DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS-R6-ES-2009-0065]

[MO 92210-0-0008-B2]

Endangered and Threatened Wildlife and Plants; Revised 12-Month Finding to List the Upper Missouri River Distinct Population Segment of Arctic Grayling as Endangered or Threatened

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of revised 12–month finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service/USFWS), announce a revised 12–month finding on a petition to list the upper Missouri River Distinct Population Segment (Missouri River DPS) of Arctic grayling (*Thymallus arcticus*) as endangered or threatened under the Endangered Species Act of 1973, as amended. After review of all available scientific and commercial information, we find that listing the upper Missouri River DPS of Arctic grayling as endangered or threatened is warranted. However, listing the upper Missouri River DPS of Arctic grayling is currently precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Upon publication of this 12–month finding, we will add the upper Missouri River DPS of Arctic grayling to our candidate species list. We will develop a proposed rule to list this DPS as our priorities allow. We will make any determination on critical habitat during development of the proposed listing rule. In the interim, we will address the status of this DPS through our annual Candidate Notice of Review (CNOR).

DATES: The finding announced in this document was made on September 8, 2010.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number **FWS-R6-ES-2009-0065**. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Montana Field Office, 585 Shepard Way, Helena, MT 59601. Please submit any new information, materials, comments, or questions concerning this finding to the above street address (Attention: Arctic grayling).

FOR FURTHER INFORMATION CONTACT: Mark Wilson, Field Supervisor, Montana Field Office (see **ADDRESSES**); by telephone at 406-449-5225; or by facsimile at 406-449-5339. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800-877-8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Endangered Species Act of 1973, as amended (ESA) (16 U.S.C. 1531 *et seq.*), requires that, for any petition containing substantial scientific or commercial information indicating that listing the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In this finding, we determine that the petitioned action is: (a) Not warranted, (b) warranted, or (c) warranted, but immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are endangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the ESA requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12–month findings in the **Federal Register**.

Previous Federal Actions

We have published a number of documents on Arctic grayling and have been involved in litigation over previous findings. We describe our actions relevant to this notice below.

We initiated a status review for the Montana Arctic grayling (*Thymallus arcticus montanus*) in a **Federal Register** notice on December 30, 1982 (47 FR 58454). In that notice, we designated the purported subspecies, Montana Arctic grayling, as a Category 2 species. At that time, we designated a species as Category 2 if a listing as endangered or threatened was possibly appropriate, but we did not have sufficient data to support a proposed rule to list the species.

On October 9, 1991, the Biodiversity Legal Foundation and George Wuerthner petitioned us to list the fluvial (riverine populations) of Arctic grayling in the upper Missouri River basin as an endangered species throughout its historical range in the coterminous United States. We published a notice of a 90–day finding in the January 19, 1993, **Federal Register** (58 FR 4975), concluding the petitioners presented substantial information indicating that listing the fluvial Arctic grayling of the upper Missouri River in Montana and northwestern Wyoming may be warranted. This finding noted that taxonomic recognition of the Montana Arctic grayling (*Thymallus arcticus montanus*) as a subspecies (previously designated as a category 2 species) was not widely accepted, and that the scientific community generally considered this population a geographically isolated member of the wider species (*T. arcticus*).

On July 25, 1994, we published a notice of a 12–month finding in the **Federal Register** (59 FR 37738), concluding that listing the DPS of fluvial Arctic grayling in the upper Missouri River was warranted but precluded by other higher priority listing actions. This DPS determination predated our DPS policy (61 FR 4722, February 7, 1996), so the entity did not undergo a DPS analysis as described in the policy. The 1994 finding placed fluvial Arctic grayling of the upper Missouri River on the candidate list and assigned it a listing priority of 9. On May 4, 2004, we elevated the listing priority number of the fluvial Arctic grayling to 3 (69 FR 24881).

On May 31, 2003, the Center for Biological Diversity and Western Watersheds Project (Plaintiffs) filed a complaint in U.S. District Court in Washington, D.C., challenging our "warranted but precluded" determination for Montana fluvial Arctic grayling. On July 22, 2004, the Plaintiffs amended their complaint to challenge our failure to emergency list this population. We settled with the Plaintiffs in August 2005, and we agreed to submit a final determination on whether this population warranted listing as endangered or threatened to the **Federal Register** on or before April 16, 2007.

On April 24, 2007, we published a revised 12–month finding on the petition to list the upper Missouri River DPS of fluvial Arctic grayling (72 FR 20305) ("2007 finding"). In this finding, we determined that fluvial Arctic grayling of the upper Missouri River did not constitute a species, subspecies, or DPS under the ESA. Therefore, we found that the upper Missouri River population of fluvial Arctic grayling was not a listable entity under the ESA, and as a result, listing was not warranted. With that notice, we withdrew the fluvial Arctic grayling from the candidate list.

On November 15, 2007, the Center for Biological Diversity, Federation of Fly Fishers, Western Watersheds Project, George Wuerthner, and Pat Munday filed a complaint (CV-07-152, in the District Court of Montana) to challenge our 2007 finding. We settled this litigation on October 5, 2009. In the stipulated settlement, we agreed to: (a) Publish, on or before December 31, 2009, a notice in the **Federal Register** soliciting information on the status of the upper Missouri River Arctic grayling; and (b) submit, on or before August 30, 2010, a new 12–month finding for the upper Missouri River Arctic grayling to the **Federal Register**.

On October 28, 2009, we published a notice of intent to conduct a status review of Arctic grayling (*Thymallus arcticus*) in the upper Missouri River system (74 FR 55524). To ensure the status review was based on the best available scientific and commercial data, we requested information on the taxonomy, biology, ecology, genetics, and population status of the Arctic grayling of the upper Missouri River system; information relevant to consideration of the potential DPS status of Arctic grayling of the upper Missouri River system; threats to the species; and conservation actions being implemented to reduce those threats in the upper Missouri River system. The notice further specified that the status review may consider various DPS designations that include different life histories of Arctic grayling in the upper Missouri River system. Specifically, we may consider DPS configurations that include: Fluvial, adfluvial (lake populations), or all life histories of Arctic grayling in the upper Missouri River system.

This notice constitutes the revised 12–month finding ("2010 finding") on whether to list the upper Missouri River DPS of Arctic grayling (*Thymallus arcticus*) as endangered or threatened.

Taxonomy and Species Description

The Arctic grayling (*Thymallus arcticus*) belongs to the family Salmonidae (salmon, trout, charr, whitefishes), subfamily *Thymallinae* (graylings), and it is represented by a single genus, *Thymallus*. Scott and Crossman (1998, p. 301) recognize four species within the genus: *T. articus* (Arctic grayling), *T. thymallus* (European grayling), *T. brevirostris* (Mongolian grayling), and *T. nigrescens* (Lake Kosgol, Mongolia). Recent research focusing on Eurasian *Thymallus* (Koskinen *et al.* 2002, entire; Froufe *et al.* 2003, entire; Froufe *et al.* 2005, entire; Weiss *et al.* 2006, entire) indicates that the systematic diversity of the genus is greater than previously thought, or at least needs better description (Knizhin *et al.* 2008, pp. 725–726, 729; Knizhin and Weiss 2009, pp. 1, 7–8; Weiss *et al.* 2007, p. 384).

Arctic grayling have elongate, laterally compressed, trout-like bodies with deeply forked tails, and adults typically average 300-380 millimeters (mm) (12-15 inches (in.)) in length. Coloration can be striking, and varies from silvery or iridescent blue and lavender, to dark blue (Behnke 2002, pp. 327–328). The sides are marked with a varying number of V-shaped or diamond-shaped spots (Scott and Crossman 1998, p. 301). During the spawning period, the colors darken and the males become more brilliantly colored than the females. A prominent morphological feature of Arctic grayling is the sail-like dorsal fin, which is large and vividly colored with rows of orange to bright green spots, and often has an orange border (Behnke 2002, pp. 327–328).

Distribution

Arctic grayling are native to Arctic Ocean drainages of Alaska and northwestern Canada, as far east as Hudson's Bay, and westward across northern Eurasia to the Ural Mountains (Scott and Crossman 1998, pp. 301–302; Froufe *et al.* 2005, pp. 106–107; Weiss *et al.* 2006, pp. 511–512; see Figure 1 below). In North America, they are native to northern Pacific Ocean drainages as far south as the Stikine River in British Columbia (Nelson and Paetz 1991, pp. 253–256; Behnke 2002, pp. 327–331).

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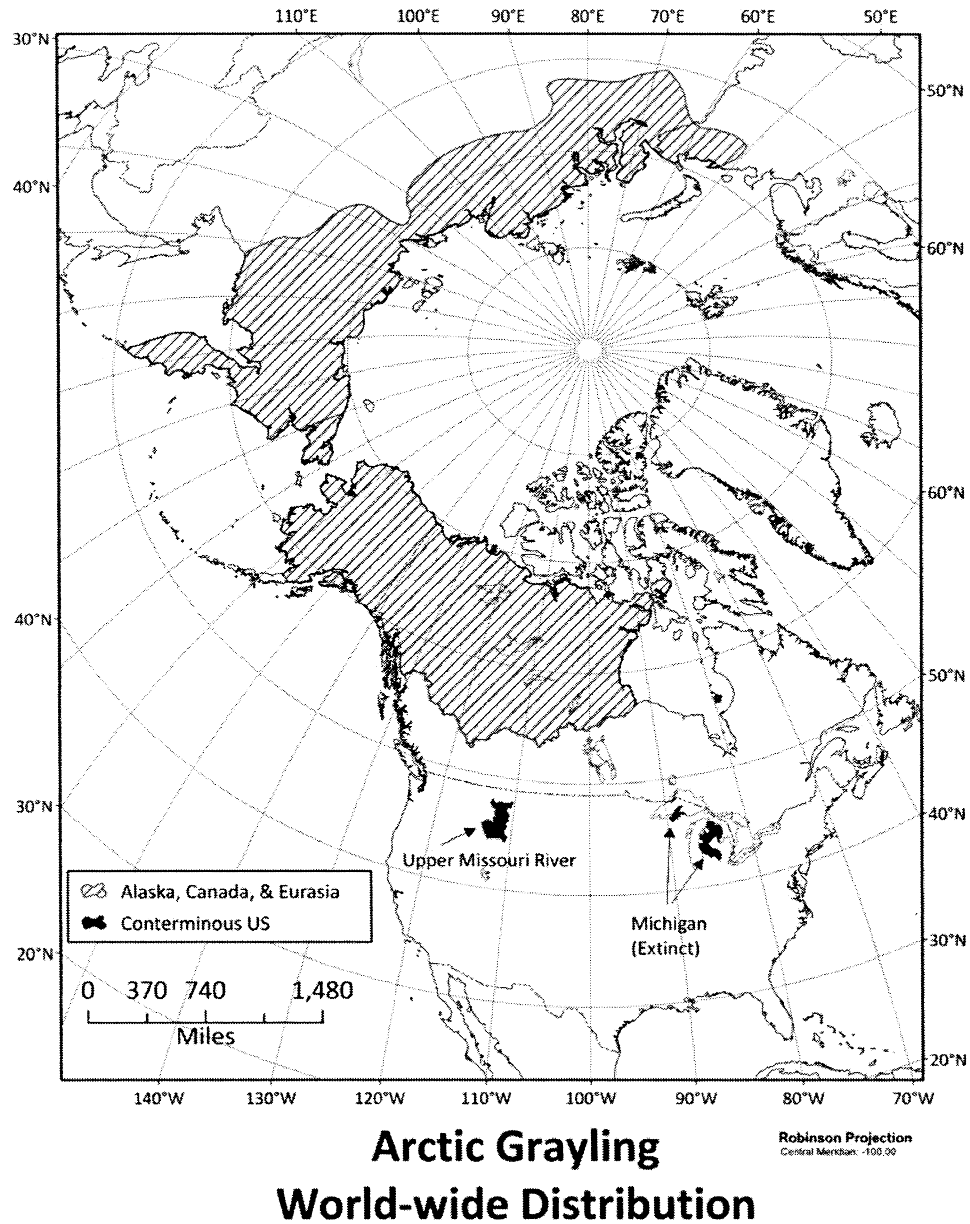


FIGURE 1. Approximate world-wide distribution of Arctic grayling (*Thymallus arcticus*) at the end of the most recent glacial cycle. The Missouri River distribution is based on Kaya (1992, pp. 47-51). The distribution of the extinct Michigan population is based on Vincent (1962, p. 12) and the University of Michigan (2010). The North American distribution in Canada and Alaska is based on Behnke (2002, p. 330) and Scott and Crossman (1998, pp. 301-302). The Eurasian distribution is based on Knizhin (2009, p. 32) and Knizhin (2010, pers. comm.).

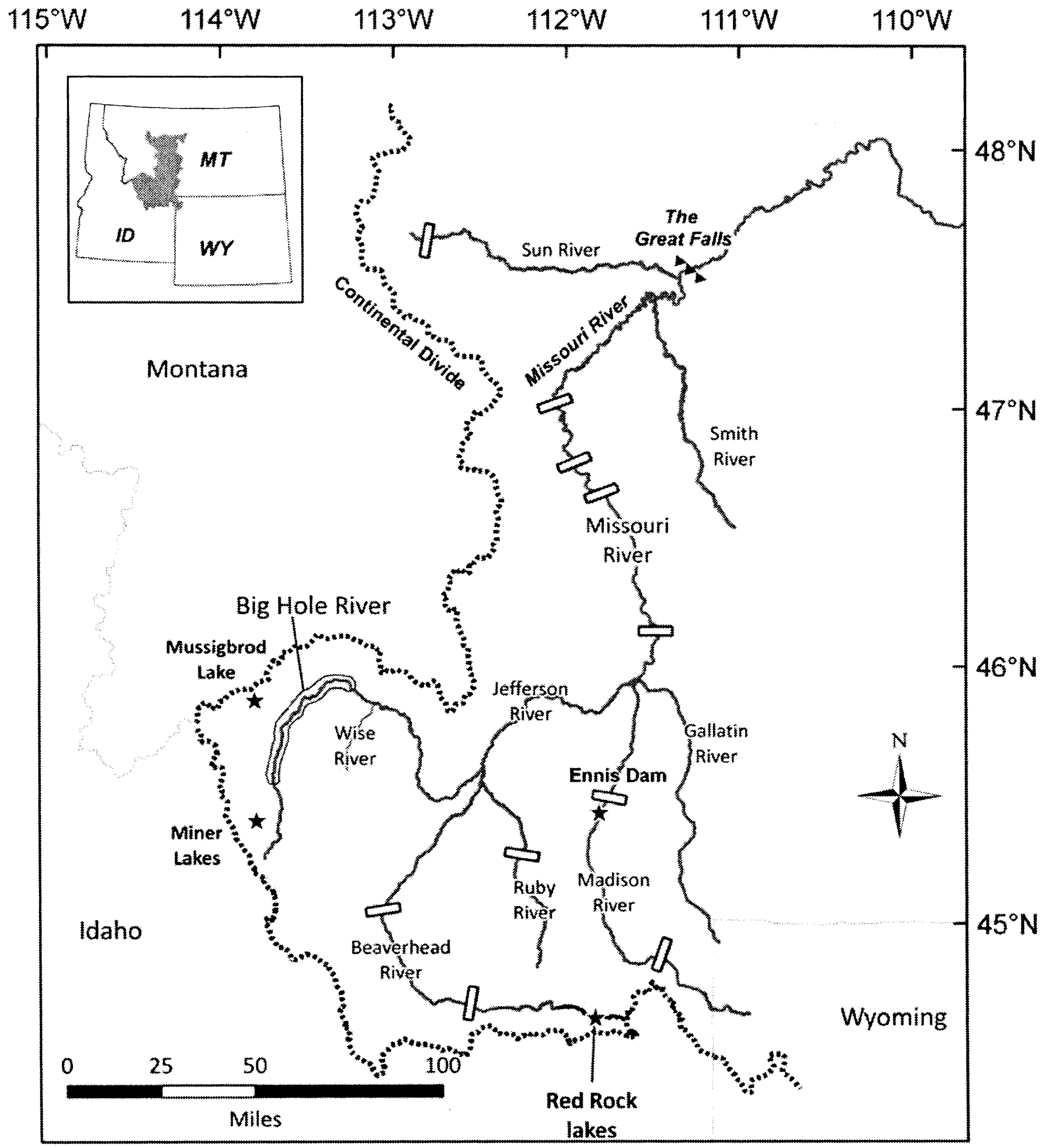
Arctic grayling remains widely distributed across its native range, but within North America, the species has experienced range decline or contraction at the southern limits of its distribution. In British Columbia, Canada, populations in the Williston River watershed are designated as a provincial "red list" species, meaning the population is a candidate for further evaluation to determine if it should be granted endangered (facing imminent extirpation or extinction) or threatened status (likely to become endangered) (British Columbia Conservation Data Centre 2010). In Alberta, Canada, Arctic grayling are native to the Athabasca, Peace, and Hay River drainages. In Alberta, the species has undergone a range contraction of about 40 percent, and half of the province's subpopulations have declined in abundance by more than 90 percent (Alberta Sustainable Resource Development (ASRD) 2005, p. iv).

Distribution in the Conterminous United States

Two disjunct groups of Arctic grayling were native to the conterminous United States: One in the upper Missouri River basin in Montana and Wyoming (extant in Montana, see Figure 2), and another in Michigan that was extirpated in the late 1930s (Hubbs and Lagler 1949, p. 44). Michigan grayling formerly occurred in the Otter River of the Lake Superior drainage in northern Michigan and in streams of the lower peninsula of Michigan in both the Lake Michigan and Lake Huron drainages including the Au Sable, Cheboygan, Jordan, Pigeon, and Rifle Rivers (Vincent 1962, p. 12).

Introduced Lake Dwelling Arctic Grayling in the Upper Missouri River

System and western U.S. populations of Arctic grayling have been established in lakes outside their native range in Arizona, Colorado, Idaho, Montana, New Mexico, Utah, Washington, and Wyoming (Vincent 1962, p. 15; Montana Fisheries Information System (MFISH) 2009; NatureServe 2010). Stocking of hatchery grayling in Montana has been particularly extensive, and there are thought to be up to 78 introduced lacustrine (lake-dwelling) populations resulting from these introductions (see Table 1 below). Over three-quarters of these introductions (79.5 percent) were established outside the native geographic range of upper Missouri River grayling, while only 16 (20.5 percent) were established within the watershed boundary of the upper Missouri River system.



Historical and current distribution of Arctic grayling in the Upper Missouri River basin

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FIGURE 2. Historical (dark grey lines) and current distribution (stars and circled portion of Big Hole River) of native Arctic grayling in the upper Missouri River basin. White bars denote mainstem river dams that are total barriers to upstream passage by fish.

TABLE 1. INTRODUCED LAKE-DWELLING POPULATIONS OF ARCTIC GRAYLING IN MONTANA. THE PRIMARY DATA SOURCE FOR THESE DESIGNATIONS IS MFISH (2009).

River Basin	Number of Introduced (Exotic) Populations[a]
Outside Native Geographic Range In Montana	
Columbia River	23
Middle Missouri River	2
Saskatchewan River	1
Yellowstone River	36[b]
Within Watershed Boundary Of Native Geographic Range In Montana	
Upper Missouri River	16
Total Exotic Populations	78

[a]List of populations does not include lake populations derived from attempts to re-establish fluvial populations in Montana, native adfluvial populations, or genetic reserves of Big Hole River grayling.

[b]Many of these populations may not reproduce naturally and are only sustained through repeated stocking (Montana Fish, Wildlife and Parks 2009, entire).

For the purposes of this finding, we are analyzing a petitioned entity that includes, at its maximum extent, populations of Arctic grayling considered native to the upper Missouri River. Introduced populations present in Montana (e.g., Table 1) or elsewhere are not considered as part of the listable entity because we do not consider them to be native populations. Neither the Act nor our implementing regulations expressly address whether introduced populations should be considered part of an entity being evaluated for listing, and no Service policy addresses the issue. Consequently, in our evaluation of whether or not to include introduced populations in the potential listable entity we considered the following: (1) Our interpretation of the intent of the Act with respect to the disposition of native populations, (2) a policy used by the National Marine Fishery Service (NMFS) to evaluate whether hatchery-origin populations warrant inclusion in the listable entity, and (3) a set of guidelines from another organization (International Union for Conservation of Nature and Natural Resources (IUCN)) with specific criteria for evaluating the conservation contribution of introduced populations.

Intent of the Endangered Species Act

The primary purpose of the Act is to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved. The Service has interpreted the Act to provide a statutory directive to conserve species in their native ecosystems (49 FR 33890, August 27, 1984) and to conserve genetic resources and biodiversity over a representative portion of a taxon's historical occurrence (61 FR 4723, February 7, 1996). This priority on natural populations is evident in the Service's DPS policy within the third significance criteria. In that, a discrete population segment may be significant if it represents the only surviving natural occurrence of the taxon that may be more abundant elsewhere as an introduced population outside of its historical range.

National Marine Fishery Service Hatchery Policy

In 2005, the NMFS published a final policy on the consideration of hatchery-origin fish in Endangered Species Act listing determinations for Pacific salmon and steelhead (anadromous *Oncorhynchus* spp.) (NMFS 2005, entire). A central tenet of this policy is the primacy of the conservation of naturally spawning salmon populations and the ecosystems on which they depend, consistent with the intent of the Act (NMFS 2005, pp. 37211, 37214). The policy recognizes that properly managed hatchery programs may provide some conservation benefit to the evolutionary significant unit (ESU, which is analogous to a DPS but applied to Pacific salmon) (NMFS 2005, p. 37211), and that hatchery stocks that contribute to survival and recovery of an ESU are considered during a listing decision (NMFS 2005, p. 37209). The policy states that since hatchery stocks are established and maintained with the intent of furthering the viability of wild populations in the ESU, that those hatchery populations have an explicit conservation value. Genetic divergence is the preferred metric to determine if hatchery fish should be included in the ESU, but NMFS recognizes that these data may be lacking in most cases (NMFS 2005, p. 37209). Thus, proxies for genetic divergence can be used, such as the length of time a stock has been isolated from its source population, the degree to which natural broodstock has been regularly incorporated into the hatchery population, the history of non-ESU fish or eggs in the hatchery population, and the attention given to genetic considerations in selecting and mating broodstocks (NMFS 2005, p. 37209).

The NMFS policy applies to artificially propagated (hatchery) populations. In this finding, however, the Service is deciding whether self-sustaining populations introduced outside its natural range should be included in the listable entity. Thus, the NMFS policy is not directly applicable. Nonetheless, if the NFMS policy's criteria are applied to the introduced lake-dwelling populations of Arctic grayling in Montana and elsewhere, these populations do not appear to warrant inclusion in the entity being evaluated for listing. First, there does not appear to be any formally recognized conservation value for the introduced populations of Arctic grayling, and they are not being used in restoration programs. Recent genetic analysis indicates that many of the introduced Arctic grayling populations in Montana are derived, in part, from stocks in the Red Rock Lakes system (Peterson and Ardren 2009, p. 1767). Nonetheless, there have been concerns that introduced, lake-dwelling populations could pose genetic risks to the native fluvial population (Arctic Grayling Workgroup (AGW) 1995, p. 15), and in practice, these introduced populations have not been used for any conservation purpose. In fact, efforts are currently underway to establish a genetically pure brood reserve population of Red Rock Lakes grayling to be used for conservation purposes (Jordan 2010, pers. comm.), analogous to the brood reserves maintained for Arctic grayling from the Big Hole River (Rens and Magee 2007, pp. 22–24).

Second, introduced populations in lakes have apparently been isolated from their original source stock for decades without any supplementation from the wild. These populations were apparently established without any formal genetic consideration to selecting and mating broodstock, the source populations were not well documented (Peterson and Ardren 2009, p. 1767), and the primary intent of culturing and introducing these grayling appears to have been to provide recreational fishing opportunities in high mountain lakes.

Guidelines Used in Other Evaluation Systems

The IUCN uses its Red List system to evaluate the conservation status and relative risk of extinction for species, and to catalogue and highlight plant and animal species that are facing a higher risk of global extinction (*http://www.iucnredlist.org*). IUCN does not use the term "listable entity" as the Service does; however, IUCN does clarify that their conservation ranking criteria apply to any taxonomic group at the species level or below (IUCN 2001, p.4). Further, the IUCN guidelines for species status and scope of the categorization process focus on wild populations inside their natural range (IUCN 2001, p. 4; 2003, p. 10) or so-called "benign" or "conservation introductions," which are defined as attempts to establish a species, for the purpose of conservation, outside its recorded distribution, when suitable habitat is lacking within the historical range (IUCN 1998, p. 6; 2003, pp. 6, 10). Guidelines for evaluating conservation status under the IUCN exclude introduced populations located outside the recorded distribution of the species if such populations were established for commercial or sporting purposes (IUCN 1998, p. 5; 2003, p. 24). In effect, the IUCN delineates between introduced and native populations in that non-benign introductions do not qualify for evaluation under the IUCN Red List system. Naturalized populations of Arctic grayling in lakes thus do not meet the IUCN criterion for a wild population that should be considered when evaluating the species status for two reasons. First, there remains 'suitable habitat' for Arctic grayling in its native range, as evidenced by extant native populations in the Big Hole River, Madison River, Miner Lake, Mussigbrod Lake, and Red Rock Lakes. Second, the naturalized populations derived from widespread stocking were apparently aimed at establishing recreational fisheries.

Our interpretation is that the ESA is intended to preserve native populations in their ecosystems. While hatchery or introduced populations of fishes may have some conservation value, this does not appear to be the case with introduced populations of Arctic grayling in the conterminous United States. These populations were apparently established to support recreational fisheries, and without any formal genetic consideration to selecting and mating broodstock, and are not part of any conservation program to benefit the native populations. Consequently, we do not consider the introduced populations of Arctic grayling in Montana and elsewhere in the conterminous United States, including those in lakes and in an irrigation canal (Sun River Slope Canal), to be part of the listable entity.

Native Distribution in the Upper Missouri River System

The first Euro-American "discovery" of Arctic grayling in North America is attributed to members of the Lewis and Clark Expedition, who encountered the species in the Beaverhead River in August 1805 (Nell and Taylor 1996, p. 133). Vincent (1962, p. 11) and Kaya (1992, pp. 47–51) synthesized accounts of Arctic grayling occurrence and abundance from historical surveys and contemporary monitoring to determine the historical distribution of the species in the upper Missouri River system (Figure 2). We base our conclusions on the historical distribution of Arctic grayling in the upper Missouri River basin on these two reviews. Arctic grayling were widely but irregularly distributed in the upper Missouri River system above the Great Falls in Montana and in northwest Wyoming within the present-day location of Yellowstone National Park (Vincent 1962, p. 11). They were estimated to inhabit up to 2,000 kilometers (km) (1,250 miles (mi)) of stream habitat until the early 20th century (Kaya 1992, pp. 47–51). Arctic grayling were reported in the mainstem Missouri River, as well as in the Smith, Sun, Jefferson, Madison, Gallatin, Big Hole, Beaverhead, and Red Rock Rivers (Vincent 1962, p. 11; Kaya 1992, pp. 47–51; USFWS 2007; 72 FR 20307, April 24, 2007). "Old-timer" accounts report that the species may have been present in the Ruby River, at least seasonally (Magee 2005, pers. comm.), and were observed as recently as the early 1970s (Holton, undated).

Fluvial Arctic grayling were historically widely distributed in the upper Missouri River basin, but a few adfluvial populations also were native to the basin. For example, Arctic grayling are native to Red Rock Lakes, in the headwaters of the Beaverhead River (Vincent 1962, pp. 112–121; Kaya 1992, p. 47). Vincent (1962, p. 120) stated that Red Rock Lakes were the only natural lakes in the upper Missouri River basin accessible to colonization by Arctic grayling, and concluded that grayling there were the only native adfluvial population in the basin. However, it appears that Arctic grayling also were native to Elk Lake (in the Red Rocks drainage; Kaya 1990, p. 44) and a few small lakes in the upper Big Hole River drainage (Peterson and Ardren 2009, p. 1768).

The distribution of native Arctic grayling in the upper Missouri River went through a dramatic reduction in the first 50 years of the 20th century, especially in riverine habitats (Vincent 1962, pp. 86–90, 97–122, 127–129; Kaya 1992, pp. 47–53). The native populations that formerly resided in the Smith, Sun, Jefferson, Beaverhead, Gallatin, and mainstem Missouri Rivers are considered extirpated, and the only remaining indigenous fluvial population is found in the Big Hole River and some if its tributaries (Kaya 1992, pp. 51–53). The fluvial form currently occupies only 4 to 5 percent of its historic range in the Missouri River system (Kaya 1992, p. 51). Other remaining native populations in the upper Missouri River occur in two small, headwater lakes in the upper Big Hole River system (Miner and Mussigbrod Lakes); the Madison River upstream from Ennis Reservoir; and the Red Rock Lakes in the headwaters of the Beaverhead River system (Everett 1986, p. 7; Kaya 1992, p. 53; Peterson and Ardren 2009, pp. 1762, 1768; Figure 1 above, and Table 2 below).

TABLE 2. EXTANT NATIVE ARCTIC GRAYLING POPULATIONS IN THE UPPER MISSOURI RIVER BASIN.

Big Hole River Drainage[a]
1. Big Hole River
2. Miner Lake
3. Mussigbrod Lake
Madison River Drainage
4. Madison River-Ennis Reservoir
Beaverhead River Drainage
5. Red Rock Lakes

[a]Arctic grayling also occur in Pintler Lake in the Big Hole River drainage, but this population has not been evaluated with genetic markers to determine whether it constitutes a native remnant population.

Origins, Biogeography, and Genetics of Arctic Grayling in North America

North American Arctic grayling are most likely descended from Eurasian *Thymallus* that crossed the Bering land bridge during or before the Pleistocene glacial period (Stamford and Taylor 2004, pp. 1533, 1546). A Eurasian origin is suggested by the substantial taxonomic diversity found in the genus in that region. There were multiple opportunities for freshwater faunal exchange between North America and Asia during the Pleistocene, but genetic divergence between North American and Eurasian Arctic grayling suggests that the species could have colonized North America as early as the mid-late Pliocene (more than 3 million years ago) (Stamford and Taylor 2004, p. 1546).

The North American distribution of Arctic grayling was strongly influenced by patterns of glaciation. Genetic studies of grayling using mitochondrial DNA (mtDNA, maternally-inherited DNA located in cellular organelles called mitochondria) and microsatellite DNA (repeating sequences of nuclear DNA) have shown that North American Arctic grayling consist of at least three major lineages that originated in distinct Pleistocene glacial refugia (Stamford and Taylor 2004, p. 1533). These three groups include a South Beringia lineage found in western Alaska to northern British Columbia, Canada; a North Beringia lineage found on the North Slope of Alaska, the lower Mackenzie River, and to eastern Saskatchewan; and a Nahanni lineage found in the lower Liard River and the upper Mackenzie River drainage (Stamford and Taylor 2004, pp. 1533, 1540). The Nahanni lineage is the most genetically distinct group (Stamford and Taylor 2004, pp. 1541–1543). Arctic grayling from the upper Missouri River basin were tentatively placed in the North Beringia lineage because a small sample (three individuals) of Montana grayling shared a mtDNA haplotype (form of the mtDNA) with populations in Saskatchewan and the lower Peace River, British Columbia (Stamford and Taylor 2004, p. 1538).

The existing mtDNA data suggest that Missouri River Arctic grayling share a common ancestry with the North Beringia lineage, but other genetic markers and biogeographic history indicate that Missouri River grayling have been physically and reproductively isolated from northern populations for millennia. The most recent ancestors of Missouri River Arctic grayling likely spent the last glacial cycle in an ice-free refuge south of the Laurentide and Cordilleran ice sheets. Pre-glacial colonization of the Missouri River basin by Arctic grayling was possible because the river flowed to the north and drained into the Arctic-Hudson Bay prior to the last glacial cycle (Cross *et al.* 1986, pp. 374–375; Pielou 1991, pp. 194–195). Low mtDNA diversity observed in a small number of Montana grayling samples and a shared ancestry with Arctic grayling from the north Beringia lineage suggest a more recent, post-glacial colonization of the upper Missouri River basin. In contrast, microsatellite DNA show substantial divergence between Montana and Saskatchewan (i.e., same putative mtDNA lineage) (Peterson and Ardren 2009, entire). Differences in the frequency and size distribution of microsatellite alleles between Montana populations and two Saskatchewan populations indicate that Montana grayling have been isolated long enough for mutations (i.e., evolution) to be responsible for the observed genetic differences.

Additional comparison of 21 Arctic grayling populations from Alaska, Canada, and the Missouri River basin using 9 of the same microsatellite loci as Peterson and Ardren (2009, entire) further supports the distinction of Missouri River Arctic grayling relative to populations elsewhere in North America (USFWS, unpublished data). Analyses of these data using two different methods clearly separates sample fish from 21 populations into two clusters: one cluster representing populations from the upper Missouri River basin, and another cluster representing populations from Canada and Alaska (USFWS, unpublished data). These new data, although not yet peer reviewed, support the interpretation that the previous analyses of Stamford and Taylor (2004, entire) underestimated the distinctiveness of Missouri River Arctic grayling relative to other sample populations, likely because of the combined effect of small sample sizes and the lack of variation observed in the Missouri River for the markers used in that study (Stamford and Taylor 2004, pp. 1537–1538). Thus, these recent microsatellite DNA data suggest that Arctic grayling may have colonized the Missouri River before the onset of Wisconsin glaciation (more than 80,000 years ago).

Genetic relationships among native and introduced populations of Arctic grayling in Montana have recently been investigated (Peterson and Ardren 2009, entire). Introduced, lake-dwelling populations of Arctic grayling trace much of their original ancestry to Red Rock Lakes (Peterson and Ardren 2009, p. 1767), and stocking of hatchery grayling did not appear to have a large effect on the genetic composition of the extant native populations (Peterson and Ardren 2009, p. 1768). Differences between native populations of the two grayling ecotypes (adfluvial, fluvial) do not appear to be as large as differences resulting from geography (i.e., drainage of origin).

Habitat

Arctic grayling generally require clear, cold water. Selong *et al.* (2001, p. 1032) characterized Arctic grayling as belonging to a "coldwater" group of salmonids, which also includes bull trout (*Salvelinus confluentus*) and Arctic char (*Salvelinus alpinus*). Hubert *et al.* (1985, p. 24) developed a habitat suitability index study for Arctic grayling and concluded that thermal habitat was optimal between 7 to 17 °C (45 to 63 °F), but became unsuitable above 20°C (68°F). Arctic grayling fry may be more tolerant of high water temperature than adults (LaPerriere and Carlson 1973, p. 30; Feldmeth and Eriksen 1978, p. 2041).

Having a broad, nearly-circumpolar distribution, Arctic grayling occupy a variety of habitats including small streams, large rivers, lakes, and even bogs (Northcote 1995, pp. 152–153; Scott and Crossman 1998, p. 303). They may even enter brackish water (less than or equal to 4 parts per thousand) when migrating between adjacent river systems (West *et al.* 1992, pp. 713–714). Native populations are found at elevations ranging from near sea level, such as in Bristol Bay, Alaska, to high-elevation montane valleys (more than 1,830 meters (m) or 6,000 feet (ft)), such as the Big Hole River and Centennial Valley in southwestern Montana. Despite this broad distribution, Arctic grayling have specific habitat requirements that can constrain their local distributions, especially water temperature and channel gradient. At the local scale, Arctic grayling prefer cold water and are often associated with spring-fed habitats in regions with warmer climates (Vincent 1962, p. 33). Arctic grayling are generally not found in swift, high-gradient streams, and Vincent (1962, p. 36–37, 41–43) characterized typical Arctic grayling habitat in Montana (and Michigan) as low-to-moderate gradient (less than 4 percent) streams and rivers with low-to-moderate water velocities (less than 60 centimeters/sec). Juvenile and adult Arctic grayling in streams and rivers spend much of their time in pool habitat (Kaya 1990 and references therein, p. 20; Lamothe and Magee 2003, pp. 13–14).

Breeding

Arctic grayling typically spawn in the spring or early summer, depending on latitude and elevation (Northcote 1995, p. 149). In Montana, Arctic grayling generally spawn from late April to mid-May by depositing adhesive eggs over gravel substrate without excavating a nest (Kaya 1990, p. 13; Northcote 1995, p. 151). In general, the reproductive ecology of Arctic grayling differs from other salmonid species (trout and salmon) in that Arctic grayling eggs tend to be comparatively small; thus, they have higher relative fecundity (females have more eggs per unit body size). Males establish and defend spawning territories rather than defending access to females (Northcote 1995, pp. 146, 150–151). The time required for development of eggs from embryo until they emerge from stream gravel and become swim-up fry depends on water temperature (Northcote 1995, p. 151). In the upper Missouri River basin, development from embryo to fry averages about 3 weeks (Kaya 1990, pp. 16–17). Small, weakly swimming fry (typically 1–1.5 centimeters (cm) (0.4–0.6 in.) at emergence) prefer low-velocity stream habitats (Armstrong 1986, p. 6; Kaya 1990, pp. 23–24; Northcote 1995, p. 151).

Arctic grayling of all ages feed primarily on aquatic and terrestrial invertebrates captured on or near the water surface, but also will feed opportunistically on fish and fish eggs (Northcote 1995, pp. 153–154; Behnke 2002, p. 328). Feeding locations for individual fish are typically established and maintained through size-mediated dominance hierarchies where larger individuals defend favorable feeding positions (Hughes 1992, p. 1996).

Life History Diversity

Migratory behavior is a common life-history trait in salmonid fishes such as Arctic grayling (Armstrong 1986, pp. 7–8; Northcote 1995, pp. 156–158; 1997, pp. 1029, 1031–1032, 1034). In general, migratory behavior in Arctic grayling and other salmonids results in cyclic patterns of movement between refuge, rearing-feeding, and spawning habitats (Northcote 1997, p. 1029).

Arctic grayling may move to refuge habitat as part of a regular seasonal migration (e.g., in winter), or in response to episodic environmental stressors (e.g., high summer water temperatures). In Alaska, Arctic grayling in rivers typically migrate downstream in the fall, moving into larger streams or mainstem rivers that do not completely freeze (Armstrong 1986, p. 7). In Arctic rivers, fish often seek overwintering habitat influenced by groundwater (Armstrong 1986, p. 7). In some drainages, individual fish may migrate considerable distances (greater than 150 km or 90 mi) to overwintering habitats (Armstrong 1986, p. 7). In the Big Hole River, Montana, similar downstream and long-distance movement to overwintering habitat has been observed in Arctic grayling (Shepard and Oswald 1989, pp. 18–21, 27). In addition, Arctic grayling in the Big Hole River may move downstream in proximity to colder tributary streams in summer when thermal conditions in the mainstem river become stressful (Lamothe and Magee 2003, p. 17).

In spring, mature Arctic grayling leave overwintering areas and migrate to suitable spawning sites. In river systems, this typically involves an upstream migration to tributary streams or shallow riffles within the mainstem (Armstrong 1986, p. 8). Arctic grayling in lakes typically migrate to either the inlet or outlet to spawn (Armstrong 1986, p. 8; Northcote 1997, p. 148). In either situation, Arctic grayling typically exhibit natal homing, whereby individuals spawn in or near the location where they were born (Northcote 1997, pp. 157–160).

Fry from river populations typically seek feeding and rearing habitats in the vicinity where they were spawned (Armstrong 1986, pp. 6–7; Northcote 1995, p. 156), while those from lake populations migrate downstream (inlet spawners) or upstream (outlet spawners) to the adjacent lake. Following spawning, adults move to appropriate feeding areas if they are not adjacent to spawning habitat (Armstrong 1986, pp. 7–8). Juvenile Arctic grayling may undertake seasonal migrations between feeding and overwintering habitats until they reach maturity and add the spawning migration to this cycle (Northcote 1995, pp. 156–157).

Life History Diversity in Arctic Grayling in the Upper Missouri River

Two general life-history forms or ecotypes of native Arctic grayling occur in the upper Missouri River Arctic: Fluvial and adfluvial. Fluvial fish use river or stream (lotic) habitat for all of their life cycles and may undergo extensive migrations within river habitat. Adfluvial fish live in lakes and migrate to tributary streams to spawn. These same life-history forms also are expressed by Arctic grayling elsewhere in North America (Northcote 1997, p. 1030). Historically, the fluvial life-history form predominated in the Missouri River basin above the Great Falls, perhaps because there were only a few lakes accessible to natural colonization of Arctic grayling that would permit expression of the adfluvial ecotype (Kaya 1992, p. 47). The fluvial and adfluvial life-history forms of Arctic grayling in the upper Missouri River do not appear to represent distinct evolutionary lineages. Instead, they appear to represent an example of adaptive radiation (Schluter 2000, p. 1), whereby the forms differentiated from a common ancestor developed traits that allowed them to exploit different habitats. The primary evidence for this conclusion is genetic data that indicate that within the Missouri River basin the two ecotypes are more closely related to each other than they are to the same ecotype elsewhere in North America (Redenbach and Taylor 1999, pp. 27–28; Stamford and Taylor 2004, p. 1538; Peterson and Ardren 2009, p. 1766). Historically, there may have been some genetic exchange between the two life-history forms as individuals strayed or dispersed into different populations (Peterson and Ardren 2009, p. 1770), but the genetic structure of current populations in the upper Missouri River basin is consistent with reproductive isolation.

The fluvial and adfluvial forms of Arctic grayling appear to differ in their genetic characteristics, but there appears to be some plasticity in behavior where individuals from a population can exhibit a range of behaviors. Arctic grayling fry in Montana can exhibit heritable, genetically-based differences in swimming behavior between fluvial and adfluvial ecotypes (Kaya 1991, pp. 53, 56–58; Kaya and Jeanes 1995, pp. 454, 456). Progeny of Arctic grayling from the fluvial ecotype exhibited a greater tendency to hold their position in flowing water relative to progeny from adfluvial ecotypes (Kaya 1991, pp. 53, 56–58; Kaya and Jeanes 1995, pp. 454, 456). Similarly, young grayling from inlet and outlet spawning adfluvial ecotypes exhibited an innate tendency to move downstream and upstream, respectively (Kaya 1989, pp. 478–480). All three studies (Kaya 1989, entire; 1991, entire; Kaya and Jeanes 1995, entire) demonstrate that the response of fry to flowing water depended strongly on the life-history form (ecotype) of the source population, and that this behavior has a genetic basis. However, behavioral responses also were mediated by environmental conditions (light—Kaya 1991, pp. 56–57; light and water temperature—Kaya 1989, pp. 477–479), and some progeny of each ecotype exhibited behavior characteristic of the other; for example some individuals from the fluvial ecotype moved downstream rather than holding position, and some individuals from an inlet-spawning adfluvial ecotype held position or moved upstream (Kaya 1991, p. 58). These observations indicate that some plasticity for behavior exists, at least for very young Arctic grayling.

However, the ability of one ecotype of Arctic grayling to give rise to a functional population of the other ecotype within a few decades is much less certain, and may parallel the differences in plasticity that have evolved between river- and lake-type European grayling (Salonen 2005, entire). Circumstantial support for reduced plasticity in adfluvial Arctic grayling comes from observations that adfluvial fish stocked in river habitats almost never establish populations (Kaya 1990, pp. 31–34). In contrast, a population of Arctic grayling in the Madison River that would have presumably expressed a fluvial ecotype under historical conditions has apparently adapted to an adfluvial life-history after construction of an impassible dam, which impounded Ennis Reservoir (Kaya 1992, p. 53; Jeanes 1996, pp. 54). We note that adfluvial Arctic grayling retain some life-history flexibility—at least in lake environments—as naturalized populations derived from inlet-spawning stocks have established outlet-spawning demes (a deme is a local populations that shares a distinct gene pool) in Montana and in Yellowstone National Park (Kruse 1959, p. 318; Kaya 1989, p. 480). While in some cases Arctic grayling may be able to adapt or adjust rapidly to a new environment, the frequent failure of introductions of Arctic grayling suggest a cautionary approach to the loss of particular life-history forms is warranted. Healey and Prince (1995, entire) reviewed patterns of genotypic and phenotypic variation in Pacific salmon and warn that recovery of lost life-history forms may not follow directly from conservation of the genotype (p. 181), and reason that the critical conservation unit is the population within its habitat (p. 181).

Age and Growth

Age at maturity and longevity in Arctic grayling varies regionally and is probably related to growth rate, with populations in colder, northern latitudes maturing at later ages and having a greater lifespan (Kruse 1959, pp. 340–341; Northcote 1995 and references therein, pp. 155–157). Arctic grayling in the upper Missouri River typically mature at age 2 (males) or age 3 (females), and individuals greater than age 6 are rare (Kaya 1990, p. 18; Magee and Lamothe 2003, pp. 16–17). Similarly, Nelson (1954, pp. 333–334) observed that the majority of the Arctic grayling spawning in two tributaries in the Red Rock Lakes system, Montana, were age 3, and the oldest individuals aged from a larger sample were age 6. Mogen (1996, pp. 32–34) found that Arctic grayling spawning in Red Rock Creek were mostly ages 2 to 5, but he did encounter some individuals age 7.

Generally, growth rates of Arctic grayling are greatest during the first years of life then slow dramatically after maturity. Within that general pattern, there is substantial variation among populations from different regions. Arctic grayling populations in Montana (Big Hole River and Red Rock Lakes) appear to have very high growth rates relative to those from British Columbia, Asia, and the interior and North Slope of Alaska (Carl *et al.* 1992, p. 240; Northcote 1995, pp. 155–157; Neyme 2005, p. 28). Growth rates of Arctic grayling from different management areas in Alberta are nearly as high as those observed in Montana grayling (ASRD 2005, p. 4).

Distinct Population Segment

In its stipulated settlement with Plaintiffs, the Service agreed to consider the appropriateness of DPS designations for Arctic grayling populations in the upper Missouri River basin that included: (a) All life ecotypes or histories, (b) the fluvial ecotype, and (c) the adfluvial ecotype. The fluvial ecotype has been the primary focus of past Service action and litigation, but the Service also has alluded to the possibility of alternative DPS designations in previous candidate species assessments (USFWS 2005, p. 11). Since the 2007 finding (72 FR 20305), additional research has been conducted and new information on the genetics of Arctic grayling is available. This finding contains a more comprehensive and robust distinct population segment analysis than the 2007 finding.

Distinct Population Segment Analysis for Native Arctic Graying in the Upper Missouri River

Discreteness

The discreteness standard under the Service's and National Oceanic and Atmospheric Administration's (NOAA) joint Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act (61 FR 4722) requires an entity to be adequately defined and described in some way that distinguishes it from other representatives of its species. A segment is discrete if it is: (1) Markedly separated from other populations of the same taxon as consequence of physical, physiological, ecological, or behavioral factors (quantitative measures of genetic or morphological discontinuity may provide evidence of this separation); or (2) 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 ESA.

Arctic grayling native to the upper Missouri River are isolated from populations of the species inhabiting the Arctic Ocean, Hudson Bay, and north Pacific Ocean drainages in Asia and North America (see Figure 1). Arctic grayling native to the upper Missouri River occur as a disjunct group of populations approximately 800 km (500 mi) to the south of the next-nearest Arctic grayling population in central Alberta, Canada. Missouri River Arctic grayling have been isolated from other populations for at least 10,000 years based on historical reconstruction of river flows at or near the end of the Pleistocene (Cross *et al.* 1986, p. 375; Pileou 1991, pp. 10–11;). Genetic data confirm Arctic grayling in the Missouri River basin have been reproductively isolated from populations to the north for millennia (Everett 1986, pp. 79–80; Redenbach and Taylor 1999, p. 23; Stamford and Taylor 2004, p. 1538; Peterson and Ardren 2009, pp. 1764–1766; USFWS, unpublished data). Consequently, we conclude that Arctic grayling native to the upper Missouri River are markedly separated from other native populations of the taxon as a result of physical factors (isolation), and therefore meet the first criterion of discreteness under the DPS policy. As a result, Arctic grayling native to the upper Missouri River are considered a discrete population according to the DPS policy. Because the entity meets the first criterion (markedly separated), an evaluation with respect to the second criterion (international boundaries) is not needed.

Significance

If we determine that a population meets the DPS discreteness element, we then consider whether it also meets the DPS significance element. The DPS policy states that, if a population segment is considered discrete under one or more of the discreteness criteria, its biological and ecological significance will be considered in light of congressional guidance that the authority to list DPSs be used "sparingly" while encouraging the conservation of genetic diversity (see U.S. Congress 1979, Senate Report 151, 96th Congress, 1st Session). In making this determination, we consider available scientific evidence of the discrete population's importance to the taxon to which it belongs. Since precise circumstances are likely to vary considerably from case to case, the DPS policy does not describe all the classes of information that might be used in determining the biological and ecological importance of a discrete population. However, the DPS policy does provide four possible reasons why a discrete population may be significant. As specified in the DPS policy, this consideration of significance may include, but is not limited to, the following: (1) Persistence of the discrete population segment in a unique or unusual ecological setting; (2) evidence that loss of the discrete segment would result in a significant gap in the range of the taxon; (3) evidence that the discrete population segment represents the only surviving natural occurrence of the taxon that may be more abundant elsewhere as an introduced population outside of its historic range; or (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

Unique Ecological Setting

Water temperature is a key factor influencing the ecology and physiology of ectothermic (body temperature regulated by ambient environmental conditions) salmonid fishes, and can dictate reproductive timing, growth and development, and life-history strategies. Groundwater temperatures can be related to air temperatures (Meisner 1990, p. 282), and thus reflect the regional climatic conditions. Warmer groundwater influences ecological factors such as food availability, the efficiency with which food is converted into energy for growth and reproduction, and ultimately growth rates of aquatic organisms (Allan 1995, pp. 73–79). Aquifer structure and groundwater temperature is important to salmonid fishes because groundwater can strongly influence stream temperature, and consequently egg incubation and fry growth rates, which are strongly temperature-dependent (Coutant 1999, pp. 32–52; Quinn 2005, pp. 143–150).

Missouri River Arctic grayling occur within the 4 to 7 °C (39 to 45 °F) ground water isotherm (see Heath 1983, p. 71; an isotherm is a line connecting bands of similar temperatures on the earth's surface), whereas most other North American grayling are found in isotherms less than 4 °C, and much of the species' range is found in areas with discontinuous or continuous permafrost (Meisner *et al.* 1988, p. 5). Much of the historical range of Arctic grayling in the upper Missouri River is encompassed by mean annual air temperature isotherms of 5 to 10 °C (41 to 50 °F) (USGS 2009), with the colder areas being in the headwaters of the Madison River in Yellowstone National Park. In contrast, Arctic grayling in Canada, Alaska, and Asia are located in regions encompassed by air temperature isotherms 5 °C and colder (41 °F and colder), with much of the species distributed within the 0 to -10 °C isolines (32 to 14 °F). This difference is significant because Arctic grayling in the Missouri River basin have evolved in isolation for millennia in a generally warmer climate than other populations. The potential for thermal adaptations makes Missouri River Arctic grayling a significant biological resource for the species under expected climate change scenarios.

TABLE 3. DIFFERENCES BETWEEN THE ECOLOGICAL SETTING OF THE UPPER MISSOURI RIVER AND ELSEWHERE IN THE SPECIES' RANGE OF ARCTIC GRAYLING.

Ecological Setting Variable	Missouri River	Rest of Taxon
Ocean watershed	Gulf of Mexico–Atlantic Ocean	Hudson Bay, Arctic Ocean, or north Pacific
Bailey's Ecoregion	Dry Domain: Temperate Steppe	Polar Domain: Tundra & Subarctic Humid Temperate: Marine, Prairie, Warm Continental Mountains
Air temperature (isotherm)	5 to 10 °C (41 to 50 °F)	-15 to 5 °C (5 to 41 °F)

TABLE 3. DIFFERENCES BETWEEN THE ECOLOGICAL SETTING OF THE UPPER MISSOURI RIVER AND ELSEWHERE IN THE SPECIES' RANGE OF ARCTIC GRAYLING.—Continued

Ecological Setting Variable	Missouri River	Rest of Taxon
Groundwater temperature (isotherm)	4 to 7°C (39 to 45 °F)	Less than 4 °C (less than 39 °F)
Native occurrence of large-bodied fish predators on salmonids	None, in most of the range[a]	Bull trout, lake trout, northern pike, taimen

[a]Lake trout are native to two small lakes in the upper Missouri River basin (Twin Lakes and Elk Lake), where their distributions presumably overlapped with the native range of Arctic grayling, so they would not have interacted with most Arctic grayling populations in the basin that were found in rivers.

Arctic grayling in the upper Missouri River basin occur in a temperate ecoregion distinct from all other Arctic grayling populations worldwide, which occur in Arctic or sub-Arctic ecoregions dominated by Arctic flora and fauna. An ecoregion is a continuous geographic area within which there are associations of interacting biotic and abiotic features (Bailey 2005, pp. S14, S23). These ecoregions delimit large areas within which local ecosystems recur more or less in a predictable fashion on similar sites (Bailey 2005, p. S14). Ecoregional classification is hierarchical, and based on the study of spatial coincidences, patterning, and relationships of climate, vegetation, soil, and landform (Bailey 2005, p. S23). The largest ecoregion categories are domains, which represent subcontinental areas of similar climate (e.g., polar, humid temperate, dry, and humid tropical) (Bailey 1994; 2005, p. S17). Domains are divided into divisions that contain areas of similar vegetation and regional climates. Arctic grayling in the upper Missouri River basin are the only example of the species naturally occurring in a dry domain (temperate steppe division; see Table 3 above). The vast majority of the species' range is found in the polar domain (all of Asia, most of North America), with small portions of the range occurring in the humid temperate domain (northern British Columbia and southeast Alaska). Occupancy of Missouri River Arctic grayling in a temperate ecoregion is significant for two primary reasons. First, an ecoregion represents a suite of factors (climate, vegetation, landform) influencing, or potentially influencing, the evolution of species within that ecoregion. Since Missouri River Arctic grayling have existed for thousands of years in an ecoregion quite different from the majority of the taxon, they have likely developed adaptations during these evolutionary timescales that distinguish them from the rest of the taxon, even if we have yet to conduct the proper studies to measure these adaptations. Second, the occurrence of Missouri River Arctic grayling in a unique ecoregion helps reduce the risk of species-level extinction, as the different regions may respond differently to environmental change.

Arctic grayling in the upper Missouri River basin have existed for at least 10,000 years in an ecological setting quite different from that experienced by Arctic grayling elsewhere in the species' range. The most salient aspects of this different setting relate to temperature and climate, which can strongly and directly influence the biology of ectothermic species (like Arctic grayling). Arctic grayling in the upper Missouri River have experienced warmer temperatures than most other populations. Physiological and life-history adaptation to local temperature regimes are regularly documented in salmonid fishes (Taylor 1991, pp. 191–193), but experimental evidence for adaptations to temperature, such as unusually high temperature tolerance or lower tolerance to colder temperatures, is lacking for Missouri River Arctic grayling because the appropriate studies have not been conducted. Lohr *et al.* (1996, p. 934) studied the upper thermal tolerances of Arctic grayling from the Big Hole River, but their research design did not include other populations from different thermal regimes, so it was not possible to make between-population contrasts under a common set of conditions. Arctic grayling from the upper Missouri River demonstrate very high growth rates relative to other populations (Northcote 1995, p. 157). Experimental evidence obtained by growing fish from populations under similar conditions would be needed to measure the relative influence of genetics (local adaptation) versus environment.

An apex fish predator that preys successfully on salmonids has been largely absent from most of the upper Missouri River basin over evolutionary time scales (tens of thousands of years). This suggests that Arctic grayling in the upper Missouri River basin have faced a different selective pressure than Arctic grayling in many other areas of the species' range, at least with respect to predation by fishes. Predators can exert a strong selective pressure on populations. One noteworthy aspect of the aquatic biota experienced by Arctic grayling in the upper Missouri River is the apparent absence of a large-bodied fish that would be an effective predator on juvenile and adult salmonids. In contrast, one or more species of large predatory fishes like northern pike (*Esox lucius*), bull trout, taimen (*Hucho taimen*), and lake trout (*Salvelinus namaycush*) are broadly distributed across much of the range of Arctic grayling in Canada and Asia (Northern pike—Scott and Crossman 1998, pp. 302, 358; taimen—VanderZanden *et al.* 2007, pp. 2281–2282; Esteve *et al.* 2009, p. 185; bull trout—Behnke 2002, pp. 296, 330; lake trout —Behnke 2002, pp. 296, 330). The only exceptions to this general pattern are where Arctic grayling formerly coexisted with lake trout native to Twin Lakes and Elk Lake (Beaverhead County) (Vincent 1963, pp. 188–189), but both of these Arctic grayling populations are thought to be extirpated (Oswald 2000, pp. 10, 16; Oswald 2006, pers. comm.). The burbot (*Lota lota*) is a freshwater fish belonging to the cod family and is native to the Missouri, Big Hole, Beaverhead, Ruby, and Madison Rivers in Montana (MFISH 2010); thus its distribution significantly overlapped the historical and current ranges of Arctic grayling in the upper Missouri River system. Burbot are voracious predators, but tend to be benthic (bottom-oriented) and apparently prefer the deeper portions of larger rivers and lakes. A few studies have investigated the diet of burbot where they overlap with native Arctic grayling in Montana, but did not detect any predation on Arctic grayling (Streu 1990, pp. 16–20; Katzman 1998, pp. 98–100). Burbot apparently do not consume salmonids in significant amounts, even when they are very abundant (Katzman 1998 and references therein, p. 106). The response of Arctic grayling in the Missouri River basin to introduced, nonnative trout suggests they were not generally pre-adapted to cope with the presence of a large-bodied salmonid predator. Missouri River Arctic grayling lack a co-evolutionary history with brown trout, and there are repeated observations that the two species tend not to coexist and that brown trout displace Arctic grayling (Kaya 1992, p. 56; 2000, pp. 14–15). We caution that competition with and predation by brown trout has not been directly studied with Arctic grayling, but at least some circumstantial evidence indicates that Missouri River Arctic grayling may not coexist well with brown trout.

We conclude that the occurrence of Arctic grayling in the upper Missouri River is biogeographically important to the species, that grayling there have occupied a distinctly different ecological setting relative to the rest of the species (see Table 3 above), and that they have been on a different evolutionary trajectory for at least 10,000 years. Consequently, we believe that Arctic grayling in the upper Missouri River occupy a unique ecological setting. The role that this unique setting plays in influencing adaptations or determining unique traits is unclear, and therefore a determination of the significance of this ecological setting to the taxon is unknown.

Gap in the Range

Arctic grayling in the upper Missouri River basin occur in an ocean drainage basin that is distinct from all other Arctic grayling populations worldwide. All other Arctic grayling occur in drainages of Hudson Bay, the Arctic Ocean, or the north Pacific Ocean; the Missouri River is part of the Gulf of Mexico–Atlantic Ocean drainage. The significance of occupancy of this drainage basin is that the upper Missouri River basin represents an important part of the species' range from a biogeographic perspective. The only other population of Arctic grayling to live in a non-Arctic environment was the Michigan–Great Lakes population that was extirpated in the 1930s.

Arctic grayling in Montana (southern extent is approximately 44°36′23″ N latitude) represent the southern-most extant population of the species' distribution since the Pleistocene glaciation (Figure 1). The next-closest native Arctic grayling population outside the Missouri River basin is found in the Pembina River (approximately 52°55′6.77″ N latitude) in central Alberta, Canada, west of Edmonton (Blackburn and Johnson 2004, pp. ii, 17; ASRD 2005, p. 6). Loss of the native Arctic grayling of the upper Missouri River would shift the southern distribution of Arctic grayling by more than 8° latitude. Such a dramatic range constriction would constitute a significant geographic gap in the species' range, and eliminate a genetically distinct group of Arctic grayling, which may limit the species' ability to cope with future environmental change.

Marginal populations, defined as those on the periphery of the species' range, are believed to have high conservation significance (see reviews by Scudder 1989, entire; Lesica and Allendorf 1995, entire; Fraser 2000, entire). Peripheral populations may occur in suboptimal habitats and thus be subjected to very strong selective pressures (Fraser 2000, p. 50). Consequently, individuals from these populations may contain adaptations that may be important to the taxon in the future. Lomolino and Channell (1998, p. 482) hypothesize that because peripheral populations should be adapted to a greater variety of environmental conditions, then they may be better suited to deal with anthropogenic (human-caused) disturbances than populations in the central part of a species' range. Arctic grayling in the upper Missouri River have, for millennia, existed in a climate warmer than that experienced by the rest of the taxon. If this selective pressure has resulted in adaptations to cope with increased water temperatures, then the population segment may contain genetic resources important to the taxon. For example, if northern populations of Arctic grayling are less suited to cope with increased water temperatures expected under climate warming, then Missouri River Arctic grayling might represent an important population for reintroduction in those northern regions. We believe that Arctic grayling from the upper Missouri River's occurrence at the southernmost extreme of the range contributes to its significance that may increased adaptability and contribute to the resilience of the overall taxon.

Only Surviving Natural Occurrence of the Taxon that May be More Abundant Elsewhere as an Introduced Population Outside of its Historical Range

This criterion does not directly apply to the Arctic grayling in the upper Missouri River because it is not the only surviving natural occurrence of the taxon; there are native Arctic grayling populations in Canada, Alaska, and Asia. That said, there are introduced Lake Dwelling Arctic Grayling within the native range in the Upper Missouri River System and Arctic grayling have been established in lakes outside their native range in Arizona, Colorado, Idaho, Montana, New Mexico, Utah, Washington, and Wyoming (Vincent 1962, p. 15; Montana Fisheries Information System (MFISH) 2009; NatureServe 2010).

Differs Markedly in Its Genetic Characteristics

Differences in genetic characteristics can be measured at the molecular genetic or phenotypic level. Three different types of molecular markers (allozymes, mtDNA, and microsatellites) demonstrate that Arctic grayling from the upper Missouri River are genetically different from those in Canada, Alaska, and Asia (Everett 1986, pp. 79–80; Redenbach and Taylor 1999, p. 23; Stamford and Taylor 2004, p. 1538; Peterson and Ardren 2009, pp. 1764–1766; USFWS, unpublished data). These data confirm the reproductive isolation among populations that establishes the discreteness of Missouri River Arctic grayling under the DPS policy. Here, we speak to whether these data also establish significance.

Allozymes

Using allozyme electrophoretic data, Everett (1986, entire) found marked genetic differences among Arctic grayling collected from the Chena River in Alaska, those descended from fish native to the Athabasca River drainage in the Northwest Territories, Canada, and native upper Missouri River drainage populations or populations descended from them (see Leary 2005, pp. 1–2). The Canadian population had a high frequency of a unique isocitrate dehydrogenase allele (form of a gene) and a unique malate dehydrogenase allele, which strongly differentiated them from all the other samples (Everett 1986, p. 44). With the exception one introduced population in Montana that is believed to have experienced extreme genetic bottlenecks, the Chena River (Alaskan) fish were highly divergent from all the other samples as they possessed an unusually low frequency of superoxide dismutase (Everett 1986, p. 60; Leary 2005, p. 1), and contained a unique variant of the malate dehydrogenase (Leary 2005, p. 1). Overall, each of the four native Missouri River populations examined (Big Hole, Miner, Mussigbrod, and Red Rock) exhibited statistically significant differences in allele frequencies relative to both the Chena River (Alaska) and Athabasca River (Canada) populations (Everett 1986, pp. 15, 67).

Combining the data of Everett (1986, entire), Hop and Gharrett (1989, entire), and Leary (1990, entire) results in information from 21 allozyme loci (genes) from the five native upper Missouri River drainage populations, five native populations in the Yukon River drainage in Alaska, and the one population descended from the Athabasca River drainage in Canada (Leary 2005, pp. 1–2). Examination of the genetic variation in these samples indicated that most of the genetic divergence is due to differences among drainages (29 percent) and comparatively little (5 percent) results from differences among populations within a drainage (Leary 2005, p. 1).

Mitochondrial DNA

Analysis using mtDNA suggest that Arctic grayling in North America represent at least three evolutionary lineages that are associated with distinct glacial refugia (Redenbach and Taylor 1999, entire; Stamford and Taylor 2004, entire). Arctic grayling in the Missouri River basin belong to the so-called North Beringia lineage (Redenbach and Taylor 1999, pp. 27–28; Samford and Taylor 2004, pp. 1538–1540). Analysis of Arctic grayling using restriction enzymes and DNA sequencing indicated that the fish from the upper Missouri River drainage possessed, in terms of North American fish, an ancestral form of the molecule (different forms of mtDNA molecules are referred to as haplotypes) that was generally absent from populations collected from other locations within the species' range in North America (Redenbach and Taylor 1999, pp. 27–28; Stamford and Taylor 2004, p. 1538). The notable exceptions were that some fish from the lower Peace River drainage in British Columbia, Canada (2 of 24 individuals in the population), and all sampled individuals from the Saskatchewan River drainage Saskatchewan, Canada (a total of 30 individuals from 2 populations), also possessed this haplotype (Stamford and Taylor 2004, p. 1538).

Variation in mtDNA haplotypes based on sequencing a portion of the 'control region' of the mtDNA molecule of Arctic grayling from 26 different populations seems to support the groupings proposed by Stamford and Taylor (2004, entire) (USFWS unpublished data). Two haplotypes were common in the five native Missouri River populations (Big Hole, Red Rock, Madison, Miner, and Mussigbrod – total sample size 143 individuals; USFWS unpublished data). Fish from three populations in Saskatchewan or near Hudson's Bay also had one of these Missouri River haplotypes at very high frequency (50 of 51 individuals sequenced had the same haplotype; USFWS unpublished data). The two "common" Missouri River haplotypes also occurred at low frequency in handful of other populations elsewhere in Canada and Alaska. For example, there a total of five such populations where a few individuals contained had one or the other of the two common Missouri River haplotypes (25 of 107 individuals sequenced; USFWS unpublished data). Also similar to the earlier study by Stamford and Taylor (2004, entire), a few individuals (9 of 40 individuals) from two populations from the Lower Peace River and the Upper Yukon River also had one or the other of the two common Missouri River haplotypes (USFWS unpublished data).

The distribution of the common Missouri River haplotype compared to others suggested that Arctic grayling native to the upper Missouri River drainage probably originated from a glacial refuge in the drainage and subsequently migrated northwards when the Missouri River temporarily flowed into the Saskatchewan River and was linked to an Arctic drainage (Cross *et al.* 1986, pp. 374–375; Pielou 1991, p. 195). When the Missouri River began to flow southwards because of the advance of the Laurentide ice sheet (Cross *et al.* 1986, p. 375; Pileou 1991, p. 10), the Arctic grayling in the drainage became physically and reproductively isolated from the rest of the species' range (Leary 2005, p. 2; Campton 2006, p. 6), which would have included those populations in Saskatchewan. Alternatively, the Missouri River Arctic grayling could have potentially colonized Saskatchewan or the Lower Peace River (in British Columbia) or both post-glacially (Stamford 2001, p. 49) via a gap in the Cordilleran and Laurentide ice sheets (Pielou 1991, pp. 10–11), which also might explain the low frequency of one or the other of the 'Missouri River' haplotypes in grayling in the Lower Peace River and Upper Yukon River.

We do not interpret the observation that Arctic grayling in Montana and Saskatchewan, and to lesser extent those from the Lower Peace and Upper Yukon River systems, share a mtDNA haplotype to mean that these groups of fish are genetically identical. Rather, we interpret it to mean that these fish shared a common ancestor tens to hundreds of thousands of years ago.

Microsatellite DNA

Recent analysis of microsatellite DNA (highly variable portions of nuclear DNA that exhibit tandem repeats of DNA base pairs) that included samples from five native Missouri River populations and two from Saskatchewan showed substantial divergence between these groups (Peterson and Ardren 2009, entire). Genetic differentiation between sample populations can be compared in terms of the genetic variation within relative to among populations, measured in terms of allele frequencies, a metric called F_{st} (Allendorf and Luikart 2007, pp. 52–54, 198–199). An analogous metric, named R_{st}, also measures genetic differentiation between populations based on microsatellite DNA, but differs from F_{st} in that it also considers the size differences between alleles (Hardy *et al.* 2003, p. 1468). An F_{st} or R_{st} of 0 indicates that populations are the same genetically (all genetic diversity within a species is shared by all populations), whereas a value of 1 indicates the populations are completely different (all the genetic diversity within a species is found as fixed differences among populations). F_{st} values ranged from 0.13 to 0.31 (average 0.18) between Missouri River and Saskatchewan populations (Peterson and Ardren 2009, pp. 1758, 1764–1765), whereas R_{st} values ranged from 0.47 to 0.71 (average 0.54) for the same comparisons (Peterson and Ardren 2009, pp. 1758, 1764–1765). This indicates that the two groups (Missouri vs. Saskatchewan populations) differ significantly in allele frequency and also in the size differences, and therefore divergence, among those alleles. This indicates that the observed genetic differences are not simply due to random loss of genetic variation because the populations are isolated (genetic drift), but they also are due to mutational differences, which suggests the groups may have been separated for millennia (Peterson and Ardren 2009, pp. 1767–1768).

Comparison of 435 individuals from 21 Arctic grayling populations from Alaska, Canada, and the Missouri River basin using nine of the same microsatellite loci as Peterson and Ardren (2009, entire) further supports the distinction of Missouri River Arctic grayling relative to populations elsewhere in North America (USFWS, unpublished data). A statistical analysis that determines the likelihood that an individual fish belongs to a particular group (e.g., STRUCTURE) (Pritchard *et al.* 2000, entire), clearly separated the sample fish from 21 populations into two clusters: one cluster representing populations from the upper Missouri River basin, and another cluster representing populations from across Canada and Alaska (USFWS, unpublished data). Factorial correspondence analysis (FCA) plots of individual fish also separated the fish into two groups, or clouds of data points when visualized in a three-dimensional space (USFWS, unpublished data). The FCA is a multivariate data analysis technique used to simplify presentation of complex data and to identify systematic relations between variables, in this case the multi-locus genotypes of Arctic grayling. As with the other analysis, the FCA plots clearly distinguished Missouri River Arctic grayling from those native to Canada and Alaska (USFWS, unpublished data). Divergence in size among these alleles further supports the distinction between Missouri River grayling from those in Canada and Alaska (USFWS, unpublished data). The interpretation of these data is that the Missouri River populations and the Canada/Alaska populations are most genetically distinct at the microsatellite loci considered.

Phenotypic Characteristics Influenced by Genetics—Meristics

Phenotypic variation can be evaluated by counts of body parts (i.e., meristic counts of the number of gill rakers, fin rays, and vertebrae characteristics of a population) that can vary within and among species. These meristic traits are influenced by both genetics and the environment (Allendorf and Luikart 2007, pp. 258–259). When the traits are controlled primarily by genetic factors, then meristic characteristics can indicate significant genetic differences among groups. Arctic grayling north of the Brooks Range in Alaska and in northern Canada had lower lateral line scale counts than those in southern Alaska and Canada (McCart and Pepper 1971, entire). These two scale-size phenotypes are thought to correspond to fish from the North and South Beringia glacial refuges, respectively (Stamford and Taylor 2004, p. 1545). Arctic grayling from the Red Rock Lakes drainage had a phenotype intermediate to the large- and small-scale types (McCart and Pepper 1971, pp. 749, 754). Arctic grayling populations from the Missouri River (and one each from Canada and Alaska) could be correctly assigned to their group 60 percent of the time using a suite of seven meristic traits (Everett 1986, pp. 32–35). Those native Missouri River populations that had high genetic similarity also tended to have similar meristic characteristics (Everett 1986, pp. 80, 83).

Arctic grayling from the Big Hole River showed marked differences in meristic characteristics relative to two populations from Siberia, and were correctly assigned to their population of origin 100 percent of the time (Weiss *et al.* 2006, pp. 512, 515–516, 518). The populations that were significantly different in terms of their meristic characteristics also exhibited differences in molecular genetic markers (Weiss *et al.* 2006, p. 518).

Inference Concerning Genetic Differences in Arctic Grayling of the Missouri River Relative to Other Examples of the Taxon

We believe the differences between Arctic grayling in the Missouri River and sample populations from Alaska and Canada measured using microsatellite DNA markers (Peterson and Ardren 2009, pp. 1764–1766; USFWS, unpublished data) represent "marked genetic differences" in terms of the extent of differentiation (e.g., F_{st}, R_{st}) and the importance of that genetic legacy to the rest of the taxon. The presence of morphological characteristics separating Missouri River Arctic grayling from other populations also likely indicates genetic differences, although this conclusion is based on a limited number of populations (Everett 1986, pp. 32–35; Weiss *et al.* 2006, entire), and we cannot entirely rule out the influence of environmental variation.

The intent of the DPS policy and the ESA is to preserve important elements of biological and genetic diversity, not necessarily to preserve the occurrence of unique alleles in particular populations. In Arctic grayling of the Missouri River, the microsatellite DNA data indicate that the group is evolving independently from the rest of the species. The extirpation of this group would mean the loss of the genetic variation in one of the two most distinct groups identified in the microsatellite DNA analysis, and the loss of the future evolutionary potential that goes with it. Thus, the genetic data support the conclusion that Arctic grayling of the upper Missouri River represent a unique and irreplaceable biological resource of the type the ESA was intended to preserve. Thus, we conclude that Missouri River Arctic grayling differ markedly in their genetic characteristics relative to the rest of the taxon.

Conclusion

We find that a population segment that includes all native ecotypes of Arctic grayling in the upper Missouri River basin satisfies the discreteness standard of the DPS policy. The segment is physically isolated, and genetic data indicates that Arctic grayling in the Missouri River basin have been separated from other populations for thousands of years. The population segment occurs in an ocean drainage different from all other Arctic grayling populations worldwide, and we find that loss of this population segment would create a significant gap in the species' range. Molecular genetic data clearly differentiate Missouri River Arctic grayling from other Arctic grayling populations, including those in Canada and Alaska. We conclude that because Arctic grayling of the upper Missouri River basin satisfy the criteria for being discrete and significant under our DPS policy, we determined that this population constitutes a DPS under our policy and the Act.

In our stipulated settlement agreement, we also agreed to consider the appropriateness of distinct population segments based on the two different ecotypes (fluvial and adfluvial) expressed by native Arctic grayling of the upper Missouri River. We acknowledge there are cases where the Service has designated distinct population segments primarily on life-history even when they co-occur with another ecotype that can be part of the same gene pool (e.g., anadromous steelhead and resident rainbow trout, *Oncorhynchus mykiss* (71 FR 838, January 5, 2006). However, we conclude that designation of a single population segment for Arctic grayling in the upper Missouri River is more appropriate than designating two separate distinct population segments delineated by life-history type. In the Missouri River basin, the two ecotypes share a common evolutionary history, and do not cluster genetically based strictly on ecotype. As we discussed above, the fluvial and adfluvial life-history forms of Arctic grayling in the upper Missouri River do not appear to represent distinct evolutionary lineages. There appears to be some plasticity in behavior where individuals from a population can exhibit a range of behaviors. From a practical standpoint, we observe that only five native Arctic grayling populations remain in the Missouri River basin, and we believe that both fluvial and adfluvial native ecotypes have a role in the conservation of the larger population segment. We believe that the intent of the ESA and the DPS policy, and our obligation to assess the appropriateness of alternate DPS designations in the settlement agreement are best served by designating a single distinct population segment, rather than multiple population segments.

As we described above, we are not including introduced populations that occur in lakes in the Upper Missouri River basin in the DPS. The Service has interpreted the Act to provide a statutory directive to conserve species in their native ecosystems (49 FR 33890, August 27, 1984) and to conserve genetic resources and biodiversity over a representative portion of a taxon's historical occurrence (61 FR 4723, February 7, 1996). The introduced Arctic grayling occur in lakes apart from native fluvial environments and from lakes where native adfluvial grayling occur. These introduced populations have not been used for any conservation purpose and could pose genetic risks to the native Arctic grayling population.

We find that the Arctic grayling of the upper Missouri River basin constitute a distinct population segment. We define the historical range of this population segment to include the major streams, lakes, and tributary streams of the upper Missouri River (mainstem Missouri, Smith, Sun, Beaverhead, Jefferson, Big Hole, and Madison Rivers, as well as their key tributaries, as well as a few small lakes where Arctic grayling are or were believed to be native (Elk Lake, Red Rock Lakes, Miner Lake, and Mussigbrod Lake, all in Beaverhead County, Montana). We define the current range of the DPS to consist of extant native populations in the Big Hole River, Miner Lake, Mussigbrod Lake, Madison River–Ennis Reservoir, and Red Rock Lakes. We refer to this DPS as the native Arctic grayling of the upper Missouri River. The remainder of this finding will thus focus on the population status of and threats to this entity.

Population Status and Trends for Native Arctic Grayling in the Upper Missouri River

We identified a DPS for Arctic grayling in the upper Missouri River basin that includes five extant populations: (1) Big Hole River, (2) Miner Lake, (3) Mussigbrod Lake, (4) Madison River-Ennis Reservoir, and (5) Red Rock Lakes. In general, we summarize what is known about the historical distribution and abundance of each of these populations, describe their current distributional extent, summarize any available population monitoring data, identify the best available information that we use to infer the current population status, and summarize the current population status and trends.

TABLE 4. EXTENT AND CURRENT ESTIMATED EFFECTIVE POPULATION SIZES (N_e) OF NATIVE ARCTIC GRAYLING POPULATIONS IN THE MISSOURI RIVER BASIN. VALUES IN PARENTHESES REPRESENT 95 PERCENT CONFIDENCE INTERVALS.

Population Name	Population Extent[a]	N_e [b]	Biological Date of Population Size [c]	Estimated Adult Population Size Assuming: N_e/N ratio 0.25 [d]	Estimated Adult Population Size Assuming: N_e/N ratio 0.14 [e]
Big Hole River	158 mi	208 (176 to 251)	2000–2003	828 (704 to 1,004)	1,486 (1,257 to 1,793)
Miner Lakes	26.9 ha	286 (143 to 4,692)	2001–2003	1,144 (572 to 18,768)	2,043 (1,021 to 33,514)
Mussigbrod Lake	42.5 ha	1,497 (262 to ∞)	2001–2003	5,988 (1,048 to ∞)	10,693 (1,871 to ∞)
Madison River–Ennis Reservoir	1,469 ha	162 (76 to ∞)	1991–1993	648 (304 to ∞)	1,157 (543 to ∞)
Red Rock Lakes	890 ha	228 (141 to 547)	2000–2002	912 (564 to 2,188)	1,629 (1,007 to 3,907)

[a] Approximate maximum spatial extent over which Arctic grayling are encountered in a given water.

[b] Effective population size estimates from Peterson and Ardren (2009, p.1767). Confidence intervals that include infinity (∞) can result from statistical artifacts of the linkage disequilibrium method (Waples and Do 2007, p. 10; Russell and Fewster 2009, pp. 309–310). The usual interpretation is that there is no evidence for any disequilibrium caused by genetic drift due to a finite number of parents—it can all be explained by sampling error (Waples and Do 2007, p. 10). Thus, the effective size is infinitely large. Small sample sizes may influence estimates in some cases (e.g., Madison River-Ennis Reservoir).

[c] Approximate date to which the N_e estimate refers. For example, N_e for the Big Hole River based on genotyping a sample of fish from 2005–2006, but the interpretation of N_e is the number of breeding adults that produced the fish in the observed sample. Thus the true biological date of the N_e estimate is one generation before 2005–2006, or approximately 2000–2003.

[d] Adult population size estimated from N_e assuming N_e /N = 0.25. This value was the midpoint of a range of values (0.2–0.3) commonly cited for N_e /N ratios in salmonid fishes (Allendorf *et al.* 1997, p. 143; McElhahey *et al.* 2000, p. 63; Rieman and Allendorf 2001, p. 762; Palm *et al.* 2003, p. 260).

[e] Adult population size estimated from N_e assuming N_e /N = 0.14. This value was the median N_e /N ratio based on a meta analysis of 83 studies for 65 different species (Palstra and Ruzzante 2008, p. 3428).

Big Hole River

Historically, Arctic grayling presumably had access to and were distributed throughout much of the Big Hole River, including the lower reaches of many tributary streams, such as Big Lake, Deep, Doolittle, Fishtrap, Francis, Governor, Johnson, LaMarche, Miner, Mussigbrod, Odell, Pintlar, Rock, Sand Hollow, Swamp, Seymour, Steel, Swamp, and Wyman Creeks, as well as the Wise River (Liknes 1981, p. 11; Liknes and Gould 1987, p. 124; Kaya 1990, pp. 36–40). Presently, Arctic grayling are found primarily in the mainstem Big Hole River between the towns of Glen and Jackson, Montana, a distance of approximately 181 river km (113 mi), and in 11 tributaries, totaling an additional 72 river km (45 mi) (Magee 2010a, pers. comm.; see Table 4 above). The total current maximum extent of Arctic grayling occurrence in the Big Hole River is approximately 250 river km (156 mi). However, the fish are not continuously distributed across this distance, and instead tend to be concentrated in discrete patches (Magee *et al.* 2006, pp. 27–28; Rens and Magee 2007, p. 15) typically associated with spawning and rearing habitats or cold-water sites that provide a thermal refuge from high summer water temperatures.

Kaya (1992, pp. 50–52) noted the general lack of monitoring data for the Big Hole River fluvial Arctic grayling population prior to the late 1970s, but data collected since that time indicate the overall range has contracted over the last 2 decades. During 1978 and 1979 Arctic grayling were observed in Governor Creek (in the headwaters of the Big Hole River) and downstream in the Big Hole River near Melrose, Montana (Liknes 1981, p. 11). Arctic grayling have not recently been encountered in Governor Creek (Rens and Magee 2007, p. 15; Montana Fish, Wildife and Parks (MFWP), unpublished data), but are occasionally encountered in the Big Hole River downstream of Divide, Montana, at very low densities and as far downstream as Melrose or Glen, Montana (Oswald 2005a, pers. comm.). More recently, Arctic grayling have become less abundant in historical spawning and rearing locations in the upper watershed near Wisdom, Montana, and also in downstream river segments with deep pool habitats considered important for overwintering (Magee and Lamothe 2003, pp. 18–21; MFWP unpublished data). Comparatively, greater numbers of Arctic grayling are encountered in the lower reaches of tributaries to the upper Big Hole River, including LaMarche, Fishtrap, Steel, and Swamp Creeks (Rens and Magee 2007, p. 13).

Based on the best available data, the adult population declined by one half between the early 1990s and the early 2000s (see Figure 3, USFWS unpublished data), which is equivalent to a decline of 7 percent per year, on average. Monitoring data collected by MFWP also support the conclusion that the Arctic grayling population in the Big Hole River declined during this time period (Byorth 1994a, p. 11; Rens and Magee 2007, entire; MFPW, unpublished data).

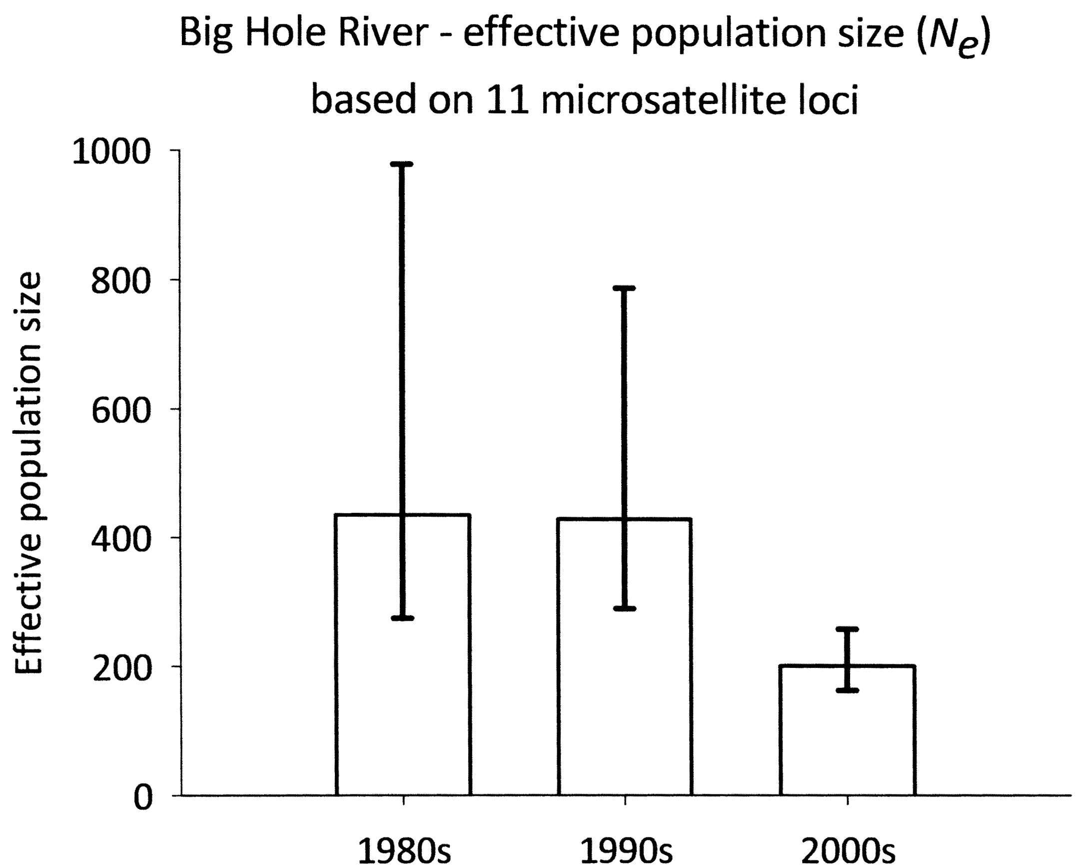

FIGURE 3. Effective population size (N_e) of Big Hole River Arctic grayling based on microsatellite DNA genotypes from fish collected in three time periods (USFWS, unpublished data). The N_e are estimated using the linkage disequilibrium method of Waples and Do (2008, entire), and error bars represent 95% confidence intervals estimated by the jackknife method.

Miner Lakes

The Miner Lakes are a complex of small lakes in the upper Big Hole River drainage. Lower Miner Lakes are two small lakes in the middle of the Miner Creek drainage connected by a narrow section approximately 100 m (330 ft) in length, functionally representing a single lake for fish populations. Arctic grayling occur in Lower Miner Lakes (hereafter Miner Lakes population), which has a total surface area of 26.7 hectares (ha) or 0.267 km^2 (66 acres (ac)). Arctic grayling primarily reside in the lake, and presumably move into the inlet or outlet tributary to spawn. Surveys conducted upstream and downstream of the Lower Miner Lakes in 1992 and 1994, respectively, captured no Arctic grayling (Downing 2006, pers. comm.). Apparently, adults do not remain in the stream long after spawning and young-of-the-year (YOY) move into Lower Miner Lakes.

The MFWP conducted limited surveys in Lower Miner Lakes, but the abundance of the population has not been estimated by traditional fishery methods. Arctic grayling are classified as “common” in Lower Miner Lakes (MFISH 2010). Introduced brook trout also are present.

The best available information on the abundance of Miner Lakes Arctic grayling comes from a genetic assessment of that population. Based on a sample of fish from 2006, Peterson and Ardren (2009, p. 1767) estimated an effective population size of 286. This estimate represents an approximation of abundance of breeding adults at a single point in time, and there are no data on which to base an assessment of the population trend.

Mussigbrod Lake

Mussigbrod Lake has a surface area of 42.5 ha (105 ac), and is found in the middle reaches of Mussigbrod Creek, a tributary to the North Fork Big Hole River. Arctic grayling primarily reside in the lake. We do not know whether Arctic grayling spawn in the inlet stream or within the lake (Magee and

Olsen 2010, pers. comm.). Arctic grayling occasionally pass over a diversion structure downstream at the outlet of Mussigbrod Lake, and become trapped in a pool that is isolated because of stream dewatering. The MFWP periodically capture grayling in this pool and return them to the lake.

Data for the Mussigbrod Lake population of Arctic grayling is minimal. The MFWP has conducted very limited surveys and the abundance of the population has not been estimated by traditional fishery methods. Genetic data indicate that Arctic grayling are comparatively abundant (see Table 4 above). Based on a sample from 2006, Peterson and Ardren (2009, p. 1767) estimated an effective size of 1,497. The best available data indicate that the Mussigbrod Lake population is comparatively large, but we have no data about the population trend.

Madison River – Ennis Reservoir

Historically, Arctic grayling were reported to be abundant in the middle and upper Madison River, but have undergone a dramatic decline in the past 100 years with the species becoming rare by the 1930s (Vincent 1962, pp. 11, 85–87). Native Arctic grayling are thought be extirpated from the upper Madison River. A major impact to fish in that area was the construction of Hebgen Dam, which flooded Horsethief Springs, a small tributary that was reportedly one of the most important streams for Arctic grayling (Vincent 1962, pp. 40–41, 128). In the middle Madison River, Arctic grayling were apparently common to plentiful in the mainstem River near Ennis, Montana, and some associated tributaries (Jack, Meadow, and O'Dell Creeks) (Vincent 1962, p. 128). In 1906, construction of Ennis Dam blocked all upstream movement of fishes, and apparently had a large negative effect on Arctic grayling. Vincent (1962) noted that "early settlers reported scooping up boxes full of grayling at the base of Ennis Dam the year after it was constructed" (p. 128), and that the species apparently became quite rare by the late 1930s (Vincent 1962, p. 85).

The current distribution of Arctic grayling in the Madison River is primarily restricted to the Ennis Reservoir and upstream into the river approximately 6.5 km (approximately 4 mi) to the Valley Garden Fishing Access Site (Byorth and Shepard 1990, p. 21). Arctic grayling are occasionally encountered in the Madison River downstream and upstream from Ennis Reservoir (Byorth and Shepard 1990, p. 25; Clancey 2004, p. 22; 2008, p. 21). Arctic grayling migrate from the reservoir into the river to spawn, then return to the reservoir (Byorth and Shepard 1990, pp. 21–22; Rens and Magee 2007, pp. 20–21). The YOY Arctic grayling spawned in the Madison River migrate downstream into Ennis Reservoir about 1 month after emergence, but while they are in the river, they are typically encountered in backwater or slackwater habitat (Jeanes 1996, pp. 31–34).

The MFWP has sporadically monitored Arctic grayling in the Madison River near Ennis Reservoir since about 1990. Despite sparse data, declining catches for both spawning adults and YOY indicate the population is less abundant now compared to the early 1990s. The highest numbers of YOY Arctic grayling were encountered in the early 1990s, and no more than two have been captured in any given year since that time. Our interpretation of this information is that Arctic grayling in the Madison River–Ennis Reservoir population have declined during the past 20 years and are presently at very low abundance.

Abundance of the Madison River–Ennis Reservoir Arctic grayling has been estimated twice. In 1990, the adult population was estimated to be 545, but the authors cautioned that the accuracy of the estimate was questionable as it was based on recapturing only. From a sample of fish collected mostly in 1996, the effective size of the population (breeding adults) was estimated as 162 (Peterson and Ardren 2009, p. 1767). The average number of Arctic grayling captured per unit effort (CPUE) declined by approximately a factor of 10 between the early 1990s and recent samples (Clancey 1998, p. 10; Clancey 2007, p.16; Clancey 2008, pp. ii, 21, A2-2; Clancey and Lohrenz 2009, pp. 30, B2; Clancey 2010a, pers. comm.; Clancey 2010b, pers. comm.). Adult Arctic grayling may currently exist at only 10 to 20 percent of the abundance observed in the early 1990s. Based on the best available data, we conclude that this Arctic grayling population has been in a decline during the past 20 years and may only consist of a few hundred adults.

Red Rocks Lakes

Arctic grayling are native to waters of the upper Beaverhead River system, including the Red Rock River drainage. During the past 50 to 100 years, both the distribution and abundance of Arctic grayling in the Centennial Valley, Beaverhead County, Montana (which contains the Red Rock River), has severely declined (Vincent 1962, pp. 115–121; Unthank 1989, pp. 13–17; Mogen 1996, pp. 2–5, 75–84). As of about 50 years ago, Arctic grayling spawned in at least 12 streams in the Centennial Valley (Mogen 1996, p. 17), but they appear to have been extirpated from all but 2 streams (Boltz 2006, p. 6). Presently, Arctic grayling spawn in two locations within the Red Rock River drainage: Odell Creek, a tributary to Lower Red Rock Lake; and Red Rock Creek, the primary tributary to Upper Red Rock Lake (Mogen 1996, pp. 47–48; Boltz 2006, p. 1). Lower and Upper Red Rock Lakes are connected by a short segment of river, and both lakes are contained within the boundaries of the Red Rock Lakes National Wildlife Refuge (NWR). The upper lake appears to be the primary rearing and overwintering habitat for Arctic grayling. Red Rock Creek is the only stream where Arctic grayling spawn in appreciable numbers (Mogen 1996, pp. 45–48). Collectively, we refer to this population as the Red Rocks Lakes Arctic grayling, and characterize it as having the adfluvial ecotype.

Arctic grayling in the Red Rock Lakes have been monitored intermittently since the 1970s. Most of that effort focused on Red Rock Creek, but periodic sampling also occurred in Odell Creek. The MFWP and the Service occasionally sampled for Arctic grayling in Odell Creek, where grayling abundance declined over the past few decades. On average, the minimum sizes of the spawning runs in Red Rock Creek since 1994 are about half of those recorded 4 decades ago (i.e., 623 vs. 308 per year) (data summarized from Mogen 1996, p. 70 and Boltz 2006, p. 7). The spawning runs into Red Rock Creek fluctuated during the 1990s and early 2000s, but about 450 or fewer adult Arctic grayling have been captured in 6 of 7 years in which weirs traps were operated. Electrofishing surveys conducted in Red Rock Creek by MFWP seem to corroborate a decline in the spawning population, as total catches decreased even as sampling effort increased (Rens and Magee 2007, pp. 16–18).

Based on a sample of fish from Red Rock Creek in 2005, Peterson and Ardren (2009, pp. 1761, 1767) estimated an effective size of 228, which is interpreted as the number of breeding adults that produced the fish sampled in 2005. The best available data indicate that the Red Rock Lakes Arctic grayling population has declined over the past 2 decades.

Population viability analysis (PVA) of native Missouri River Arctic grayling

To gauge the probability that the different native populations of Arctic grayling in the upper Missouri River basin will go extinct from unpredictable events in the foreseeable future, we conducted a simple population viability analysis (PVA) (see Dennis *et al.* (1991, entire) in Morris and Doak 2002, pp. 85–87 for details on the PVA model and the software code to run the model). We assumed that a population with 50 or fewer adults is likely influenced by demographic stochasticity (chance variation in the fates of individuals within a given year) and genetic stochasticity (random changes in a population's genetic makeup), and would not be expected to persist long as a viable population. For the different PVA scenarios, we assume either the population has stabilized, or the estimated decline will continue at a constant rate.

We considered the probability of extinction individually by population, as populations appear to be reproductively isolated. The relative risk of extinction in the foreseeable future (30 years based on the observation that the variability in predictions for extinction risk from the PVA model increases substantially after 30 years) varies among the different populations, with the largest population, Mussigbrod Lake, having a very low probability of extinction (less than 1 percent) in the foreseeable future, even given a population decline. The other four populations have comparatively greater probabilities of extinction in the foreseeable future, with all being roughly similar in magnitude (13-55 percent across populations) when considering only stochastic (random or chance) processes. The Madison River has the greatest probability of extinction by stochastic processes (36-55 percent), followed by Big Hole (33-42 percent), Red Rocks (31-40 percent), and Miner (13-37 percent).

Overall, the PVA analyses indicate that four populations (Madison, Big Hole, Red Rocks, and Miner) appear to be at risk from chance environmental variation because of low population abundance. This is a general conclusion, and the actual risk may vary substantially among populations (USFWS unpublished data). For example, Arctic grayling in the Big Hole River population spawn in different locations, which would reduce the risk that an environmental catastrophe would simultaneously kill all breeding adults, relative to a situation where adults appear to be primarily in a single location or reach of river (e.g., Red Rocks and Madison populations).

Arctic Grayling Conservation Efforts

Native Arctic Grayling Genetic Reserves and Translocation

Given concern over the status of native Arctic grayling, the Montana Arctic Grayling Recovery Program (AGRP) was formed in 1987, to address conservation concerns for primarily the fluvial ecotype in Big Hole River, and to a lesser extent the native adflvuial population in Red Rock Lakes (Memorandum of Understanding (MOU) 2007, p. 2). The AGW was established as an ad hoc technical workgroup of the AGRP. In 1995, the AGW finalized a restoration plan that outlined an agenda of restoration tasks and research, including management actions to secure the Big Hole River population, brood stock development, and a program to re-establish four additional fluvial populations (AGW 1995, pp. 7–17).

Consequently, the State of Montana established genetic reserves of Big Hole River grayling (Leary 1991, entire), and has used the progeny from those reserves in efforts to re-establish additional fluvial populations within the historical native range in the Missouri River basin (Rens and Magee 2007, pp. 21–38). Currently, brood (genetic) reserves of Big Hole River grayling are held in two closed-basin lakes in south-central Montana (Rens and Magee 2007, p. 22). These fish are manually spawned to provide gametes for translocation efforts in Montana (Rens and Magee 2007, p. 22). Functionally, these brood reserves are hatchery populations maintained in a natural setting, and we do not consider them wild populations for the purposes of evaluating the status of native Arctic grayling in the Missouri River basin. However, they are important to recovery efforts.

For more than 13 years, MFWP has attempted to re-establish populations of fluvial Arctic grayling in various locations in the Missouri River basin, including the Ruby, Sun, Beaverhead, Missouri, Madison, Gallatin, and Jefferson Rivers (Lamothe and Magee 2004a, pp. 2, 28). A self-sustaining population has not yet been established from these reintroductions (Lamothe and Magee 2004a, p. 28; Rens and Magee 2007, pp. 35–36, 38). Recent efforts have focused more intensively on the Ruby and Sun Rivers, and have used methods that should improve reintroduction success (Rens and Magee 2007, pp. 24–36). Encouragingly, natural reproduction by Arctic grayling in the Ruby River was confirmed during fall 2009 (Magee 2010b, pp. 6–7, 22). Monitoring will continue in subsequent years to determine whether the population has become a stable and viable population, as defined by the guidance and implementation documents of the translocation programs (AGW 1995, p. 1; Memorandum of Agreement (MOA) 1996, p. 2). Consequently, we do not consider the Ruby River to represent a self-sustaining population for the purposes of evaluating the population status of Missouri River grayling in this finding. Arctic grayling presumably from previous translocations are occasionally encountered near translocation sites in other waters (Rens and Magee 2007, pp. 35–38; MFWP, unpublished data). There is no evidence that these individuals represent progeny from a re-established population, so we cannot consider them elements of a stable and viable population for the purposes of evaluating the population status of Missouri River Arctic grayling in this finding.

Big Hole River Candidate Conservation Agreement with Assurances

On August 1, 2006, the Service issued ESA section 10(a)(1)(A) enhancement of survival permit (TE-104415-0) to Montana Fish, Wildlife and Parks (MFWP) to implement a Candidate Conservation Agreement with Assurances for Arctic grayling in the upper Big Hole River (Big Hole Grayling CCAA) (MFWP *et al.* 2006, entire). This permit is valid through August 1, 2026. The goal of the Big Hole Grayling CCAA is to secure and enhance a population of fluvial Arctic grayling within the upper reaches of their historic range in the Big Hole River drainage by working with non-Federal property owners to implement conservation measures on their lands. The guidelines of this CCAA will be met by implementing conservation measures that improve stream flows, protect and restore riparian habitats, identify and reduce or eliminate entrainment (inadvertent capture) of grayling in irrigation ditches, and remove human-made barriers to grayling migration (MFWP *et al.* 2006, p. 3). Currently, 32 landowners representing 64,822 ha (160,178 ac) in the upper Big Hole River drainage are participating in the CCAA (Lamothe 2009, p. 5). The MFWP leads the Big Hole Grayling CCAA implementation effort, and is supported by Montana Department of Natural Resources and Conservation (MDNRC), USDA Natural Resources Conservation Service (NRCS), and the Service. Other groups helping implement the CCAA include the Big Hole Watershed Committee, the Big Hole River Foundation, Montana Trout Unlimited, the Western Water Project (affiliated with Trout Unlimited), and

The Nature Conservancy (Lamothe 2008, p. 23). Detailed information on conservation actions and restoration projects implemented under the plan are available in various reports (AGW 2010, p. 4; Everett 2010, entire; Lamothe *et al.* 2007, pp. 6–35; Lamothe 2008, pp. 7–21; Lamothe 2009, entire; Lamothe 2010, entire; Magee 2010b, entire; Roberts 2010, entire).

Biological Effectiveness of the Ongoing Conservation Programs

The current and anticipated effects of the aforementioned conservation programs on the biological status and threats to Arctic grayling of the upper Missouri River are discussed elsewhere in the document (see **Summary of Information Pertaining to the Five Factors** and **Finding** sections, below). We continue to encourage and promote collaborative efforts to secure existing populations, and to increase the distribution of the Arctic grayling within its historical range in the upper Missouri River basin.

Summary of Information Pertaining to the Five Factors

Section 4 of the ESA (16 U.S.C. 1533) and implementing regulations (50 CFR 424) set forth procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the ESA, a species may be determined to be endangered or threatened based on any of the following five 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; or (E) other natural or manmade factors affecting its continued existence. In making this finding, information pertaining to the Missouri River DPS of Arctic grayling in relation to the five factors provided in section 4(a)(1) of the Act is discussed below.

In considering what factors might constitute threats to a species, we must look beyond the exposure of the species to a factor to evaluate whether the species may respond to the factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat and we attempt to determine how significant a threat it is. The threat is significant if it drives, or contributes to, the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined in the Act.

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

Curtailment of Range and Distribution

The number of river kilometers (miles) occupied by the fluvial ecotype of Arctic grayling in the Missouri River has been reduced by approximately 95 percent during the past 100 to 150 years (Kaya 1992, p. 51). The fluvial life history is only expressed in the population residing in the Big Hole River; the remnant population in the Madison River near Ennis Reservoir has apparently diverged toward an adfluvial life history. Arctic grayling distribution within the Centennial Valley in the upper Beaverhead River also has been severely curtailed during the last 50 to 100 years, such that the only remaining example of the species in that drainage is an adfluvial population associated with the Red Rock Lakes. Indigenous populations in the Big Hole River, Madison River, and Red Rock Lakes all exist at reduced densities on both contemporary and historical timescales. The Miner Lakes and Mussigbrod Lake populations appear to have been reproductively isolated for hundreds of years (USFWS, unpublished data), so a restricted distribution may represent the natural historical condition for these populations. The curtailment of range and distribution is a current threat, because the probability of extirpation of the DPS is related to the number of populations and their resilience. Since the DPS currently exists as a set of generally small, isolated populations that cannot naturally re-found or 'rescue' another population. Thus, the curtailment of range and distribution will remain a threat in the foreseeable future, absent the reestablishment of additional populations within the DPS' historical range. Reintroduction attempted under the auspices of the 1995 Restoration Plan (AGW 1995, entire) have been underway since 1997, but have not yet resulted in re-establishment of populations or the expansion of the DPS' current range.

Dams on Mainstem Rivers

The majority of the historical range of the Upper Missouri River DPS of Arctic grayling has been altered by the construction of dams and reservoirs that created barriers obstructing migrations to spawning, wintering, or feeding areas; inundated grayling habitat; and impacted the historical hydrology of river systems (Kaya 1990, pp. 51–52; Kaya 1992, p. 57). The construction of large dams on mainstem river habitats throughout the upper Missouri River system fragmented river corridors necessary for the expression of migratory life histories. Construction of dams that obstructed fish passage on the mainstem Missouri River (Hauser, Holter, Canyon Ferry, and Toston), Madison River (Madison–Ennis, Hebgen), Beaverhead River and its tributary Red Rock River (Clark Canyon, Lima), Ruby River (Ruby), and Sun River (Gibson) all contributed to the rangewide decline of this DPS (Vincent 1962, pp. 127–128; Kaya 1992, p. 57; see Figure 2).

Dams also may continue to impact the extant population in the Madison River. The Madison Dam (also known as Ennis Dam), as with the aforementioned dams, is a migration barrier with no fish passage facilities. Anglers have reported encountering Arctic grayling in pools below the dam, implying that fish occasionally pass (downstream) over or through the dam. These fish would be "lost" to the population residing above the dam because they cannot return upstream, but have apparently not established populations downstream. Operational practices of the Madison Dam also have been shown to affect the resident fishes. A population decline of Arctic grayling coincided with a reservoir drawdown in winter 1982–1983 that was intended to reduce the effects of aquatic vegetation on the hydroelectric operations at the dam (Byorth and Shepard 1990, pp. 52–53). This drawdown likely affected the forage base, rearing habitat, and spawning cycle of Arctic grayling in the reservoir.

The presence of mainstem dams is a historical, current, and future threat to the DPS. Lack of fish passage at these dams contributed to the extirpation of Arctic grayling from some waters by blocking migratory corridors (Vincent 1962, p. 128), curtailing access to important spawning and rearing habitats, and impounding water over former spawning locations (Vincent 1962, p. 128). These dams are an impediment to fish migration and limit the ability of fish to disperse between existing populations or recolonize habitat fragments, and will continue to act in this manner for the foreseeable future. We believe the presence of a mainstem dam is an immediate and imminent threat to the Madison River population, as the remaining grayling habitat is adjacent to Ennis Dam (see Figure 2). We not aware of any plans to retrofit the Ennis Dam or any other mainstem dam to provide upstream fish passage, so we expect the current situation to continue. The Federal Energy Regulatory Commission (FERC) license for hydroelectric generation at Ennis Dam will not expire until the year

2040 (FERC 2010, entire). The upper Missouri River basin dam having the FERC license with the latest expiration date is Clark Canyon Dam, which will not expire until 2059 (FERC 2010, entire). Thus, mainstem dams will remain a threat in the foreseeable future, which is 30 to 50 years based on the duration of existing FERC licenses in the upper basin.

Agriculture and Ranching

The predominant use of private lands in the upper Missouri River basin is irrigated agriculture and ranching, and these activities had and continue to have significant effects on aquatic habitats. In general, these effects relate to changes in water availability and alteration to the structure and function of aquatic habitats. The specific activities and their impacts are discussed below.

Smaller Dams and Fish Passage Barriers

Smaller dams or diversions associated with irrigation structures within specific watersheds continue to pose problems to Arctic grayling migratory behavior, especially in the Big Hole River drainage. In the Big Hole River, numerous diversion structures have been identified as putative fish migration barriers (Petersen and Lamothe 2006, pp. 8, 12–13, 29) that may limit the ability of Arctic grayling to migrate to spawning, rearing, or sheltering habitats under certain conditions. The Divide Dam on the Big Hole River near the town of Divide, Montana, has existed for nearly 80 years and is believed to be at least a partial barrier to upstream movement by fishes (Kaya 1992, p. 58). As with the larger dams, these smaller fish passage barriers can reduce reproduction (access to spawning habitat is blocked), reduce growth (access to feeding habitat is blocked), and increase mortality (access to refuge habitat is blocked). A number of planned or ongoing conservation actions to address connectivity issues on the Big Hole River and its tributaries may reduce the threat posed by movement barriers for Arctic grayling in that habitat. The Divide Dam is being replaced with a new structure that provides fish passage, and construction began in July 2010 (Nicolai 2010, pers. comm.). At least 17 fish ladders have been installed at diversion structures in the Big Hole River since 2006 as part of the Big Hole Grayling CCAA (AGW 2010, p. 4), and a culvert barrier at a road crossing on Governor Creek (headwaters of Big Hole River) was replaced with a bridge that is expected to provide upstream passage for aquatic organisms under all flow conditions (Everett 2010, pp. 2–6). Non-Federal landowners who control approximately 50 to 70 percent of the points of irrigation diversion in the upper Big Hole River are enrolled in the CCAA (Roberts and Lamothe 2010, pers. comm.), so the threats posed by fish passage barriers should be substantially reduced in the Big Hole River during the next 10 to 20 years (foreseeable future) based on the minimum duration of site-specific plans for landowners enrolled in the CCAA and the duration of the ESA section 10(a)(1)(A) enhancement of survival permit (TE 104415-0) associated with the CCAA (MFWP *et al.* 2006, p. 75).

Fish passage barriers also have been noted in the Red Rock Lakes system (Unthank 1989, p. 9). Henshall (1907, p. 5) noted that spawning Arctic grayling migrated from the Jefferson River system, through the Beaverhead River and Red Rock River through the Red Rock Lakes and into the upper drainage, and then returned downstream after spawning. The construction of a water control structure (sill) at the outlet of Lower Red Rock Lake in 1930 (and reconstructed in 1957 (USFWS 2009, p. 74)) created an upstream migration barrier that blocked these migrations (Unthank 1989, p. 10; Gillin 2001, p. 4-4). This structure, along with mainstem dams at Lima and Clark Canyon, extirpated spawning runs of Arctic grayling that historically migrated through the Beaverhead and Red Rock Rivers (see Figure 2; USFWS 2009, p. 72). All of these structures preclude upstream movement by fishes, and continue to prohibit immigration of Arctic grayling from the Big Hole River (see Figure 2). Because recovery of Arctic grayling will necessitate expansion into unoccupied habitat, and the Big Hole River includes some of the best remaining habitat for the species, these dams constitute a threat to Arctic grayling now and in the foreseeable future, which is 30 to 50 years based on the duration of existing FERC licenses in the upper basin.

In Mussigbrod Lake, Arctic grayling occasionally pass downstream over a diversion structure at the lake outlet, and become trapped in a pool that is isolated because of stream dewatering (Magee and Olsen 2010, pers. comm.). However, the potential for mortality in these fish is partially mitigated by MFWP, which periodically captures Arctic grayling in this pool and returns them to the lake.

In the Red Rock Lakes system, the presence of fish passage barriers represents a past and present threat. The magnitude of the threat may be reduced in the next 15 years as a result of implementation of the Red Rock Lakes NWR Comprehensive Conservation Plan (CCP) (USFWS 2009, entire — see Factor D discussion below), but we conclude that not all barriers that potentially affect the population will addressed during this time (e.g., Lower Red Rock Lake Water Control Structure) (USFWS 2009, p. 43). Thus, fish passage barriers will remain a threat to the Red Rock Lakes grayling in the foreseeable future.

In the Big Hole River, fish passage barriers represent a past and present threat. The magnitude of the threat in the Big Hole River should decrease appreciably during the next 10 to 20 years, which represents the foreseeable future in terms of the potential for the Big Hole Grayling CCAA to address the threat. Additional projects, such as the replacement of the Divide Dam, also should reduce the threat in the foreseeable future.

Dewatering From Irrigation and Consequent Increased Water Temperatures

Demand for irrigation water in the semi-arid upper Missouri River basin has dewatered many rivers formerly or currently occupied by Arctic grayling. The primary effects of this dewatering are: 1) Increased water temperatures, and 2) reduced habitat capacity. In ectothermic species like salmonid fishes, water temperature sets basic constraints on species distribution and physiological performance, such as activity and growth (Coutant 1999, pp. 32–52). Increased water temperatures can reduce the growth and survival of Arctic grayling (physiological stressor). Reduced habitat capacity can concentrate fishes and thereby increase competition and predation (ecological stressor).

In the Big Hole River system, surface-water (flood) irrigation has substantially altered the natural hydrologic function of the river and has led to acute and chronic stream dewatering (Shepard and Oswald 1989, p. 29; Byorth 1993, p. 14; 1995, pp. 8–10; Magee *et al.* 2005, pp. 13–15). Most of the Big Hole River mainstem exceeds water quality standards under the Clean Water Act (33. U.S.C. 1251 *et seq.*; see discussion under Factor D, below) because of high summer water temperatures (Flynn *et al.* 2008, p. 2). Stream water temperature is affected by flow volume, stream morphology, and riparian shading, along with other factors, but an inverse relationship between flow volume and water temperature is apparent in the Big Hole River (Flynn *et al.* 2008, pp. 18–19). Summer water temperatures exceeding 21 °C (70 °F) are considered to be physiologically stressful for cold-water fish species, such as Arctic grayling (Hubert *et al.* 1985, pp. 7, 9). Summer water temperatures consistently exceed 21 °C (70 °F) in the mainstem of Big Hole River (Magee and Lamothe 2003, pp. 13–14; Magee *et al.* 2005, p. 15; Rens and Magee 2007, p. 11). Recently, summer water temperatures have consistently exceeded the upper incipient lethal temperature (UILT) for Arctic grayling (e.g., 25 °C or 77 °F) (Lohr *et al.* 1996) at a number of monitoring stations throughout the Big Hole River (Magee and Lamothe 2003, pp. 13–14; Magee *et al.* 2005, p. 15; Rens and Magee 2007, p. 11). The UILT is the temperature that is survivable indefinitely (for periods longer than 1 week) by 50 percent of the "test population" in an experimental setting. Fish kills are a clear result of high water temperature and have been documented in the Big Hole River (Lohr *et al.* 1996, p. 934). Consequently, water temperatures that are high enough to cause mortality of fish in the Big Hole River represent a clear threat to Arctic grayling because of the potential to directly and quickly reduce the size of the population.

Water temperatures below that which can lead to instant mortality also can affect individual fish. At water temperatures between 21 °C (70 °F) and 25 °C (77 °F), Arctic grayling can survive but experience chronic stress that can impair feeding and growth, reduce physiological performance, and ultimately reduce survival and reproduction. As described above, the Big Hole River periodically experiences summer water temperatures high enough to cause morality and chronic stress to Arctic grayling. Increased water temperature also appears to be a threat to Arctic grayling in the Madison River and Red Rock watershed. Mean and maximum summer water temperatures can exceed 21 °C (70 °F) in the Madison River below Ennis Reservoir (U.S. Geological Survey (USGS) 2010), and have exceeded 22 °C (72 °F) in the reservoir, and 24 °C (75 °F) in the reservoir inlet (Clancey and Lohrenz 2005, p. 34). Similar or higher temperatures have been noted at these same locations in recent years (Clancey 2002, p. 17; 2003, p. 25; 2004, pp. 29–30). Surface water temperatures in Upper Red Rock Lake as high as 24 °C (75 °F) have been recorded (Gillin 2001, p. 4-6), and presence of Arctic grayling in the lower 100 m (328 ft) of East Shambow Creek in 1994 was attributed to fish seeking refuge from high water temperatures in the lake (Mogen 1996, p. 44). Mean summer water temperatures in Red Rock Creek can occasionally exceed 20°C or 68°F during drought conditions (Mogen 1996, pp. 19, 45). Arctic grayling can survive but experience chronic stress that can impair feeding and growth, reduce physiological performance, and ultimately reduce survival and reproduction.

Experimental data specifically linking hydrologic alteration and dewatering to individual and population-level effects for Arctic grayling is generally lacking (Kaya 1992, p. 54), but we can infer effects from observations that the abundance and distribution of Arctic grayling has declined concurrent with reduced streamflows (MFWP *et al.* 2006, pp. 39–40) and increased water temperatures associated with low streamflows.

In the Big Hole River system, early-season (April through May) irrigation withdrawals may dewater grayling spawning sites (Byorth 1993, p. 22), preventing spawning or causing egg mortality; can prevent juvenile grayling from accessing cover in the vegetation along the shoreline; and may reduce connectivity between necessary spawning, rearing, and refuge habitats. Severe dewatering reduces habitat volume and may concentrate fish, increasing the probability of competition and predation among and between species. Nonnative trout species presently dominate the salmonid community in the Big Hole River, so dewatering would tend to concentrate Arctic grayling in habitats where interactions with these nonnative trout would be likely.

Especially in the Big Hole River, dewatering from irrigation represents a past and present threat to Arctic grayling. Thermal loading has apparently been a more frequent occurrence in the Big Hole River than in other locations containing native Arctic grayling (e.g., Red Rock Creek and Madison River–Ennis Reservoir). Implementation of the Big Hole Grayling CCAA during the next 20 years, which requires conservation measures to increase stream flows and restore riparian habitats (MFWP 2006, pp. 22–48), should significantly reduce the threat of thermal loading for Big Hole River grayling in the foreseeable future. While we expect agricultural and ranching-related use of water to continue, we expect that the threat will be reduced, but not eliminated, in the foreseeable future in the Big Hole River as a consequence of the CCAA. The ability of the Big Hole Grayling CCAA to augment streamflows should be substantial, as non-Federal landowners who control approximately 50 to 70 percent of the points of irrigation diversion in the upper Big Hole River are enrolled in the CCAA (Roberts and Lamothe 2010, pers. comm.). However, the Big Hole River constitutes one population in the DPS and high water temperatures are likely to continue to affect grayling in the Madison River and Red Rock Lakes. Thus, stream dewatering and high water temperatures are expected to remain a threat to the DPS in the foreseeable future.

Entrainment

Entrainment can permanently remove individuals from the natural population and strand them in a habitat that lacks the required characteristics for reproduction and survival. Irrigation ditches may dry completely when irrigation headgates are closed, resulting in mortality of entrained grayling. Entrainment of individual Arctic grayling in irrigation ditches occurs in the Big Hole River (Skarr 1989, p. 19; Streu 1990, pp. 24–25; MFWP *et al.* 2006, p. 49; Lamothe 2008, p. 22). Over 1,000 unscreened diversion structures occur in the upper Big Hole River watershed, and more than 300 of these are located in or near occupied grayling habitat (MFWP *et al.* 2006, pp. 48–49).

The magnitude of entrainment at unscreened diversions can depend on a variety of physical and biological factors, including the volume of water diverted (Kennedy 2009, p. iv, 36–38; but see Post *et al.* 2007, p. 885), species-specific differences in the timing of migratory behavior relative to when water is being diverted (Carlson and Rahel 2007, pp. 1340–1341), and differences in vulnerability among body size or life-stage (Gale 2005, pp. 30–47; Post *et al.* 2006, p. 975; Carlson and Rahel 2007 pp. 1340–1341). Studies of other salmonid species in a river basin in southwestern Wyoming determined that ditches typically entrain a small proportion (less than 4 percent) of the total estimated trout in the basin (Carlson and Rahel 2007, p. 1335) and that this represented a very small percentage of the total mortality for those populations (Post *et al.* 2006, pp. 875, 884; Carlson and Rahel 2007, pp. 1335, 1339). Whether or not this amount of mortality can cause population instability is unclear (Post *et al.* 2006, p. 886; Carlson and Rahel 2007, pp. 1340–1341). However, in some cases, even small vital rate changes in a trout population can theoretically cause population declines (Hilderbrand 2003, pp. 260–261).

The overall magnitude and population-level effect of entrainment on Arctic grayling in the Big Hole River is unknown but possibly significant given the large number of unscreened surface-water diversions in the system and the large volumes of water diverted for irrigation. Given the low abundance of the species, even a small amount of entrainment may be biologically significant and is unlikely to be offset by compensatory effects (i.e., higher survival in Arctic grayling that are not entrained).

Entrainment also may be a problem for Arctic grayling at some locations within the Red Rock Lakes system (Unthank 1989, p. 10; Gillin 2001, pp. 2-4, 3-18, 3-25), particularly outside of the Red Rock Lakes NWR (Boltz 2010, pers. comm.).

Entrainment has been a past threat to Arctic grayling in the Big Hole River and the Red Rock Lakes system. It remains a current threat as most, if not all, irrigation diversions located in occupied habitat do not have any devices to exclude fish (i.e., fish screens). Entrainment will remain a threat in the foreseeable future unless diversion structures are modified to exclude fish. The Big Hole Grayling CCAA has provisions to reduce entrainment at diversions operated by enrolled landowners (MFWP *et al.* 2006, pp. 50–52). Non-Federal landowners enrolled in the CCAA control approximately 50 to 70 percent of the points of irrigation diversion in the upper Big Hole River (Roberts and Lamothe 2010, pers. comm.), so the threat of entrainment in the Big Hole River should be significantly reduced in the foreseeable future. We consider the foreseeable future to represent approximately 20 years based on the duration of the Big Hole Grayling CCAA. Under the auspices of the Red Rock Lakes NWR CCP, a fish screen is planned to be installed on at least one diversion on the Red Rock Creek (USFWS 2009, p. 72), which is the primary spawning tributary for Arctic grayling in the Red Rock Lakes system. Overall, we anticipate it may take years to design and install fish screens on all the diversions that can entrain grayling in the Big Hole River and Red Rock Lakes systems; thus we conclude that entrainment remains a current threat that will continue to exist, but will decline in magnitude during the foreseeable future (next 10 to 20 years) because of implementation of the CCAA and CCP.

Degradation of Riparian Habitat

Riparian corridors are important for maintaining habitat for Arctic grayling in the upper Missouri River basin, and in general are critical for the ecological function of aquatic systems (Gregory *et al.* 1991, entire). These riparian zones are important for Arctic grayling because of their effect on water quality and role in creating and maintaining physical habitat features (pools) used by the species.

Removal of willows and riparian clearing concurrent with livestock and water management along the Big Hole River has apparently accelerated in recent decades, and, in conjunction with streamside cattle grazing, has led to localized bank erosion, channel instability, and channel widening (Confluence Consulting *et al.* 2003, pp. 24–26; Petersen and Lamothe 2006, pp. 16–17; Bureau of Land Management (BLM) 2009a, pp. 14–21). Arctic grayling abundance in the upper Big Hole River is positively related to the presence of overhanging vegetation, primarily willows, which are associated with pool habitat (Lamothe and Magee 2004b, pp. 21–22). Degradation of riparian habitat in the upper Big Hole River has led to a shift in channel form (from multiple threads to a single wide channel), increased erosion rates, reduced cover, increased water temperatures, and reduced recruitment of large wood into the active stream channel (Confluence Consulting *et al.* 2003, pp. 24–26). All of these combine to reduce the suitability of the habitat for species like Arctic grayling, and likely reduce grayling growth, survival, and reproduction.

Livestock grazing both within the Red Rock Lakes NWR and on adjacent private lands has negatively affected the condition of riparian habitats on tributaries to the Red Rock Lakes (Mogen 1996, pp. 75–77; Gillin 2001, pp. 3-12, 3-14). In general, degraded riparian habitat limits the creation and maintenance of aquatic habitats, especially pools, that are preferred habitats for adult Arctic grayling (Lamothe and Magee 2004b, pp. 21–22; Hughes 1992, entire). Loss of pools likely reduces growth and survival of adult grayling. Loss of riparian vegetation increases bank erosion, which can lead to siltation of spawning gravels, which may in turn harm grayling by reducing the extent of suitable spawning habitat and reducing survival of Arctic grayling embryos already present in the stream gravels. The condition of riparian habitats upstream from the Upper and Lower Red Rock Lakes may have improved during the 1990s (Mogen 1996, p. 77), and ongoing efforts to improve grazing management and restore riparian habitats are ongoing both inside the Red Rock Lakes NWR (USFWS 2009, pp. 67, 75) and upstream (AGW 2010, p. 7; Korb 2010, pers. comm.). However, the existing condition of riparian habitats continues to constitute a threat to Arctic grayling because the loss of pool habitat and the deposition of fine sediments may take some time to be reversed after the recovery of riparian vegetation.

Much of the degradation of riparian habitats in the Big Hole River and Red Rock Lakes systems has occurred within the past 50 to 100 years, but the influence of these past actions continues to affect the structure and function of aquatic habitats in these systems. Thus, while the actual loss of riparian vegetation has presumably slowed during the past 10 years, the effect of reduced riparian vegetation continues to promote channel widening and sedimentation, and limits the creation and maintenance of pool habitats. Thus, degradation of riparian habitats is a current threat. Degradation of riparian habitats will remain a threat in the foreseeable future until riparian vegetation recovers naturally or through direct restoration, which may occur during the next 20 years in the Big Hole River and portions of the Red Rock Lakes system. Protection and direct restoration of riparian habitats in the Big Hole River is occurring on a fairly large scale under the provisions of the Big Hole Grayling CCAA (Lamothe *et al.* 2007, pp. 13–26; Everett 2010, pp. 10–23), which should substantially reduce threats from riparian habitat degradation on private lands. Protection and restoration of riparian habitats implemented under the Red Rock Lakes NWR's CCP (see discussion under Factor D, below) should reduce threats from riparian habitat degradation within the NWR's boundary, but similar actions need to be taken on private lands adjacent to it (AGW 2010, p. 7; Korb 2010, pers. comm.) to appreciably reduce these threats in the foreseeable future and to expand the distribution of the species into formerly occupied habitat within that drainage.

Sedimentation

Sedimentation has been proposed as a mechanism behind the decline of Arctic grayling and its habitat in the Red Rock Lakes (Unthank 1989, p. 10; Mogen 1996, p. 76). Livestock grazing upstream has led to accelerated sediment transport in tributary streams, and deposition of silt in both stream and lakes has likely led to loss of fish habitat by filling in pools, covering spawning gravels, and reducing water depth in Odell and Red Rock Creeks, where Arctic grayling are still believed to spawn (MFWP 1981, p. 105; Mogen 1996, pp. 73–76).

Sedimentation in the Upper and Lower Red Rock Lakes is believed to affect Arctic grayling by, in winter, reducing habitat volume (e.g., lakes freezing to the bottom) and promoting hypoxia (low oxygen), which generally concentrates fish in specific locations which have suitable depth, and thus increases the probability of competition and predation, and, in summer, causing thermal loading stress (see Dewatering From Irrigation and Consequent Increased Water Temperatures discussion, above). Depths in the Red Rock Lakes have decreased significantly, with a decline in maximum depth from 7.6 to 5.0 m (25 to 16.4 ft) to less than 2 m (6.5 ft) noted in Upper Red Rock Lake over the past century (Mogen 1996, p. 76). Lower Red Rock Lake has a maximum depth of approximately 0.5 m (1.6 ft), and freezes within a few inches of the bottom or freezes solid (Unthank 1989, p. 10). Consequently, the Lower Red Rock Lake does not appear to provide suitable overwintering habitat for adfluvial Arctic grayling and may be devoid of grayling except for the few individuals that may migrate between Odell Creek and Upper Red Rock Lake (Mogen, 1996, p. 47).

Dissolved oxygen levels in Upper Red Rock Lake during winter 1994-1995 dropped as low as 0.5 to 0.15 parts per million (ppm; Gangloff 1996, pp. 41–42, 72), well below the critical minimum of 1.3 to 1.7 ppm measured for adult Arctic grayling acclimated to water temperatures less than or equal to 8 °C (46 °F) (Feldmeth and Eriksen 1978, pp. 2042–2043). Thus, lethally low oxygen levels can occur during winter in Upper Red Rock Lake, the primary overwintering area for adfluvial Arctic grayling in the system. Winter kill of invertebrates and fishes (e.g., suckers *Catostomus* spp.) has been recorded in Upper Red Rock Lake (Gangloff 1996, pp. 39–40). Gangloff (1996, pp. 71, 79) hypothesized that Arctic grayling in Upper Red Rock Lake exhibit behavioral mechanisms or physiological adaptations that permit them to survive otherwise lethally low oxygen levels. Oxygen conditions in the lake during winter are related to the effect of snowpack and ice cover on light penetration and the density of macrophytes (rooted aquatic plants) during the preceding growing season (Gangloff 1996, pp. 72-74). Arctic grayling under winter ice seek areas of higher oxygen concentration (oxygen refugia) within the lake or near inlet streams of Upper Red Rock Lake (Gangloff 1996, pp. 78-79). Consequently, we expect factors leading to reduced lake depth due to upstream erosion and sedimentation within the lake, or factors that promote eutrophication due to macrophyte growth, to lead to more frequent winter hypoxia (low dissolved oxygen concentrations detrimental to aquatic organsims) in Upper Red Rock Lake, which is the most important overwintering habitat for adfluvial Arctic grayling in the system.

The effects of erosion and sedimentation on spawning gravels and reduction of habitat volume in Upper and Lower Red Rock Lakes are past and current threats. Improved land use may be reducing the rates of erosion in tributary streams (USFWS 2009, pp. 75–76; Korb 2010, pers. comm.). However, sedimentation of the lakes will likely remain a threat (because of reduced overwintering habitat, and high water temperatures in summer) in the foreseeable future unless some event mobilizes these sediments and transports them out of the lakes.

Protection and restoration of riparian habitats implemented under the Red Rock Lakes NWR's CCP (see discussion under Factor D, below) should reduce the magnitude of sedimentation within the NWR's boundaries, but similar actions need to be taken on private lands adjacent to it (AGW 2010, p. 7; Korb 2010, pers. comm.) to appreciably reduce threats in the foreseeable future.

Summary of Factor A

Based on the best available information, we find that the historical range of the Missouri River DPS of Arctic grayling has been greatly reduced, and the remaining native populations continue to face significant threats to their habitat. Large-scale habitat fragmentation by dams was likely a significant historical factor causing the range-wide decline of the DPS. The most significant current threats to the DPS are from land and water use activities that have affected the structure and function of aquatic systems, namely stream dewatering from irrigation withdrawals, which reduces habitat volume and increases summer water temperatures; potential loss of individuals in irrigation ditches (entrainment); degraded riparian habitats promoting erosion, sedimentation, increased water temperatures, and loss of pool habitat; and migration barriers that restrict movement to and from spawning, feeding, and sheltering habitats. These are among the significant current threats to Arctic grayling populations in the Big Hole River, Madison River–Ennis Reservoir, and Red Rock Lakes system. The habitat-related threats to the Big Hole River population should be reduced in the foreseeable future by implementation of the Big Hole Grayling CCAA, a formalized conservation plan with 32 private landowners currently enrolled. The Big Hole Grayling CCAA is expected to reduce threats from dewatering, high water temperatures, barriers to fish passage, and entrainment in irrigation ditches that are associated with land and water use in the upper Big Hole River watershed during the foreseeable future (next 20 years based on the duration of the CCAA). Non-Federal landowners enrolled in the Big Hole Grayling CCAA control or own approximately 50 to 70 percent of the points of irrigation diversion in the upper Big Hole River, so these landowners should have the ability to reduce habitat-related threats to Arctic grayling in the Big Hole River by a corresponding amount. However, the present or threatened destruction, modification, or curtailment of habitat remains a threat to the DPS overall. This factor is expected to continue to be a threat to the species in the foreseeable future because it is not comprehensively addressed for other populations, especially those in the Madison River and Red Rock Lakes systems where ongoing habitat-related threats (described above) may be making unoccupied habitat unsuitable for Arctic grayling, and may thus limit the recovery potential of the DPS.

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

Arctic grayling of the upper Missouri River are handled for recreational angling; and for scientific, population monitoring, and restoration purposes.

Recreational Angling

Arctic grayling are highly susceptible to capture by angling (ASRD 2005, pp. 19–20), and intense angling pressure can reduce densities and influence the demography of exploited populations (Northcote 1995, pp. 171–172). Overfishing likely contributed to the rangewide decline of the DPS in the upper Missouri River system (Vincent 1962, pp. 49–52, 55; Kaya 1992, pp. 54–55). In 1994, concern over the effects of angling on fluvial Arctic grayling led the State of Montana to implement catch-and-release regulations for Arctic grayling captured in streams and rivers within its native range, and those regulations remain in effect (MFWP 2010, p. 52). Catch-and-release regulations for Arctic grayling in the Big Hole River have been in effect since 1988 (Byorth 1993, p. 8). Catch-and-release regulations also are in effect for Ennis Reservoir on the Madison River (MFWP 2010, p. 61). Angling is not permitted in either of the Red Rock Lakes to protect breeding waterfowl and trumpeter swans (*Cygnus buccinator*) (USFWS 2009, p. 147), and catch-and-release regulations remain in effect for any Arctic grayling captured in streams (e.g., Odell Creek or Red Rock Creek) in the Red Rock Lakes system (MFWP 2010, p. 56).

In Miner and Mussigbrod Lakes, anglers can keep up to 5 Arctic grayling per day and have up to 10 in possession, in accordance with standard daily and possession limits for that angling management district (MFWP 2010, p. 52). The current abundance of Arctic grayling in Mussigbrod Lake (see Table 4 above) suggests that present angling exploitation rates are not a threat to that population. Miner Lakes grayling are less abundant compared to Mussigbrod Lake, but we are not sure whether angling exploitation constitutes a threat to Miner Lakes grayling.

Repeated catch-and-release angling may harm individual fish, causing physiological stress and injury (i.e., hooking wounds). Catch-and-release angling also can result in mortality at a rate dependent on hooking location, hooking duration, fish size, water quality, and water temperature (Faragher *et al.* 2004, entire; Bartholomew and Bohnsack 2005, p. 140). Repeated hooking (up to five times) of Arctic grayling in Alaska did not result in significant additional mortality (rates 0 to 1.4 percent; Clark 1991, pp. 1, 25–26). In Michigan, hooking mortality of Arctic grayling in lakes averaged 1.7 percent per capture event based on 355 individuals captured with artificial flies and lures (Nuhfer 1992, pp. 11, 29). Higher mortality rates (5 percent) have been reported for Arctic grayling populations in the Great Slave Lake area, Canada (Falk and Gillman 1975, cited in Casselman 2005, p. 23). Comparatively high catch rates for Arctic grayling have been observed in the Big Hole River, Montana (Byorth 1993, pp. 26–27, 36), and average hooking wound rates ranged from 15 to 30 percent among study sections (Byorth 1993, p. 28). However, overall hooking mortality from single capture events was low (1.4 percent), which led Byorth to conclude that the Big Hole River population was not limited by angling (Byorth 1994b, entire).

Compared to the average catch-and-release mortality rates of 4.2 to 4.5 percent in salmonids as reported by Schill and Scarpella (1997, p. 873), and the mean and median catch-and-release mortality rates of 18 percent and 11 percent from a meta-analysis of 274 studies (Bartholomew and Bohnsack 2005, pp. 136–137), the catch-and-release mortality rates for Arctic grayling are comparatively low (Clark 1991, pp. 1, 25–26; Nuhfer 1992, pp. 11, 29; Byorth 1994b, entire). We are uncertain whether these lower observed rates reflect an innate resistance to effects of catch-and-release angling in Arctic grayling or whether they reflect differences among particular populations or study designs used to estimate mortality. Even if catch-and-release angling mortality is low (e.g., 1.4 percent as reported in Byorth 1994b, entire), the high catchability of Arctic grayling (ASRD 2005, pp. 19–20) raises some concern about the cumulative mortality of repeated catch-and-release captures. For example, based on the Arctic grayling catch rates and angler pressure reported by Byorth (1993, pp. 25–26) and the population estimate for the Big Hole River reported in Byorth (1994a, p. ii), a simple calculation suggests that age 1 and older grayling susceptible to recreational angling may be captured and released 3 to 6 times per year.

The MFWP closes recreational angling in specific reaches of the Big Hole River when environmental conditions are considered stressful. Specific streamflow and temperature thresholds initiate mandatory closure of the fishery (Big Hole Watershed Committee 1997, entire). Such closures have been implemented in recent years. For example, the upper segment of the Big Hole River between Rock Creek Road to the confluence of the North Fork Big Hole River has been closed to angling at various times during 2004 (Magee *et al.* 2005, p. 7), 2005 (Magee *et al.* 2006, p. 20), and 2006 (Rens and Magee 2007, p. 8).

In conclusion, angling harvest may have significantly reduced the abundance and distribution of the upper Missouri River DPS of Arctic grayling during the past 50 to 100 years, but current catch-and-release fishing regulations (or angling closures) in most waters occupied by extant populations have likely ameliorated the past threat of overharvest. Although we have some concerns about the potential for cumulative mortality caused by repeated catch-and-release of individual Arctic grayling in the Big Hole River, we have no strong evidence indicating that repeated capture of Arctic grayling under catch-and-release regulations is currently limiting that population or the DPS. Moreover, fishing is restricted in the Big Hole River, an important recreational fishing destination in southwestern Montana, when streamflow and temperature conditions are likely to increase stress to captured grayling. Anglers can still capture and keep Arctic grayling in Miner and Mussigbrod Lakes in accordance with State fishing regulations, but we have no evidence that current levels of angling are affecting these populations. We thus have no evidence that recreational angling represents a current threat to the DPS. If we assume that future fishing regulations would be at least as conservative as current regulations, and that the current levels of angling pressure will continue, then recreational angling does not represent a threat in the foreseeable future.

Monitoring and Scientific Study

The MFWP consistently monitors the Arctic grayling population in the Big Hole River and its tributaries, and to a lesser extent those populations in the Madison River and Red Rock Lakes system (Rens and Magee 20007, entire). Electrofishing (use of electrical current to temporarily and non-lethally immobilize a fish for capture) is a primary sampling method to monitor Arctic grayling in the Big Hole River, Madison River, and Red Rock Lakes (Rens and Magee 2007, pp. 13, 17, 20). A number of studies have investigated the effects of electrofishing on various life stages of Arctic grayling. Dwyer and White (1997, p. 174) found that electrofishing reduced the growth of juvenile Arctic grayling and concluded that long-term, sublethal effects of electrofishing were possible. Hughes (1998, pp. 1072, 1074–1075) found evidence that electrofishing and tagging affected the growth rate and movement behavior of Arctic grayling in the Chena River, Alaska. Roach (1999, p. 923) studied the effects of electrofishing on fertilized Arctic grayling eggs and found that while electrofishing could result in egg mortality, the population-level effects of such mortality were not likely to be significant. Lamothe and Magee (2003, pp. 16, 18–19) noted mortality of Arctic grayling in the Big Hole River during a radio-telemetry study, and concluded that handling stress or predation were possible causes of mortality. Population monitoring activities in the Big Hole River are curtailed when environmental conditions become unsuitable (Big Hole Watershed Committee 1997, entire), and recent monitoring reports (Magee and Lamothe 2004, entire; Magee *et al.* 2005, entire; Rens and Magee 2007, entire) provide no evidence that electrofishing is harming the Arctic grayling population in the Big Hole River.

A study in the Big Hole River is investigating the availability and use of coldwater thermal refugia for Arctic grayling and other resident fishes (Vatland and Gressewell 2009, entire).

The study uses fish tagged with passive integrated transponder (PIT) tag technology to record movement past receiving antennas. The PIT tags are small (23 mm or less than 1 in. long) and implanted into the body cavity of the fish during a quick surgical procedure. During 2007–2008, a total of 81 Arctic grayling from the Big Hole River and its tributaries were implanted with these PIT tags (Vatland and Gressewell 2009, p. 12). A short-term study on the potential effects of PIT tag implantation on Arctic grayling found 100 percent retention of tags and 100 percent survival of tagged individuals during a 4–day trial (Montana State University 2008, p. 7). Based on the results of the controlled trials, we have no evidence to indicate that PIT tagging the wild Arctic grayling in the Big Hole River constitutes a significant threat to the population.

Traps, electrofishing, and radio telemetry have been used to monitor and study Arctic graying in the Red Rock Lakes system (Gangloff 1996, pp. 13–14; Mogen 1996, pp. 10–13, 15; Kaeding and Boltz 1999, p. 4; Rens and Magee 2007, p. 17); however, there is no data to indicate these monitoring activities reduce the growth and survival of individual Arctic grayling or otherwise constitute a current or future threat to the population.

The Arctic grayling population in the Madison River–Ennis Reservoir is not monitored as intensively as the Big Hole River population (Rens and Magee 2007, pp. 20–21). When electrofishing surveys targeting Arctic grayling in the Madison River do occur, they are conducted during the spawning run for that population (Clancey 1996, p. 6). Capture and handling during spawning migrations or during actual spawning could affect the reproductive success of individual Arctic grayling. However, under recent monitoring frequencies, any population-level effect of these activities is likely negligible, and we have no data to indicate these monitoring activities reduce the growth and survival of individual Arctic grayling or otherwise constitute a current or future threat to the Madison River population.

The Miner Lakes and Mussigbrod Lake populations of Arctic grayling are infrequently monitored (Olsen 2010, pers. comm.). Since monitoring of these populations has been minimal, we do not believe that monitoring or scientific study constitutes a current or foreseeable threat to these particular populations.

The intensity of monitoring and scientific investigation varies among the different populations in the DPS, but we have no evidence suggesting that monitoring or scientific study has influenced the decline of Arctic grayling in the Missouri River basin. We also have no evidence indicating these activities constitute a current threat to the DPS that would result in measurable, population-level effects. We expect similar levels of population monitoring and scientific study in the future, and we have no basis to conclude that these activities represent a threat in the foreseeable future.

Reintroduction Efforts

Attempts to restore or re-establish native populations of both fluvial and adfluvial Arctic grayling may result in the mortality of embryos and young fish. The MFWP attempted to restore fluvial Arctic graying to historic waters in the upper Missouri River using a combination of stocking and embryo incubating devices (remote site incubators) placed in target streams (Rens and Magee 2007, pp. 24–38). Currently, gametes (eggs and sperm) used to re-establish the fluvial ecotype come from captive brood reserves of Big Hole River grayling maintained in Axolotl and Green Hollow II Lakes (Rens and Magee 2007, pp. 22–24). Removal of gametes from the wild Big Hole River population was necessary to establish this brood reserve (Leary 1991, entire). The previous removal of gametes for conservation purposes may have reduced temporarily the abundance of the wild population if the population was unable to compensate for this effective mortality by increased survival of remaining individuals. However, the establishment of a brood reserve provides a conservation benefit from the standpoint that gametes from the reserve can be harvested to use for translocation efforts to benefit the species. Unfortunately, these translocations have not yet resulted in establishment of any fluvial populations. Ultimately, we do not have any data to indicate that past gamete collection from the Big Hole River population harmed the wild population. Consequently, we have no basis to conclude that gamete collection from the wild Big Hole River Arctic grayling population constitutes a current or future threat to the population.

Efforts to re-establish native, genetically pure populations of adfluvial Arctic grayling in the Red Rock Lakes system and to maintain a brood reserve for that population have resulted in the direct collection of eggs from Arctic grayling spawning runs in Red Rock Creek. During 2000–2002, an estimated 315,000 Arctic grayling eggs were collected from females captured in Red Rock Creek (Boltz and Kaeding 2002, pp. v, 8). The Service placed over 180,000 of these eggs in remote site incubators in streams within the Red Rock Lakes NWR that historically supported Arctic grayling spawning runs (Boltz and Kaeding 2002, pp. v, 10). Despite preliminary observations of grayling spawning in historically occupied waters within the Red Rock Lakes NWR following the use of remote site incubators (Kaeding and Boltz 2004, pp. 1036), spawning runs at these locations have apparently not become established (Boltz 2006, pers. comm.). Attempts to establish a brood reserve of adfluvial Arctic grayling within the NWR's boundaries (MacDonald Pond) were not successful (Boltz and Kaeding 2002, pp. 21–22). Red Rock Lakes NWR plans to re-establish Arctic grayling in Elk Springs and Picnic Creeks and establish a brood stock in Widgeon Pond as part of its CCP (USFWS 2009, pp. 72, 75). The MFWP and the Service are currently collaborating on an effort to re-establish an Arctic grayling spawning run in Elk Springs Creek and to establish a genetically pure brood reserve of Red Rock Lakes grayling in Elk Lake as no such population exists for use in conservation and recovery (Jordan 2010, pers. comm.). These actions will require the collection of gametes (approximately 360,000 eggs) from Arctic grayling captured in Red Rock Creek (Jordan 2010, pers. comm.). Approximately 10 percent of these eggs will be returned to Red Rock Creek and incubated in that stream (using a remote site incubation method that results in high survivorship of embryos) (Kaeding and Boltz 2004, entire) to mitigate for collection of gametes from the wild spawning population (Jordan 2010, pers. comm.). We presume these ongoing actions may necessitate the collection of gametes from wild Arctic grayling in Red Rock Creek, so the potential effect of such collections on the extant wild population should be evaluated and mitigation for the use of these gametes (e.g., using remote site incubators at the collection source or another method) should continue.

Overall, we have no evidence to indicate that collection of gametes from the wild populations in the Big Hole River and Red Rock Lakes systems have contributed to population-level declines in those populations, or that the previous collections represent overexploitation. Future plans to collect gametes from Arctic grayling in the Big Hole River and Red Rock Lakes should be carefully evaluated in light of the status of those populations at the anticipated time of the collections. We encourage the agencies involved to coordinate their efforts and develop a strategy for broodstock development and recovery efforts that minimizes any potential impacts to wild native populations. However, at present, we do not have any data indicating collection of gametes for conservation purposes represents a current threat to the Big Hole River and Red Rock Lakes populations. We have no evidence to indicate that gamete collection will increase in the future, so we have no basis to conclude that this represents a threat in the foreseeable future.

Summary of Factor B

Based on the information available at this time, we conclude that overexploitation by angling may have contributed to the historical decline of the upper Missouri River DPS of Arctic grayling, but we have no evidence to indicate that current levels of recreational angling, population monitoring, scientific study, or conservation actions constitute overexploitation; therefore, we do not consider them a threat. We expect similar levels of these activities to continue in the future, and we do not believe they represent a threat in the foreseeable future.

C. Disease or Predation

Disease

Arctic grayling are resistant to whirling disease, which is responsible for population-level declines of other stream salmonids (Hedrick *et al.* 1999, pp. 330, 333). However, Arctic grayling are susceptible to bacterial kidney disease (BKD). Some wild populations in pristine habitats test positive for BKD (Meyers *et al.* 1993, pp. 186–187), but clinical effects of the disease are more likely to be evident in captive populations (Meyers *et al.* 1993, entire; Peterson 1997, entire). To preclude transmission of BKD between grayling during brood reserve, hatchery, and wild grayling translocation efforts, MFWP tests kidney tissue and ovarian fluid for the causative agent for BKD as well as other pathogens in brood populations (Rens and Magee 2007, pp. 22–24).

Information on the prevalence of the BKD or other diseases in native Arctic grayling populations in Montana is generally lacking. One reason is that some disease assays are invasive or require the sacrifice of individual fish (e.g., removal of kidney tissue to test for BKD pathogen.) Therefore, such testing is typically avoided in native populations of Missouri River Arctic grayling that are low in abundance. Arctic grayling in captive brood reserves (e.g., Axolotl Lake, Green Hollow Lake) and introduced populations (e.g., Sunnyslope Canal, Rogers Lake) have all tested negative for infectious hematopoietic necrosis virus (IHNV), infectious pancreatic necrosis virus (IPNV), *Myxobolus cerebralis* (the pathogen that causes whirling disease), *Renibacterium salmoninarum* (the pathogen that causes BKD), and *Aeromonas salmonicida* (the pathogen that causes furunculosis) (USFWS 2010a). Consequently, we have no evidence at this time that disease threatens native Arctic grayling of the upper Missouri River. We have no basis to conclude that disease will become a future threat, so we conclude that disease does not constitute a threat in the foreseeable future.

Predation By and Competition With Nonnative Trout

Brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), and rainbow trout have been introduced across the United States to provide recreational fishing opportunities, and are now widely distributed and abundant in the western United States, including the upper Missouri River system (Schade and Bonar 2005, p. 1386). One or more of these nonnative trout species co-occur with every native Arctic grayling population in the basin. Ecological interactions (predation and competition) with the brook trout, brown trout, and rainbow trout are among the long-standing hypotheses to explain decline of Arctic grayling in the upper Missouri River system and the extirpation of populations from specific waters (Nelson 1954, p. 327; Vincent 1962, pp. 81–96; Kaya 1992, pp. 55–56).

The potential for interspecific interactions should be greatest among species with similar life histories and ecologies that did not co-evolve (Fausch and White 1986, p. 364). Arctic grayling in the Missouri River basin have similar ecologies to brook trout, rainbow trout, and brown trout, yet they do not share a recent evolutionary history. The evidence for predation and competition by nonnative trout on Arctic grayling in the upper Missouri River basin is largely circumstantial, and inferred from the reduced abundance and distribution of Arctic grayling following encroachment by nonnative trout (Kaya 1990, pp. 52–54; Kaya 1992, p. 56; Magee and Byorth 1995, p. 54), as well as the difficulty in establishing Arctic grayling populations in waters already occupied by nonnative trout, especially brown trout (Kaya 2000, pp. 14–15). Presumably, competition with ecologically-similar species for food, shelter, and spawning locations can lead to reduced growth, reproduction, and survival of Arctic grayling (i.e., where they are outcompeted by nonnative trout). The strength of competition is very difficult to measure in wild trout populations (Fausch 1988, pp. 2238, 2243; 1998, pp. 220, 227). Few studies have evaluated competition between Arctic grayling and these nonnative species. Brook trout do not appear to negatively affect habitat use or growth of juvenile, hatchery-reared Arctic grayling (Byorth and Magee 1998, p. 921), but further studies are necessary to determine whether competition or predation occur at other life stages or with brown or rainbow trout (Byorth and Magee 1998, p. 929).

Predation represents direct mortality that can limit populations, and YOY Arctic grayling may be particularly susceptible to predation by other fishes because they are smaller and weaker swimmers than trout fry (Kaya 1990, pp. 52–53).

The incidence of competition and predation between nonnative trout and Arctic grayling likely depends on environmental context (e.g., habitat type and quality, environmental conditions such as temperature, and so forth). Nonetheless, it is widely accepted that biotic interactions with nonnative species are to some extent responsible for the decline of many native fishes in the western United States (Dunham *et al.* 2002, pp. 373–374 and references therein; Fausch *et al.* 2006, pp. 9–11 and references therein).

In the Big Hole River, brook trout, rainbow trout, and brown trout have been established for some time (Kaya 1992, pp. 50–51) and are much more abundant than Arctic grayling (Rens and Magee 2007, p. 42). In general, brook trout is the most abundant nonnative trout species in the Big Hole River upstream from Wisdom, Montana (Rens and Magee 2007, pp. 7, 42; Lamothe *et al.* 2007, pp. 35–38), whereas rainbow trout and brown trout are comparatively more abundant in the reaches immediately above and downstream from the Divide Dam (Kaya 1992, p. 56; Oswald 2005b, pp. 22–29; Lamothe *et al.* 2007, pp. 35–38; Rens and Magee 2007, p. 10). Rainbow trout are apparently more abundant than brown trout above the Divide Dam (Olsen 2010, pers. comm.), but brown trout are more abundant than rainbow trout below the dam (Oswald 2005b, pp. 22–33). Recent observations of increased brown trout abundance and distribution in the upper Big Hole River indicate that the species may be encroaching further upstream (AGW 2008, p. 1). Overall, at least one nonnative species occurs in the mainstem Big Hole River and tributary locations where Arctic grayling are present (Lamothe *et al.* 2007, p. 37; Rens and Magee 2007, p. 42). The Big Hole Grayling CCAA recognizes that the potential for competition with and predation by nonnative trout may limit the effectiveness of its conservation actions (MFWP *et al.* 2006, pp. 54–55).

The MFWP is the lead agency implementing the Big Hole Grayling CCAA under an agreement with the Service, and MFWP establishes fishing regulations for most waters in Montana. Different regulations may apply on NWR lands administered by the Service. The MFWP has agreed to continue catch-and-release regulations for Arctic grayling in the Big Hole River, to increase daily possession limits for nonnative brook trout (MFWP *et al.* 2006, p. 55; MFWP 2010, p. 52), and to consider whether additional management actions are necessary to address threats from nonnative trout based on recommendations of a technical committee of the AGW (MFWP *et al.* 2006, p. 55). However, we are not aware of data that shows angling regulations currently, or are expected to, reduce threats from brook trout. We also are not aware of any evaluations provided by the technical committee or of any additional management actions taken by MFWP to address potential threats from nonnative trout. Nonnative trout are widely distributed and abundant in the Big Hole River, and eradication may be impossible. The Big Hole Grayling CCAA focuses primarily on habitat-related threats (not nonnative trout), so we presume that nonnative trout will remain a threat to Arctic grayling for the foreseeable future.

Arctic grayling in Miner and Mussigbrod Lakes co-occur with one or more species of nonnative trout, but we have no quantitative information on the relative abundance of the introduced species. Brook trout and rainbow trout are both characterized as “common” in lower Miner Lakes (MFISH 2010), and brook trout in Mussigbrod Lake are similarly categorized as “common” (MFISH 2010). Brook trout have been present in the Big Hole River for at least 60 years (Liknes 1981, p. 34). The date when brook trout were introduced into Miner and Mussibrod Lakes is unknown (Liknes 1981, p. 33), but the co-occurrence of the brook trout with Arctic grayling in these habitats suggests that displacement of Arctic grayling by brook trout is not inevitable.

In the Madison River in and near Ennis Reservoir, brown trout and rainbow trout are abundant and are the foundation of an important recreational fishery (e.g., Byorth and Shepard 1990, p. 1). Nonnative rainbow trout and brown trout substantially outnumber Arctic grayling in the Madison River near Ennis Reservoir (Clancey and Lohrenz 2005, pp. 26, 29–31; 2009, pp. 91, 93).

In the Red Rock Lakes system, brook trout and hybrid cutthroat trout (Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*) rainbow trout; Mogen 1996, p. 42) have well-established populations and dominate the abundance and biomass of the salmonid community (Katzman 1998, pp. 2–3; Boltz 2010, pp. 2–3). Competition and predation risk for the Arctic grayling may be particularly acute in the shallow Upper Red Rock Lake when all fish species are forced to congregate in a few discrete deeper sites in response to environmental conditions, such as ice formation in winter (Boltz 2010, pers. comm.). Removal of nonnative trout from certain waters on the Red Rock Lakes NWR is part of the CCP (USFWS 2009, pp. 72, 75), so the frequency of predation of and competition with Arctic grayling by these species may be reduced at a limited spatial scale during the 15–year timeframe of the CCP.

Studies attempting to specifically measure the strength of competition with and magnitude of predation by nonnative trout on Arctic grayling in Montana have yielded mixed results. Only one study attempted to measure competition between brook trout and Arctic grayling (Byorth and Magee 1998, entire), and their study did not find strong evidence for presumed effects of competition, such as differences in microhabitat use or growth rate (Byorth and Magee 1998, p. 1998). However, the authors cautioned that further studies were needed to determine whether or not competition may be occurring between fish of different sizes or ages (other than those tested) or whether competition with or predation by rainbow trout or brown trout is occurring (Byorth and Magee, 1998, p. 929). Measuring the strength of competition and determining the relevant mechanisms (e.g., competition for food vs. space) is difficult to measure in fish populations (Fausch 1998, pp. 220, 227), so the lack of definitive evidence for the mechanisms of competition may simply be due to the inherent difficulties in measuring these effects and determining their influence on the population. Similarly, predation by brook trout on Arctic grayling eggs and fry has been observed in both the Big Hole River and Red Rock Lakes systems (Nelson 1954, entire; Streu 1990, p. 17; Katzman 1998, pp. 35, 47, 114), but such observations have not been definitively linked with a population decline of Arctic grayling. To our knowledge, no studies have investigated or attempted to measure predation by brown trout or rainbow trout on Arctic grayling in Montana.

Experimental evidence notwithstanding, the decline of Arctic grayling concurrent with encroachment by nonnative trout, combined with the difficulty in establishing grayling populations where nonnatives trout are present (Kaya 1992, pp. 55–56, 61; Kaya 2000, pp. 14–16), provides strong circumstantial evidence that a combination of predation and competition by nonnative trout has negatively affected Arctic grayling populations in the upper Missouri River. The lack of direct evidence for competition (e.g., with brook trout) or predation (e.g., by brown trout) most likely indicates that these mechanisms can be difficult to detect and measure in wild populations and that additional scientific investigation is needed. We recognize that displacement of Arctic grayling is not a certain outcome where the species comes into contact with brook trout (e.g., Big Hole River), but the circumstances that facilitate long-term co-existence vs. transitory co-existence are unknown. Ultimately, circumstantial evidence from Montana and the western United States suggests that the presence of nonnative trout species represents a substantial threat to native fishes including Arctic grayling. At least one species of nonnative trout is present in all waters occupied by native Arctic grayling populations in the upper Missouri River, so the threat is widespread and imminent, and we expect that nonnative trout will remain a part of the biological community. Thus, we expect that nonnative trout are a threat to Missouri River Arctic grayling in the foreseeable future.

Predation by Birds and Mammals

In general, the incidence and effect of predation by birds and mammals on Arctic grayling is not well understood because few detailed studies have been completed (Northcote 1995, p. 163). Black bear (*Ursus americanus*), mink (*Neovison vison*), and river otter (*Lontra canadensis*) are present in southwestern Montana, but direct evidence of predatory activity by these species is often lacking (Kruse 1959, p. 348). Osprey (*Pandion halaietus*) can capture Arctic grayling during the summer (Kruse 1959, p. 348). In the Big Hole River, Byorth and Magee (1998, p. 926) attributed the loss of Arctic grayling from artificial enclosures used in a competition experiment to predation by minks, belted kingfisher (*Ceryl alcyon*), osprey, and great blue heron (*Ardea herodia*). In addition, American white pelican (*Pelecanus erythrorhynchos*) are seasonally present in the Big Hole River, and they also may feed on grayling. The aforementioned mammals and birds can be effective fish predators, but we have no data demonstrating any of these species historically or currently consume Arctic grayling at levels sufficient to exert a measureable, population-level impact on native Arctic grayling in the upper Missouri River system. We expect the current situation to continue, so we conclude that predation by birds and mammals does not constitute a substantial threat to Missouri River Arctic grayling in the foreseeable future.

Summary of Factor C

Based on the information available at this time, we conclude disease does not represent a past or current threat to the Missouri River DPS of Arctic grayling. We have no factual basis for concluding that disease may become a future threat, but anticipate that the likelihood of disease in native populations will depend on and interact with other factors (e.g., habitat condition, climate change) that may cumulatively stress individual fish and reduce their ability to withstand infection by disease-causing pathogens.

Circumstantial evidence indicates that ecological interactions with nonnative trout species have led to the displacement of Arctic grayling from portions of its historic range in the upper Missouri River basin. Nonnative trout species, such as brook trout, brown trout, and rainbow trout, remain widely distributed and abundant in habitats currently occupied by native Arctic grayling populations. Consequently, we determined that the presence of nonnative trout represents a substantial current and foreseeable threat to native Arctic grayling of the upper Missouri River.

Little is known about the effect of predation on Arctic grayling by birds and mammals. Such predation likely does occur, but in contrast to the pattern of displacement observed concurrent with encroachment by nonnative trout, we are not aware of any situation where an increase in fish-eating birds or mammals has coincided with the decline of Arctic grayling. Consequently, the available information does not support a conclusion that predation by birds or mammals represents a substantial past, present, or foreseeable threat to native Arctic grayling in the upper Missouri River.

D. Inadequacy of Existing Regulatory Mechanisms

The ESA requires us to examine the adequacy of existing regulatory mechanisms with respect to those extant threats that place the species in danger of becoming either endangered or threatened. Thus, the scope of this analysis generally focuses on the extant native populations of Arctic grayling and potential current and foreseeable threats based on the inadequacy of existing regulatory mechanisms.

Federal Laws and Regulations

Native Arctic grayling are present in or adjacent to land managed by the U.S. Forest Service (USFS) (Big Hole River, Miner, and Mussigbrod Lakes: Beaverhead–Deerlodge National Forest), National Park Service (NPS) (Big Hole River: Big Hole National Battlefield), Bureau of Land Management (BLM) (Big Hole River: Dillon Resource Area), USFWS (Red Rock Lakes NWR); and the Federal Energy Regulatory Commission (Madison River–Ennis Reservoir: Ennis Dam, operated under Project 2188 license).

National Environmental Policy Act

All Federal agencies are required to adhere to the National Environmental Policy Act (NEPA) of 1970 (42 U.S.C. 4321 *et seq.*) for projects they fund, authorize, or carry out. The Council on Environmental Quality's regulations for implementing NEPA (40 CFR 1500–1518) state that, when preparing environmental impact statements, agencies shall include a discussion on the environmental impacts of the various project alternatives, any adverse environmental effects which cannot be avoided, and any irreversible or irretrievable commitments of resources involved (40 CFR 1502). The NEPA itself is a disclosure law, and does not require subsequent minimization or mitigation measures by the Federal agency involved. Although Federal agencies may include conservation measures for Arctic grayling as a result of the NEPA process, any such measures are typically voluntary in nature and are not required by NEPA.

Federal Land Policy and Management Act

The BLM's Federal Land Policy and Management Act (FLPMA) of 1976 (43 U.S.C. 1701 *et seq.*), as amended, states that the public lands shall be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values.

The BLM considers the fluvial Arctic grayling a sensitive species requiring special management consideration for planning and environmental analysis (BLM 2009b, entire). The BLM has recently developed a Resource Management Plan (RMP) for the Dillon Field Office Area that provides guidance for the management of over 900,000 acres of public land administered by BLM in southwest Montana (BLM 2006a, p. 2). The Dillon RMP area thus includes the geographic area that contains the Big Hole, Miner, Mussigbrod, Madison River, and Red Rock populations of Arctic grayling. A RMP planning area encompasses all private, State, and Federal lands within a designated geographic area (BLM 2006a, p. 2), but the actual implementation of the RMP focuses on lands administered by the BLM that typically represent only a fraction of the total land area within that planning area (BLM 2006b, entire). Restoring Arctic grayling habitat and ensuring the long-term persistence of both fluvial and adfluvial ecotypes are among the RMP's goals (BLM 2006a, pp. 30–31). However, there is little actual overlap between the specific parcels of BLM land managed by the Dillon RMP and the current distribution of Arctic grayling (BLM 2006b, entire).

The BLM also has a RMP for the Butte Field Office Area, which includes more than 300,000 acres in south-central Montana (BLM 2008, entire), including portions of the Big Hole River in Deerlodge and Silver Bow counties (BLM 2008, p. 8; 2009c, entire). The Butte RMP considers conservation and management strategies and agreements for Arctic grayling in its planning process and includes a goal to opportunistically enhance or restore habitat for Arctic grayling (BLM 2008, pp. 10, 30, 36). However, the Butte RMP does not mandate specific actions to improve habitat for Arctic grayling in the Big Hole River.

National Forest Management Act

Under the USFS' National Forest Management Act (NFMA) of 1976, as amended (16 U.S.C. 1600–1614), the USFS shall strive to provide for a diversity of plant and animal communities when managing national forest lands. Individual national forests may identify species of concern that are significant to each forest's biodiversity. The USFS Northern Rocky Mountain Region (R1) considers fluvial Arctic grayling a sensitive species (USFS 2004, entire) for which population viability is a concern, as evidenced by a significant downward trend in population or a significant downward trend in habitat capacity.

Much of the headwaters of the Big Hole River drainage are within the boundary of the Beaverhead–Deerlodge National Forest. The Miner and Mussigbrod Lakes Arctic grayling populations are entirely within Forest boundaries. The Beaverhead–Deerlodge National Forest is currently revising its forest plan. The USFS does not propose to designate key fish watersheds solely to benefit grayling, but fluvial Arctic grayling will remain a sensitive species with Forest-wide standards and objectives to meet the species' habitat requirements (USFS 2009a, p. 19). With respect to fluvial Arctic grayling, the USFS is proposing a Controlled Surface Use (CSU) stipulation in the Ruby River (an ongoing reintroduction site) and certain tributaries of the Big Hole River (USFS 2009b, pp. 29, B-13) to avoid impacts from mineral, gas, and oil extraction (USFS 2009b, pp. 27–28). These CSU stipulations define the minimum extent of buffer areas adjacent to streams. In general, the preferred forest plan alternative (Alternative 6, USFS 2009a, p. 6) is deemed by the USFS to provide management direction designed to ensure the persistence of grayling populations Forest-wide, and to meet viability requirements of this species (USFS 2009a, p. 146). The forest plan revision has not yet been finalized through a record of decision (ROD), so we are unable to specifically evaluate its potential effect on native Arctic grayling populations.

National Park Service Organic Act

The NPS Organic Act of 1916 (16 U.S.C. 1 *et seq.*), as amended, states that the NPS "shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations ... to conserve the scenery and the national and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Native populations of Arctic grayling have been extirpated from Yellowstone National Park, but the Big Hole National Battlefield is adjacent to the North Fork of the Big Hole River (NPS 2006, entire), and Arctic grayling are occasionally encountered downstream from the Battlefield (Rens and Magee 2007, pp. 7, 13). Consequently, a very small amount of currently occupied grayling habitat is in the vicinity of lands managed by the NPS; therefore, the NPS Organic Act is not thought to have any significant effect on native Arctic grayling populations.

National Wildlife Refuge System Improvement Act of 1997

The National Wildlife Refuge Systems Improvement Act (NWRSIA) of 1997 (Pub. L. 105-57) amends the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd *et seq.*). The NWRSIA directs the Service to manage the Refuge System's lands and waters for conservation. The NWRSIA also requires monitoring of the status and trends of refuge fish, wildlife, and plants. The NWRSIA requires development of a Comprehensive Conservation Plan (CCP) for each refuge and management of each refuge consistent with its plan.

The Service has developed a final CCP to provide a foundation for the management and use of Red Rock Lakes NWR (USFWS 2009, entire). Red Rocks NWR is 2,033-2,865 m (6,670-9,400 ft) above sea level, comprises 48,955 ac, and lies east of the Continental Divide near the uppermost reach of the Missouri drainage (USFWS 2009, pp. v, 2). The Red Rocks NWR encompasses Lower and Upper Red Rock Lakes, which contain native grayling. The Red Rocks NWR CCP outlines a set of broad goals and specific objectives or strategies with respect to conservation of Arctic grayling that focuses on habitat improvements, reestablishment of populations, and removal of nonnative trout where necessary (USFWS 2009, pp. 67, 75–76). We expect that implementation of the CCP during the next 15 years will address a number of significant resource issues that affect grayling (e.g., riparian habitat condition, entrainment in irrigation ditches, increasing the extent of occupancy in the system). Nonetheless, actions similar to those planned inside the NWR will be needed on adjacent properties to reduce threats to the existing population of grayling in the Red Rock Lakes system.

Federal Power Act

The Federal Power Act of 1920 (16 U.S.C. 791-828c, as amended) provides the legal authority for the Federal Energy Regulatory Commission (FERC), as an independent agency, to regulate hydropower projects. In deciding whether to issue a license, FERC is required to give equal consideration to mitigation of damage to, and enhancement of, fish and wildlife (16 U.S.C. 797(e)). A number of FERC-licensed dams exist in the Missouri River basin in current (i.e., Ennis Dam on the Madison River) and historical Arctic grayling habitat (e.g., Hebgen Dam on the Madison River; Hauser, Holter, and Toston dams on the mainstem Missouri River; and Clark Canyon Dam on the Beaverhead River). The FERC license expiration dates for these dams range from 2024 (Toston) to 2059 (Clark Canyon) (FERC 2010, entire). None of these structures provide upstream passage of fish, and such dams are believed to be one of the primary factors leading to the decline of Arctic grayling in the Missouri River basin (see discussion under Factor A, above). Consequently, we conclude that historically the Federal Power Act has not adequately protected Arctic grayling or its habitat. We anticipate this will remain a threat it in the foreseeable future because of future expiration dates of the FERC-licensed dams in the upper Missouri River basin.

Clean Water Act

The Clean Water Act (CWA) of 1972 (33 U.S.C. 1251 *et seq.*) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The CWA's general goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 U.S.C. 1251 (a)). The CWA requires States to adopt standards for the protection of surface water quality and establishment of Total Maximum Daily Load (TMDL) guidelines for rivers. The Big Hole River has approved TMDL plans for its various reaches (MDEQ 2009a, entire; 2009b, entire); thus, complete implementation of this plan should improve water quality (by reducing water temperatures, and reducing sediment and nutrient inputs) in the Big Hole River in the foreseeable future. As of November 2009, the Red Rocks watershed was in the pre-TMDL planning and assessment phase, but there was no significant TMDL plan development activity in the Madison River (see MDEQ 2010). Consequently, implementation of the CWA through an EPA-approved TMDL plan began in 2009 for the Big Hole River watershed, but has yet to begin in other waters occupied by native Arctic grayling in the upper Missouri River. The CWA does not appear to be adequate to protect the Missouri River DPS of Arctic grayling, but implementation of TMDL plans should improve habitat conditions for Big Hole River grayling in the foreseeable future.

Montana State Laws and Regulations

Arctic grayling is considered a species of special concern by Montana, but this is not a statutory or regulatory classification (Montana Natural Heritage Program 2010).

State Comprehensive Wildlife Conservation Strategies

These strategies, while not State or national legislation, can help prioritize conservation actions within each State. Species and habitats named within each Comprehensive Wildlife Conservation Strategy (CWCS) may receive focused attention. The MFWP considers Arctic grayling as a Tier I conservation species under its CWCS and the Big Hole River also is a Tier I Aquatic Conservation Focus Area (Montana's Comprehensive Fish and Wildlife Conservation Strategy (MCFWCS) 2005, pp. 75–76).

Montana Environmental Policy Act

The legislature of Montana enacted the Montana Environmental Policy Act (MEPA) as a policy statement to encourage productive and enjoyable harmony between humans and their environment, to protect the right to use and enjoy private property free of undue government regulation, to promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humans, to enrich the understanding of the ecological systems and natural resources important to the State, and to establish an environmental quality council (MCA 75-1-102). Part 1 of the MEPA establishes and declares Montana's environmental policy. Part 1 has no legal requirements, but the policy and purpose provide guidance in interpreting and applying statutes. Part 2 requires State agencies to carry out the policies in Part 1 through the use of systematic, interdisciplinary analysis of State actions that have an impact on the human environment. This is accomplished through the use of a deliberative, written environmental review. In practice, MEPA provides a basis for the adequate review of State actions in order to ensure that environmental concerns are fully considered (MCA 75-1-102). Similar to NEPA, the MEPA is largely a disclosure law and a decision-making tool that does not specifically require subsequent minimization or mitigation measures.

Laws Affecting Physical Aquatic Habitats

A number of Montana State laws have a permitting process applicable to projects that may affect stream beds, river banks, or floodplains. These include the Montana Stream Protection Act (SPA), the Streamside Management Zone Law (SMZL), and the Montana Natural Streambed and Land Preservation Act (Montana Department of Natural Resources (MDNRC) 2001, pp. 7.1–7.2). The SPA requires that a permit be obtained for any project that may affect the natural and existing shape and form of any stream or its banks or tributaries (MDNRC 2001, p. 7.1). The Montana Natural Streambed and Land Preservation Act (i.e., MNSLPA or 310 permit) requires private, nongovernmental entities to obtain a permit for any activity that physically alters or modifies the bed or banks of a perennially-flowing stream (MDNRC 2001, p. 7.1). The SPA and MNSLPA laws do not mandate any special recognition for species of concern, but in practice, biologists that review projects permitted under these laws usually stipulate restrictions to avoid harming such species (Horton 2010, pers. comm.). The SMZL regulates forest practices near streams (MDNRC 2001, p. 7.2). The Montana Pollutant Discharge Elimination System (MPDES) Stormwater Permit applies to all discharges to surface water or groundwater, including those related to construction, dewatering, suction dredges, and placer mining, as well as to construction that will disturb more than 1 acre within 100 ft (30.5 m) of streams, rivers, or lakes (MDNRC 2001, p. 7.2).

Review of applications by MFWP, MTDEQ, or MDNRC is required prior to issuance of permits under the above regulatory mechanisms (MDNRC 2001, pp. 7.1–7.2). Although these regulatory mechanisms would be expected to limit impacts to aquatic habitats in general, the decline of Arctic grayling in the Big Hole River, Madison River, and certain waters in the Red Rock Lakes system does not provide evidence that past implementation of these laws, regulations, and permitting processes has effectively limited impacts to Arctic grayling habitat. Thus, we have no basis for concluding that these same regulatory mechanisms are adequate to protect the Arctic grayling and its habitat now or in the foreseeable future.

Montana Water Use Act

The implementation of Montana Water Use Act (Title 85: Chapter 2, Montana Codes Annotated) may not adequately address threats to Arctic grayling in basins where the allocation of water rights exceeds the available water (overallocation) and the water rights holders fully execute their rights (i.e., use all water legally available for diversion). The Missouri River system is generally believed to be overappropriated, and water for additional consumptive uses is only available for a few months during very wet years (MDNRC 1997, p. 12). The Upper Missouri River basin and Madison River basin have been closed to new water appropriations because of water availability problems, overappropriation, and a concern for protecting existing water rights (MDNRC 2009, p. 45). In addition, recent compacts (a legal agreement between Montana, a Federal agency, or an Indian tribe determining the quantification of federally or tribally claimed water rights) have been signed that close appropriations in specific waters in or adjacent to Arctic grayling habitats. For example, the USFWS–Red Rock Lakes–Montana Compact includes a closure of appropriations for consumptive use in the drainage basins upstream of the most downstream point on the Red Rock Lakes NWR and the Red Rock Lakes Wilderness Area (MDNRC 2009, pp. 18, 47). The NPS–Montana Compact specifies that certain waters will be closed to new appropriations when the total appropriations reach a specified level, and it applies to Big Hole National Battlefield and adjacent waters (North Fork of the Big Hole River and its tributaries including Ruby and Trail Creeks), and the portion of Yellowstone National Park that is in Montana (MDNRC 2009, p. 48).

The State of Montana is currently engaged in a state-wide effort to adjudicate (finalize) water rights claimed before July 1, 1973. The final product of adjudication in a river basin is a final decree. To reach completion, a decree progresses through several stages: (1) Examination, (2) temporary preliminary decree, (3) preliminary decree, (4) public notice, (5) hearings, and (6) final decree (MDNRC 2009, pp. 9–14). As of February 2010, the Red Rock River system is currently being examined, and the Big Hole and Madison Rivers have temporary decrees (MDNRC 2010, entire). We anticipate the final adjudication of all the river basins in Montana that currently contain native Arctic grayling will be completed in the foreseeable future, but we do not know if this process will eliminate the overallocation of water rights.

Fishing Regulations

Arctic grayling is considered a game fish (MFWP 2010, p. 16), but is subject to special catch-and-release regulations in streams and rivers within its native range (MFWP 2010, p. 52). Catch-and-release regulations also are in effect for Ennis Reservoir on the Madison River (MFWP 2010, p. 61). Arctic grayling in Miner and Mussigbrod Lakes are subject to more liberal regulations; anglers can keep up to 5 per day and have up to 10 in possession in accordance with standard daily and possession limits for that angling management district

(MFWP 2010, p. 52). We have no evidence to indicate that current fishing regulations are inadequate to protect native Arctic grayling in the Missouri River basin (see discussion under Factor B, above).

Summary of Factor D

We infer that current Federal and State regulatory mechanisms are inadequate to protect native Arctic grayling of the upper Missouri River. We conclude this because the regulatory mechanisms may only apply to specific populations (or parts of populations) depending on land ownership and jurisdiction, they have no track record of addressing significant threats to habitat, and they do not address the threat posed by nonnative trout.

Regulatory mechanisms on Federal lands may be adequate to protect certain fragments of Arctic grayling habitat or isolated populations (e.g., Miner and Mussigbrod Lakes). However, the extirpation of more than one lake population within the Beaverhead–Deerlodge National Forest (e.g., Elk Lake – Oswald 2000, p. 10; Hamby Lake – Oswald 2005a, pers. comm.) suggests the existing regulatory mechanisms may not be sufficient. Difficulties in coordinating land and water use across jurisdictional boundaries (State, Federal, private) within a watershed also present challenges for coordinated management of Arctic grayling. In the Big Hole River, fluvial Arctic grayling generally occupy waters adjacent to private lands (MFWP *et al.* 2006, p. 13; Lamothe *et al.* 2007, p. 4), so Federal regulations may have limited scope to protect the species.

Conceivably, application of existing regulations concerning occupied Arctic grayling habitat in the upper Missouri River basin (e.g., CWA, FLPMA, NFMA, SMZL, SPA) should promote and ensure the persistence of Arctic grayling because these regulations were promulgated, to some extent, to limit impacts of human activity on the environment. However, based on the current status of the DPS and the degradation of habitat and declines in populations observed in the past 20 to 30 years, during which time many of the above regulatory mechanisms have been in place, we have no basis to conclude that they have adequately protected grayling up to this time. In other words, existing regulations theoretically limit threats to Arctic grayling, but in practice have not done so. We suspect that incomplete or inconsistent application of these regulatory mechanisms and jurisdictional difficulties (State vs. Federal regulations, private vs. public lands) relative to the distribution of Arctic grayling may be partially responsible. Other regulatory mechanisms simply require disclosure (e.g., NEPA) and do not necessarily mandate protection for a species or its habitat. Consequently, we believe that existing regulatory mechanisms that deal with land and water management have not demonstrably reduced threats to Arctic grayling in the past, and we have no basis to conclude that they are adequate now or will be in the future.

Existing regulatory mechanisms do not directly address threats posed by nonnative brook trout, brown trout, or rainbow trout (see Factor C discussion, above). One exception is that the Red Rock Lakes NWR CCP does consider removal of nonnative trout to be a possible action to benefit Arctic grayling, but this may not apply to occupied habitat outside the NWR, so the CCP is likely to only address this threat for a portion of the population.

For the reasons described above, we conclude that the inadequacy of existing regulatory mechanisms poses a current threat to native Arctic grayling of the upper Missouri River. We do not anticipate any changes to the existing regulatory mechanisms, thus we conclude that the inadequacy of existing regulatory mechanisms is a threat in the foreseeable future.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

Drought

Drought appears to be a significant natural factor that threatens Arctic grayling populations in streams and rivers in the upper Missouri River basin. Drought can affect fish populations by reducing stream flow volumes. This leads to dewatering and high temperatures that can limit connectivity among spawning, rearing, and sheltering habitats; to a reduced volume of thermally suitable habitat; and to an increased frequency of water temperatures above the physiological limits for optimum growth and survival in Arctic grayling. Drought is a natural occurrence in the interior western United States (see National Drought Mitigation Center 2010). The duration and severity of drought in Montana appears to have increased during the last 50 years, and precipitation has tended to be lower than average in the last 20 years (National Climatic Data Center 2010). In addition, drought can interact with human-caused stressors (e.g., irrigation withdrawals, riparian habitat degradation) to further reduce stream flows and increase water temperatures.

Reduced stream flows and elevated water temperatures during drought have been most apparent in the Big Hole River system (Magee and Lamothe 2003, pp. 10-14; Magee *et al.* 2005, pp. 23-25; Rens and Magee 2007, pp. 11-12, 14). Although the response of stream and river habitats to drought is expected to be most pronounced because of the strong seasonality of flows in those habitats, effects in lake environments do occur. For example, both the Upper and Lower Red Rock Lakes are very shallow (Mogen 1996, p. 7). Reduced water availability during drought would result in further shallowing (loss of habitat volume) that can lead to increased temperatures in summer and the likelihood of complete freezing or anoxia (lack of oxygen) in winter.

In the Big Hole River, evidence for the detrimental effects of drought on Arctic grayling populations is primarily inferential; observed declines in fluvial Arctic grayling and nonnative trout abundances in the Big Hole River coincide with periods of drought (Magee and Lamothe 2003, pp. 22–23, 28) and fish kills (Byorth 1995, pp. 10–11, 31). Similarly, lack of success with fluvial Arctic grayling restoration efforts elsewhere in the upper Missouri River basin also has been attributed, in part, to drought (Lamothe and Magee 2004a, p. 28).

Given the climate of the intermountain West, we conclude that drought has been and will continue to be a natural occurrence. We assume that negative effects of drought on Arctic grayling populations, such as reduced connectivity among habitats or increased water temperatures at or above physiological thresholds for growth and survival, are more frequent in stream and river environments and in very shallow lakes relative to larger, deeper lakes. Therefore, we expect the threat of drought to be most pronounced for Arctic grayling populations in the Big Hole River, Madison River–Ennis Reservoir, and Red Rock Lakes. We do not know whether drought has or is currently limiting Arctic grayling populations in Miner and Mussigbrod Lakes, as there are few monitoring data for these populations. Arctic grayling in Miner and Mussigbrod Lakes presumably use inlet or outlet streams for spawning; thus, if severe drought occurs during spawning and before subsequent emigration of YOY grayling to the rearing lakes, then population-level effects are possible. Overall, we conclude that drought has been a past threat, is a current threat, and will continue to be a threat to Arctic grayling of the upper Missouri River basin, especially for those populations in the

Big Hole River, Madison River–Ennis Reservoir, and Red Rock Lakes. Successful implementation of the Big Hole Grayling CCAA may partially ameliorate the effects of drought in the Big Hole River, by reducing the likelihood that human-influenced actions or outcomes (irrigation withdrawals, destruction of riparian habitats, and fish passage barriers) will interact with the natural effects of drought (reduced stream flows and increased water temperatures) to negatively affect suitable habitat for Arctic grayling. We expect the magnitude of the threat from drought to increase in the foreseeable future under the anticipated air temperature and precipitation trends projected by climate change models (discussed in detail below).

Climate Change

Climate is influenced primarily by long-term patterns in air temperature and precipitation. The Intergovernmental Panel on Climate Change (IPCC) has concluded that climate warming is unequivocal, and is now evident from observed increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level (IPCC 2007, pp. 30–31). Continued greenhouse gas emissions at or above current rates are expected to cause further warming (IPCC 2007, p. 30). Eleven of the 12 years from 1995 through 2006 rank among the 12 warmest years in the instrumental record of global average near-surface temperature since 1850 (ISAB 2007, p.7; IPCC 2007, p. 30). During the last century, mean annual air temperature increased by approximately 0.6 °C (1.1 °F) (IPCC 2007, p. 30). Warming appears to be accelerating in recent decades, as the linear warming trend over the 50 years from 1956 to 2005 (average 0.13 °C or 0.24 °F per decade) is nearly twice that for the 100 years from 1906 to 2005 (IPCC 2007, p. 30). Climate change scenarios estimate that the mean air temperature could increase by over 3 °C (5.4 °F) by 2100 (IPCC 2007, pp. 45–46). The IPCC also projects that there will likely be regional increases in the frequency of hot extremes, heat waves, and heavy precipitation, as well as greater warming in high northern latitudes (IPCC 2007, p. 46). We recognize that there are scientific differences of opinion on many aspects of climate change, including the role of natural variability in climate. In our analysis, we rely primarily on synthesis documents (IPCC 2007; ISAB 2007; Karl *et al.* 2009) that present the consensus view of a large number of experts on climate change from around the world. We found that these synthesis reports, as well as the scientific papers used in those reports, or resulting from those reports, represent the best available scientific information we can use to inform our decision. Where possible, we used empirical data or projections specific to the western United States, which includes the range of Arctic grayling in the Missouri River basin, and focused on observed or expected effects on aquatic systems.

Water temperature and hydrology (stream flow) are sensitive to climate change, and influence many of the basic physical and biological processes in aquatic systems. For ectothermic organisms like fish, temperature sets basic constraints on species' distribution and physiological performance, such as activity and growth (Coutant 1999, pp. 32–52). Stream hydrology not only affects the structure of aquatic systems across space and time, but influences the life-history and phenology (timing of life-cycle events) of aquatic organisms, such as fishes. For example, the timing of snowmelt runoff can be an environmental cue that triggers spawning migrations in salmonid fishes (Brenkman *et al.* 2001, pp. 981, 984), and the timing of floods relative to spawning and emergence can strongly affect population establishment and persistence (Fausch *et al.* 2001, pp. 1438, 1450). Significant trends in water temperature and stream flow have been observed in the western United States (Stewart *et al.* 2005, entire; Kaushal *et al.* 2010, entire), and climatic forcing caused by increased air temperatures and changes in precipitation are partially responsible.

Warming patterns in the western United States are not limited to streams. In California and Nevada, water surface temperatures have increased by an average of 0.11 °C (0.2 °F) per year since 1992 and at a rate twice that of the average minimum air surface temperature (Schneider *et al.* 2009, p. L22402). In the western United States, runoff from snowmelt occurs 1 to 4 weeks earlier (Regonda *et al.* 2005, p. 380; Stewart *et al.* 2005, pp. 1136, 1141; Hamlett *et al.* 2007, p. 1468), presumably as a result of increased temperatures (Hamlet *et al.* 2007, p. 1468), increased frequency of melting (Mote *et al.* 2005, p. 45), and decreased snowpack (Mote *et al.* 2005, p. 41).

Trends in decreased water availability also are apparent across the Pacific Northwest. For example, Luce and Holden (2009, entire) found a tendency toward more extreme droughts at 72 percent of the stream flow gages they examined across Idaho, Montana, Oregon, and Washington.

Climate forcing may be directly or indirectly altering those habitats. Long-term water temperature data are not available for sites currently occupied by native Arctic grayling populations (e.g., Big Hole River, Red Rock Creek); however, if trends in air temperature are consistently related to increases in water temperature (Isaak *et al.* 2010, p. 1), then a regional pattern of increased water temperature is likely, and it is reasonable to assume that Arctic grayling in the Big Hole River, Red Rock Creek, and Madison River near Ennis Reservoir also have experienced the same trend. Mean annual air temperature recorded at Lakeview, Montana, near the Red Rock Lakes between 1948 and 2005 did not increase significantly, although mean temperatures in March and April did show a statistically significant increase consistent with earlier spring warming observed elsewhere in North America during recent decades (USFWS 2009, pp. 36–39).

The effect of such warming would be similar to that described for increased temperatures associated with stream dewatering (see discussion under Factor A), namely there has been an increased frequency of high water temperatures that may be above the physiological limits for survival or optimal growth for Arctic grayling, which is considered a cold-water (stenothermic) species (Selong *et al.* 2001, p. 1032). Changes in water temperature also may influence the distribution of nonnative trout species (Rahel and Olden 2008, p. 524) and the outcome of competitive interactions between those species and Arctic grayling. Brown trout are generally considered to be more tolerant of warm water than many salmonid species common in western North America (Coutant 1999, pp. 52–53; Selong *et al.* 2001, p. 1032), and higher water temperatures may favor brown trout where they compete against salmonids with lower thermal tolerances (Rahel and Olden 2008, p. 524). Recently observed increases in the abundance and distribution of brown trout in the upper reaches of the Big Hole River may be consistent with the hypothesis that stream warming is facilitating encroachment. Further study is needed to evaluate this hypothesis.

Observations on flow timing in the Big Hole River, upper Madison River, and Red Rock Creek indicate a tendency toward earlier snowmelt runoff (USFWS 2010b). These hydrologic alterations may be biologically significant for Arctic grayling in the Missouri River basin because they typically spawn prior to the peak of snowmelt runoff (Shepard and Oswald 1989, p. 7; Mogen 1996, pp. 22–23; Rens and Magee 2007, pp. 6–7). A trend toward earlier snowmelt runoff could thus result in earlier average spawning dates, with potential (and presently unknown) implications for spawning success and growth and survival of fry. Water availability has measurably decreased in some watersheds occupied by Arctic grayling. For example, mean annual precipitation recorded at Lakeview, Montana, near the Red Rock Lakes, decreased significantly between 1948 and 2005 (USFWS 2009, pp. 36–39).

The western United States appears to be warming faster than the global average. In the Pacific Northwest, regionally averaged temperatures have risen 0.8 °C (1.5 °F) over the last century and as much as 2 °C (4 °F) in some areas. They are projected to increase by another 1.5 to 5.5 °C (3 to 10 °F) over the next 100 years (Karl *et al.* 2009, p. 135). For the purposes of this finding, we consider the foreseeable future for anticipated climate changes as approximately 40 years, because various global climate models (GCM) and emissions scenarios give consistent predictions within that timeframe (Ray *et al.* 2010, p. 11). We used a similar foreseeable future to consider climate change projects in other 12–month findings (see American pika (*Ochotona princeps)* – 75 FR 6448, February 9, 2010). While projected patterns of warming across North America are generally consistent across different GCMs and emissions scenarios (Ray *et al.* 2010, p. 22), there tends to be less agreement among models for whether mean annual precipitation will increase or decrease, but the models seem to indicate an increase in precipitation in winter and a decrease in summer (Ray *et al.* 2010, pp. 22–23). In the foreseeable future, natural variation will likely confound a clear prediction for precipitation based on current climate models (Ray *et al.* 2010, p. 29). Although there is considerable uncertainty about how climate will evolve at any specific location, statistically downscaled climate projection models (models that predict climate at finer spatial resolution than GCMs) for the Pacific Northwest also support widespread warming, with warmer temperature zones shifting to the north and upward in elevation (Ray *et al.* 2010, pp. 23–24).

The land area of the upper Missouri River basin also is predicted to warm (Ray *et al.* 2010, p. 23), although currently occupied Arctic grayling habitat tends be in colder areas of moderate-to-high elevation. Four out of five populations are at approximately 1,775 to 2,125 m (5,860 to 7,012 ft) (Peterson and Ardren 2009, p. 1761). Presumably, any existing trends in water temperature increase and earlier snowmelt runoff in streams and rivers that is being forced by increases in air temperature should continue. To the extent that these trends in water temperature and hydrology already exist in habitats occupied by native Arctic grayling, they should continue into the foreseeable future. In general, climate change is expected to substantially reduce the thermally suitable habitat for coldwater fish species (Keleher and Rahel 1996, pp. 1, 6–11; Mohseni *et al.* 2003, pp. 389, 401; Flebbe *et al.* 2006, p. 1371, 1378; Rieman *et al.* 2007, pp. 1552, 1559). The range of native Arctic grayling in the upper Missouri River has already contracted significantly during the past 50 to 100 years (Vincent 1962, pp. 96–121; Kaya 1992, pp. 49–51). The currently occupied native Arctic grayling habitat tends be in colder areas of moderate-to-high elevation that may, to some extent, be more resistant to large or rapid changes in hydrology (Regonda *et al.* 2005, p. 380; Stewart *et al.* 2005, p. 1142) or perhaps stream warming.

Nonetheless, we do not expect these habitats to be entirely immune from effects of climate warming, so we expect that climate change could lead to further range contractions of Arctic grayling of the upper Missouri River and may increase the species' risk of extinction over the next 30 to 40 years as climate impacts interact with existing stressors (Karl *et al.* 2009, p. 81), such as habitat degradation, stream dewatering, drought, and interactions with nonnative trout that are already affecting the DPS. We anticipate that implementation of the Big Hole Grayling CCAA may partially compensate for, or reduce the severity of, likely effects of climate change on Arctic grayling in the Big Hole River. However, if current projections are realized, climate change is likely to exacerbate the existing primary threats to Arctic grayling outside the Big Hole River. The IPCC projects that the changes to the global climate system in the 21st century will likely be greater than those observed in the 20th century (IPCC 2007, p. 45); therefore, we anticipate that these effects will continue and likely increase into the foreseeable future. We do not consider climate change in and of itself to be a significant factor in our determination of whether Arctic grayling of the upper Missouri River is warranted for listing because of the greater imminence and magnitude of other threats (e.g., Factor A: habitat degradation, Factor C: nonnative trout). However, we expect the severity and scope of key threats (habitat degradation and fragmentation, stream dewatering, and nonnative trout) to increase in the foreseeable future because of climate change effects that are already measureable (i.e., increased water temperature, increased frequency of extreme drought, changes in runoff patterns). Thus, we consider that climate change will potentially intensify some of the significant current threats to all Arctic grayling populations in the DPS. After approximately 40 years, the variation in GCM projections based on the various emissions scenarios begins to increase dramatically (Ray *et al.* 2010 pp. 12–13), so 40 years represents the foreseeable future in terms of the extent to which the effects of climate change (a major environmental driver) can reliably be modeled or predicted. Thus we conclude that climate change constitutes a threat in the Missouri DPS of Arctic grayling in the foreseeable future.

Stochastic (Random) Threats

A principle of conservation biology is that the presence of larger and more productive (resilient) populations can reduce overall extinction risk. To minimize extinction risk due to (random) stochastic threats, life-history diversity should be maintained, populations should not all share common catastrophic risks, and both widespread and spatially close populations are needed (Fausch *et al.* 2006, p. 23; Allendorf *et al.* 1997, entire). Based on these principles, the upper Missouri River DPS of Arctic grayling may face current and future threats from stochastic processes that act on small, reproductively isolated populations.

The upper Missouri River DPS of Arctic grayling exists as a collection of small, isolated populations (Figure 2; Peterson and Ardren 2009, entire). Patterns of dispersal among extant Arctic grayling populations have been constrained dramatically by the presence of dams. The inability of fish to move between populations limits genetic exchange, the maintenance of local populations (demographic support; Hilderbrand 2003, p. 257), and recolonization of habitat fragments (reviewed by Fausch *et al.* 2006, pp. 8-9). Isolated populations cannot offset the random loss of genetic variation (Fausch *et al.* 2006, p. 8). This in turn can lead to loss of phenotypic variation and evolutionary potential (Allendorf and Ryman 2002, p. 54). Relative to the presumed historical condition of connectivity among most of the major rivers in the upper Missouri River basin, the extant native Arctic grayling populations face both genetic and demographic threats from isolation, both currently and in the foreseeable future.

Four of the five individual populations in the upper Missouri River DPS of Arctic grayling are at low-to-moderate abundance (see Population Status and Trends for Native Arctic Grayling of the Upper Missouri River, above). Individually, small populations need to maintain enough adults to minimize loss of variability through genetic drift and inbreeding (Rieman and McIntyre 1993, pp. 10–11). The point estimates for genetic effective population sizes observed in the Big Hole River, Miner Lakes, Madison River, and Red Rock Lakes populations are above the level at which inbreeding is an immediate concern, but below the level presumed to provide the genetic variation necessary to conserve long-term adaptive potential (Peterson and Ardren 2009, pp. 1767, 1769). Historically, effective population sizes of Arctic grayling in the Missouri River were estimated to be 1 or 2 orders of magnitude greater (10 to 100 times) than those currently observed (Peterson and Ardren 2009, pp. 1767). Loss of genetic variation relative to the historical condition thus represents a threat to Arctic grayling in the foreseeable future.

Only the Big Hole River population expresses the migratory fluvial ecotype that presumably dominated in the upper Missouri River basin (Kaya 1992, pp. 47–50); therefore, the DPS lacks functional redundancy in ecotypes. Conservation of life-history diversity is important to the persistence of species confronted by habitat change and environmental perturbations (Beechie *et al.* 2006, entire). Therefore, the lack of additional fluvial populations represents a current threat to the upper Missouri River DPS. Reintroduction efforts have been ongoing to reduce this threat, but have not yet produced a self-sustaining population at any of the reintroduction sites (Rens and Magee 2007, pp. 21–38). Future successful reintroductions may reduce this threat, but at the present time we consider the threat to extend into the foreseeable future.

Populations of Arctic grayling in the upper Missouri River DPS are for the most part widely separated from one another, particularly those populations in the Big Hole, Madison, and Red Rock drainages (see Figure 2). Thus, they do not appear to all share a common risk of being extirpated by a rare, high-magnitude environmental disturbance (i.e., catastrophe). Three of the five populations are within the same watershed (Big Hole River, Miner Lakes, and Mussigbrod Lake populations), so collectively these three populations would be at greater risk. Individually, each population appears to be at substantial risk of extirpation by catastrophe from one or more factor, such as restricted distribution (Miner Lakes, Mussigbrod Lake), low population abundance (Madison Lake, Red Rocks Lakes , Big Hole River), and concentration of spawning primarily in a single, discrete location (Red Rock Lakes). The Big Hole River population may be at a comparatively lower risk from catastrophe because individuals still spawn at multiple locations within the drainage (Rens and Magee 2007, p. 13).

The population viability analysis (PVA) demonstrates that four of the five extant populations in the upper Missouri River DPS of Arctic grayling are at moderate (at least 13 percent) to high risk (more than 50 percent) of extinction from random environmental variation. In this context, random environmental variation is simply considered to be common environmental fluctuations, such as drought, floods, debris flows, changes in food availability, etc. that affect population size and population growth. These PVA analyses assume that variation in annual population growth increases as population size decreases (Rieman and McIntyre 1993, pp. 43–46), which seems a reasonable assumption given the large inter-annual variability in relative abundance and recruitment observed in some Arctic grayling populations in Montana (e.g., Big Hole River) (Magee *et al.* 2005, pp. 27–28). Simply stated, smaller populations are more likely to go extinct even if they are stable because they are already close to the extinction threshold, and random environmental events can drive their abundance below that threshold. Consequently, we believe that extinction risk from random environmental variation (droughts, floods, etc.) represents a significant threat in the foreseeable future based on the PVA.

We are unsure whether chance variation in the fates of individuals within a given year (demographic stochasticity) is a current threat to the upper Missouri River DPS of Arctic grayling. The magnitude of demographic stochasticity is inversely related to population size (Morris and Doak 2002, pp. 22–23), but we do not know whether any of the Arctic grayling populations currently exist at or below an abundance where demographic stochasticity is likely.

Overall, we conclude that the upper Missouri River DPS of Arctic grayling faces threats from population isolation, loss of genetic diversity, and small population size, which all interact to increase the likelihood that random environmental variation or a catastrophe can extirpate an individual population. The uncertainty of PVA predictions increases dramatically after about 25 to 30 years, so we feel this represents a foreseeable future in terms of stochastic threats to the DPS. Lack of connectivity among extant populations and lack of replicate populations for the fluvial ecotype represent current threats. Threats from reduced genetic diversity, environmental variation, or catastrophe are threats in the foreseeable future, because their effects may take longer to play out (i.e., link between genetic diversity and adaptation) and are based on probabilistic inference concerning the magnitude of variation in population growth, environmental fluctuation, and periodic disturbance.

Summary of Factor E

Based on the information available at this time, we conclude that drought represents a current and future threat to native Arctic grayling in the upper Missouri River system. Drought can affect fish populations by reducing stream flow volumes, which leads to dewatering and high temperatures that can limit connectivity among spawning, rearing, and sheltering habitats; a reduced volume of thermally suitable habitat; and an increased frequency of water temperatures above the physiological limits for optimum growth and survival.

Climate projections suggest that the frequency and severity of drought is expected to increase; thus the magnitude of drought-related threats and impacts also may increase. We anticipate the effects of drought to be most pronounced in streams, rivers, and shallow lakes; therefore, the Big Hole River, Madison River–Ennis Reservoir, and Red Rock Lakes populations are likely to be most threatened by drought. There is evidence for increasing air temperatures and changing hydrologic pattern resulting from climate change in the Pacific Northwest and intermountain West, and we conclude that climate change is a secondary threat that can interact with and magnify the effects of primary threats, such as drought, stream dewatering from irrigation withdrawals, and the outcome of interactions with nonnative trout species that have higher thermal tolerances. We anticipate that climate change will remain a threat in the foreseeable future, but that conservation programs that increase connectivity among refuge habitats and improve stream flows (e.g., Big Hole Grayling CCAA) will to some extent mitigate or lessen the effects of climate change. Climate change effects should be most pronounced in those same habitats and populations most strongly affected by water availability (Big Hole River, Madison River–Ennis Reservoir, Red Rock Lakes), but lake habitats also can be affected (Schneider *et al.* 2009, entire), so threats likely extend to the other populations in the DPS (Miner and Mussigbrod Lakes).

The Missouri River DPS of Arctic grayling currently exists as a collection of small, isolated populations that face some current and foreseeable threats from a collection of random (stochastic) processes characteristic of small populations, such as loss of genetic diversity because of habitat fragmentation and isolation, and individual populations face increased risk of extirpation from random environmental variation (results of PVA) and catastrophe.

Finding

As defined by the DPS Policy, we determined that the native Arctic grayling of the upper Missouri River constitutes a listable entity under the ESA. We also considered the appropriateness of listing separate distinct population segments based on each of the ecotypes (fluvial and adfluvial) that occur naturally in Arctic grayling populations in the Missouri River basin. The best scientific information indicates these ecotypes share a recent evolutionary history and the populations do not cluster genetically by life-history type. Maintaining life-history diversity increases the likelihood that a species (or DPS) will maintain both the genetic diversity and evolutionary flexibility to deal with future environmental challenges. Consequently we feel that preservation of both native ecotypes in their native habitats is essential to conservation of the DPS; thus we have determined that a single DPS that includes both ecotypes is most appropriate from both a practical management and conservation perspective. We refer to this DPS as the Missouri River DPS of Arctic grayling. As discussed above, we do not include the nonnative Arctic grayling in the DPS, based on intent of the Act, IUCN guidelines, and NMFS policy. The Service does not currently have a specific policy concerning nonnative species, therefore we will investigate this topic in more detail during the proposed rulemaking process.

As required by the ESA, we considered the five factors in assessing whether the Missouri River DPS of Arctic grayling is endangered or threatened throughout all or a significant portion of its range. We carefully examined the best scientific and commercial information available regarding the past, present, and future threats faced by the DPS. We reviewed the petition, information available in our files, other available published and unpublished information, and we consulted with recognized species experts and other Federal, State, and tribal agencies. On the basis of the best scientific and commercial information available, we find that listing the DPS as endangered or threatened is warranted. We will make a determination on the status of the species as endangered or threatened when we do a proposed listing determination. However, as explained in more detail below (see **Preclusion and Expeditious Progress** section), an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

The historical range of Arctic grayling in the upper Missouri River basin has declined dramatically in the past century. The five remaining indigenous populations are isolated from one another by dams or other factors. Moreover, three of these five populations (Big Hole, Madison–Ennis, Red Rocks) appear to be at low abundance (perhaps no more than 650 to 2,000 adults per population) and have declined in abundance during the past few decades. The Big Hole River contains the only remaining example of the fluvial ecotype in the DPS, and the effective number of breeding adults declined by half during the past 15 years. Populations of Arctic grayling in two small lakes in the Big Hole River drainage (Miner and Mussigbrod) appear to be more abundant, and perhaps more secure than the other native populations.

This status review identified threats to the DPS related to Factors A, C, D, and E (see Table 5). All populations face potential threats from competition with and predation by nonnative trout (Factor C) now and in the foreseeable future. The magnitude of this threat likely varies by Arctic grayling population, and is greater in locations where multiple species of nonnative trout are present, abundant, and comprise a large proportion of the salmonid biomass (e.g., Big Hole River, Madison River–Ennis Reservoir, Red Rock Lakes). Most populations face threats that result from the alteration of their habitats (Factor A), such as habitat fragmentation from large dams or smaller irrigation diversion structures, stream dewatering, high summer water temperatures, loss of riparian habitats, and entrainment in irrigation ditches (see Table 5). Severe drought (Factor E) likely affects all populations by reducing water availability and reducing the extent of thermally suitable habitat, but we presume the effects of drought are most pronounced for Arctic grayling that reside primarily in streams and rivers (Big Hole River) or shallow lakes (Madison River–Ennis Reservoir, Red Rock Lakes). We did not consider climate change (Factor E) in and of itself to be a significant current threat, but if current climate changes projections are realized, we expect that climate change will influence severity and scope of key threats (habitat degradation and fragmentation, stream dewatering, interactions with nonnative trout, drought). As applied, existing regulatory mechanisms (Factor D) do not appear to be adequate to address primary threats to grayling (e.g., stream dewatering, loss of riparian habitats), as at least three native Arctic grayling populations have continued to decline in abundance in recent decades.

TABLE 5. CURRENT AND FORESEEABLE THREATS TO INDIVIDUAL POPULATIONS OF NATIVE ARCTIC GRAYLING IN THE UPPER MISSOURI RIVER DPS.

Threat Factor	Big Hole River	Miner Lakes	Mussigbrod Lake	Madison River–Ennis Reservoir	Red Rocks Lakes
A	Dams/habitat fragmentation[a] Dewatering[a] Thermal stress[a] Entrainment[a] Riparian habitat loss[a]		Dams/habitat fragmentation	Dams/habitat fragmentation Thermal stress	Dams/habitat fragmentation Dewatering Thermal stress Entrainment Riparian habitat loss Sediments
C	Predation & competition with nonnative trout	Predation & competition with nonnative trout	Predation & competition with nonnative trout	Predation & competition with nonnative trout	Predation & competition with nonnative trout
D	Inadequate regulations[b] (nonnative trout, continued population decline)	Inadequate regulations[b] (nonnative trout, extirpation of other lake populations of grayling)	Inadequate regulations[b] (nonnative trout, extirpation of other lake populations of grayling)	Inadequate regulations[b] (nonnative trout, federally-permitted dam, continued population decline)	Inadequate regulations[b] (nonnative trout, continued population decline)
E	Reduced genetic diversity, low abundance, random events Drought Climate change[c] No replicate of fluvial ecotype	Reduced genetic diversity, low abundance, random events Drought Climate change[c]	Drought Climate change[c]	Reduced genetic diversity, low abundance, random events Drought Climate change[c]	Reduced genetic diversity, low abundance, random events Drought Climate change[c]

[a] The magnitude of current threats to the majority of the extant population or its habitat are expected be reduced in the foreseeable future from implementation of a formalized conservation plan (i.e., Big Hole Grayling CCAA).

[b] Terms in parenthesis characterize the inadequacy of the regulatory mechanisms in terms of not addressing specific threats (e.g., nonnative trout, Factor C; dams, Factor A) or having no observed record of success with protecting existing populations (continued population decline, extirpation of other similarly situated populations).

[c] Threats believed to be of secondary importance or that interact with primary threats.

In the Big Hole River, ongoing implementation of a formalized conservation program (Big Hole Grayling CCAA) with substantial participation from non-Federal landowners and State and Federal agency partners should significantly reduce many of the habitat-related threats to that population in the foreseeable future. In the Red Rock Lakes NWR, implementation of a CCP should reduce many of the primary threats to Arctic grayling that occur within the NWR's boundary, but threats to Arctic grayling and its habitat also exist outside the administrative boundary of the CCP.

Four of five populations appear to be at risk of extirpation in the foreseeable future (next 20 to 30 years) from random fluctuations in environmental conditions (e.g., precipitation, food availability, density of competitors, etc.), simply because they are at low abundance and cannot receive demographic support from other native populations (Factor E). Low abundance and isolation also raises concerns that the loss of genetic variation from chance events (genetic drift) also may be a threat in some populations. Maintaining life-history diversity is important for species conservation given anticipated environmental challenges such as those anticipated under climate change, so having only a single population of the fluvial ecotype represents a significant threat to that ecotype's long-term persistence. A reintroduction program designed to address this threat has been implemented for more than a decade and has made some recent technical advances in the production of Arctic grayling fry. Natural reproduction by grayling has been observed at a re-introduction site in the Ruby River. At least 5 to 10 more years of monitoring is needed for us to establish that the reintroduced fish in the Ruby River constitute a viable population.

We reviewed the available information to determine if the existing and foreseeable threats render the species at risk of extinction now such that issuing an emergency regulation temporarily listing the species under section 4(b)(7) of the ESA is warranted. We determined that issuing an emergency regulation temporarily listing the DPS is not warranted at this time because there are five populations in the DPS and the probability of simultaneous extinction of all five populations is low, as the populations are physically discrete and isolated from one another such that a natural or human-caused catastrophe is not likely to extirpate all populations at once. In addition, the remaining population that expresses the fluvial ecotype (Big Hole River) is subject to ongoing implementation of a formalized conservation agreement (Big Hole Grayling CCAA) with adaptive management stipulations if Arctic grayling population goals are not being met (MFWP *et al.* 2006, pp. 60–61), and provisions to rescue Arctic grayling or address alteration to habitat in the event of a large-magnitude disturbance such as a debris flow or flood (MFWP 2006, pp. 85–86).

Listing Priority Number

The Service adopted guidelines on September 21, 1983 (48 FR 43098), to establish a rational system for utilizing available resources for the highest priority species when adding species to the Lists of Endangered or Threatened Wildlife and Plants or reclassifying species listed as threatened to endangered status. These guidelines, titled "Endangered and Threatened Species Listing and Recovery Priority Guidelines" address the immediacy and magnitude of threats, and the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera (genus with one species), full species, and subspecies (or equivalently, distinct population segments of vertebrates).

As a result of our analysis of the best available scientific and commercial information, we assigned the native Arctic grayling of the upper Missouri River a Listing Priority Number (LPN) of 3 based on our finding that the DPS faces threats that are of high magnitude and are imminent. These primary threats include the present or threatened destruction, modification, or curtailment of its habitat; competition with and predation by nonnative trout; inadequacy of existing regulatory mechanisms to address all threats; extinction risk from small population size and isolation; drought; and lack of replication of the fluvial life history.

Under the Service's guidelines, the magnitude of threat is the first criterion we look at when establishing a listing priority. The guidance indicates that species with the highest magnitude of threat are those species facing the greatest threats to their continued existence. These species receive the highest listing priority. We consider the threats that the native Arctic grayling of the upper Missouri River faces to be high in magnitude because many of the threats that we analyzed are present throughout the range and currently impact the DPS to varying degrees (e.g., habitat fragmentation, nonnative trout, inadequate regulatory mechanisms), and will continue to impact the DPS into the future. The threats that are of high magnitude include present or threatened destruction, modification, or curtailment of its habitat; competition with and predation by nonnative trout; inadequacy of existing regulatory mechanisms to address all threats; extinction risk from small population size and isolation and vulnerability to catastrophes; drought; and lack of replication of the fluvial life-history. Also, the small number (five) and size and isolation of the populations may magnify the impact of the other threats under Factors A and C.

The DPS consists of only five populations, so loss of any individual population would incrementally increase the risk that the DPS will not persist. However, we presume that loss of the Big Hole River population would create the highest risk, as this population contains much of the genetic diversity present in the species within the Missouri River basin (Peterson and Ardren 2009, pp. 1763, 1768, 1770) and is the only example of the fluvial ecotype. A conservation program (Big Hole Grayling CCAA) is being implemented to address habitat-related threats to the Big Hole River population, but the scope of the threat posed by nonnative trout remains high. Due to the scope and scale of the high magnitude threats and current isolation of already small populations, we conclude that the magnitude of threats to native Arctic grayling of the upper Missouri River is high.

Under our LPN guidelines, the second criterion we consider in assigning a listing priority is the immediacy of threats. This criterion is intended to ensure that the species facing actual, identifiable threats are given priority over those for which threats are only potential or that are intrinsically vulnerable but are not known to be presently facing such threats. Not all the threats facing the DPS are imminent. For example, threats from climate change and catastrophe are reasonably certain to occur, and their effects may be particularly acute for small, isolated populations, but the specific nature and influence of these effects, although ongoing, are uncertain at this point. With relative certainty, we can project that climate change effects will exacerbate other ongoing effects throughout the DPS. In contrast, we have factual information that some threats are imminent because we have factual information that the threats are identifiable and that the DPS is currently facing them in many areas of its range. These other threats are covered in detail in the discussions under Factors A and C of this finding and include habitat fragmentation, stream dewatering, and riparian degradation from agriculture and ranching; dams; and competition with and predation by nonnative trout. Therefore, based on our LPN Policy, the threats are imminent (ongoing).

The third criterion in our LPN guidelines is intended to devote resources to those species representing highly distinctive or isolated gene pools as reflected by taxonomy. We determined the native Arctic grayling of the upper Missouri River to be a valid DPS according to our DPS Policy. Therefore, under our LPN guidance, the native Arctic grayling of the upper Missouri River is assigned a lower priority than a species in a monotypic genus or a full species that faces the same magnitude and imminence of threats. Therefore, we assigned the native Arctic grayling of the upper Missouri River an LPN of 3 based on our determination that the DPS faces threats that are overall of high magnitude and are imminent. An LPN of 3 is the highest priority that can be assigned to a distinct population segment. We will continue to monitor the threats to the native Arctic grayling of the upper Missouri River, and the DPS' status on an annual basis, and should the magnitude or the imminence of the threats change, we will revisit our assessment of LPN.

Preclusion and Expeditious Progress

Preclusion is a function of the listing priority of a species in relation to the resources that are available and competing demands for those resources. Thus, in any given fiscal year (FY), multiple factors dictate whether it will be possible to undertake work on a proposed listing regulation or whether promulgation of such a proposal is warranted but precluded by higher priority listing actions.

The resources available for listing actions are determined through the annual Congressional appropriations process. The appropriation for the Listing Program is available to support work involving the following listing actions: Proposed and final listing rules; 90–day and 12–month findings on petitions to add species to the Lists of Endangered and Threatened Wildlife and Plants (Lists) or to change the status of a species from threatened to endangered; annual determinations on prior "warranted but precluded" petition findings as required under section 4(b)(3)(C)(i) of the ESA; critical habitat petition findings; proposed and final rules designating critical habitat; and litigation-related, administrative, and program-management functions (including preparing and allocating budgets, responding to congressional and public inquiries, and conducting public outreach regarding listing and critical habitat). The work involved in preparing various listing documents can be extensive and may include, but is not limited to: Gathering and assessing the best scientific and commercial data available and conducting analyses used as the basis for our decisions; writing and publishing documents; and obtaining, reviewing, and evaluating public comments and peer review comments on proposed rules and incorporating relevant information into final rules. The number of listing actions that we can undertake in a given year also is influenced by the complexity of those listing actions; that is, more complex actions generally are more costly. For example, during the past several years, the cost (excluding publication costs) for preparing a 12–month finding, without a proposed rule, has ranged from approximately $11,000 for one species with a restricted range and involving a relatively uncomplicated analysis to $305,000 for another species that is wide-ranging and involving a complex analysis.

We cannot spend more than is appropriated for the Listing Program without violating the Anti-Deficiency Act (see 31 U.S.C. 1341(a)(1)(A)). In addition, in FY 1998 and for each FY since then, Congress has placed a statutory cap on funds which may be expended for the Listing Program, equal to the amount expressly appropriated for that purpose in that FY. This cap was designed to prevent funds appropriated for other functions under the ESA (for example, recovery funds for removing species from the Lists), or for other Service programs, from being used for Listing Program actions (see House Report 105-163, 105th Congress, 1st Session, July 1, 1997).

Recognizing that designation of critical habitat for species already listed would consume most of the overall Listing Program appropriation, Congress also put a critical habitat subcap in place in FY 2002 and has retained it each subsequent year to ensure that some funds are available for other work in the Listing Program: "The critical habitat designation subcap will ensure that some funding is available to address other listing activities" (House Report No. 107 - 103, 107th Congress, 1st Session, June 19, 2001). In FY 2002 and each year until FY 2006, the Service has had to use virtually the entire critical habitat subcap to address court-mandated designations of critical habitat, and consequently none of the critical habitat subcap funds have been available for other listing activities. In FY 2007, we were able to use some of the critical habitat subcap funds to fund proposed listing determinations for high-priority candidate species. In FY 2009, while we were unable to use any of the critical habitat subcap funds to fund proposed listing determinations, we did use some of this money to fund the critical habitat portion of some proposed listing determinations so that the proposed listing determination and proposed critical habitat designation could be combined into one rule, thereby being more efficient in our work. In FY 2010, we are using some of the critical habitat subcap funds to fund actions with statutory deadlines.

Thus, through the listing cap, the critical habitat subcap, and the amount of funds needed to address court-mandated critical habitat designations, Congress and the courts have in effect determined the amount of money available for other listing activities. Therefore, the funds in the listing cap, other than those needed to address court-mandated critical habitat for already listed species, set the limits on our determinations of preclusion and expeditious progress.

Congress also recognized that the availability of resources was the key element in deciding, when making a 12–month petition finding, whether we would prepare and issue a listing proposal or instead make a "warranted but precluded" finding for a given species. The Conference Report accompanying Public Law 97-304, which established the current statutory deadlines and the warranted-but-precluded finding, states (in a discussion on 90–day petition findings that by its own terms also covers 12–month findings) that the deadlines were "not intended to allow the Secretary to delay commencing the rulemaking process for any reason other than that the existence of pending or imminent proposals to list species subject to a greater degree of threat would make allocation of resources to such a petition [that is, for a lower-ranking species] unwise."

In FY 2010, expeditious progress is that amount of work that can be achieved with $10,471,000, which is the amount of money that Congress appropriated for the Listing Program (that is, the portion of the Listing Program funding not related to critical habitat designations for species that are already listed). However these funds are not enough to fully fund all our court-ordered and statutory listing actions in FY 2010, so we are using $1,114,417 of our critical habitat subcap funds in order to work on all of our required petition findings and listing determinations. This brings the total amount of funds we have for listing actions in FY 2010 to $11,585,417. Our process is to make our determinations of preclusion on a nationwide basis to ensure that the species most in need of listing will be addressed first and also because we allocate our listing budget on a nationwide basis. The $11,585,417 is being used to fund work in the following categories: compliance with court orders and court-approved settlement agreements requiring that petition findings or listing determinations be completed by a specific date; section 4 (of the ESA) listing actions with absolute statutory deadlines; essential litigation-related, administrative, and listing program-management functions; and high-priority listing actions for some of our candidate species. In 2009, the responsibility for listing foreign species under the ESA was transferred from the Division of Scientific Authority, International Affairs Program, to the Endangered Species Program. Starting in FY 2010, a portion of our funding is being used to work on the actions described above as they apply to listing actions for foreign species. This has the potential to further reduce funding available for domestic listing actions, although there are currently no foreign species issues included in our high-priority listing actions at this time. The allocations for each specific listing action are identified in the Service's FY 2010 Allocation Table (part of our administrative record).

In FY 2007, we had more than 120 species with an LPN of 2, based on our September 21, 1983, guidance for assigning an LPN for each candidate species (48 FR 43098). Using this guidance, we assign each candidate an LPN of 1 to 12, depending on the magnitude of threats (high vs. moderate to low), immediacy of threats (imminent or nonimminent), and taxonomic status of the species (in order of priority: monotypic genus (a species that is the sole member of a genus); species; or part of a species (subspecies, distinct population segment, or significant portion of the range)). The lower the listing priority number, the higher the listing priority (that is, a species with an LPN of 1 would have the highest listing priority). Because of the large number of high-priority species, we further ranked the candidate species with an LPN of 2 by using the following extinction-risk type criteria: IUCN Red list status/rank, Heritage rank (provided by NatureServe), Heritage threat rank (provided by NatureServe), and species currently with fewer than 50 individuals, or 4 or fewer populations. Those species with the highest IUCN rank (critically endangered), the highest Heritage rank (G1), the highest Heritage threat rank (substantial, imminent threats), and currently with fewer than 50 individuals, or fewer than 4 populations, comprised a group of approximately 40 candidate species ("Top 40"). These 40 candidate species have had the highest priority to receive funding to work on a proposed listing determination. As we work on proposed and final listing rules for these 40 candidates, we are applying the ranking criteria to the next group of candidates with an LPN of 2 and 3 to determine the next set of highest priority candidate species.

To be more efficient in our listing process, as we work on proposed rules for these species in the next several years, we are preparing multi-species proposals when appropriate, and these may include species with lower priority if they overlap geographically or have the same threats as a species with an LPN of 2. In addition, available staff resources also are a factor in determining high-priority species provided with funding. Finally, proposed rules for reclassification of threatened species to endangered are lower priority, since as listed species, they are already afforded the protection of the ESA and implementing regulations.

We assigned the upper Missouri River DPS of Arctic grayling an LPN of 3, based on our finding that the DPS faces immediate and high magnitude threats from the present or threatened destruction, modification, or curtailment of its habitat; competition with and predation by nonnative trout; and the inadequacy of existing regulatory mechanisms. One or more of the threats discussed above occurs in each known population in the Missouri River basin. These threats are ongoing and, in some cases (e.g., nonnative species), considered irreversible. Under our 1983 Guidelines, a "species" facing imminent high-magnitude threats is assigned an LPN of 1, 2, or 3, depending on its taxonomic status. Work on a proposed listing determination for the upper Missouri River DPS of Arctic grayling is precluded by work on higher priority candidate species (i.e., species with LPN of 2); listing actions with absolute statutory, court ordered, or court-approved deadlines; and final listing determinations for those species that were proposed for listing with funds from previous FYs. This work includes all the actions listed in the tables below under expeditious progress.

As explained above, a determination that listing is warranted but precluded also must demonstrate that expeditious progress is being made to add or remove qualified species to and from the Lists of Endangered and Threatened Wildlife and Plants. (Although we do not discuss it in detail here, we also are making expeditious progress in removing species from the Lists under the Recovery program, which is funded by a separate line item in the budget of the Endangered Species Program. As explained above in our description of the statutory cap on Listing Program funds, the Recovery Program funds and actions supported by them cannot be considered in determining expeditious progress made in the Listing Program.) As with our "precluded" finding, expeditious progress in adding qualified species to the Lists is a function of the resources available and the competing demands for those funds. Given that limitation, we find that we are making progress in FY 2010 in the Listing Program. This progress included preparing and publishing the determinations presented in Table 6.

TABLE 6. FY2010 COMPLETED LISTING ACTIONS

Publication Date	Title	Actions	FR Pages
10/08/2009	Listing *Lepidium papilliferum* (Slickspot Peppergrass) as a Threatened Species Throughout Its Range	Final Listing, Threatened	74 FR 52013-52064
10/27/2009	90-day Finding on a Petition To List the American Dipper in the Black Hills of South Dakota as Threatened or Endangered	Notice of 90–day Petition Finding, Not Substantial	74 FR 55177-55180
10/28/2009	Status Review of Arctic Grayling (*Thymallus arcticus*) in the Upper Missouri River System	Notice of Intent to Conduct Status Review	74 FR 55524-55525
11/03/2009	Listing the British Columbia Distinct Population Segment of the Queen Charlotte Goshawk Under the ESA: Proposed rule.	Proposed Listing Threatened	74 FR 56757-56770
11/03/2009	Listing the Salmon-Crested Cockatoo as Threatened Throughout Its Range with Special Rule	Proposed Listing Threatened	74 FR 56770-56791
11/23/2009	Status Review of Gunnison sage-grouse (*Centrocercus minimus*)	Notice of Intent to Conduct Status Review	74 FR 61100-61102
12/03/2009	12-Month Finding on a Petition to List the Black-tailed Prairie Dog as Threatened or Endangered	Notice of 12–month Petition Finding, Not warranted	74 FR 63343-63366
12/03/2009	90-Day Finding on a Petition to List Sprague's Pipit as Threatened or Endangered	Notice of 90–day Petition Finding, Substantial	74 FR 63337-63343
12/15/2009	90-Day Finding on Petitions To List 9 Species of Mussels From Texas as Threatened or Endangered With Critical Habitat	Notice of 90–day Petition Finding, Substantial	74 FR 66260-66271
12/16/2009	Partial 90-Day Finding on a Petition to List 475 Species in the Southwestern United States as Threatened or Endangered With Critical Habitat	Notice of 90–day Petition Finding, Not Substantial & Substantial	74 FR 66865-66905
12/17/2009	12–month Finding on a Petition To Change the Final Listing of the Distinct Population Segment of the Canada Lynx To Include New Mexico	Notice of 12–month Petition Finding, Warranted but Precluded	74 FR 66937-66950
01/05/2010	Listing Foreign Bird Species in Peru & Bolivia as Endangered Throughout Their Range	Proposed Listing, Endangered	75 FR 605-649

TABLE 6. FY2010 COMPLETED LISTING ACTIONS—Continued

Publication Date	Title	Actions	FR Pages
01/05/2010	Listing Six Foreign Birds as Endangered Throughout Their Range	Proposed Listing, Endangered	75 FR 286-310
01/05/2010	Withdrawal of Proposed Rule to List Cook's Petrel	Proposed rule, Withdrawal	75 FR 310-316
01/05/2010	Final Rule to List the Galapagos Petrel & Heinroth's Shearwater as Threatened Throughout Their Ranges	Final Listing, Threatened	75 FR 235-250
01/20/2010	Initiation of Status Review for *Agave eggersiana* & *Solanum conocarpum*	Notice of Intent to Conduct Status Review	75 FR 3190-3191
02/09/2010	12–month Finding on a Petition to List the American Pika as Threatened or Endangered	Notice of 12–month Petition Finding, Not Warranted	75 FR 6437-6471
02/25/2010	12-Month Finding on a Petition To List the Sonoran Desert Population of the Bald Eagle as a Threatened or Endangered Distinct Population Segment	Notice of 12–month Petition Finding, Not Warranted	75 FR 8601-8621
02/25/2010	Withdrawal of Proposed Rule To List the Southwestern Washington/Columbia River Distinct Population Segment of Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) as Threatened	Withdrawal of Proposed Rule to List	75 FR 8621-8644
03/18/2010	90-Day Finding on a Petition to List the Berry Cave salamander as Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 13068-13071
03/23/2010	90-Day Finding on a Petition to List the Southern Hickorynut Mussel (*Obovaria jacksoniana*) as Endangered or Threatened	Notice of 90–day Petition Finding, Not Substantial	75 FR 13717-13720
03/23/2010	90-Day Finding on a Petition to List the Striped Newt as Threatened	Notice of 90–day Petition Finding, Substantial	75 FR 13720-13726
03/23/2010	12-Month Findings for Petitions to List the Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered	Notice of 12–month Petition Finding, Warranted but Precluded	75 FR 13910-14014
03/31/2010	12-Month Finding on a Petition to List the Tucson Shovel-Nosed Snake (*Chionactis occipitalis klauberi*) as Threatened or Endangered with Critical Habitat	Notice of 12–month Petition Finding, Warranted but Precluded	75 FR 16050-16065
04/05/2010	90-Day Finding on a Petition To List Thorne's Hairstreak Butterfly as or Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 17062-17070
04/06/2010	12–month Finding on a Petition To List the Mountain Whitefish in the Big Lost River, Idaho, as Endangered or Threatened	Notice of 12–month Petition Finding, Not Warranted	75 FR 17352-17363
04/06/2010	90-Day Finding on a Petition to List a Stonefly (*Isoperla jewetti*) & a Mayfly (*Fallceon eatoni*) as Threatened or Endangered with Critical Habitat	Notice of 90–day Petition Finding, Not Substantial	75 FR 17363-17367
04/07/2010	12-Month Finding on a Petition to Reclassify the Delta Smelt From Threatened to Endangered Throughout Its Range	Notice of 12–month Petition Finding, Warranted but Precluded	75 FR 17667-17680
04/13/2010	Determination of Endangered Status for 48 Species on Kauai & Designation of Critical Habitat	Final Listing, Endangered	75 FR 18959-19165
04/15/2010	Initiation of Status Review of the North American Wolverine in the Contiguous United States	Notice of Initiation of Status Review	75 FR 19591-19592

TABLE 6. FY2010 COMPLETED LISTING ACTIONS—Continued

Publication Date	Title	Actions	FR Pages
04/15/2010	12-Month Finding on a Petition to List the Wyoming Pocket Gopher as Endangered or Threatened with Critical Habitat	Notice of 12–month Petition Finding, Not Warranted	75 FR 19592-19607
04/16/2010	90-Day Finding on a Petition to List a Distinct Population Segment of the Fisher in Its United States Northern Rocky Mountain Range as Endangered or Threatened with Critical Habitat	Notice of 90–day Petition Finding, Substantial	75 FR 19925-19935
04/20/2010	Initiation of Status Review for Sacramento splittail (*Pogonichthys macrolepidotus*)	Notice of Initiation of Status Review	75 FR 20547-20548
04/26/2010	90-Day Finding on a Petition to List the Harlequin Butterfly as Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 21568-21571
04/27/2010	12-Month Finding on a Petition to List Susan's Purse-making Caddisfly (*Ochrotrichia susanae*) as Threatened or Endangered	Notice of 12–month Petition Finding, Not Warranted	75 FR 22012-22025
04/27/2010	90–day Finding on a Petition to List the Mohave Ground Squirrel as Endangered with Critical Habitat	Notice of 90–day Petition Finding, Substantial	75 FR 22063-22070
05/04/2010	90-Day Finding on a Petition to List Hermes Copper Butterfly as Threatened or Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 23654-23663
6/1/2010	90-Day Finding on a Petition To List Castanea pumila var. ozarkensis	Notice of 90–day Petition Finding, Substantial	75 FR 30313-30318
6/1/2010	12–month Finding on a Petition to List the White-tailed Prairie Dog as Endangered or Threatened	Notice of 12–month petition finding, Not warranted	75 FR 30338-30363
6/9/2010	90-Day Finding on a Petition To List van Rossem's Gull-billed Tern as Endangered orThreatened.	Notice of 90–day Petition Finding, Substantial	75 FR 32728-32734
6/16/2010	90-Day Finding on Five Petitions to List Seven Species of Hawaiian Yellow-faced Bees as Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 34077-34088
6/22/2010	12-Month Finding on a Petition to List the Least Chub as Threatened or Endangered	Notice of 12–month petition finding, Warranted but precluded	75 FR 35398-35424
6/23/2010	90-Day Finding on a Petition to List the Honduran Emerald Hummingbird as Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 35746-35751
6/23/2010	Listing Ipomopsis polyantha (*Pagosa Skyrocket*) as Endangered Throughout Its Range, and Listing *Penstemon debilis* (Parachute Beardtongue) and *Phacelia submutica* (DeBeque Phacelia) as Threatened Throughout Their Range	Proposed Listing Endangered Proposed Listing Threatened	75 FR 35721-35746
6/24/2010	Listing the Flying Earwig Hawaiian Damselfly and Pacific Hawaiian Damselfly As Endangered Throughout Their Ranges	Final Listing Endangered	75 FR 35990-36012
6/24/2010	Listing the Cumberland Darter, Rush Darter, Yellowcheek Darter, Chucky Madtom, and Laurel Dace as Endangered Throughout Their Ranges	Proposed Listing Endangered	75 FR 36035-36057
6/29/2010	Listing the Mountain Plover as Threatened	Reinstatement of Proposed Listing Threatened	75 FR 37353-37358
7/20/2010	90-Day Finding on a Petition to List *Pinus albicaulis* (Whitebark Pine) as Endangered or Threatened with Critical Habitat	Notice of 90–day Petition Finding, Substantial	75 FR 42033-42040

TABLE 6. FY2010 COMPLETED LISTING ACTIONS—Continued

Publication Date	Title	Actions	FR Pages
7/20/2010	12-Month Finding on a Petition to List the Amargosa Toad as Threatened or Endangered	Notice of 12–month petition finding, Not warranted	75 FR 42040-42054
7/20/2010	90-Day Finding on a Petition to List the Giant Palouse Earthworm (*Driloleirus americanus*) as Threatened or Endangered	Notice of 90–day Petition Finding, Substantial	75 FR 42059-42066
7/27/2010	Determination on Listing the Black-Breasted Puffleg as Endangered Throughout its Range; Final Rule	Final Listing Endangered	75 FR 43844-43853
7/27/2010	Final Rule to List the Medium Tree-Finch (*Camarhynchus pauper*) as Endangered Throughout Its Range	Final Listing Endangered	75 FR 43853-43864
8/3/2010	Determination of Threatened Status for Five Penguin Species	Final Listing Threatened	75 FR 45497- 45527
8/4/2010	90-Day Finding on a Petition To List the Mexican Gray Wolf as an Endangered Subspecies With Critical Habitat	Notice of 90–day Petition Finding, Substantial	75 FR 46894- 46898
8/10/2010	90-Day Finding on a Petition to List *Arctostaphylos franciscana* as Endangered with Critical Habitat	Notice of 90–day Petition Finding, Substantial	75 FR 48294-48298
8/17/2010	Listing Three Foreign Bird Species from Latin America and the Caribbean as Endangered Throughout Their Range	Final Listing Endangered	75 FR 50813-50842
8/17/2010	90-Day Finding on a Petition to List Brian Head Mountainsnail as Endangered or Threatened with Critical Habitat	Notice of 90–day Petition Finding, Not substantial	75 FR 50739-50742
8/24/2010	90-Day Finding on a Petition to List the Oklahoma Grass Pink Orchid as Endangered or Threatened	Notice of 90–day Petition Finding, Substantial	75 FR 51969-51974

Our expeditious progress also includes work on listing actions that we funded in FY 2010 but have not yet been completed to date (Table 7). These actions are listed below. Actions in the top section of the table are being conducted under a deadline set by a court. Actions in the middle section of the table are being conducted to meet statutory timelines, that is, timelines required under the ESA. Actions in the bottom section of the table are high-priority listing actions. These actions include work primarily on species with an LPN of 2, and selection of these species is partially based on available staff resources, and when appropriate, include species with a lower priority if they overlap geographically or have the same threats as the species with the high priority. Including these species together in the same proposed rule results in considerable savings in time and funding, as compared to preparing separate proposed rules for each of them in the future.

TABLE 7. ACTIONS FUNDED IN FY 2010 BUT NOT YET COMPLETED

Species	Action
Actions Subject to Court Order/Settlement Agreement	
6 Birds from Eurasia	Final listing determination
African penguin	Final listing determination
Flat-tailed horned lizard	Final listing determination
Mountain plover[4]	Final listing determination
6 Birds from Peru	Proposed listing determination
Sacramento splittail	12–month petition finding
Pacific walrus	12–month petition finding
Gunnison sage-grouse	12–month petition finding
Wolverine	12–month petition finding

TABLE 7. ACTIONS FUNDED IN FY 2010 BUT NOT YET COMPLETED—Continued

Species	Action
Arctic grayling	12–month petition finding
Agave eggergsiana	12–month petition finding
Solanum conocarpum	12–month petition finding
Jemez Mountains salamander	12–month petition finding
Sprague's pipit	12–month petition finding
Desert tortoise – Sonoran population	12–month petition finding
Pygmy rabbit (rangewide)[1]	12–month petition finding
Thorne's Hairstreak butterfly[4]	12–month petition finding
Hermes copper butterfly[4]	12–month petition finding
Actions with Statutory Deadlines	
Casey's june beetle	Final listing determination
Georgia pigtoe, interrupted rocksnail, and rough hornsnail	Final listing determination
7 Bird species from Brazil	Final listing determination
Southern rockhopper penguin – Campbell Plateau population	Final listing determination
5 Bird species from Colombia and Ecuador	Final listing determination
Queen Charlotte goshawk	Final listing determination
5 species southeast fish (Cumberland Darter, Rush Darter, Yellowcheek Darter, Chucky Madtom, and Laurel Dace)	Final listing determination
Salmon crested cockatoo	Proposed listing determination
CA golden trout	12–month petition finding
Black-footed albatross	12–month petition finding
Mount Charleston blue butterfly	12–month petition finding
Mojave fringe-toed lizard[1]	12–month petition finding
Kokanee – Lake Sammamish population[1]	12–month petition finding
Cactus ferruginous pygmy-owl[1]	12–month petition finding
Northern leopard frog	12–month petition finding
Tehachapi slender salamander	12–month petition finding
Coqui Llanero	12–month petition finding
Dusky tree vole	12–month petition finding
3 MT invertebrates (mist forestfly(*Lednia tumana*), *Oreohelix* sp.3, *Oreohelix* sp. 31) from 206 species petition	12–month petition finding
5 UT plants (*Astragalus hamiltonii*, *Eriogonum soredium*, *Lepidium ostleri*, *Penstemon flowersii*, *Trifolium friscanum*) from 206 species petition	12–month petition finding
2 CO plants (*Astragalus microcymbus*, *Astragalus schmolliae*) from 206 species petition	12–month petition finding
5 WY plants (*Abronia ammophila*, *Agrostis* rossiae, *Astragalus proimanthus*, *Boechere (Arabis) pusilla*, *Penstemon gibbensii*) from 206 species petition	12–month petition finding
Leatherside chub (from 206 species petition)	12–month petition finding

TABLE 7. ACTIONS FUNDED IN FY 2010 BUT NOT YET COMPLETED—Continued

Species	Action
Frigid ambersnail (from 206 species petition)	12–month petition finding
Gopher tortoise – eastern population	12–month petition finding
Wrights marsh thistle	12–month petition finding
67 of 475 southwest species	12–month petition finding
Grand Canyon scorpion (from 475 species petition)	12–month petition finding
Anacroneuria wipukupa (a stonefly from 475 species petition)	12–month petition finding
Rattlesnake-master borer moth (from 475 species petition)	12–month petition finding
3 Texas moths (*Ursia furtiva*, *Sphingicampa blanchardi*, *Agapema galbina*) (from 475 species petition)	12–month petition finding
2 Texas shiners (*Cyprinella* sp., *Cyprinella lepida*) (from 475 species petition)	12–month petition finding
3 South Arizona plants (*Erigeron piscaticus*, *Astragalus hypoxylus*, *Amoreuxia gonzalezii*) (from 475 species petition)	12–month petition finding
5 Central Texas mussel species (3 from 474 species petition)	12–month petition finding
14 parrots (foreign species)	12–month petition finding
Berry Cave salamander[1]	12–month petition finding
Striped Newt[1]	12–month petition finding
Fisher – Northern Rocky Mountain Range[1]	12–month petition finding
Mohave Ground Squirrel[1]	12–month petition finding
Puerto Rico Harlequin Butterfly	12–month petition finding
Western gull-billed tern	12–month petition finding
Ozark chinquapin (*Castanea pumila* var. *ozarkensis*)	12–month petition finding
HI yellow-faced bees	12–month petition finding
Giant Palouse earthworm	12–month petition finding
Whitebark pine	12–month petition finding
OK grass pink (*Calopogon oklahomensis*)[1]	12–month petition finding
Southeastern pop snowy plover & wintering pop. of piping plover[1]	90–day petition finding
Eagle Lake trout[1]	90–day petition finding
Smooth-billed ani[1]	90–day petition finding
Bay Springs salamander[1]	90–day petition finding
32 species of snails and slugs[1]	90–day petition finding
42 snail species (Nevada & Utah)	90–day petition finding
Red knot *roselaari* subspecies	90–day petition finding
Peary caribou	90–day petition finding
Plains bison	90–day petition finding
Spring Mountains checkerspot butterfly	90–day petition finding
Spring pygmy sunfish	90–day petition finding
Bay skipper	90–day petition finding

TABLE 7. ACTIONS FUNDED IN FY 2010 BUT NOT YET COMPLETED—Continued

Species	Action
Unsilvered fritillary	90–day petition finding
Texas kangaroo rat	90–day petition finding
Spot-tailed earless lizard	90–day petition finding
Eastern small-footed bat	90–day petition finding
Northern long-eared bat	90–day petition finding
Prairie chub	90–day petition finding
10 species of Great Basin butterfly	90–day petition finding
6 sand dune (scarab) beetles	90–day petition finding
Golden-winged warbler	90–day petition finding
Sand-verbena moth	90–day petition finding
404 Southeast species	90–day petition finding
High Priority Listing Actions[3]	
19 Oahu candidate species[3] (16 plants, 3 damselflies) (15 with LPN = 2, 3 with LPN = 3, 1 with LPN =9)	Proposed listing
19 Maui-Nui candidate species[3] (16 plants, 3 tree snails) (14 with LPN = 2, 2 with LPN = 3, 3 with LPN = 8)	Proposed listing
Dune sagebrush lizard (formerly Sand dune lizard)[3] (LPN = 2)	Proposed listing
2 Arizona springsnails[3] *(Pyrgulopsis bernadina* (LPN = 2), *Pyrgulopsis trivialis* (LPN = 2))	Proposed listing
New Mexico springsnail[3] *(Pyrgulopsis chupaderae* (LPN = 2)	Proposed listing
2 mussels[3] (rayed bean (LPN = 2), snuffbox No LPN)	Proposed listing
2 mussels[3] (sheepnose (LPN = 2), spectaclecase (LPN = 4),)	Proposed listing
Ozark hellbender[2] (LPN = 3)	Proposed listing
Altamaha spinymussel[3] (LPN = 2)	Proposed listing
8 southeast mussels (southern kidneyshell (LPN = 2), round ebonyshell (LPN = 2), Alabama pearlshell (LPN = 2), southern sandshell (LPN = 5), fuzzy pigtoe (LPN = 5), Choctaw bean (LPN = 5), narrow pigtoe (LPN = 5), and tapered pigtoe (LPN = 11))	Proposed listing

[1] Funds for listing actions for these species were provided in previous FYs.
[2] We funded a proposed rule for this subspecies with an LPN of 3 ahead of other species with LPN of 2, because the threats to the species were so imminent and of a high magnitude that we considered emergency listing if we were unable to fund work on a proposed listing rule in FY 2008.
[3] Although funds for these high-priority listing actions were provided in FY 2008 or 2009, due to the complexity of these actions and competing priorities, these actions are still being developed.
[4]Partially funded with FY 2010 funds; also will be funded with FY 2011 funds.

We have endeavored to make our listing actions as efficient and timely as possible, given the requirements of the relevant law and regulations, and constraints relating to workload and personnel. We are continually considering ways to streamline processes or achieve economies of scale, such as by batching related actions together. Given our limited budget for implementing section 4 of the ESA, these actions described above collectively constitute expeditious progress.

The upper Missouri River DPS of Arctic grayling will be added to the list of candidate species upon publication of this 12–month finding. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

We intend that any proposed listing action for the upper Missouri River DPS of Arctic grayling will be as accurate as possible. Therefore, we will continue to accept additional information and comments from all concerned governmental agencies, the scientific community, industry, or any other interested party concerning this finding.

References Cited

A complete list of references cited is available on the Internet at *http://*

www.regulations.gov and upon request from the Montana Field Office (see **ADDRESSES** section).

Authors

The primary authors of this notice are the staff members of the Montana Field Office.

Authority

The authority for this action is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: August 30, 2010

Daniel M. Ashe,

Acting Director, Fish and Wildlife Service.

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