan also feed on *Empertrum nigrum* during the summer and fall as well as *Alnus* (birch) and *Betula* in the winter. Within Canada and Washington, white-tailed ptarmigan feed on *Polygonum, Empertrum nigrum, Carex, and Cassiope.* In the Rocky Mountain range, their diet is more diverse as it lacks competition from other ptarmigan species. In Colorado, white-tailed ptarmigan also feed on *Draba*, *Vaccinium,* and *Carex* (Weeden 1967, Moss 1973, 1974). Ptarmigan rely primarily on willow during the winter.

In winter, white-tailed ptarmigan forage most intensely during the morning and immediately before roosting at night (Braun and Schmidt 1971). They tend to congregate in flocks of 2 to 25 members during the winter months, from late October to early April (Braun et al. 1976, Hoffman and Braun 1977, Giesen and Braun 1992). These congregations are thought to assist in locating food sources and detecting predators (Bergerud 1988). Males typically reside at elevations 200 meters higher than females during the winter and associate in smaller flocks (Braun et al. 1976, Hoffman and Braun 1977). Because of this separation, the winter diet of males and females varies slightly.

Invertebrates are consumed by fledglings younger than 3 weeks but are absent in the diet of adults (May 1975).

II. Distinct Population Segments

The Service has two options for listing the white-tailed ptarmigan as threatened or endangered. First, the entire contiguous United States population may be listed as a distinct population segment (DPS) based on its discreteness and significance. Alternatively, the service may choose to list only the Rocky Mountain population as a DPS.

The term "species" is defined broadly under the ESA 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" 16 U.S.C. § 1532 (16).

The Service and NOAA Fisheries have published a policy to define a "distinct population segment" for the purposes of listing, delisting, and reclassifying species under the ESA. 61 Fed. Reg. 4722 (February 7, 1996). Under this policy, a population segment must be found to be both "discrete" and "significant" to be recognized as a DPS. The contiguous United States and Rocky Mountain populations of white-tailed ptarmigan meet both of these criteria, and thus are listable entities under the ESA.

A. The Contiguous United States Population Qualifies as a Distinct Population Segment

Based on the following information, the entire contiguous United States population of white-tailed ptarmigan is both discrete and significant and therefore qualifies for listing under the ESA as a DPS.

Discreteness. Under the DPS Policy, a population segment is discrete if it satisfies either one of the following criteria:

i. It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this separation. The policy further clarifies that a population need not have "absolute reproductive isolation" to be recognized as discrete.

ii. It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act. 61 Fed. Reg. 4725.

The contiguous United States population of white-tailed ptarmigan is markedly separated from other populations of the same taxon by the international governmental boundary with Canada where differences in exploitation and types of threats are significant. Also, based on subspecies accounts, northern populations of white-tailed ptarmigan outside of the contiguous United States have markedly different physiological characteristics than the southern populations which occur south of the international boundary.

White tailed ptarmigan undergo different exploitation in Canada and the United States. In both countries, there are regions where hunting of the birds is legal and areas where it is illegal. All of the white-tailed ptarmigan populations in Canada can be hunted except for the subspecies *Lagopus leucurus saxatilis*, found on Vancouver Island. The British Columbia population on the Washington border can be hunted but in Washington, hunting is illegal. In the contiguous United States, hunting of white-tailed ptarmigan is legal in Colorado, Utah, and California.

The threats to white-tailed ptarmigan in the contiguous United States differ from threats to populations further north. Climate change is the biggest threat facing white-tailed ptarmigan in the southern part of its range. As temperatures warm, tree line moves up, and precipitation patterns change, species will be forced to shift their range northward to find suitable habitat, leaving isolated southern populations at the greatest risk of extinction (Lawler et al. 2009).

Significance. Under the DPS policy, a population will be considered significant based on, but not limited to, the following factors:

(i) Persistence of the discrete population segment in an ecological setting unusual or unique for the taxon,

(ii) Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon,

(iii) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range, or

(iv) Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

The contiguous United States population of white-tailed ptarmigan is significant based on the following discussion.

a. Loss of the contiguous United States population would result in a significant gap in the range of the taxon

Loss of the white-tailed ptarmigan in the contiguous United States would create a significant gap in the distribution of the species. It would eliminate the entire southern range of the species south of the international boundary including all populations in the United States Rocky Mountains, the Sierra Nevada and the Cascade Ranges.

b. The contiguous United States population likely differs markedly from other populations of the species in its genetic characteristics

Because the white-tailed ptarmigan is only found at or near alpine habitat, its distribution is limited by mountain ranges that provide the required elevation characteristics. Populations that inhabit different mountain ranges, are therefore isolated from each other and likely differ genetically.

Martin and Forbes (2004) studied the physiological differences between white-tailed ptarmigan found on Vancouver Island in Canada and those in the United States Rocky Mountains. They found that the birds on Vancouver Island had shorter wings and a heavier body mass during the breeding season than did the Rocky Mountain population further south. In late summer, females on Vancouver Island weighed as much as 40 grams more than those in the Rocky Mountains and males weighed 50 grams more. Differences in coloration and bill shape have also been cited (McTaggart-Cowan 1938).

Although conclusive comparative evidence is lacking on the five subspecies designations, examinations of museum specimens suggest that the 3 subspecies that reside further south have marked differences in size and color from the 2 northern subspecies (Braun et al. 1993). This provides evidence of marked physiological differences between populations in the contiguous United States and those that reside further north.

Clearly, the contiguous United States population of white-tailed ptarmigan is physically isolated from populations in Canada and likely has marked genetic differences.

c. The white-tailed ptarmigan is an indicator species for western North American alpine ecosystems

Braun et al. (1993) argue that the white-tailed ptarmigan is the most important indicator of the health of alpine ecosystems. It is one of the few species that lives in the alpine throughout its entire life cycle and its reliance on these ecosystems makes it particularly susceptible to disturbances, development and changes resulting from global warming.

The immediate threats of grazing, mining, and recreational activities have an especially damaging effect on fragile alpine habitats. These areas may require decades if not centuries to recover from disturbances. Current restoration technology has not proven capable of restoring alpine plant communities to their pre-disturbance condition (Hoffman 2006). White-tailed ptarmigan are an important indicator of human-related impacts on this ecosystem.

d. The white-tailed ptarmigan is threatened or endangered in its entire range in the contiguous United States.

The white-tailed ptarmigan is threatened or endangered in its entire range in the contiguous United States. The Service has listed several species, including the bald eagle, gray wolf, Canada lynx, and grizzly bear to avoid extinction of these species in the contiguous United States. This is consistent with the purposes of the Endangered Species Act, which declared that preservation of the Nation's imperiled species is of "esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people." 16 U.S.C. § 1531(a)(3). Congress cited the case of the bald eagle throughout the legislative history as an example of why it is necessary to list a DPS of a species when it is threatened with extinction in the U.S., although common in Canada and Alaska. Clearly, Congress intended the Service to list DPSs of species to avoid loss of those species from the nation.

B. The Rocky Mountain Population Qualifies as a Distinct Population Segment

Alternately, the Service could list the Rocky Mountain distinct population segment as threatened or endangered based on the following information:

Discreteness. The Rocky Mountain population is discrete. Between the northern and Rocky Mountain populations lies a dearth of suitable habitat for white-tailed ptarmigan. This physical geography is the dominant factor separating the two populations. Without suitable habitat through which to travel and a lack of observed travel corridors, the two populations are likely to be ecologically isolated as well. Furthermore, because white-tailed ptarmigan are not observed to migrate further than distances of 50 km, the Rocky Mountain population is isolated from the arctic population. The assumed extirpation of white-tailed ptarmigan from Wyoming further compounds this problem. It is highly unlikely that there is any genetic transfer between the arctic and Rocky Mountain populations.

Significance. The Rocky Mountain DPS is significant for many of the same reasons that the contiguous United States DPS is significant. Like the contiguous United States DPS, the Rocky Mountain DPS differs markedly in its genetic characteristics from other white-tailed ptarmigan in Canada and is an indicator species for alpine ecosystems. The majority of the population of white-tailed ptarmigan in the United States is in the Rocky Mountains. Loss of this DPS would result in a significant geographic gap in the range of this species.

III. Population Status and Trends

The white-tailed ptarmigan's range is highly disjunct with scattered populations in the Rocky Mountains from Montana to northern New Mexico. Isolated populations exist on Vancouver Island in British Columbia and on Mount Rainier in Washington. Populations have been introduced in California, Colorado, New Mexico and Utah (Storch 2007). Specific population distribution, abundance and demography information is particularly lacking for the white-tailed ptarmigan among grouse species. The population estimates that do exist within the contiguous United States do not suggest large populations of white-tailed ptarmigan in any portion of its range. In some parts of its range, decreasing population trends have been reported. With the additional threat of global warming, more populations are at risk of extirpation (Storch 2007).

A. Statewide Status and Trends

Colorado

The distribution of white-tailed ptarmigan includes all alpine areas in Colorado except the Spanish Peaks and Greenhorn Mountain in the southern part of the state (Braun et al., 1994). Total population estimates within Colorado vary widely because population densities vary by location and fluctuate dramatically from year to year. The Colorado statewide breeding population, derived from measurements of occupied range and breeding densities provided by Braun and Rogers (1971) is estimated at 34,800 birds (Hoffman 2006). These estimates are uncertain because breeding densities vary dramatically, surveys of occupied habitat are imprecise, and because the precise distribution and suitability of habitat is unknown. Averaged over 27 years, breeding densities on Mt. Evans were reportedly 2.0-10.3 birds/km^2 and in Rocky Mountain National Park, 4.5-13.5 birds/km^2 (Braun et al. 1993).

The Forest Service has listed the white-tailed ptarmigan as sensitive in the Rocky Mountain Region. The rationale for sensitive species designation addresses species distribution, population dynamics and the effects of mining on white-tailed ptarmigan (USFS 2005b). National Forest Service land supports the majority of suitable habitat for white-tailed ptarmigan and populations in this region are isolated from nearest populations in the north by long distances. Also, populations in the region are small and white-tailed ptarmigan are not thought to colonize new areas well. The Forest Service cites these factors and the evidence of damage to white-tailed ptarmigan populations from toxic cadmium runoff of mining sites to show that white-tailed ptarmigan are susceptible to extirpation and therefore sensitive (USFS 2005b).

In addition, climate change poses a significant new threat to this population. Based on observations of ptarmigan response to warmer temperatures, Wang et al. (2002b) found that high winter minimum temperatures retarded the growth rate of the population. When simulating the results of future warming in Rocky Mountain National Park, Wang et al (2002b) predicted that future warming will accelerate declines in ptarmigan abundance and may result in local extinctions.

Washington

No population studies of white-tailed ptarmigan have occurred in Washington other than general monitoring to determine the presence of the species in the Cascade Mountains (Hoffman 2006). Partners in Flight designates the white-tailed ptarmigan in the North and South Cascades as being of highest priority for surveys based on inadequate monitoring (Altman and Bart 2001).

New Mexico

In New Mexico, the white-tailed ptarmigan had become extremely rare throughout its range by the early 1900s. It historically inhabited all ridges and peaks above treeline within the Sangre de Cristo Mountains, an expanse of over 130 miles. By the mid-1900s, it was extirpated from the southern peaks and restricted to only a few peaks in the northernmost reaches of its former habitat (NMDGF 1996).

New Mexico added the white-tailed ptarmigan to its endangered species list in 1975. In 1997, the Natural Heritage New Mexico State Rank changed to “Critically Imperiled” and in 2006, the white-tailed ptarmigan was identified as a species of greatest conservation need in the Comprehensive Wildlife Conservation Strategy for New Mexico (NMNHP 1997, NMDGF 2006a).

A 1994 report by New Mexico Department of Game and Fish (NMDGF) cited incompatible habitat pressures such as livestock grazing and increased human use as the cause of white-tailed ptarmigan decline (NMDGF 1994). White-tailed ptarmigan were reported by New Mexico Department of Game and Fish in only 3 out of 6 years from 1990 and 1995 (NMDGF 1996).

Montana

The white-tailed ptarmigan is known to inhabit Glacier National Park as well as the Swan and Mission Mountain Ranges (Casey 2000). One sighting was confirmed outside of these regions (Wright 1996). Choate (1963) reported a stable population in the Logan’s Pass area of Glacier National Park and indicated increasing numbers of adult ptarmigan throughout the summer as a result of immigration.

As in other subsequent studies of white-tailed ptarmigan, the Choate study found that breeding densities varied widely among years and areas within the same year. The percentage of hens with broods varied from 35 to 82 percent over 4 years of study and Choate (1963) attributed the annual differences in nesting success to weather conditions (Hoffman 2006). With the projected changes in weather conditions on mountaintops in the west due to global warming, nesting success will be threatened.

There is no recent data available on the current population status of white-tailed ptarmigan in Montana.

Wyoming

Population densities in Wyoming are uncertain and the presence of ptarmigan in the state is widely disputed (Clarke and Johnson 1990, USDA 2003a, McEaeaney 1995). Although Wyoming contains 340,362 ha of alpine habitat, the areas historically occupied by white-tailed ptarmigan are now unsuitable due to grazing and heavy recreational use (Hoffman 2006). Accounts of ptarmigan are exclusive to the Wind River Mountains, the Bighorn Mountains, Quadrant Mountain in Yellowstone National Park (McCreary 1939, Skinner 1927), and the Snowy Range in the Medicine Bow National Forest (Gates 1940, Harju 1977, Braun 1988). Sightings in Yellowstone National Park, the Beartooth Plateau, the Bighorn Mountains, and the Wind River mountains have been disputed and the only verified sightings of the white-tailed ptarmigan in Wyoming have been in the Snowy Range (Braun 1988, McEneaney 1995). Although white-tailed ptarmigan are historically thought to inhabit the Snowy Range, confirmed observations of the ptarmigan in this area since the early 1970s are unconfirmed or anecdotal and the species has likely been extirpated (USDA Forest Service 2003b, Hoffman 2006). The ptarmigan is listed as S1 (Critically imperiled) in Wyoming.

B. Status of Introduced Populations

White-tailed ptarmigan have been introduced in the Wallowa Mountains in Oregon (1967-1969; Braun et al. 1993), the Sierra Nevada Mountains in California (1971-1972; Gaines 1988), Pike's Peak in Colorado (1975; Hoffman and Giesen 1983), and the Uinta Mountains in Utah (1976; Braun et al. 1978). They were also reintroduced into the Pecos Wilderness Area of New Mexico in 1981 (Braun et al. 1993).

The introduction in Oregon in to the Wallowa Mountains between 1967 and 1969 is considered a failure.

In the Sierra Nevada Mountains, 72 white-tailed ptarmigan were introduced at Eagle Peak and Twin Lakes in Mono County by the California Department of Fish and Game in 1971-72. They have been reported to be breeding successfully and expanding their range (Spencer 1976, Gaines 1977). Clarke and Johnson (1990) reported the continued survival and breeding success of white-tailed ptarmigan in the area.

Original reports after the 1976-1977 introduction of white-tailed ptarmigan into Utah suggested positive results (Braun et al. 1978). Successful nesting and production were documented with good survival suggested from one breeding season to the next. However, more recent accounts are lacking for this area.

In the 1981 reintroduction in New Mexico by the New Mexico Department of Game and Fish, in conjunction with the Colorado Division of Wildlife and the U.S. Forest Service, 43 white-tailed ptarmigan were transplanted into the Truchas Peak area of the Pecos Wilderness. Based on subsequent sightings of adults and young, the introduction appears to have been successful (NMDGF 1988).

Not all apparently suitable habitats have been historically occupied by white-tailed ptarmigan (Aldrich 1963, Braun and Pattie 1969, Scott 1982, Braun 1988, McEneaney 1995, Wright 1996). This includes alpine areas in Idaho, Oregon, California, Utah and the Olympic Mountains of Washington. The absence of white-tailed ptarmigan in these areas, apart from introduced populations, has been attributed to the isolation of suitable alpine habitats from the nearest occupied ranges (Hoffman 2006).

C. Connectivity and Demographic Rescue Between Populations

Because of its reliance on alpine environments, white-tailed ptarmigan populations are naturally fragmented. Each mountaintop provides enough space for only a few breeding pairs. If they were isolated, such small populations could not persist for very long. Therefore, white-tailed ptarmigan survival in patchy habitats depends on contact and exchange between neighboring populations (Storch 2007). This contact occurs through dispersal when juvenile birds disperse between local populations creating demographic rescue (Martin et al. 2000). In a 12-year population study of white-tailed ptarmigan in the Rocky Mountains, Martin et al. (2000) found that external recruitment varied annually from 78-100% for females and 37-100% for males. They concluded:

> "Given the demographic and environmental stochasticity characteristic of this ground-nesting tetraonid, the well developed rescue pattern of immigration of individuals from elsewhere in the multi-population system appears responsible for maintaining stability in white-tailed ptarmigan populations."

This study suggested that demographic exchange occurs most significantly between populations within 5-10 km for males and 20-30 km for females. Maximum travel distances have been recorded for white-tailed ptarmigan when two transplanted males traveled over mostly forested landscape 43 and 50 km respectively to return to their territories (Braun et al. 1993). White-tailed ptarmigan are not thought to be capable of traveling more than 60 miles between populations (Martin et al. 2000).

Breeding densities range among years and areas in the same year between 2-10 birds per km^2. At times when breeding densities are particularly low, populations rely on demographic rescue from other populations to persist. With the increasing altitude of treeline, an expected consequence of climate change, alpine habitats will become more fragmented with smaller and more isolated patches. White-tailed ptarmigan living in these patches will need to disperse longer distances to other patches which will put increased strain on populations (Martin et al. 2000). Known population extinctions of white-tailed ptarmigan have already occurred and climate change will likely increase these population extirpations. Further isolation of remaining populations will inhibit the important process of demographic rescue.

D. The Effect of Weather on White-tailed Ptarmigan Populations

An important factor affecting white-tailed ptarmigan population status and trends from year to year across their range in the contiguous United States is weather (Choate 1963, Clarke and Johnson 1992, Wang et al. 2002a,b, Martin and Wiebe 2004, Hoffman 2006). Productivity or breeding success varies based on differences in nesting success and chick survival. Harsh, inclement weather has been shown to depress breeding success in white-tailed ptarmigan. This is an important concern, due to the projected increase in the frequency and severity of extreme weather events due to climate change (Allison et al. 2009).

Another weather variable that has been shown to affect population growth is winter temperature. Wang et al. (2002b) reported that populations in the Rocky Mountains were negatively affected by higher winter temperatures. In simulating future climate scenarios, they noted the potential for accelerated decline and abundance of white-tailed ptarmigan in the Rocky Mountains and an increased probability of local extinction.

In the Sierra Nevada, higher spring snow depth was shown to lower breeding success (Clarke &Johnson 1992). However, the same relationship has not been detected in naturally occurring populations in the Rocky Mountains so this may be a unique dynamic for the Sierra Nevada population.

Across its range in the contiguous United States, weather characteristics have been reportedly among the most important factors in defining population size and productivity of white-tailed ptarmigan. Projected changes to its habitat due to climate change can be expected to threaten the viability of this species.

IV. The White-tailed Ptarmigan Warrants Listing Under the ESA

Under the ESA, 16 U.S.C. § 1533(a)(1), USFWS is required to list a species for protection if it is in danger of extinction or threatened by possible extinction in all or a significant portion of its range. In making such a determination, USFWS must analyze the species' status in light of five statutory listing factors:

(A) the present or threatened destruction, modification, or curtailment of its habitat or range;
(B) overutilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) the inadequacy of existing regulatory mechanisms;
(E) other natural or manmade factors affecting its continued existence.

16 U.S.C. § 1533(a)(1)(A)-(E); 50 C.F.R. § 424.11(c)(1) - (5).

A species is "endangered" if it is "in danger of extinction throughout all or a significant portion of its range" due to one or more of the five listing factors. 16 U.S.C. § 1531(6). A species is "threatened" if it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." 16 U.S.C. § 1531(20). While the ESA does not define the "foreseeable future," the FWS must use a definition that is reasonable, that ensures protection of the petitioned species, and that gives the benefit of the doubt regarding any scientific uncertainty to the species.

Because global warming is one of the foremost threats to white-tailed ptarmigan, the USFWS should consider the timeframes used in climate modeling. The minimum time period that meets these criteria is 100 years. Predictions of impacts in the next 100 years or more are routine in the climate literature, demonstrating that impacts within this timeframe are inherently "foreseeable." The IUCN threatened species classification system, described below, also uses a timeframe of 100 years. Moreover, in planning for species recovery, the USFWS (as well as its sister agency, the National Marine Fisheries Service) routinely considers a 75-200 year foreseeable future threshold. For example, the Alaska Region has previously stated in the Steller's Eider Recovery Plan:

> The Alaska-breeding population will be considered for delisting from threatened status when: The Alaska-breeding populations has <1% probability of extinction in the next 100 years; AND Subpopulations in each of the northern and western subpopulations have <10% probability of extinction in 100 years and are stable or increasing. The Alaska-breeding population will be considered for reclassification from Threatened to Endangered when: The populations has > 20% probability of extinction in the next 100 years for 3 consecutive years; OR The population has > 20% probability of extinction in the next 100 years and is decreasing in abundance (USFWS 2002).

With regard to the Mount Graham red squirrel, the FWS stated "At least 10 years will be needed to stabilize the Mt. Graham red squirrel population and at least 100 to 300 years will be needed to restore Mt. Graham red squirrel habitat" (Suckling 2006). With regard to the Utah prairie dog, the Service defined the delisting criteria as "[t]o establish and maintain the species as a self-sustaining, viable unit with retention of 90 percent of its genetic diversity for 200 years" (Sucking 2006). The National Marine Fisheries Service stated of the Northern right whale: "[g]iven the small size of the North Atlantic population, downlisting to threatened may take 150 years even in good conditions" (Suckling 2006).

Perhaps most importantly, the time period the USFWS uses in its listing decision must be long enough so that actions can be taken to ameliorate the threats to the petitioned species and prevent extinction. Slowing and reversing impacts from anthropogenic greenhouse gas emissions, a primary threat to the white-tailed ptarmigan, will be a long-term process for a number of reasons, including the long lived nature of carbon dioxide and other greenhouse gases and the lag time between emissions and climate changes. For all these reasons, Petitioner suggests a minimum of 100 years as the "foreseeable future" for analyzing the threats to the continued survival of the white-tailed ptarmigan. The use of less than 100 years as the "foreseeable future" in this rulemaking would be clearly unreasonable, frustrate the intent of Congress to have imperiled species protected promptly and proactively, and fail to give the benefit of the doubt to the species as required by law. USFWS must include these considerations in its listing decision.

Hoffman (2006) prepared a comprehensive report summarizing the research to date on the white-tailed ptarmigan, threats to its continued existence in the Rocky Mountain Region, and management guidelines. Hoffman states,

> "The greatest threat to the long-term survival of ptarmigan populations in Region 2 is global climate change, which may lead to a gradual loss of alpine habitats as the treeline moves upward in response to large-scale atmospheric temperature changes. More immediate and localized threats include grazing, mining, water development, and recreation. While alpine ecosystems are hardy and resilient to natural environmental factors, they are particularly vulnerable to human-related disturbances and may require decades, if not centuries, to recover from such disturbances. Although substantial progress has been achieved in developing techniques to restore damaged alpine landscapes, this technology is still not capable of restoring alpine plant communities to their pre-disturbance condition."

Hoffman points to the threat of habitat destruction as the most urgent conservation concern. He argues that natural processes are still intact that perpetuate alpine ecosystems and therefore the role of management is to provide protection of existing conditions:

> "The key to the successful management of ptarmigan populations and the alpine ecosystems upon which they rely is protection—protection against over-use due to grazing, recreation (including hunting), mining and development, and protection from environmental perturbations that contribute to global climate change, pollution, and depletion of the ozone layer."

In order to ensure that the white-tailed ptarmigan receives the protection necessary for its ongoing survival in the Rocky Mountain region and in the contiguous United States, the species must be listed as threatened under the ESA. The following discussion demonstrates that the white-tailed ptarmigan does in fact qualify for this designation.

A. The Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

1. Global Climate Change

Global warming refers to the current trend of global climate change in which the climate system is warming at an unprecedented rate. The Intergovernmental Panel on Climate Change (IPCC) calls this warming "unequivocal" based on recent observations of global average air and ocean temperatures, the widespread melting of snow and ice and rising global average sea level (IPCC 2007). Scientists agree that these trends are largely human-induced, resulting from human activities that release greenhouse gases such as carbon dioxide into the atmosphere where they accumulate and create a greenhouse effect. Current concentrations of greenhouse gases far exceed the natural range over the last 650,000 years (Allison et al. 2009). Global levels of carbon dioxide emissions from fossil fuels were 40% higher in 2008 than in 1990 (Allison et al. 2009). Depending on future greenhouse gas emissions, global mean air temperatures are projected to rise anywhere between 2^{o}C and 7^{o}C. Scientists agree that limiting warming to no more than 2^{o}C is desirable to avoid the worst effects of global warming. If temperatures rise more than this, climate change will be locked in at a level that will profoundly and adversely affect all of human civilization and all of the world's major ecosystems (Allison et al. 2009). Even if global emission rates are stabilized at present-day levels, with 20 more years of emissions, there would be a 25% probability that warming will exceed 2°C by 2030 (Allison et al. 2009).

Devastating consequences are predicted for humans and other species as global warming continues. Changes to the hydrological cycle around the globe will increase the length, frequency, and intensity of droughts. Also, a rising sea level will lead many millions more people to experience floods on a yearly basis. Densely populated areas of Asia and Africa and small islands will be the most vulnerable. Millions of people will also experience compromised health with increases in diarrheal diseases, cardio-respiratory diseases, and changes in spatial distribution of some infectious diseases (IPCC 2007). In addition to effects on the human population, biodiversity is threatened by global warming. If temperatures increase 1.5-2.5°C, major changes in ecosystem structure and function are predicted. Changes will occur in species' ecological interactions, and geographical ranges and the effects for biodiversity will be predominantly negative. Overall, 20%-30% of existing plant and animal species are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5-2.5°C (IPCC 2007).

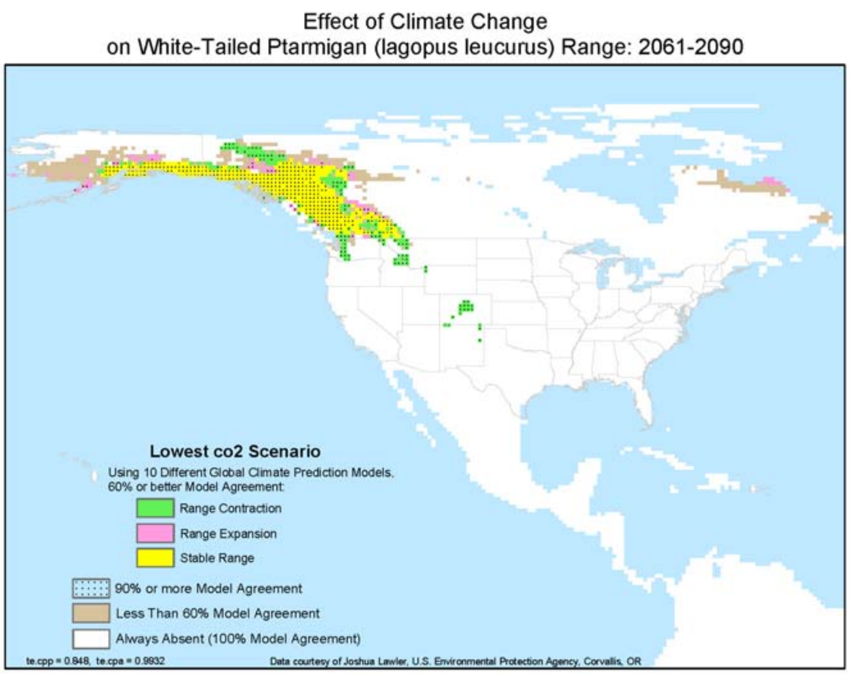
Among the ecosystems affected by climate change, mountaintops are particularly vulnerable to changes in climate (Houghton et al. 1995, 1996). It is generally accepted that high elevations will experience amplified versions of the effects of global warming (Pepin 2000). Studies at high-elevation sites in the European Alps have shown that the warming experienced in the mountains, while synchronous with global warming, is of far greater amplitude. Some sites experienced as much as 5-fold the global increase in temperature (Beniston et al. 1997). In addition, mountaintop species are especially inhibited by changes to their habitat because the environmental conditions of mountainous regions vary significantly over short distances. The edges of species ranges occur, according to elevation in these regions so that populations are restricted geographically. As treeline rises in response to warmer temperatures, alpine species, including the white-tailed ptarmigan will also face loss of habitat (Hoffman 2006). Overall, changes in vegetation will be especially dramatic in alpine habitats because of the greater photosynthetic efficiency of alpine plants at low carbon dioxide concentrations. Increased availability of carbon dioxide in the atmosphere combined with increased temperatures will cause changes to abundance and distribution within alpine plant communities with unknown consequences (Korner and Diemer 1994, Hoffman 2006).

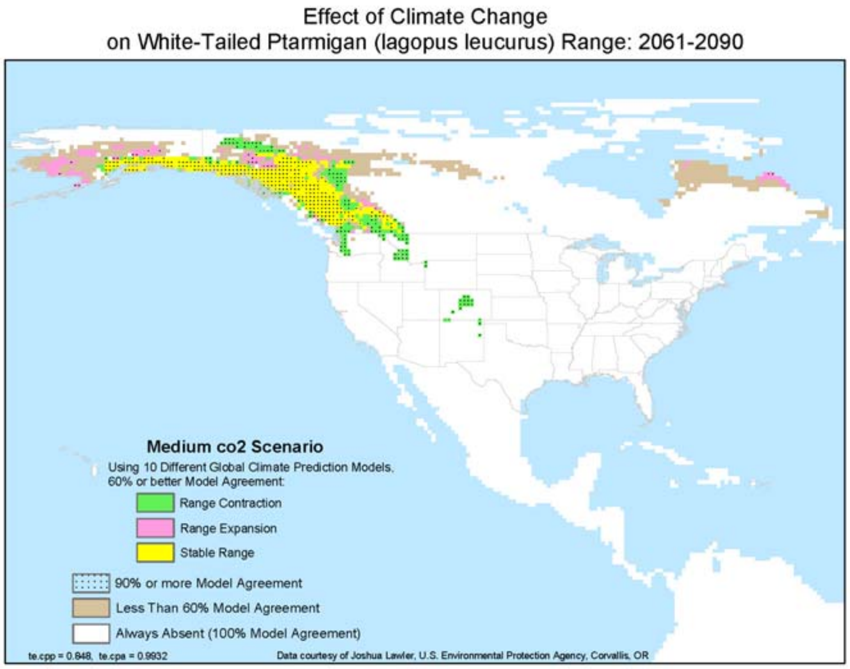
The white-tailed ptarmigan is dangerously underequipped to adapt to the changes that are predicted to occur with global warming. Throughout its range, the white-tailed ptarmigan depends on snow in which it can burrow in the winter (Wang et al. 2002b), the maintenance of cool temperatures in the summer for which it is uniquely adapted (Hoffman 2006), open alpine habitat and the presence of willow, its main food source (Hoffman 2006). As a result of global warming, habitats with these characteristics are likely to sharply decline. Predictions of changes within ptarmigan's current range include warmer winter temperatures (Wang et al. 2002b, Karl et al. 2009), warmer summer temperatures (Hoffman 2006), movement of treeline upslope and changes to alpine vegetation (Hoffman 2006).

These and other unpredictable results of climate change seriously threaten the continued existence of white-tailed ptarmigan in the United States.

a. Global Warming Poses a Serious Obstacle to the Continued Existence of White-tailed Ptarmigan Populations in the United States

Lawler et al. predicted range shifts of 2,954 species based on 10 different global climate prediction models during the coming century, from 2071 to 2100, reporting whether climatic conditions in a particular area are predicted to shift so much that a species will not likely be found in that location and whether new areas with suitable climatic conditions will emerge (Lawler et al. 2009). Overall they predicted the local loss of 11-17% of species under different emissions scenarios. Species turnover was especially significant in mountainous areas (Lawler et al. 2009). Under high, medium and low CO_2 scenarios, ptarmigan are completely extirpated from their current range within the United States with more than 90% model agreement (Lawler et al. 2009).





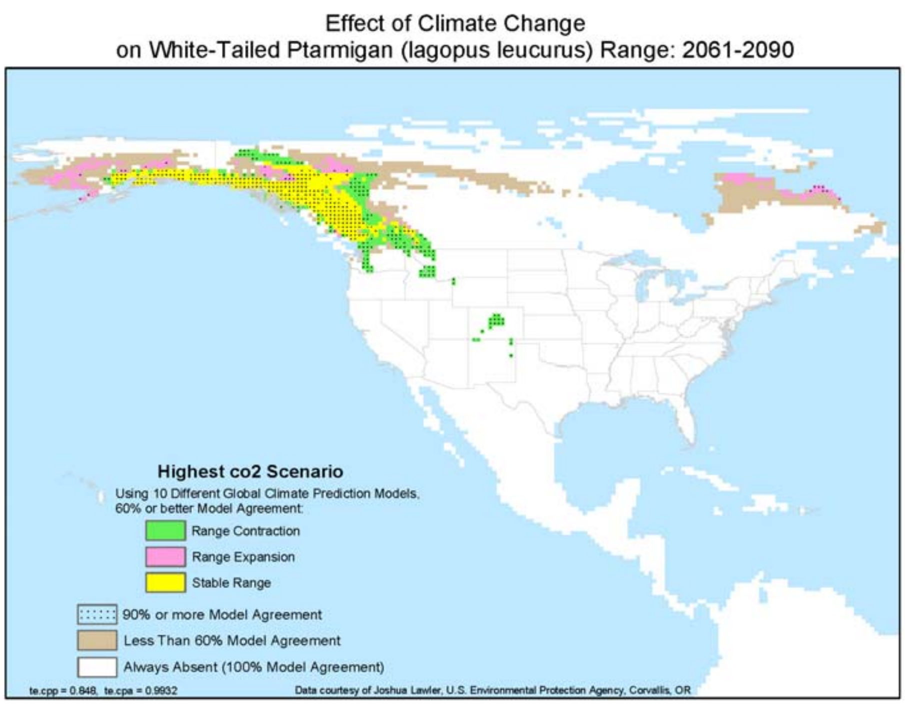


Figure 2. Predicted range contraction of the white-tailed ptarmigan under three carbon emission scenarios.

Global warming poses a serious obstacle to the continued existence of white-tailed ptarmigan in the United States. Specifically, higher winter minimum temperatures, higher summer temperatures, the advancement of treeline upslope and other changes in alpine vegetation all will contribute to shrinking existing suitable habitat for these birds (Mote et al. 2005, Hoffman 2006, Knowles et al. 2006, Barnett et al. 2008).

i. Higher winter temperatures

Temperatures increases over the West are consistent with rising greenhouse gases, and will almost certainly continue. According to Knowles et al. (2006), average minimum and maximum temperature increases over the western United States were 1.4°C and 1.0°C respectively from 1949 to 2004 for wet-day measurements. Estimates of future warming rates for the West are in the range of 2°–5.6°C over the next century (Karl et al. 2009).

In Colorado, where the majority of the contiguous United States populations of white-tailed ptarmigan exist, temperatures have increased significantly more than the average for the western United States. A recent report for the Colorado Water Conservation Board (Ray et al. 2008) synthesizes models of historic Colorado climate conditions as well as projections for future conditions. In only the past 30 years, temperatures have increased about 1.1°C in the state, twice the average increase over the western United States for the same time period (Ray et al. 2008). Colorado is expected to warm 2.2°C by 2050. Projections for winter temperatures by 2050 show winter temperatures increasing by 1.7°C (1.1 to 2.8°C). These projections show few extreme cold months and more extreme warm months with more series of consecutive warm winters (Ray et al. 2008). To illustrate these winter temperature changes, according to the report,

> "Typical projected winter monthly temperatures, although significantly warmer than current, are between the 10th and 90th percentiles of the historical record. Between today and 2050, typical January temperatures of the Eastern Plains of Colorado are expected to shift northward by ~150 miles. In all seasons, the climate of the mountains is projected to migrate upward in elevation, and the climate of the Desert Southwest to progress up into the valleys of the Western Slope" (Ray et al. 2008).

Warmer winter temperatures which result from climate change will make current white-tailed ptarmigan habitat unsuitable and could lead to local extinctions of this species. The Cascade Mountains have seen a rise of cool season temperatures of 1.4°C in the past 40-70 years and warming is projected to continue (Karl et al. 2009). According to a 2009 Washington State Climate Change Impacts Assessment Report (Littell et al. 2009), climate models project increases in annual average temperature for the state by the 2080s of 2.9°C (1.6 to 5.4°C). This report also showed historical increases since 1920 of 0.8°C for the state.

Warmer winter temperatures mean a higher percentage of total precipitation falling as rain rather than snow (Mote 2005, Knowles et al. 2006, Karl et al. 2009). Mote (2003) analyzed reports of snow water equivalent and spring snowpack in the Pacific Northwest and compared these with local climate data. Throughout the region, spring snowpack has declined since the mid-20th century and is consistent with observed increases in temperature. This trend is especially dramatic in ptarmigan habitat in the north Cascades of Washington State where the percentage of total precipitation that falls as snow has shown a significant decreasing trend, as much as 40% (Mote 2003). Mote et al. (2005) focused on the causes of observed trends in decreased snowfall in western North America, finding them to be predominantly climatic. Mote concluded, "it is therefore likely that the losses in snowpack observed to date will continue and even accelerate" (Mote 2005).

With increasing mountain temperatures, the elevation which experiences increased rainfall can be expected to go up. In addition, further declines in snowpack will occur, with projections of decline in spring snowpack in the Cascades by as much as 40% by the 2040s (Payne et al. 2004). A situation with less snowpack combined with wetter, icier snow will have disastrous effects on the white-tailed ptarmigan as they will be inhibited from creating burrows in the snow, their primary adaptation for staying warm in the winter.

Winter temperature was one of the factors addressed in a key study on the relationship between climate and ptarmigan population dynamics in Rocky Mountain National Park. Wang et al. (2002b) fit the Ricker population model to 25 years of data on population sizes of white-tailed ptarmigan in the area using 12 different weather variables from a nearby weather station as covariates. They then simulated the effects of future warming using the best ptarmigan population model and 2 future climate scenarios to predict dynamics for the decade 2021-2030. The study found that median hatch dates advanced significantly from 1975 to 1999 in response to increases in April and May temperatures. Also according to 3 separate models, high mean winter temperatures depressed the population growth rate of the ptarmigan. In general, the warmer the winter, the lower the population growth rate was. When projecting for future climate conditions, anticipated warming of 2.3ºC and 2.6ºC was used. This resulted in a population projection of only 2-3 individuals where there were historically 30-40. Therefore, the study concluded that there is a clear population level response in white-tailed ptarmigan to variation in climate and that projected temperature increases in Rocky Mountain National Park have the potential to accelerate declines in abundance and increase the probability of local extinction.

ii. Higher nesting season and summer temperatures

Global warming is causing higher temperatures in the western United States year round. Average annual temperatures have increased 0.8 °C in the past century and are projected to increase during this century by 2-5.6°C (Karl et al. 2009). A rise in nesting-season and summer temperatures will significantly increase stress for white-tailed ptarmigan and will negatively affect reproduction and survival of this species.

The 2008 Colorado Water Conservation Board report details the significant projected increases in summer temperatures in the state. The 2050 projections show summers warming by 2.8ºC (1.7 to 3.9ºC). Typical summer monthly temperatures are projected to be as warm or warmer than the hottest 10% of summers that occurred between 1950 and 1999 (Ray et al. 2008). According to this report,

> "mid-21st century summer temperatures on the Eastern Plains of Colorado are projected to shift westward and upslope, bringing into the Front Range temperature regimes that today occur near the Kansas border" (Ray et al. 2008).

In Washington States, where white-tailed ptarmigan inhabit the Cascade Mountains, warming is expected to occur during all seasons but the largest temperature increases are expected during the summer (Littell et al. 2009).

White-tailed ptarmigan are uniquely cold-adapted birds and have little faculty for coping with these projected warm temperatures (Johnson 1968, May 1975, Hoffman 2006):

> "Mean body temperature has been measured at 39.9 °C (Johnson 1968) and 39.5 °C (May 1975). The thermoneutral zone where little or no energy needs to be expended to control body temperature ranges from 6 to 38 °C (Johnson 1968). The Lower Critical Temperature of 6 °C is exceptionally low for birds and is most likely due to the low conductance (high insulation value) of the ptarmigans' plumage (Veghte and Herreid 1965, Johnson 1968). Ptarmigan have one of the lowest evaporative efficiency estimates recorded in birds (Lasiewski et al. 1966, Johnson 1968). Even at high ambient temperatures, ptarmigan can evaporate no more than 90 percent and usually only about 60 percent of their metabolic heat (Johnson 1968). Consequently, ptarmigan are highly susceptible to heat stress" (Hoffman 2006).

In order not to become overheated when ambient air temperature increases, even in winter, ptarmigan tend to seek shade and other cooler microhabitats. Calm, warm, and clear days have therefore been observed to inhibit white-tailed ptarmigan activity (Braun and Schmidt 1971). In nesting season, rising temperatures may force ptarmigan to nest in denser vegetation where there is more shade but where they become vulnerable to predation. They may also take fewer incubation breaks during the day, when the temperatures are highest. "If nesting hens cannot obtain sufficient food, their body condition will deteriorate and they may abandon the nest" (Hoffman 2006).

Warmer temperatures during nesting and summer seasons will cause increased hardship to white-tailed ptarmigan in the form of heat stress and forced changes in nesting and habitat use patterns that may put them at risk of predation and reproductive failure.

iii. The advancement of treeline upslope

The advancement of treeline upslope in alpine areas will constrict white-tailed ptarmigan habitat, further fragment its range, and may lead to local extirpations. When facing a warming climate, the general trend is for plant and animal species to shift their ranges northward and upslope (Walter et al. 2002, Hoffman 2006, Janetos et al. 2008, Karl et al. 2009, Lawler et al. 2009).This temperature-related shift of species ranges is already documented and well under way in response to a warming climate (Root et al. 2003). Following this trend, alpine treelines are expected to migrate upwards in response to warming (Markham et al. 1993; Beniston 1994; Gottfried et al. 1998; Theurillat and Guisan 2001). Upper vegetation zones will be threatened by plants from lower belts shifting upwards (Peters and Darling 1985; Dullinger et al. 2004). The advancement of treeline and invasion of trees into alpine meadows has been predicted based on both expected temperature increases (Grace et al. 2002), as well as higher concentrations of CO_2 in the air (Hattenschwiler et al. 2002).

Cannone et al. (2007) points out evidence from existing studies of the sensitivity of alpine habitats to warming temperatures. They reference shifts in the altitudinal range margins of plant species and bioclimatic zones in the past 50 years, with upward displacement of 120-340 meters for tree and woody shrub species (Kullman 2002), upward migration of alpine and nival plant species at a rate of 8-10 meters per decade (Grabherr et al. 1994; Walther et al. 2005), and changes in community composition (Keller et al. 2000). Cannone et al. (2007) also suggest that small increments of 1-2^{o}C warming of air temperature may produce important changes in vegetation community dynamics. Other locations with similar habitat in the arctic have been studied to reveal a response of forest expansion to generalized warming trends (Millar et al. 2004). In Alaska, northward shifting of treeline is causing vegetation to encroach on tundra habitat, threatening migratory birds and land animals such as caribou (Karl et al. 2009). In mountains in the western United States, white-tailed ptarmigan will be threatened by similar events.

A study of the global climate change impacts in the Colorado Rocky Mountains details specific vegetation changes and implications in light of the location of treeline (Stohlgren and Baron 2003). Stohlgren and Baron suggested that due to extreme elevation and vegetation gradients, the Colorado Rocky Mountains are very sensitive to regional and global climate change (2003). Specifically, the report highlighted the following:

(1) "Krummholz (wind-trimmed low-growing trees) in the forest-tundra ecotone of Rocky Mountain National Park is growing vertically at an average rate of about 1 m per 27 yrs, and, if this continues unabated, krummholz may become patchy forest on certain sites. There is abundant and widespread tree invasion into openings between patches of forest in the so-called "patch forest" zone, below the krummholz zone in the Park. If this invasion persists and the trees continue to grow up, the patch forest zone will become closed, dense forest. This will reduce understory plant diversity and habitat for subalpine/alpine wildlife species."

(2) "Field studies in Rocky Mountain National Park indicate that forested ecotones (i.e., boundaries) are sensitive to changes in regional climate. Environmental factors (temperature, soil moisture) appear to be more significant in controlling forest distribution than soil characteristics (texture, depth, rockiness). Soil factors will not inhibit changes in vegetation distribution, while shorter term changes in climate could affect vegetation dominance…(Stohlgren and Baron 2003)."

Mountaintop species such as the white-tailed ptarmigan are especially sensitive as their habitats are compressed by environmental changes. Some species that try to shift uphill simply run out of habitat and face local extinctions (Janetos et al. 2008). Any upslope movement of treeline will result in compression and fragmentation of the white-tailed ptarmigan's habitat (Braun 1984, Wang et al. 2002b). Alpine areas will become smaller and less continuous. This will cause decreased opportunities for migration, emigration and immigration and the resulting isolated ptarmigan populations will be more vulnerable to disruptions by extreme events that are expected to happen more frequently with a changing climate (Hoffman and Braun 1975, Giesen and Braun 1992). The result is a decreased likelihood of ptarmigan population viability and the increased risk of local extinctions (Giesen and Braun 1993, Martin et al. 2000, Wang et al. 2002b, Sandercock et al. 2005, Hoffman 2006).

iv. Other changes to alpine vegetation

Global warming will have various direct and indirect effects on alpine vegetation which will have unpredictable results on white-tailed ptarmigan. An important characteristic of current ptarmigan habitat is the presence of willow (*salix spp*.), their main food source from late fall through spring (Hoffman 2006). Changes to alpine vegetation resulting from the response of plants to increased carbon dioxide in the air (Hoffman 2006), and shifts in precipitation patterns (Billings 1988), may threaten the distribution of willow or other important plant communities in ptarmigan habitat (Braun 1971, Hoffman 2006).

Increased carbon dioxide in the atmosphere will likely affect the photosynthesis and growth of alpine plants especially because alpine plants have an especially high photosynthetic efficiency at low carbon dioxide concentrations. The combined effects of increased carbon dioxide levels and nitrogen deposition may significantly alter alpine plant communities although exact consequences are unknown (Hoffman 2006). White-tailed ptarmigan will experience this along with rising treelines as significant change to their alpine environment.

Changes in precipitation patterns, discussed above are likely to affect alpine vegetation communities. Snowfall patterns along with topography and wind are the ultimate characteristics which govern distribution, composition, and structure of alpine plant communities (Billings 1988). Therefore, long-term changes in snowfall patterns will alter vegetation features presumably to the detriment of white-tailed ptarmigan (Hoffman 2006). For example, wet meadows below late-lying snowfields, a vital brood-rearing and summer use area, and one of the most productive alpine plant communities (Braun 1971), will shrink or disappear if warmer winter temperatures result in less snowfall" (Hoffman 2006).

Conclusion

Global warming is the greatest threat to the survival of white-tailed ptarmigan populations in the United States because of their insufficient ability to adapt to rises in winter, breeding season and summer temperatures; advancement of treeline upslope; and other changes to alpine vegetation (Walther et al. 2002, Wang et al. 2002ab, Krajick 2004, Hoffman 2006). Global warming will have significant negative and potentially disastrous effects on white-tailed ptarmigan in the United States. In order to protect this impressive and unique species, swift action must be taken to lessen and mitigate the effects of climate change.

2. Recreation

Recreational activities in alpine areas include hiking, skiing, and the use of off-road vehicles. These activities are increasingly popular throughout western North America, including areas inhabited by white-tailed ptarmigan (Hoffman 2006). As far back as 1978, Brown et al. (1978b) reported that 38,000 ha of alpine land were disturbed by trails, campsites and trampling and an additional 12,748 ha were disturbed from roads and off-road vehicles. Since this time, recreational use has only increased. Records show that 75,000 people climb Colorado's 14,000-foot peaks annually (Hesse 2000). The 1990s saw a 10-25% annual increase in use of trailheads that provide access to 14,000-foot peaks (Ebersole et al. 2002) causing the number of climbers to double every 3-7 years. The consequences of recreational use to alpine ecosystems include immediate seasonal effects such as compaction of snow and disturbance of wildlife as well as more long-term shifts including changes to vegetation communities, erosion patterns, and species survival. White-tailed ptarmigan are affected through direct disturbances as well as destruction of their habitat for recreational activities.

The main destruction to alpine habitat caused by hiking is the trampling of vulnerable alpine vegetation. Even when trampling occurs in a small contained area such as on a trail, disturbance can extend out into a larger area due to resulting erosion from wind and water (Hoffman 2006). Willard and Marr (1971) estimated the time required for trampled alpine vegetation to recover. In some cases, even short periods of disturbance can result in damage which requires hundreds or even a thousand years of recovery.

The use of vehicles causes harm to alpine ecosystems and species. Off-road vehicles including snowmobiles cause erosion, slumping, soil compaction, vegetation damage, noise pollution and harassment of wildlife (Lodico 1973, Hoffman 2006). Snowmobiles in particular are dangerous for white-tailed ptarmigan. In addition to occasionally being killed by a vehicle, the birds may temporarily leave their optimal feeding and roosting sites when disturbed (Hoffman 2006). Flushing exposes the birds to predators, and expends precious energy that is needed for keeping warm. Snowmobiles also compact snow and may run over willows, with direct consequences to the white-tailed ptarmigan (Hoffman 2006).

Skiing is the winter sport with the most wide-spread impacts on alpine ecosystems. Braun et al. (1976) reported white-tailed ptarmigan to exist within ski areas but to a lesser extent because of development. Colorado has 40,000 acres of skiable terrain and boasts 26 major ski resorts, most of which access terrain above treeline. Skiers most likely cause repeated displacement of white-tailed ptarmigan forcing them to expend extra energy in the winter months. In addition, ski area development results in habitat loss (Hoffman 2006). Willows that grow above the snow are likely to be cut or removed and if not, skiers and grooming machines will run over these plants and cause damage to white-tailed ptarmigan's most important food source. Also, snow-making operations may cover up willow that would otherwise be exposed, making them inaccessible to white-tailed ptarmigan. Skiers and grooming machines also serve to compact the snow, making ptarmigan travel further to find suitable soft snow for roosting.

Ski area development also creates habitat for predators of white-tailed ptarmigan. For instance, power poles and lifts above treeline provide raptors and corvids with places to perch (Hoffman 2006). In a study of rock ptarmigan in Scotland, ski areas tended to attract generalist predators such as foxes and ravens which caused significant decline in breeding success for the ptarmigan (Watson and Moss 2004). There is likely a similar affect in Western North America on white-tailed ptarmigan (Hoffman 2006).

Under the Freedom of Information Act, we requested all biological evaluations, environmental assessments, environmental impact statements and decision memos where the conclusion was that the project would affect white-tailed ptarmigan from the last ten years produced in the Rocky Mountain Region of the Forest Service. In response, we received 63 projects, 41 of which resulted in the conclusion that the project may adversely affect individual white-tailed ptarmigan, but not lead to a trend towards federal listing. The majority of the projects (44) were related to recreation and for 27 of these projects the authors concluded that white-tailed ptarmigan individuals may be adversely impacted. For example, one biological report for road improvements on the Guanella Pass Road to better serve recreational users analyzed the effects of the project on white-tailed ptarmigan (USFS 2002). In the vicinity of the project 20-200 white-tailed ptarmigan were estimated to use winter habitat. Projected results were disturbance of white-tailed ptarmigan by recreational users, redistribution and dispersal from the area. In a 2006 Environmental Impact Statement for a project at Copper Mountain Resort, white-tailed ptarmigan were predicted to be affected by reduced habitat availability, habitat quality and habitat effectiveness primarily because of snow compaction and skier disturbance (USFS 2006b). As these examples clearly indicate, recreation-related projects are being planned and implemented that negatively affect white-tailed ptarmigan.

The increased popularity of alpine habitat for recreation throughout the year puts stress on white-tailed ptarmigan. Specific threats result from a variety of forms of recreation that have both short and long term implications for this species.

3. Livestock Grazing

Livestock grazing is the dominant land use practice in western North America and affects a wide variety of ecological communities (Hoffman 2006, Fleischner 1994, Fleischner 2010). In the 11 westernmost states (those including and west of the Rocky Mountains), 70% of the land is grazed during all or part of the year and 90% of federal land in these states is grazed (Crumpacker 1984, Armour et al. 1991). In 1979, an interagency committee of state and federal biologists concluded that livestock grazing was the most important factor degrading fish and wildlife habitat in the west (Oregon-Washington Interagency Wildlife Committee 1979, Fleischner 2010) The ecological consequences of livestock grazing are compounded in some locations by an overabundance of native ungulates including elk (Anderson 2007). The effects of grazing include removal of vegetation, structural adjustment of plant communities (Krueper 1993; Saab et al. 1995; Dobkin et al. 1998; Krueper et al. 2003), trampling and compaction of soils. Consequent effects may involve changes to water availability, the alteration of foraging guilds and the disruption of successional patterns of nutrient cycling (Fleischner 1994). These factors may affect animals through changes to food resources, alteration of nesting habitat, and greater exposure to predation (Ammon and Stacy 1997, Walsberg 2005).

Alpine ranges in the Rocky Mountains are affected by livestock grazing of sheep. Cattle are poorly adapted to using this environment (Alexander and Jensen 1959, Thilenius 1975) and are not a major influence on alpine areas. The abundance of domestic sheep peaked in the western U.S. around 1910 but by 1959, there were still over 300 sheep allotments that were partially using alpine rangeland in Colorado and Wyoming (Wasser and Retzner 1966). In general, sheep herding practices have been negligent and have had deleterious effects on alpine ecosystems by creating trails and through over-grazing and trampling of native vegetation (Paulsen 1960, Bonham 1972). Alpine ecosystems are particularly slow to recover from disturbances so improper grazing has a significant and lasting impact on these areas (Hoffman 2006). Because of the lack of information concerning specific vegetation responses to grazing in alpine environments, it is difficult to design proper range management practices for these areas. Those methods that apply to other ecosystems may not apply in the alpine and many portions of the alpine environment are simply not suited for grazing by domestic livestock (Thilenius 1975).

Within the range occupied by white-tailed ptarmigan in the United States outside of Alaska, livestock grazing is the dominant land use (Hoffman 2006). Because sheep consume plants which are important in ptarmigan diets, ptarmigan of all ages and gender are in competition with sheep for scarce resources (Hoffman 2006). In addition, the vegetation type which results after grazing occurs is significantly less palatable to ptarmigan (Hoffman 2006).

In addition to domestic livestock in alpine areas, elk populations have grown dramatically because of greater protection and enforcement of game laws as well as a lack of natural predators (Hoffman 2006). Elk use of alpine ranges has increased during all seasons of the year and elk generally cause conversion of willow habitat into shrub-steppe habitat, making it significantly less hospitable to white-tailed ptarmigan (Anderson 2007). Elk most profoundly affect willow shorter than 2 feet and this is directly in conflict with the ptarmigan's requirement for willow of the same size (Anderson 2007).

White-tailed ptarmigan behavior has been documented to be disrupted in heavily grazed areas of the Rocky Mountains. In these cases, there is no marked movement uphill to summering areas following the completion of breeding activities. White-tailed ptarmigan must find suitable summering areas elsewhere and may wander between different areas at higher elevations (Hoffman 2006).

According to the documents received from the Rocky Mountain Forest Service Region 2 concerning projects affecting white-tailed ptarmigan over the past 10 years, 13 grazing projects were documented. Of these, 8 reports concluded that the grazing allotment may adversely impact individuals of the species but not lead to a trend toward federal listing. For example, a 2006 Biological Evaluation of the South San Juan Sheep and Goat Allotments, increasing the number of sheep grazed was expected to increase the chances of crushing of individual white-tailed ptarmigan or their eggs, disturbance to ptarmigan caused by herds. Also working dogs were predicted to cause disturbance or mortality of ptarmigan or their eggs. Over-grazing of willow habitat was also documented as a potential impact to white-tailed ptarmigan (USFS 2006c). Clearly, grazing projects in ptarmigan habitat that will negatively affect this species are still being planned and implemented.

Grazing by domestic livestock as well as overabundant native ungulates threatens the health and survival of white-tailed ptarmigan populations. Grazing negatively impacts their habitat, the presence of their most important food source and forces changes in migration patterns.

4. Mining

Mining became an important industry in the American west in the 1860s. At the time, mining operations were much smaller than they are today but occurred in dense clusters so that their effects on the landscape were significant (Hoffman 2006). Without any environmental standards or regulations until recently, mines caused enormous damage to ecosystems and then were abandoned when mineral deposits became depleted. Environmental damages resulting from mines include surface-disturbance, removal of forest cover, building of roads, powerlines, and buildings, spillage of petroleum products, disruption of surface and ground water flows, acidification of water sources, heavy-metal pollution, and an increased chance of mass slumping (Dickens et al. 1989, Brown et al. 1978b, Chambers 1997, Macyk 2000, Hoffman 2006). With insufficient effort applied to reclamation in many areas, problems from mines that were abandoned 150 years ago still persist today (Larison et al. 2000, Larison 2001).

Alpine ecosystems are particularly vulnerable to human disturbance and historically, mining has been considered the most destructive human activity in alpine habitats, causing complete and lasting devastation of alpine soils and vegetation in some cases (Chambers 1997, Macyk 2000). Brown et al. (1978b) estimated that 34,677 ha of alpine habitat have been disturbed by mining in the western United States, excluding Alaska. As in other mountainous regions in the west, in the Southern Rocky Mountain ecoregion, distribution of heavy-metal pollution due to mining is ubiquitous and has a major impact on the health of watersheds in the region (Clements et al. 2000).

White-tailed ptarmigan are negatively affected by the presence of abandoned mines within their range. Their habitat, particularly in the Rocky Mountains, has been degraded by historical mining activities in the alpine zone (Brown et al. 1978b, Hoffman 2006). In addition to more general consequences of disturbed soil and vegetation, white-tailed ptarmigan are particularly threatened by toxic levels of cadmium pollution that persist in some parts of their range (Larison et al. 2000). Cadmium is one of the toxic heavy metals that are readily mobilized through mining activities and it is particularly dangerous to white-tailed ptarmigan because the only genus that biomagnifies the toxin, willow, is their main food source (Larison et al. 2000). In a study by Larison et al., levels of cadmium concentrations sufficient to be toxic were found in 44% of ore-belt birds examined with females more affected than males. Cadmium pollution and associated calcium deficiencies are likely the cause of populations of white-tailed ptarmigan observed to have particularly fragile bones (Larison 2000). In addition to threatening the health of individuals, cadmium pollution negatively skews the sex-ratio of affected populations (Larison et al. 2000).

Abandoned mining sites that have not undergone appropriate reclamation continue to pose a threat to white-tailed ptarmigan populations.

One new mining project occurred in the last 10 years, in 2006, according to the Forest Service documents requested by the petitioner. The Biological Evaluation of the project to re-open an 1890's lode mine at an elevation of 12,500 feet on Mt. Loveland concluded that white-tailed ptarmigan individuals may be adversely impacted. Potential affects were listed including destruction of nests and summer foraging habitat by vehicles used during the project (USFS

2006a). The only other documented mining project was a 2008 mine-closing, which was also expected to adversely impact individuals (USFS 2008).

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

1. Hunting

Hunting of white-tailed ptarmigan is legal in the United States in Alaska, Colorado, Utah, and California. These birds are unwary of humans, tend to congregate in large flocks in the fall and continue to use the same habitat even after they are repeatedly disturbed. For this reason, white-tailed ptarmigan are exceptionally vulnerable to over-harvest (Hoffman 2006). Populations in Colorado's Front Range are within 1 to 2 hours driving distance of major cities making them easily accessible to human residents.

Braun (1969) reported that hunted study populations experienced additive mortality due to hunting. He suggested that hunting of these populations resulted in 15-27% higher mortality rates (Braun 1969). Studies of willow ptarmigan and other grouse species have made similar conclusions, that hunting is additive to natural mortality in these species (Smith and Willebrand 1999, Ellison 1991, Small et al. 1991, Steen and Erikstad 1996). In the field, this dynamic may not always be apparent. This is because immigration from non-hunted or lightly-hunted populations may be sufficient to sustain densities, thus giving an inaccurate impression of population stability (Hoffman 2006).

In some locations, females with broods are more accessible and vulnerable to hunting (Hoffman 2006). This is the case at Crown Point in Rocky Mountain National Park where brood habitat is limited and occurs along the edges of rocky areas (Braun and Rogers 1971). In this area and others like it, where females and broods are more susceptible to hunting, the overall productivity of the population may decline (Sandercock et al. 2005).

The current threat of hunting to white-tailed ptarmigan populations is restricted to particular localized areas. However, the threat may become more widespread in the future as Colorado's human population expands and as more people gain accessibility to white-tailed ptarmigan habitat through increased abundance of four-wheel drive vehicles and four-wheel drive roads (Hoffman 2006). Declining populations of other grouse species are also causing increased interest among hunters in white-tailed ptarmigan. Populations of white-tailed ptarmigan are also accessible to hunters because 90% of their occupied range in Colorado is publicly owned and open to hunting (Hoffman 2006).

C. Disease or Predation

Development of ski areas in alpine habitat may increase the presence of generalist predators that harm white-tailed ptarmigan. Based on studies of rock ptarmigan in Scotland, the most pronounced effect of ski area development is the influx of generalist predators, especially carrion crows (*Corvus corone*; Watson and Moss 2004). This causes declines in breeding success and population size of ptarmigan. In the study, areas closest to development showed that ptarmigan lost nests to frequent crows, and reared abnormally few broods. These effects were lessened according to distance from development. Detailed studies are lacking on the effects of post-development increase in generalist predators on white-tailed ptarmigan. However it is likely that the white-tailed ptarmigan in the United States are affected in ways similar to the rock ptarmigan in Scotland. Any developments that result in an increased abundance of generalist corvid, canid, and mustelid predators, can have a large impact on the number of juvenile white-tailed ptarmigan (Storch 2007).

D. Existing Regulatory Mechanisms are Inadequate to Protect the White-tailed Ptarmigan

The white-tailed ptarmigan faces formidable threats which could be ameliorated or eliminated by regulatory actions. To date, few of these regulatory actions have been implemented with regard to the white-tailed ptarmigan, despite the existence of regulatory authority by various agencies. To protect the white-tailed ptarmigan's habitat, the reduction of greenhouse gas pollution is essential. This will slow global warming and ultimately stabilize the climate system, protecting the alpine habitat that remains in western North America.

1. Regulatory Mechanisms Addressing Greenhouse Gas Pollution and Global Warming are Inadequate

Existing international and U.S. regulatory mechanisms to reduce global greenhouse gas emissions are clearly inadequate to safeguard the white-tailed ptarmigan against extinction resulting from climate change.

National and international emissions reductions needed to protect the white-tailed ptarmigan

The best-available science indicates that the atmospheric concentration of CO_2 must be reduced from the current level of ~390 ppm to at most 350 ppm to protect species and ecosystems from anthropogenic climate change. Numerous scientific studies indicate that climate change resulting from greenhouse gases currently in the atmosphere already constitutes "dangerous anthropogenic interference" (DAI) with regard to species and ecosystems (Warren 2006, Hansen et al. 2008, Lenton et al. 2008, Jones et al. 2009, Smith et al. 2009). Climatic changes experienced so far, including the ~0.7°C temperature rise and 30% increase in ocean acidity since the pre-industrial era, have resulted in significant changes in distribution, phenology, physiology, demographic rates, and genetics across taxa and regions, which have lead to population declines and species extinctions (Walther et al. 2002, Parmesan and Yohe 2003, Root et al. 2003, Walther et al. 2005, Parmesan 2006, Warren 2006, Walther 2010). Moreover, the impacts to biodiversity from the greenhouse gases currently in the atmosphere have not been fully realized. Due to thermal inertia in the climate system, there is a time lag between the emission of greenhouse gases and the full physical climate response to those emissions. The delayed effects from existing emissions are known as the "climate commitment." Based on the greenhouse gases already emitted, the Earth is committed to additional warming estimated at 0.6°C to 1.6°C within this century (Meehl et al. 2007, Ramanathan and Feng 2008), which commits species and ecosystems to further impacts.

Continuing greenhouse gas emissions, which are occurring at a rapid rate tracking the most fossil-fuel intensive emissions scenario of the Intergovernmental Panel on Climate Change (IPCC) (Raupach et al. 2007, Richardson et al. 2009), further jeopardize species and ecosystems. The IPCC has warned that 20 to 30% of plant and animal species will face an increased risk of extinction if global average temperature rise exceeds 1.5 to 2.5°C (relative to 1980-1999), with an increased risk of extinction for up to 70% of species worldwide if global average temperature rise exceeds 3.5°C relative to 1980-1999 (IPCC 2007). Thomas et al. (2004) projected that 15-37% of species will be committed to extinction by 2050 under a mid-level emissions scenario, which the world has been exceeding.

Hansen et al. (2008) presented evidence that the safe upper limit for atmospheric CO_2 needed to avoid "dangerous climate change" and "maintain the climate to which humanity, wildlife, and the rest of the biosphere are adapted" is at most 350 ppm. Hansen et al. (2008) found that our current CO_2 level has committed us to a dangerous warming commitment of ~2°C temperature rise still to come and is already resulting in dangerous changes: the rapid loss of Arctic sea-ice cover, 4° poleward latitudinal shift in subtropical regions leading to increased aridity in many regions of the earth; the near-global retreat of alpine glaciers affecting water supply during the summer; accelerating mass loss from the Greenland and west Antarctic ice sheets; and increasing stress to coral reefs from rising temperatures and ocean acidification. Hansen et al. (2008) concluded that the overall target of at most 350 ppm CO_2 must be pursued on a timescale of decades since paleoclimatic evidence and ongoing changes suggest that it would be dangerous to allow emissions to overshoot this target for an extended period of time:

> If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that. (Hansen et al. 2008:217).

In order to reach a 350 ppm CO_2 target or below, numerous studies indicate that global CO_2 emissions must peak before 2020 followed by rapid annual reductions bringing emissions to or very close to net zero by 2050. The IPCC found that to reach a 450 ppm CO_2eq target, the emissions of the United States and other developed countries should be reduced by 25 to 40% below 1990 levels by 2020 and by 80-95% below 1990 levels by 2050 (Gupta et al. 2007); thus reductions to reach a 350 ppm CO_2 target must be more stringent. Baer and Athanasiou (2009) outlined a trajectory to reach 350 ppm CO_2 target by 2100 that requires 2020 global emissions to reach 42% below 1990 levels, with emissions reaching zero in 2050. Negative emissions options make such a pathway more feasible. Baer and Athanasiou (2009) concluded that Annex I (developed country) emissions must be more than 50% below 1990 levels by 2020 and reach zero emissions in 2050 (Baer and Athanasiou 2009).

With atmospheric carbon dioxide at ~390 ppm and worldwide emissions continuing to increase by more than 2 ppm each year, rapid and substantial reductions are clearly needed immediately to protect the white-tailed ptarmigan and prevent dangerous levels of climate change.

United States Climate Initiatives are Ineffective

The United States is responsible for approximately 20% of worldwide annual carbon dioxide emissions (U.S. Energy Information Administration 2010, http://www.eia.gov), yet does not currently have adequate regulations to reduce greenhouse gas emissions. This was acknowledged by the Department of Interior in the final listing rule for the polar bear, which concluded that regulatory mechanisms in the United States are inadequate to effectively address climate change (73 Fed. Reg. 28287-28288). While existing laws including the Clean Air Act, Energy Policy and Conservation Act, Clean Water Act, Endangered Species Act, and others provide authority to executive branch agencies to require greenhouse gas emissions reductions from virtually all major sources in the U.S., these agencies are either failing to implement or only partially implementing these laws for greenhouse gases. For example, the EPA has recently issued a rulemaking regulating greenhouse gas emissions from automobiles (75 Fed. Reg. 25324, Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule), but has to date failed to implement the majority of other Clean Air Act programs, such as the new source review, the new source pollution standards, or the criteria air pollutant/national ambient air quality standards programs, to address the climate crisis (See, e.g. 75 Fed. Reg. 17004, Reconsideration of Interpretation of Regulations That Determine Pollutants Covered by Clean Air Act Permitting Programs). While full implementation of these flagship environmental laws, particularly the Clean Air Act, would provide an effective and comprehensive greenhouse gas reduction strategy, due to their non-implementation, existing regulatory mechanisms must be considered inadequate to protect the white-tailed ptarmigan from climate change.

International Climate Initiatives are Ineffective

The primary international regulatory mechanisms addressing greenhouse gas emissions are the United Nations Framework Convention on Climate Change and the Kyoto Protocol. As acknowledged by the Department of Interior in the final listing rule for the polar bear, these international initiatives are inadequate to effectively address climate change (73 Fed. Reg. 28287-28288). The Kyoto Protocol’s first commitment period only sets targets for action through 2012. Importantly, there is still no binding international agreement governing greenhouse gas emissions in the years beyond 2012. While the 2009 U.N. Climate Change Conference in Copenhagen called on countries to hold the increase in global temperature below 2°C (an inadequate target for avoiding dangerous climate change), the *non-binding* "Copenhagen Accord" that emerged from the conference failed to enact binding regulations that limit emissions to reach this goal. Even if countries did meet their pledges, analyses of the Accord found that collective national pledges to cut greenhouse gas emissions are inadequate to achieve the 2°C, and instead suggest emission scenarios leading to a 3 to 3.9°C warming (Pew 2010, Rogelj et al. 2010). Thus international regulatory mechanisms must be considered inadequate to protect the white-tailed ptarmigan from climate change.

2. Regulatory Mechanisms are Inadequate to Protect White-tailed Ptarmigan from Other Threats

In the United States, the National Environmental Policy Act (NEPA) requires Federal agencies, including the Forest Service, to consider the effects of their actions on the environment. It, however, does not prohibit them from choosing alternatives that will negatively affect individuals or populations of white-tailed ptarmigan.

The white-tailed ptarmigan is listed as a sensitive species by the Forest Service in Regions 2 and 3, requiring analysis of impacts to the ptarmigan under NEPA. Because NEPA does not require avoidance of harm, this affords it little protection. Indeed, as demonstrated by our FOIA request to the Rocky Mountain Region, the Forest Service has planned at least 41 projects in the last ten years that harmed ptarmigan.

Under the National Forest Management Act, the Forest Service is required to "maintain viable populations of existing native and desired nonnative vertebrate species in the planning area" (36 C.F.R. §219.19). As with NEPA, this requirement does not prohibit the Forest Service from carrying out actions that harm species or their habitat, stating only that "where appropriate, measures to mitigate adverse affects shall be prescribed" (36 C.F.R. §219.19(a)(1)).

The New Mexico Endangered Species list included the white-tailed ptarmigan as endangered in 1975 and in 2006, it was identified as a species of greatest conservation need in the Comprehensive Wildlife Conservation Strategy for New Mexico (NMNHP 1997, NMDGF 2006a). However, this confers no regulatory authority to the New Mexico Department of Game and Fish (NMDGF) over the habitat protection of this species (NMDGF 2006b).

Given the serious threat posed to the ptarmigan from climate change, it would be prudent to protect all existing habitat in order to give the species the best possible chance to find suitable habitat in a warmer world. None of the existing regulatory mechanisms provide substantial protection for the ptarmigan from projects resulting in habitat degradation, including livestock grazing, recreation, mining or others.

E. Other Natural and Anthropogenic Factors

1. Population Isolation and Limited Dispersal Distances

The white-tailed ptarmigan is particularly vulnerable to extinction because of the isolation of its populations, small population sizes, low densities, and limited dispersal distances (Martin and Forbes 2004, USFS 2005b). Throughout the contiguous United States, populations are separated from each other by long distances because of vast expanses of unsuitable habitat between alpine zones of different mountain ranges.

As discussed above, small population sizes and low densities require connectivity between populations in the same mountain range for demographic rescue to occur when stochastic population and environmental events take place (Martin et al. 2000). As alpine habitat becomes more fragmented due to the effects of global warming, distances between populations will increase.

The distance in which demographic exchange can occur is limited to 5-10 km for males and 20-30 km for females (Martin et al. 2000). The maximum recorded travel distances that has been recorded is 50 km (Braun et al. 1993). This limited dispersal distance in the face of threats to white-tailed ptarmigan habitat and populations will further compound negative impacts to the species in the contiguous United States.

V. Critical Habitat

The ESA mandates that, when the USFWS lists a species as endangered or threatened, the agency generally must also concurrently designate critical habitat for that species. Section 4(a)(3)(A)(i) of the ESA states that, "to the maximum extent prudent and determinable," the USFWS:

> shall, concurrently with making a determination . . . that a species is an endangered species or threatened species, designate any habitat of such species which is then considered to be critical habitat . . . .

16 U.S.C. § 1533(a)(3)(A)(i); *see also id.* at § 1533(b)(6)(C). The ESA defines the term "critical habitat" to mean:

i. the specific areas within the geographical area occupied by the species, at the time it is listed . . . , on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and

ii. specific areas outside the geographical area occupied by the species at the time it is listed . . . , upon a determination by the Secretary that such areas are essential for the conservation of the species.

Id. at § 1532(5)(A).

Petitioner expects that USFWS will comply with this unambiguous mandate and designate critical habitat concurrently with the listing of the white-tailed ptarmigan. We believe that all current mountaintops and alpine areas utilized by the species for nesting and foraging meet the criteria for designation as critical habitat and must therefore be designated as such.

Conclusion

For all the reasons discussed above, Petitioner Center for Biological Diversity requests that the U.S. Fish and Wildlife Service list the white-tailed ptarmigan as a threatened species because it is likely to become in danger of extinction in the foreseeable future in a significant portion of its range. Both the Contiguous United States DPS and the Rocky Mountain DPS qualify for listing as threatened due to the impending threat of global warming and its effects on alpine ecosystems as well as other factors that cause damage to white-tailed ptarmigan and their alpine habitat. No existing regulatory mechanisms are adequate to ensure the survival of the white-tailed ptarmigan in the contiguous United States. For this and other reasons, the white-tailed ptarmigan should be listed as threatened under the Endangered Species Act.

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