Species and Habitat Conservation Gap Analysis for the Rocky Mountain Region

Focal Species:
Arctic Grayling (*Thymallus arcticus*)
Bull Trout (*Salvelinus confluentus*)
Bonneville Cutthroat Trout (*Oncorhynchus clarkii utah*)
Colorado River Cutthroat Trout (*Oncorhynchus clarkii pleuriticus*)
Greenback Cutthroat Trout (*Oncorhynchus clarkii stomias*)
Westslope Cutthroat Trout (*Oncorhynchus clarkii lewisi*)
Yellowstone Cutthroat Trout (*Oncorhynchus clarkii bouvieri*)

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EXECUTIVE SUMMARY

The Fish and Wildlife Conservation Offices (FWCOs) of the U.S. Fish and Wildlife Service (Service) invest significant resources in the conservation and management of arctic grayling (*Thymallus arcticus*), bull trout (*Salvelinus confluentus*), and five inland subspecies of cutthroat trout (*Oncorhynchus clarkii*) in the Rocky Mountain region. In the present analysis, we identify the Service's conservation goals for these taxa; describe current Service and partner activities that contribute toward these goals; assess gaps in current efforts that may hinder conservation success; and offer recommendations to address the identified gaps. The Service has unique responsibilities with respect to bull trout and greenback cutthroat trout management under the Endangered Species Act, but primary management authority lies with the States for all other focal taxa. We provide our recommendations for the Service with the expectation that it will continue to partner with States and other relevant stakeholders on future activities.

In the Rockies, arctic grayling, bull trout, and cutthroat trout are vulnerable to changes in habitat and impacts from nonnative salmonids; numerous existing conservation strategies attempt to address these limiting factors. For the gap analysis, we grouped taxon-specific goals adopted by the Service under five themes: improve habitat conditions, secure native populations with conservation value, restore or enhance populations within the native range, cooperate with partners to achieve conservation goals, and maintain sources of genetically pure cutthroat trout. Ultimately, the Service and its partners seek recovery of these species on the landscape.

The States chair range-wide conservation teams that facilitate much of the work on cutthroat trout conservation and they lead the majority of monitoring and reintroduction projects for all three species. FWCOs currently contribute to conservation goals through National Fish Passage Program and National Fish Habitat Partnership grants and technical assistance, population monitoring in defined locations, limited nonnative salmonid management, and collaboration with a large and diverse group of partners. Within the Service, other active participants in arctic grayling, bull trout, and inland cutthroat trout conservation efforts include the National Fish Hatcheries, Fish Technology Centers, Partners for Fish and Wildlife program, and Ecological Services program. Several other Federal agencies take active roles in native salmonid conservation, particularly where populations are present on lands under their management.

We find that the Service, the States, and their many partners have made notable progress on improving habitat conditions and carrying out reintroduction efforts for native salmonids in the Rockies. However, nonnative salmonids and an evolving understanding of cutthroat trout genetic diversity continue to present biological and management hurdles. Other barriers to accomplishing conservation goals include limited capacity for monitoring in some areas and inadequate communication, especially across programs and regions within the Service. To better ensure the continued persistence of arctic grayling, bull trout, and cutthroat trout in the Rockies, we recommend that the Service support robust conservation planning within range-wide conservation teams and increase technical and financial capacity for population and habitat monitoring and restoration, including nonnative salmonid management. The agency should also reflect internally on structures that could facilitate better intra-agency communication and collaboration, its position on cutthroat trout genetic diversity, and its own potential for inadvertent contributions to nonnative species spread.

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Cover image: Carr Creek cutthroat trout. Kayt Jonsson, U.S. Fish and Wildlife Service.

ACRONYMS AND ABBREVIATIONS

°C = degrees Celsius
°F = degrees Fahreinheit
AIS = aquatic invasive species
BCT = Bonneville cutthroat trout
BLM = Bureau of Land Management, U.S. Department of the Interior
BOR = Bureau of Reclamation, U.S. Department of the Interior
CCAA = Candidate Conservation Agreement with Assurances
CPW = Colorado Parks and Wildlife Department
CRCT = Colorado River cutthroat trout
CSKT = Confederated Salish and Kootenai Tribes
DPS = Distinct Population Segment
eDNA = environmental DNA
ES = Ecological Services Program, U.S. Fish and Wildlife Service
ESA = Endangered Species Act of 1973, as amended
ESFO = Ecological Services Field Office, U.S. Fish and Wildlife Service
FAC = Fisheries and Aquatic Conservation Program, U.S. Fish and Wildlife Service
FHC = Fish Health Center, U.S. Fish and Wildlife Service
FTC = Fish Technology Center, U.S. Fish and Wildlife Service
FWCO = Fish and Wildlife Conservation Office, U.S. Fish and Wildlife Service
FY = fiscal year
GBCT = greenback cutthroat trout
GMU = Geographical Management Unit
IDFG = Idaho Department of Fish and Game
km = kilometers
MFWP = Montana Fish, Wildlife and Parks Department
n.d. = no date
NEPA = National Environmental Policy Act
NFH = National Fish Hatchery
NFHP = National Fish Habitat Partnership
NFPP = National Fish Passage Program
NPS = National Park Service
NRCS = Natural Resources Conservation Service, U.S. Department of Agriculture
NWR = National Wildlife Refuge
PIT = Passive Integrated Transponder
Service = U.S. Fish and Wildlife Service, U.S. Department of the Interior (see also "USFWS")
SFH = State Fish Hatchery
UDWR = Utah Department of Wildlife Resources
USFS = U.S. Forest Service, U.S. Department of Agriculture
USFWS = U.S. Fish and Wildlife Service, U.S. Department of the Interior (see also "Service")
WCT = westslope cutthroat trout
WGFD = Wyoming Game and Fish Department
WNTI = Western Native Trout Initiative
YCT = Yellowstone cutthroat trout

1. GOALS OF SPECIES GAP ANALYSIS

This document describes efforts by the U.S. Fish and Wildlife Service (Service) and its partners to reach conservation goals for arctic grayling (*Thymallus arcticus*), bull trout (*Salvelinus confluentus*), and five subspecies of cutthroat trout (*Oncorhynchus clarkii*) in the northern and central Rocky Mountains of the United States. It describes the conservation gap between the current state and the desired state for these taxa, an approach we refer to as a "gap analysis." The document also identifies specific conservation actions that are largely achievable by the Service in collaboration with partners (provided available resources) and that will contribute meaningfully to achieving the desired state for these taxa.

The geographic scope of this work includes the entire native range of Bonneville cutthroat trout (BCT; *O. c. utah*), Colorado River cutthroat trout (CRCT; *O. c. pleuriticus*), greenback cutthroat trout (GBCT; *O. c. stomias*), and Yellowstone cutthroat trout (YCT; *O. c. bouvieri*), covering portions of Montana, Idaho, Wyoming, Colorado, Utah, Nevada, and New Mexico (Figure 1). Also included in the geographic scope are portions of the native ranges of arctic grayling, bull trout, and westslope cutthroat trout (WCT; *O. c. lewisi*) in Montana, northern Idaho, and northeastern Washington. In management terms, the gap analysis covers the Upper Missouri River population of arctic grayling, the Columbia Headwaters and Saint Mary Recovery Units for bull trout (Figure A1; USFWS 2015a) and the Missouri River, Clark Fork, Flathead, and Coeur d'Alene-Pend Oreille Geographical Management Units (GMUs) for WCT (Figure A2; IDFG 2013). The division of arctic grayling, bull trout and WCT native ranges is justified on the basis of distinct management strategies and genetic or geographic separation from other populations (see *2.1 Taxonomy*, Populations Defined for Conservation or Management Purposes; Spruell et al. 2003; Peterson and Ardren 2009; USFWS 2015a; Young et al. 2018). One or more future gap analyses focused on the Pacific Northwest will address activities and conservation gaps within the remainder of the coterminous U.S. range of bull trout.

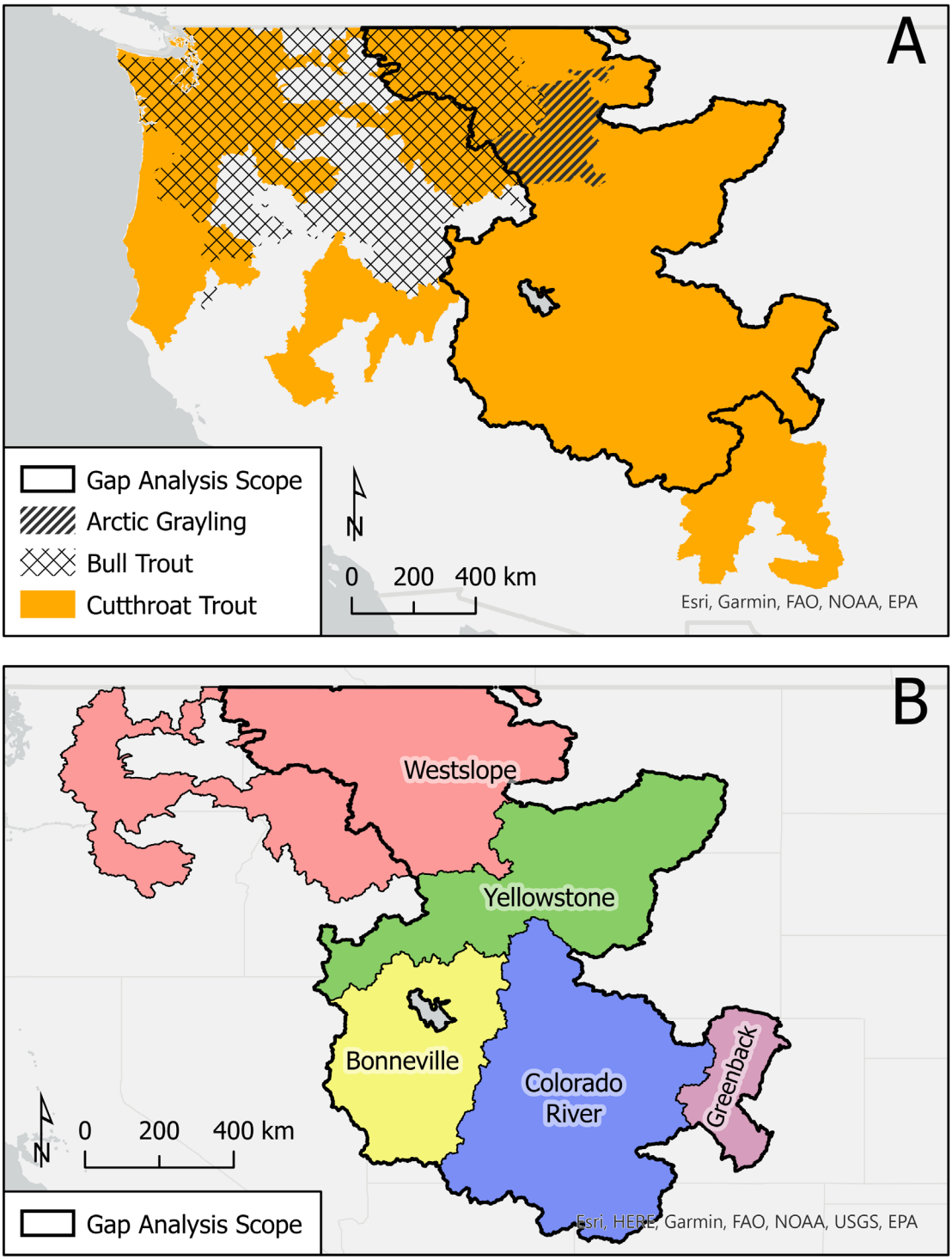

Figure 1. Maps of (A) native watersheds (8-digit hydrologic units; Seaber et al. 1987) of arctic grayling, bull trout, and cutthroat trout, and (B) native watersheds of cutthroat trout subspecies, in relation to the geographic scope of this gap analysis. Native range data from Daniel and Neilson (2020), adapted with additional data from Hirsch et al. (2013), USFWS (2015a), and MNHP and MFWP (2021).

2. TARGET SPECIES OVERVIEW

2.1. TAXONOMY

The taxa addressed in this conservation gap analysis are all members of the fish family Salmonidae. Arctic grayling is classified within the grayling subfamily Thymallinae, genus *Thymallus*, species *arcticus*. The remaining taxa are classified within the salmon, trout, and char subfamily Salmoninae. Bull trout belongs to the genus *Salvelinus*, species *confluentus*. Cutthroat trout belongs to the genus *Oncorhynchus*, species *clarkii* (ITIS 2021).

This document recognizes five subspecies of cutthroat trout with non-overlapping geographic ranges: *O. c. bouvieri* (YCT), *O. c. lewisi* (WCT), *O. c. pleuriticus* (CRCT), *O. c. stomias* (GBCT), and *O. c. utah* (BCT; ITIS 2021). Differentiation among cutthroat trout populations, and how this differentiation should be codified taxonomically, is an area of active research and discussion (Trotter et al. 2018). Morphological and genetic differentiation among populations is particularly relevant to Service activities in the Snake, Bear, and Colorado River basins. Populations of YCT and BCT in the Snake and Bear River basins, respectively, are morphologically and sometimes genetically distinct from other populations of these subspecies yet not necessarily from each other (Gresswell 2011; Loxterman and Keeley 2012; Trotter et al. 2018). Recent genetic and morphological studies have also identified three separate genetic lineages among cutthroat trout of the Colorado River basin: a "green" lineage native to the Dolores, Gunnison, and Upper Colorado drainages; a "blue" lineage native to the Yampa, Upper Green, Lower Green, and Lower Colorado drainages; and a "San Juan" lineage in the San Juan drainage (Metcalf et al. 2012; CPW 2018; Bestgen et al. 2019). In this document, lineage-level information is presented where available and relevant to Service activities and goals, but the default subspecies definitions are those given within the management plans that guide Service work on these species (see *3.2 Service Goals*).

Populations Defined for Conservation or Management Purposes

The Missouri River arctic grayling has been designated as a Distinct Population Segment (DPS) by the Service on the basis of its geographic and genetic separation from other populations of the species (75 FR 54708). The DPS designation allows the Service to take independent regulatory actions for the DPS under the Endangered Species Act of 1973, as amended (ESA), regardless of the status of populations outside the DPS.

Bull trout within the coterminous United States have also been designated as a DPS (64 FR 58910). For management purposes, the DPS is subdivided into six biogeographical recovery units, each of which is comprised of multiple "core areas" that represent local populations ("simple core areas") or metapopulations ("complex core areas"). Two recovery units are within the geographic scope of this analysis: the Saint Mary Recovery Unit in northwestern Montana and the Columbia Headwaters Recovery Unit in northwestern Montana, northern Idaho, and northeastern Washington (Figure A1). The core areas within each recovery unit are identified in the recovery plan (USFWS 2015a).

Cutthroat trout populations may be differentiated for conservation and management purposes on the basis of geographic location or genetic integrity. In terms of geographic location, GMUs have been defined for BCT (Figure A3; UDWR 2019), CRCT (Figure A4; CRCT Coordination Team 2006), WCT (Figure A2; IDFG 2013), and YCT (Figure A5; May et al. 2007). GMUs are not intended to be biologically relevant; they are intended to organize and facilitate management activities. In terms of genetic integrity, the States of Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming have collaborated to define three levels of genetic integrity for cutthroat trout populations (UDWR 2000). "Core conservation populations" of a subspecies are those with no detectable introgression of genetic material from other subspecies or species (>99% genetically pure) and in which individuals present phenotypically as the subspecies to which they belong. "Conservation populations" of a subspecies have generally less than 10% introgression, while "sportfish populations" have greater than 10% introgression. Different management goals and strategies may be applied to populations according to the level of genetic integrity (UDWR 2000).

2.2. LIFE HISTORY SUMMARY

Note: Limited information is available on GBCT life history and habitat requirements due to recent genetic work that has redefined the subspecies (see 2.5. Current and Historical Species Condition*). Life history and habitat requirements are assumed to be similar to other cutthroat trout subspecies unless otherwise specified.*

Arctic grayling, bull trout, and cutthroat trout exhibit a variety of migratory and nonmigratory life history strategies. These include strategies in which individuals migrate from rivers ("fluvial" life history) or lakes ("adfluvial" life history) into smaller tributary streams to spawn, as well as nonmigratory strategies in which individuals spawn in the same stream or lake in which they otherwise reside. Multiple life history forms may co-occur within the same population; this has been observed for WCT (McIntyre and Rieman 1995) and bull trout (USFWS 2015a). Migratory individuals tend to be larger than stream resident individuals, which correlates with higher survival rates and fecundity for migratory individuals (Meyer et al. 2003; Al-Chokhachy and Budy 2008).

Length of seasonal and spawning migrations depends greatly on habitat connectivity. Arctic grayling and cutthroat trout have been recorded moving 50 to 100 kilometers (km) between winter and spawning habitats (Young 2008), with bull trout migrating up to 250 km (USFWS 2015a). However, when barriers to movement exist, migration distances may be reduced to less than 5 km (Young 2008).

Arctic grayling and cutthroat trout spawn in the spring or early summer, with timing dependent on water temperature, elevation, life history strategy, and occurrence of peak flows (Kaya 1990; Gresswell 1995; Young 1995a). Cutthroat trout construct redds, shallow depressions in the substrate, within which to deposit their eggs (Young 1995b), while arctic grayling spawn over unaltered substrate in shallow water (Kaya 1990). In both species, fecundity increases with female body size (Kaya 1990; Gresswell 1995; Downs et al. 1997). Fry emerge from the substrate in mid-summer to early fall and may either migrate quickly out of natal tributaries or

remain in the tributaries for months or even up to four years (Liknes and Gould 1987; McIntyre and Rieman 1995).

Bull trout spawn in the late summer into fall as temperatures drop, although migration to the spawning grounds can begin as early as April for those individuals with long distances to travel. Like cutthroat trout, bull trout construct redds in the substrate, where their eggs will develop over the course of three or more months. After hatching, fry remain in the substrate until April or May before emerging (USFWS 2015a). Although numerous fry will emigrate out of the natal tributary shortly thereafter, other migratory individuals will remain in the natal tributary for up to four years before emigrating; those delaying emigration are more likely to recruit as future spawners (Downs et al. 2006).

Sexual maturity is reached around two to three years in most populations of arctic grayling and cutthroat trout, although some cutthroat trout individuals do not reach sexual maturity until five years or older (Gresswell 1995; Kershner 1995). Bull trout reach sexual maturity between ages four and seven (Rieman and McIntyre 1993). Lifespans range from six years for arctic grayling and CRCT to a decade or more for YCT and bull trout (McPhail and Baxter 1996).

The diets of arctic grayling, bull trout, and cutthroat trout include a mix of aquatic invertebrates, terrestrial invertebrates, and small fishes. Invertebrate prey include amphipods and other zooplankton, chironomids and other dipterans, ephemeropterans, hemipterans, homopterans, and terrestrial hymenopterans such as ants (Cutting et al. 2016; Young 1995b). Fish were not a significant component of the diet for arctic grayling in one Montana study (Cutting et al. 2016) but in other parts of their North American range, larger individuals can be partially or primarily piscivorous (Stewart et al. 2007; McFarland et al. 2018). Bull trout are highly piscivorous at larger body sizes, although stream residents and smaller individuals in general consume mostly invertebrate prey (Goetz 1989; Guy et al. 2011). Among the cutthroat trout subspecies, certain populations of BCT and YCT may consume a larger share of fish prey, including suckers, sculpins, and minnows depending on both individual size and location (Gresswell 1995; Kershner 1995). WCT has been reported as less piscivorous than other subspecies, possibly as a result of niche partitioning with sympatric bull trout (McIntyre and Rieman 1995). The trophic niches of arctic grayling, bull trout, and cutthroat trout in their native ranges are similar to those of introduced salmonids such as brown trout, brook trout, rainbow trout, other subspecies of cutthroat trout, and their hybrids (Young et al. 1995b; Guy et al. 2011; Cutting et al. 2016).

2.3. HABITAT REQUIREMENTS

In general, arctic grayling, bull trout, and cutthroat trout live in cold headwater streams and high altitude lakes. Temperature is a critical abiotic habitat feature for both egg and juvenile development. Optimal water temperatures are generally below 17 degrees Celsius (°C; 63 degrees Fahrenheit [°F]) for all species (Liknes and Gould 1987; Rieman and McIntyre 1993; Young 1995b; Gresswell 2011). Bull trout appear to prefer the coldest waters, with optimal egg incubation occurring over winter between 2°C and 4°C (36-39°F) and optimal juvenile development occurring between 8°C and 13°C (46-55°F; Rieman and McIntyre 1993; Selong et al. 2001). On the other hand, summer water temperatures that are too low (median temperatures below approximately 8°C or 46°F) can interfere with GBCT and CRCT egg and juvenile

development and reduce overwinter survival (Harig and Fausch 2002; L. Ellwood, U.S. Fish and Wildlife Service [USFWS], personal communication, 2021). Some current YCT populations inhabit geothermally heated streams and historical records suggest that YCT previously existed in large rivers with water temperatures of 26°C (79°F) or warmer, although this is atypical of the subspecies in general (Gresswell 2011).

As for other physico-chemical habitat characteristics, low turbidity benefits all three species. High turbidity reduces macroinvertebrate abundances as well as feeding success due to all three species' reliance on visual cues for feeding (Henley et al. 2000; Stewart et al. 2007), and may increase predation risk (Schmetterling 2001). Presence of fine sediment is also associated with reduced egg and juvenile survival for cutthroat trout and bull trout (McIntyre and Rieman 1995; Bowerman et al. 2014). Bull trout require high dissolved oxygen concentrations, particularly in spawning and rearing habitats (USFWS 2015a), while arctic grayling are more tolerant of low dissolved oxygen concentrations than most salmonids (Kaya 1990). YCT appear to be limited by acidic waters (pH less than 5.0; Gresswell 2011).

All three species use sand or gravel substrates for spawning (Kaya 1990; Young 1995b; McPhail and Baxter 1996), although arctic grayling may tolerate a wider variety of substrates because they do not construct a redd (Kaya 1990). Preferences for water depth, stream gradient, and stream velocity at spawning sites vary by species and sometimes by population. Arctic grayling prefer to spawn in shallow water moving at moderate velocity (Kaya 1990). Bull trout prefer low gradient, low velocity, third or fourth order streams and avoid the smallest headwater streams for spawning (Goetz 1989; Rich et al. 2003). Among the cutthroat trout subspecies, spawning stream characteristics vary by population from first- to fourth-order streams and from low to moderate stream gradients and velocities (Kershner 1995; Schmetterling 2001; Gresswell 2011; Budy et al. 2012).

Fry of all three species are typically found in microhabitats with lower water velocities such as stream margins and backwaters, although they avoid still or very shallow water (Kaya 1990; Bozek and Rahel 1991; McPhail and Baxter 1996; Young 2008). For those individuals that delay emigration out of the natal tributary, habitat use tends to center on pool microhabitats that are complex or provide overhead cover (McPhail and Baxter 1996). In lake-resident or adfluvial populations of cutthroat trout, juveniles largely inhabit the pelagic zone (Gresswell 1995; McIntyre and Rieman 1995).

Outside of the spawning period, adult habitat use is more variable. Although often restricted to high-elevation habitats today, historical habitat use by all three species varied from headwater tributaries to larger streams, rivers, and lakes as long as water temperatures did not exceed their maximum tolerances (Kaya 1990; Young 1995b; McPhail and Baxter 1996; USFWS 2015a). For populations in riverine systems, preferred microhabitats are complex with an abundance of pools (Kaya 1990; Harig and Fausch 2002). Deep pools can be particularly important in winter (Kaya 1990; McPhail and Baxter 1996). Adult bull trout and cutthroat trout also show strong preference for microhabitats formed by in-stream large woody debris (Schmetterling 2001; Rich et al. 2003; Young 2009). In lacustrine systems, adults use the littoral and pelagic zones. YCT adults can be found in the littoral zone of lakes year-round (Gresswell 1995), while BCT at Bear Lake in Utah move to the pelagic zone in winter (McIntyre and Rieman 1995).

2.4. LIMITING FACTORS

Habitat Loss and Alteration

Habitat loss and alteration was a significant contributor to historical declines in arctic grayling, bull trout, and cutthroat trout populations (see *2.5 Current and Historical Species Condition*), and remains a threat today. Agriculture, forestry, mining, and urban land uses can affect water quality by increasing sedimentation and turbidity, which are detrimental to the survival of the three salmonid species at various life stages (McIntyre and Rieman 1995; Henley et al. 2000; Bowerman et al. 2014).

The impacts of dams, culverts, water diversions, and other forms of water development on habitat for these species are several-fold. Habitat can become unsuitable if flows decline substantially downstream of dams or due to water diversions (IDFG 2007). Poorly-designed dams and culverts create barriers to movement that isolate populations, reduce genetic and life history diversity, and make populations more susceptible to extirpation from natural disasters like fire and drought (Neraas and Spruell 2001; Cook et al. 2010; Ardren and Bernall 2017). Entrainment of fish in water diversion or water control structures can substantially increase mortality rates for a population (IDFG 2007; Gale et al. 2008).

Nonnative Salmonids

Nonnative salmonid fishes pose some of the most significant threats to cutthroat trout persistence today. Extensive stocking over many decades has introduced brook trout (*Salvelinus fontinalis*) from eastern North America, lake trout (*Salvelinus namaycush*) from northern North America, rainbow trout (*Oncorhynchus mykiss*) from the Pacific coast, and brown trout (*Salmo trutta*) from Europe into Rocky Mountain streams and lakes (Quist and Hubert 2004). Subspecies of cutthroat trout, most commonly YCT, have also been translocated across geographical boundaries that historically isolated the subspecies from each other (Metcalf et al. 2012; Love Stowell et al. 2015). Today, illegal introductions of nonnative salmonids into locations with conservation populations are believed to occur relatively rarely; barrier failures are more likely to allow spread of nonnative salmonids into new areas (GBCT Recovery Team 2019).

Nonnative salmonids influence native cutthroat trout populations through mechanisms of competition, predation, and hybridization. Brook trout are the most significant competitor of native cutthroat trout in small streams, while brown trout and lake trout exhibit competitive advantages over cutthroat trout in larger stream and lakes, respectively. Brown trout and lake trout are also highly piscivorous. Hybridization most commonly occurs between native cutthroat trout and either rainbow trout or introduced YCT (Young 1995b; Quist and Hubert 2004; Young 2009). Up to 59% of native YCT populations (Gresswell 2011) and up to 42% of native WCT populations (Shepard et al. 2005) contain a detectable percentage of genes from other species or subspecies, although in some portions of the native range of WCT the rate of introgression has been estimated to be much higher (M. Boyer, Montana Fish, Wildlife and Parks [MFWP], personal communication, 2021).

Nonnative salmonids also limit bull trout populations. Bull trout are less likely to occupy streams where brook trout are present (Rich et al. 2003), and competitive interactions favor brook trout, especially in warmer waters or where bull trout are resident in streams as opposed to migratory (Rodtka and Volpe 2007; Warnock and Rasmussen 2014). Brown trout is a competitor for food and spawning habitat, and both brown trout and lake trout prey on bull trout where their distributions overlap (USFWS 2015a). Bull trout and brook trout are known to hybridize and produce fertile offspring, although hybrid survival and fertility is reduced relative to the parents (Kanda et al. 2002).

For arctic grayling, there is mixed evidence for negative impacts of nonnative species (Kaya 1990). For example, there is potential for arctic grayling to experience food resource competition with nonnative YCT-rainbow trout hybrids (*O. clarkii bouvieri* × *O. mykiss*) and brook trout (*Salvelinus fontinalis*) due to trophic niche overlap (Cutting et al. 2016). However, Byorth and Magee (1998) found intraspecific competition to have a greater negative effect on arctic grayling growth rates than interspecific competition with brook trout.

Other Limiting Factors

Although harvest had a major influence on arctic grayling, bull trout, and cutthroat trout populations historically, it is not thought to pose a threat to the persistence of any of these species at present (Lentsch et al. 2000; CRCT Coordination Team 2006; MFWP and USFWS 2006; Young 2009; Gresswell 2011; USFWS 2015a). Harvest is actively regulated for all species and subspecies by the States in which they are present (UDWR 2021; WGFD 2018; Colorado Secretary of State 2020; IDFG 2020; MFWP 2021a; NDNH 2021).

Climate change is likely to exacerbate issues of habitat loss and nonnative species interactions as water temperatures rise, decreasing the extent of suitable habitat for the native species and increasing the extent of suitable habitat for introduced species (Jones et al. 2014; Warnock and Rasmussen 2014). Increasing frequency of droughts and wildfires due to climate change has the potential to further isolate or destroy habitat. More than half of arctic grayling conservation populations and the vast majority of BCT conservation populations have been estimated at high risk from wildfire or drought (Haak et al. 2010).

Whirling disease, caused by the exotic parasite *Myxobolus cerebralis*, has become a concern for cutthroat trout in the last few decades (Sarker et al. 2015) and likely contributed to an observed YCT population decline in Yellowstone Lake (Koel et al. 2006; Gresswell 2011). Bull trout are much less susceptible to whirling disease than cutthroat trout, while arctic grayling appear to be completely resistant (Sarker et al. 2015).

In the conservation of very small or isolated populations, inbreeding depression can serve as a limiting factor to population recovery. Studies of GBCT and WCT populations have indicated a relationship between low population genetic diversity and reduced juvenile survival (Andrews et al. 2016; Love Stowell 2016). GBCT propagation efforts at Leadville National Fish Hatchery (NFH) experience high mortality rates, likely due to the extremely low genetic diversity remaining in the subspecies (P. Sponholtz and L. Ellwood, USFWS, personal communications, 2021). Initially, propagation efforts also saw high rates of deformity such as missing eyes,

malformed jaws, and scoliosis. However, such deformities are not necessarily heritable and have become much less common in recent hatchery year classes (C. Kennedy, USFWS, personal communication, 2022).

2.5. CURRENT AND HISTORIC SPECIES CONDITION

Arctic grayling, bull trout, and cutthroat trout have each experienced population declines and range contractions over the past one to two centuries. The common causes of decline include overexploitation and habitat degradation. In bull trout and cutthroat trout, hybridization, competition, and predation by nonnative fish species have also played a significant role (Kaya 1990; Young 1995b; USFWS 2015a; 59 FR 30254). Comparisons of the current and historic distributions of the seven taxa and their current conservation status are described below.

Arctic Grayling

Arctic grayling is a Holarctic species that existed in the coterminous United States historically in two disjunct populations, one in the Great Lakes region (now extirpated) and one in the Upper Missouri River drainage (Lee et al. 1980 et seq.; Stamford and Taylor 2004). Until the end of the nineteenth century, arctic grayling were widely, if irregularly, distributed within the Upper Missouri River basin upstream of present-day Great Falls, Montana. The native range included rivers, streams, and occasionally lakes within the six major drainages of the Upper Missouri (Big Hole, Red Rock-Beaverhead-Jefferson, Madison, Gallatin, Smith, and Sun; Figure 1; Kaya 1990; Peterson and Ardren 2009).

Although historical populations of arctic grayling exhibited mostly fluvial life histories, current populations of arctic grayling are mostly adfluvial. Only one native fluvial population remains, inhabiting the Big Hole River (Montana Fluvial Arctic Grayling Workgroup 1995; Peterson and Ardren 2009). Native adfluvial populations exist in two small lakes in the Big Hole drainage, in the Red Rock lakes in the Beaverhead drainage, and in Ennis Reservoir in the Madison drainage (Peterson and Ardren 2009). In addition, early successes in arctic grayling hatchery propagation resulted in widespread stocking in lakes both within and outside of the native range during the twentieth century (Montana Fluvial Artic Grayling Workgroup 1995).

There have been two periods since the initial passage of the ESA in which threatened or endangered status was considered warranted for arctic grayling in Montana, but listing was precluded due to other higher priorities for the Service (1994-2007 and 2010-2014; 59 FR 37738; 72 FR 20305; 75 FR 54708; 79 FR 49384). The most recent 12-month finding was issued in 2020, in which the Service determined that listing was not warranted (85 FR 44478). In evaluating the current status of the Upper Missouri River DPS for this 12-month finding, the Service found that the 15 adfluvial populations in the DPS were stable and secure from threats. Of the four fluvial populations in the DPS, the Big Hole River population is by far the largest and although it experienced a well-documented decline in the latter part of the twentieth century, conservation activities since 2006 have significantly increased the number of effective breeders in the population (85 FR 44478). Arctic grayling is considered a Species of Concern in Montana (MNHP 2021) and a Sensitive Species by the U.S. Forest Service (USFS; 2011).

Bull Trout

Historically, bull trout were distributed from northern California to southern Alaska and from the Pacific coast to the headwaters of the Saskatchewan River on the eastern side of the Continental Divide (Figure 1; Lee et al. 1980 et seq.; 64 FR 58910). Occupancy within that range was patchy due to the species habitat requirements, but it is clear that extirpations have occurred over time, particularly in larger mainstem rivers, affecting approximately 60% of the native range (USFWS 2015a; 59 FR 30254). All bull trout in the coterminous United States were listed as threatened under the ESA in 1999 (64 FR 58910). At the State level, Montana considers bull trout to be a Species of Concern (MNHP 2021), Nevada designates it as an At-Risk species (NDNH 2021), and the U.S. Bureau of Land Management (BLM; no date [n.d.]) treats it as a Special Status Animal Species in Idaho.

Within the geographic scope of this analysis, bull trout currently occupy the headwaters of the Columbia River including the Clark Fork, Coeur d'Alene, Flathead, Kootenai, and Pend Oreille basins (USFWS 2015b); and the headwaters of the South Saskatchewan River including the Belly and Saint Mary Rivers (USFWS 2015c). In 2015, the Service described bull trout populations in the Columbia headwaters as "vulnerable" and populations in the Saint Mary basin as "imperiled" reflecting a lower certainty of persistence within the smaller, simply-structured populations of the Saint Mary basin (USFWS 2015a). However, only one metapopulation in the Columbia headwaters (in Lake Koocanusa, northwestern Montana) was considered to be at little to no risk of extirpation (USFWS 2015b).

Bonneville Cutthroat Trout

The BCT subspecies of cutthroat trout evolved within the Pleistocene Lake Bonneville basin and in the Bear River basin, including portions of present-day Idaho, Nevada, Utah, and Wyoming. The populations in the two basins were joined when a lava flow separated the Bear River from the Snake River drainage and diverted it into the Great Basin. Historically, BCT inhabited a wide range of fluvial habitats and were also found in four lakes in Utah and Wyoming: Alice, Bear, Panguitch, and Utah (Lentsch et al. 2000; UDWR 2019; 73 FR 52237).

In the mid-twentieth century, BCT was briefly believed to be extinct (Kershner 1995). However, by the end of that century, new surveys had identified 81 "pure" BCT populations (Duff 1996). Lake populations of BCT had been extirpated except in Bear Lake and Lake Alice. Stream populations were restricted to isolated reaches. In 2008, the Service published a 12-month finding on a petition to list the subspecies under the ESA, determining that listing was not warranted. At least 153 BCT conservation populations were known at that point and the subspecies occupied approximately 3300 km of stream habitat (73 FR 52235). A more recent status assessment in 2015 recorded 163 conservation populations (<10% introgressed) occupying 39% of historical BCT habitat, although populations are considerably more secure in the northern and northeastern portions of the native range than in the southern and western portions (UDWR 2019). BCT is considered a Species of Greatest Conservation Need in Utah and Wyoming and an At-Risk Species in Nevada (Utah Wildlife Action Plan Joint Team 2015; WGFD 2017; NDNH 2021). The U.S. Forest Service (USFS), BLM, and Great Basin National

Park also apply special conservation status to the subspecies (Lentsch et al. 2000; USDA Forest Service 2005; BLM n.d.).

Colorado River Cutthroat Trout

CRCT once occupied over 32,000 km of rivers and streams in the upper Colorado River basin across present-day Arizona, Colorado, New Mexico, Utah, and Wyoming (Hirsch et al. 2013). The historic range likely included the Green, Yampa, White, Colorado, and San Juan river basins (Young 1995a). Significant declines in CRCT populations occurred beginning in the late nineteenth century into the early twentieth century (72 FR 32589). The subspecies is now mostly restricted to small, isolated, high-elevation habitat patches, with fluvial life histories dominating over adfluvial ones (Hirsch et al. 2013). As of 2015, there were 384 known conservation populations of CRCT occupying only 11% of the subspecies historic range, mostly in the Green, Yampa, and upper Colorado basins (Albeke 2020). Of the three genetic lineages formerly recognized as CRCT (see *2.1 Taxonomy*), most belong to the blue lineage. Approximately 60 green lineage populations and eight San Juan lineage populations are currently known (CPW 2018; L. Ellwood, personal communication, 2021).

In a 12-month petition finding in 2007, the Service determined that the listing of CRCT as threatened or endangered under the ESA was not warranted because the subspecies maintained a wide geographic distribution and the number of known populations has increased in recent decades (72 FR 32589). The status of distinct genetic lineages has not yet been evaluated. CRCT is recognized in Colorado as a Species of Special Concern (CPW n.d.), in Wyoming and Utah as a Species of Greatest Conservation Need (Utah Wildlife Action Plan Joint Team 2015; WGFD 2017), and in Nevada as an At-Risk Species (NDNH 2021). At the Federal level, USFS has designated CRCT as a Sensitive Species (USFS 2005), and the subspecies has special conservation status with BLM in Utah and Wyoming (BLM n.d.).

Greenback Cutthroat Trout

GBCT was once thought to be native to the Arkansas and South Platte River basins in Colorado and southeastern Wyoming, but recent genetic and morpho-meristic work has raised questions about the native status in the Arkansas River basin (Metcalf et al. 2012; Bestgen 2019). The historic range of GBCT is poorly understood due to how quickly the subspecies declined as large numbers of immigrants arrived in the Front Range of Colorado in the mid-to-late nineteenth century (Young and Harig 2001). GBCT was considered extinct by the 1930s but was purportedly rediscovered in the 1950s (Young and Harig 2001). Metcalf and colleagues (2012) later argued that those "rediscovered" populations were actually descendants of transplants from another subspecies. These authors identified a single extant population of GBCT at Bear Creek in the Arkansas River headwaters, which itself was the product of translocation from the South Platte River basin. Thanks to recent reintroduction efforts, as of August 2021, pure GBCT were present in three streams (Bear Creek, Herman Gulch, and Dry Gulch) and one lake (Zimmerman Lake; GBCT Recovery Team 2019; L. Ellwood, personal communication, 2021). Population density in the Bear Creek population has declined dramatically in the last couple of years for unknown reasons, and Herman Gulch, Dry Gulch, and Zimmerman Lake have shown little to no recruitment (L. Ellwood, personal communication, 2021).

GBCT is the only subspecies of cutthroat trout currently listed under the ESA. The subspecies was first listed as endangered in 1967 under the Endangered Species Preservation Act of 1966, and then as endangered under the ESA. Its status was changed to threatened in 1978 (43 FR 16343). The most recent 5-year review in 2018 recommended no change in status due to lack of data (USFWS 2018), but a full Species Status Assessment is expected in calendar year 2023 and another 5-year review in 2024 (C. Kennedy, personal communication, 2022). GBCT is also regulated by the State of Colorado as a threatened species (Colorado Secretary of State 2020).

Westslope Cutthroat Trout

Although there is some uncertainty about the exact boundaries of its historic range, WCT is believed to have been the most widespread of the inland cutthroat trout subspecies. The historic range spanned the Continental Divide, including parts of the Kootenai, Clark Fork, Pend Oreille, Spokane, Coeur d'Alene, and St. Joe River drainages in the Columbia River basin; the Salmon and Clearwater River drainages in the Snake River basin; the John Day River drainage; several disjunct regions in British Columbia; the headwaters of the South Saskatchewan River; and parts of the upper Missouri River drainage in western Montana and northwest Wyoming (68 FR 46990). Portions of the native range within the Snake and John Day River systems, the Middle Columbia River basin, and British Columbia are not addressed in this report.

Today, the range of WCT in the United States has contracted to approximately 59% of its historical extent. Most extirpations have occurred in the Missouri River basin. Of the remaining occupied range, Shepard and colleagues estimated in 2005 that only about 10% is occupied by known genetically unaltered WCT populations, while another 27% is occupied by populations suspected to be genetically unaltered (Shepard et al. 2005). Today, the percentage of genetically unaltered WCT populations may be closer to 5% of the occupied range (M. Boyer, personal communication, 2021). The Service determined that threatened or endangered status under the ESA was not warranted in a 2003 finding (68 FR 46990), but the subspecies is considered a Species of Concern in Montana (MNHP 2021) and a Sensitive Species by USFS (2011).

Yellowstone Cutthroat Trout

Like WCT, YCT have a large native range spanning the Continental Divide, five States, and two major drainages. Within the Yellowstone River drainage on the eastern side of the Continental Divide, YCT were present from the Yellowstone and Bighorn River headwaters to their confluence, as well as in the upper Tongue River. Within the Snake River drainage on the western side of the Continental Divide, YCT were present upstream of Shoshone Falls, Idaho, with the range just barely extending into northeastern Nevada and northwestern Utah. Estimates of the size of the historic range include nearly 18,000 miles of stream and 126,000 acres of lake habitats. However, most of the lakes within the YCT native range are montane cirques that were fishless historically due to natural barriers (Endicott et al. 2016; 71 FR 8818).

Only 42% of historical YCT stream habitat is still occupied by the subspecies, and only 28% is occupied by genetically unaltered populations. Of the currently occupied stream habitat, the majority is located in Wyoming, followed by Idaho and Montana; less than 1% of occupied

stream habitat is located in each of Nevada and Utah (May et al. 2007; Gresswell 2011). Status assessments completed in 2006 and 2011 show a slight negative trend in the total number of YCT conservation populations (from 1018 to 1009) and a slight positive trend in spatial distribution (from 7527 to 7592 miles of stream, from 205 to 232 lakes; Endicott et al. 2016). In the early 2000s, concern over the subspecies decline led to a petition for listing as threatened or endangered under the ESA; the Service issued its 12-month finding that listing was not warranted in 2006 (71 FR 8818).

3. DESIRED STATE: SPECIES CONSERVATION GOALS

3.1. SUMMARY

For all three species of native salmonids addressed in this analysis, the ultimate goal for the Service and its partners is recovery on the landscape, precluding ESA listing of the five unlisted entities and leading to the delisting of the two listed entities. Various plans and partners may emphasize certain nuances of this goal, but it is present in some form in all the plans described in the following sections.

For the two currently listed entities, bull trout and GBCT, the Service uses its authority under the ESA to create recovery plans and set recovery criteria. For these two taxa, the recovery criteria constitute more specific and measurable Service goals than the general goal of recovery and delisting. For the remaining taxa, the States have primary jurisdiction and the Service and other Federal partners follow the States' leadership.

3.2. SERVICE GOALS

After discussions with Service staff across the Rocky Mountain region, the authors identified eight species- or subspecies-specific plans that are actively used by the Service to guide conservation and management activities for arctic grayling, bull trout, and cutthroat trout in the region (Table 1). Only two of these documents—those for the two ESA-listed entities—were authored solely by the Service, and even those two were substantially informed by partner input.

For the purposes of this report, the numerous species- and subspecies-specific goals present in the eight plans are further organized into four themes applicable to all three species: improve habitat conditions, secure native populations with conservation value, restore or enhance populations within the native range, and cooperate with partners to achieve conservation goals. A fifth theme is applicable to the five cutthroat trout subspecies: maintain sources of genetically pure cutthroat trout for propagation, reintroduction, and population augmentation. The naming of these themes is adapted from language used in the high-level conservation strategies for CRCT and YCT (CRCT Coordination Team 2006; Range-wide YCT Conservation Team 2008).

Table 1. Conservation strategies and plans identified by U.S. Fish and Wildlife Service (Service) staff as guiding their activities for arctic grayling, bull trout, and cutthroat trout conservation in the Rockies. The Service is a signatory on all documents except where noted. Other signatories are listed alphabetically. Agency acronyms: BLM = Bureau of Land Management, U.S. Department of the Interior; MFWP = Montana Fish, Wildlife and Parks; MT DNRC = Montana Department of Natural Resources and Conservation; NRCS = Natural Resources Conservation Service, U.S. Department of Agriculture; USFS = U.S. Forest Service, U.S. Department of Agriculture; USFWS = U.S. Fish and Wildlife Service, U.S. Department of the Interior.

No.	Plan Name	Other Signatories	Description
1	Candidate Conservation Agreement with Assurances for Fluvial Arctic Grayling in the Upper Big Hole River (MFWP and USFWS 2006)	MFWP, MT DNRC, NRCS	A Candidate Conservation Agreement with Assurances (CCAA) is a conservation tool for species that are candidates for Endangered Species Act listing at the time the agreement is made. The arctic grayling CCAA identifies a series of conservation measures with restoration targets, a system for prioritizing conservation projects, and the obligations of the partners in the agreement. This CCAA has a 20-year duration.
2	Centennial Valley Arctic Grayling Adaptive Management Plan (Warren and Jaeger 2017)	BLM, MFWP, Montana State University*	The adaptive management plan lays out a process for understanding limiting factors for arctic grayling in the Centennial Valley (Red Rock River drainage, Montana), and for selecting the most beneficial management actions to address those limiting factors. It was the product of an informal workgroup.
3	Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*) (USFWS 2015a) and associated Recovery Unit Implementation Plans (USFWS 2015b,c)	N/A	The recovery plan divides bull trout in the coterminous United States into six recovery units that each have their own recovery goals and implementation plans (e.g., USFWS 2015b,c). Implementation plans identify strategies to accomplish recovery goals and assign leadership roles, timelines, and cost estimates. Implementation plans can be revised as situations change (D. Brewer, USFWS, personal communication, 2021).
4	Bonneville Cutthroat Trout Range-wide Conservation Agreement and Strategy (UDWR 2019)	BLM, Confederated Tribes of the Goshute Reservation, NPS, State of Idaho, State of Nevada, State of Utah, State of Wyoming, Trout Unlimited, USFS, Utah Reclamation Mitigation and Conservation Commission	The agreement and strategy serves as an umbrella approach to BCT conservation for a 10-year time span, complementing State and Tribal management plans with more limited geographic scope. The conservation strategy adopts Trout Unlimited's Conservation Portfolio approach and Conservation Success Index (Williams et al. 2007) to guide conservation for individual populations and to prioritize actions across sub-watersheds.
5	Conservation Strategy for Colorado River Cutthroat Trout (*Oncorhynchus clarkii pleuriticus*) in the States of Colorado, Utah, and Wyoming (CRCT Coordination Team 2006)	State of Colorado, State of Utah, State of Wyoming	The range-wide management strategy was adopted in 2001 and updated in 2006. It provides general objectives for conservation of Colorado River cutthroat trout throughout its range, leaving specific targets to be determined by local partners. It was written prior to the discovery of multiple genetic lineages of cutthroat trout within the Colorado River basin, but the goals and objectives can be applied to all three lineages.
6	Recovery Outline for the Greenback Cutthroat Trout (*Oncorhynchus clarkii stomias*) (GBCT Recovery Team 2019)	N/A	The 2019 recovery outline updates the recovery vision for greenback cutthroat trout from the 1998 recovery plan (USFWS 1998) to reflect new understanding of the subspecies' status. The outline serves as a placeholder until the Recovery Team finalizes a full, updated recovery plan in 2025.
7	Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout and Yellowstone Cutthroat Trout in Montana (MCTSC 2007)	American Wildlands, Blackfeet Tribe, BLM, Confederated Salish and Kootenai Tribes, Federation of Fly-Fishers, Greater Yellowstone Coalition, MFWP, MT Chapter American Fisheries Society, MT Cutthroat Trout Technical Committee, MT Department of Environmental Quality, MT DNRC, MT Farm Bureau Federation, MT Stockgrowers Association, MT Trout Unlimited, MT Wildlife Federation, NRCS, USFS, Yellowstone National Park	The conservation agreement is specific to waters within the State of Montana. It describes a goal to ensure long-term persistence of cutthroat trout subspecies, maintain genetic purity and diversity, and preserve the ecological and socioeconomic values of the two subspecies native to Montana. Following this agreement, Endicott and colleagues (2013) wrote an implementation plan specific to Yellowstone cutthroat trout in Montana that identified conservation needs and priority actions at the watershed scale but did not identify which parties would be responsible for undertaking the actions within the plan.
8	Conservation Strategy for Yellowstone Cutthroat Trout *Oncorhychus clarkii bouvieri* in the States of Idaho, Montana, Nevada, Utah, and Wyoming (Range-wide YCT Conservation Team 2008)	State of Idaho, State of Montana, State of Wyoming, USFS, Yellowstone National Park**	The range-wide strategy provides general objectives for Yellowstone cutthroat trout conservation throughout its range, leaving specific conservation targets to be determined by local partners. It is very similar to the range-wide conservation strategy for Colorado River cutthroat trout (plan #5).

* There was no formal signature process for this document.
** A full list of signatories was not available for this document and the Service's status as a signatory could not be confirmed.

Theme 1: Improve habitat conditions

Habitat loss and alteration is an important limiting factor for arctic grayling, bull trout, and cutthroat trout. Programs like the National Fish Habitat Partnership (NFHP), the National Fish Passage Program (NFPP), and the Partners for Fish and Wildlife program allow the Service to direct considerable resources toward habitat improvement, especially toward the issue of habitat connectivity. The targets for habitat restoration in species-specific plans are generally qualitative (Table 2) and habitat targets do not exist range-wide for WCT, although Service staff agree that improving habitat conditions is a goal for WCT.

Table 2. Targets for arctic grayling, bull trout, and cutthroat trout conservation relevant to the theme of improving habitat conditions. Species abbreviations: BCT = Bonneville cutthroat trout; CRCT = Colorado River cutthroat trout; GBCT = greenback cutthroat trout; YCT = Yellowstone cutthroat trout. See Table 1 for information on conservation and management plans referenced by number in this table.

Species	Desired Outcome	Plan
arctic grayling	increased stream flows; sustainable riparian zones; reduced entrainment; effective fish passage; establish and maintain spawning or refugia in at least two tributaries upstream and downstream of Upper Red Rock Lake and connectivity among tributaries	1, 2
bull trout	essential cold water habitats conserved and connected	3
BCT	maintain or improve stream connectivity to promote migratory life history forms	4
CRCT	improved lake and stream habitat; adequate instream flows and lake levels; water quality standards met	5
GBCT	restored habitat, achieved through physical manipulation and sound land and water management practices; effective barriers against nonnative salmonids	6
YCT	improved watershed conditions; established protocols for monitoring habitat status and restoration effectiveness	8

Theme 2: Secure native populations with conservation value

Securing native populations of arctic grayling, bull trout, and cutthroat trout from further decline is a central theme for the Service in conservation efforts for each of these species. Management plans target demographic trends and other population characteristics such as life history diversity (Table 3). In some plans, qualitative or semi-quantitative targets were used because there was insufficient information available to set defensible quantitative population targets (MFWP and USFWS 2006).

Not all populations of cutthroat trout are similarly valued for conservation purposes; emphasis is placed on cutthroat trout populations that are genetically pure to the subspecies level ("core conservation" populations) or show low levels of introgression ("conservation" populations; see *2.1 Taxonomy*; UDWR 2000). For CRCT and YCT, the range-wide conservation strategies highlight the need to characterize existing populations through population surveys and genetic analyses (CRCT Coordination Team 2006; Range-wide YCT Conservation Team 2008). Without

information on current population status, it is difficult to effectively secure, enhance, or restore populations.

Conservation of genetic integrity and conservation of life history diversity for bull trout and cutthroat trout are often at odds with each other. Barriers reduce migration opportunities but can protect genetically pure populations from hybridization and introgression or create habitat for reintroduction of genetically pure populations. Resolution of this conflict requires assessing the relative risks and benefits for each species and scenario. Management goals place greater emphasis on conservation of life history diversity for bull trout, which produce fewer reproductively viable hybrid offspring, compared to management goals for cutthroat trout, where there is greater emphasis on conservation of genetic integrity (see Theme 5).

Table 3. Targets for arctic grayling, bull trout, and cutthroat trout conservation relevant to the theme of securing native populations with conservation value. Species abbreviations: BCT = Bonneville cutthroat trout; CRCT = Colorado River cutthroat trout; GBCT = greenback cutthroat trout; WCT = westslope cutthroat trout; YCT = Yellowstone cutthroat trout. See Table 1 for information on conservation and management plans referenced by number in this table.

Species	Desired Outcome	Plan
arctic grayling	positive trend in index of abundance in the Big Hole drainage; ≥ 1000 spawning adults in the Red Rock Lakes population; conserve existing genetic diversity in the Centennial Valley	1, 2
bull trout	geographically widespread and demographically stable populations across representative habitats; conservation of genetic diversity and diverse life history forms	3
BCT	reduce potential for introgression by stocking nonnative salmonids into BCT-occupied waters only if sterilized; see population targets in Table 4	4
CRCT	introduction and spread of nonnative fish species and diseases minimized; in-channel barriers protect against nonnative and hybrid trout invasion	5
GBCT	all known genetically pure populations maintained	6
WCT	number and miles of conservation populations maintained at year 1999 levels or above	7
YCT	number and miles of conservation populations maintained at year 2000 levels or above; introduction and spread of nonnative fish species and diseases minimized; in-channel barriers protect against nonnative and hybrid trout invasion	7,8

Theme 3: Restore or enhance populations within the native range

The theme of restoring extirpated populations is complementary to the theme of securing extant native populations. Arctic grayling, bull trout, and cutthroat trout have all experienced reductions in population number and geographic extent over the past two centuries. For arctic grayling and often for bull trout, restoration focuses on removing threats or barriers to enable natural recolonization, while cutthroat trout management plans often include hatchery propagation and reintroduction components as well. Restoration is a highly emphasized goal for GBCT and some of the newly identified cutthroat trout lineages in the Colorado River basin, given their rarity on the landscape (L. Ellwood, personal communication, 2021). Most management plans set targets

based on population size or trend (Table 4). The range-wide management strategy for BCT specifies a combined target number of populations to be either secured or restored (UDWR 2019). Range-wide strategies for CRCT and YCT describe biotic and political conditions required to reach the desired state of recovery for those subspecies without specific population objectives (CRCT Coordination Team 2006; Range-wide YCT Conservation Team 2008).

Table 4. Targets for arctic grayling, bull trout, and cutthroat trout conservation relevant to the theme of restoring or enhancing populations within the native range. Species abbreviations: BCT = Bonneville cutthroat trout; CRCT = Colorado River cutthroat trout; GBCT = greenback cutthroat trout; WCT = westslope cutthroat trout; YCT = Yellowstone cutthroat trout. See Table 1 for information on conservation and management plans referenced by number in this table.

Species	Desired Outcome	Plan
arctic grayling	positive trend in the number of sites occupied in the Big Hole drainage	1
bull trout	reintroduction of extirpated local populations if and where appropriate	3
BCT	expand BCT populations and distribution through introduction or reintroduction; Northern Bonneville and Bear River Geographical Management Units (GMUs): 30 conservation populations, ≥ 2 adfluvial populations, ≥ 2 fluvial populations, redundant populations in each subbasin of the GMU; West Desert and Southern Bonneville GMUs: 30 conservation populations, 15 disjunct populations, redundant populations in each GMU	4
CRCT	reintroduction sites cleared of nonnative fishes and secured by cooperative management agreements; redundant populations created for unique life-history attributes; metapopulations where possible	5
GBCT	sizeable (>500 adults), self-sustaining (recruitment in 2 of every 5 years), well-distributed conservation populations located primarily within the South Platte River drainage; representation within each of six subbasins containing substantial suitable habitat	6
WCT	expansion within historic range	7
YCT	expansion within historic range; increased number of populations; reintroduction sites cleared of nonnative fishes and secured by cooperative management agreements as needed; redundant populations created for unique life-history attributes; metapopulations where possible	7,8

Theme 4: Cooperate with partners to achieve conservation goals

The Service has explicit obligations to its partners under Candidate Conservation Agreements with Assurances (CCAAs) that are in place locally for arctic grayling (MFWP and USFWS 2006) and WCT (MFWP and USFWS 2004) in Montana. Formal agreements between signatories are also written into the range-wide conservation strategies for BCT (Lentsch et al. 2000) and CRCT (CRCT Coordination Team 2006), and into Montana's conservation agreement for WCT and YCT (MCTSC 2007).

Regardless of the level of formality, maintaining effective partnerships is recognized by Service staff and nearly every management plan as crucial to achieving conservation goals for all three species. Recognized benefits include enhanced communication, prioritization, funding, and

ability to implement conservation actions that yield long-term benefits (Lentsch et al. 2000; CRCT Coordination Team 2006; Range-wide YCT Conservation Team 2008; USFWS 2015a). Much of the conservation planning for native salmonids in the Rockies is led by State agencies rather than the Service. Even for the ESA-listed bull trout and GBCT where the Service has a larger role to play in defining recovery criteria, many of the strategies to achieve recovery criteria rely heavily on Federal, State, and Tribal partners who hold ownership or other rights to the waters in which the fish are located. Recovery unit implementation plans for bull trout indicate that the Service will act in a supporting role on most tasks within the plan (USFWS 2015b,c).

Theme 5: Maintain sources of genetically pure cutthroat trout

Hybridization with nonnative salmonids (including translocated cutthroat trout subspecies) is a particularly salient threat to persistence of cutthroat trout. The Service and its partners have set goals to maintain at least some genetically pure populations of different cutthroat trout subspecies and lineages both in the wild and in captivity. The conservation strategies for BCT, CRCT, and YCT stipulate the maintenance of one genetically pure broodstock per GMU (CRCT Coordination Team 2006; Range-wide YCT Conservation Team 2008; UDWR 2019). Because GMU boundaries for CRCT align with river basin boundaries, the goal of a genetically pure broodstock in each GMU would simultaneously preserve pure broodstocks for the different genetic lineages of cutthroat trout (green, blue, San Juan) in the Colorado River basin. The 1998 recovery plan for GBCT specified the maintenance of both a captive broodstock and a wild broodstock (USFWS 1998).

3.3. COMPLEMENTARY GOALS

The eight species-specific plans discussed in *3.2 Service Goals* exist within the context of a wide range of plans with broader taxonomic scope. These include plans that have broad geographic scope like the strategic plan for the Western Native Trout Initiative (WNTI), as well as State Wildlife Action Plans, Tribal management plans, and plans that are specific to a single watershed or subbasin.

WNTI began as an initiative of the Western Association of Fish and Wildlife Agencies in 2006 and was recognized as an official Fish Habitat Partnership under the Service's NFHP program in 2007 (WNTI 2019). The partnership is focused on the conservation of 21 native species of trout and char within 12 western U.S. States. These States all participate in the partnership along with several Federal agencies and nongovernmental organizations. WNTI's strategic plan, last updated in 2016, includes four goals focused on species conservation, habitat conservation, internal collaboration, and outreach. Across all four goals, there is a strong emphasis on sound science and data management, strategic action, and communication (WNTI 2016). WNTI awards NFHP funding through the Service for fish habitat conservation projects, in addition to facilitating collaborations, fundraising from private donors, and educating the public about the value of native trout and char. The WNTI Steering Committee has recently agreed to rotate project funding prioritization among subsets of focal species. BCT was one of the focal species for calendar years 2018-2020. Focal species for calendar years 2021-2024 include CRCT, WCT, and YCT. Bull trout will be a focus in calendar years 2025-2027.

State agencies were heavily involved in the development of the range-wide conservation plans for cutthroat trout and use these plans as their primary guidance on cutthroat trout conservation activities. In addition, each State within the native range of Upper Missouri arctic grayling, bull trout, and cutthroat trout has a State Wildlife Action Plan, a prerequisite for receiving State Wildlife Grants administered by the Service. State Wildlife Action Plans include nonregulatory designation of Species of Greatest Conservation Need, indicating that species were or are currently experiencing substantial population declines and laying out actions needed for species conservation. Arctic grayling, bull trout, and cutthroat trout are considered Species of Greatest Conservation Need by each of the States in which they are present except Idaho (USGS 2021). The Wyoming State Wildlife Action Plan places a particularly strong emphasis on fish passage restoration (WGFD 2017).

Many of the Tribes within the geographic scope of this analysis have existing fisheries management plans. The Confederated Salish and Kootenai Tribes (CSKT) and MFWP led the development of a Flathead River Subbasin Management Plan for this section of the Columbia River headwaters; 11% of land in the subbasin is owned by CSKT (CSKT and MFWP 2004). The plan includes general aquatic habitat objectives focused on riparian habitat quality and diversity, flow through Hungry Horse Dam, stream channel stability, and fish passage as well as species-specific conservation objectives for bull trout and WCT, which were designated as focal aquatic species. Under the plan, bull trout and WCT populations would be maintained or increase in number, size, and distribution, and nonnative salmonid populations would be contained or eradicated where feasible. Simultaneously, the plan provides for the maintenance and growth of sport fisheries where such activities will not interfere with native species persistence (CSKT and MFWP 2004). As for other Tribes in the region, fisheries management plans exist for the Goshute Reservation and the Northern Ute Reservation, and there are several plans addressing fisheries management on the Wind River Reservation dating back to the 1980s, including a lowland lakes and reservoirs management plan, a rivers and streams management plan, and a research plan for fisheries management.

A fourth driver of large-scale fisheries conservation and management activities in the region is mitigation of major hydropower projects. The Colorado River Storage Project Act of 1956 (43 U.S.C. 620) has had a substantial impact on the presence of both native and nonnative fishes on the landscape, introducing both native and nonnative salmonids to reservoirs in the Upper Colorado basin. Several decades later, the Hungry Horse Dam Fisheries Mitigation Implementation Plan outlined a suite of habitat improvement, fish passage improvement, fish rearing and stocking, offsite mitigation, and operational mitigation activities to offset negative impacts to fisheries, aquatic insects, and aquatic habitat from the operation of the Hungry Horse Dam on the South Fork of the Flathead River (MFWP and CSKT 1991).

4. CURRENT ACTIVITY TOWARDS CONSERVATION GOALS

4.1. CURRENT SERVICE ACTIVITIES

The Fish and Aquatic Conservation (FAC) program, the Ecological Services (ES) program, and the National Wildlife Refuge System (including Partners for Fish and Wildlife in Legacy Region 6) are the primary Service programs engaged in conservation and management of arctic grayling,

bull trout, and cutthroat trout in the Rockies. However, with the exception of ESA-listed bull trout and GBCT, the States maintain primary management authority. Information on Service activities described in this section is drawn from the Service's Fisheries Information System (FIS) and from conversations with relevant Service staff, with an emphasis on Fish and Wildlife Conservation Office (FWCO) and FAC contributions over the past five years (Fiscal Years [FY] 2017-2021).

The subsections below break down Service activities by theme. One activity that crosses all themes is the ongoing effort by the ES program to complete statewide threats assessments and prioritization within the coterminous U.S. range of bull trout. This effort is being conducted in collaboration with State natural resource agencies, and FWCO offices vary in their level of engagement. The prioritization of activities coming out of the threats assessments will likely affect FAC work in the years to come.

Theme 1: Improve habitat conditions

The National Fish Passage Program and the National Fish Habitat Partnership

Through NFPP and NFHP, FWCOs provide financial and technical assistance to partners to support habitat restoration for native fishes. Over the past five fiscal years, FAC offices have reported a total of 369 activities that directly implement NFHP and NFPP funding for conservation of arctic grayling, bull trout, and cutthroat trout within the geographic scope of this analysis (Figure 2). Of the taxa included in this gap analysis, BCT and YCT were by far the biggest beneficiaries of the two programs over the last five fiscal years, both in spending and number of activities (Figure 3). CRCT also benefitted significantly, with nearly as many activities as BCT but much lower financial investment. Most activities involved improvements in habitat connectivity, with smaller fractions addressing entrainment, nonnative species, and other habitat restoration issues.

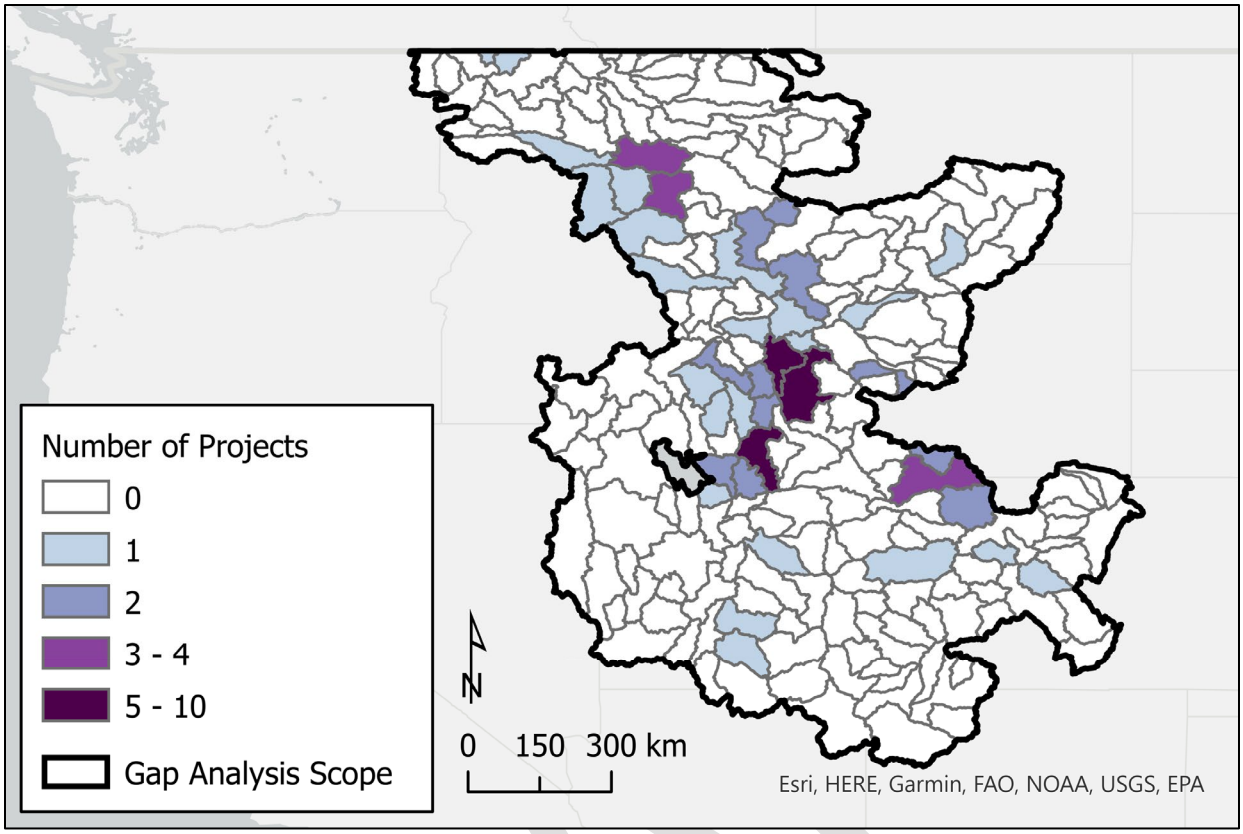

Figure 2. Geographic distribution of Service-funded National Fish Passage Program and National Fish Habitat Partnership projects to benefit arctic grayling, bull trout, and cutthroat trout within the geographic scope of this gap analysis. Projects active between Fiscal Year 2017 and Fiscal Year 2021 are aggregated by watershed (8-digit hydrologic unit; Seaber et al. 1987).

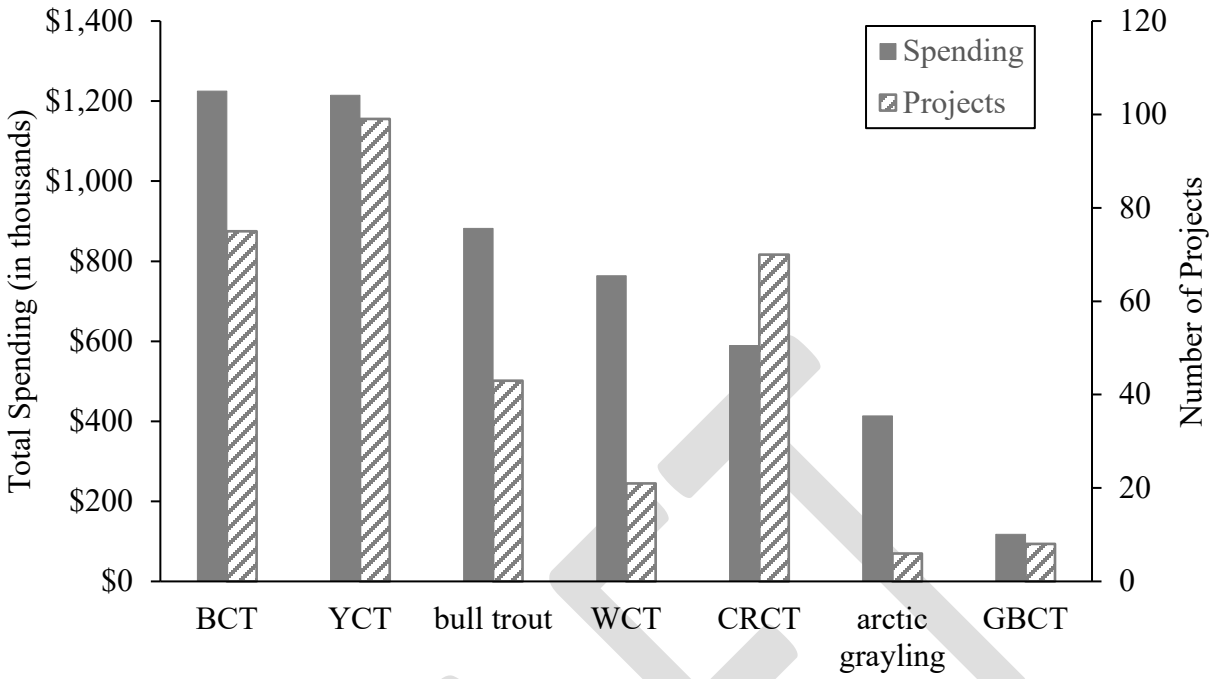

Figure 3. Combined National Fish Habitat Partnership and National Fish Passage Program spending (solid bars) and number of activities completed (striped bars) within the Fish and Aquatic Conservation program, Fiscal Years 2017-2021, by primary species benefitted. Activities completed to benefit bull trout or westslope cutthroat trout in the States of Idaho, Oregon, and Washington were excluded unless they fell within the geographic scope of this report (Figure 1). Westslope cutthroat trout was a secondary beneficiary of most bull trout projects. Species abbreviations: BCT = Bonneville cutthroat trout; CRCT = Colorado River cutthroat trout; GBCT = greenback cutthroat trout; WCT = westslope cutthroat trout; YCT = Yellowstone cutthroat trout.

The largest investments by the Service between FY2017 and FY2021 were on NFPP barrier removal projects in Idaho's Priest and Kootenai River basins to benefit bull trout and WCT, and on NFPP and NFHP barrier removal projects in Utah's Weber River basin to benefit BCT. Other high-impact projects completed during this time include a multiphase sediment mitigation project to protect the one remaining naturally recruiting population of GBCT in Colorado and the installation of a fish screen in Montana's Bitterroot basin that ended the entrainment and death of tens of thousands of fish including bull trout and WCT. The combination of NFPP, NFHP, and non-Service investments to benefit BCT in Utah and CRCT in the Yampa River basin, Wyoming, have largely addressed the current habitat restoration needs in those areas according to State biologists. Significant needs remain in other locations.

Occasionally, NFHP and NFPP funds are used to support research that will facilitate prioritization or implementation of future habitat improvement projects. The FAC program's Bozeman Fish Technology Center (FTC) in Montana received NFHP funding in FY2017 and FY2018 to study optimal fish passage design parameters under various flow conditions. More recently, the Legacy Region 6 NFPP coordinator and others have been working with the Southeast Aquatic Resources Partnership and other Fish Habitat Partnerships in the Great Plains

and the West to expand a database of fish passage barrier locations that was initially focused on the southeastern United States (https://connectivity.sarpdata.com/). The expanded database will cover the ranges of Upper Missouri arctic grayling, bull trout, and the five subspecies of cutthroat trout included in this report and will help partners identify and prioritize locations for future fish passage projects. Validation of the expanded dataset is expected to take another four years.

Other Habitat Improvement Activities

Although NFHP and NFPP provide significant resources to improve habitat conditions for arctic grayling, bull trout, and cutthroat trout, the Service is actively improving habitat conditions via other mechanisms as well. The Partners for Fish and Wildlife program often leads such efforts.

In western Wyoming, cutthroat trout are one of the priority species for the Partners for Fish and Wildlife program. The program has been particularly focused on BCT in the Bear River basin and CRCT in the Green River basin, with limited attention to YCT outside of the Wind River Reservation. Although the program initially invested a lot of resources on removing seasonal barriers and installing fish screens on irrigation diversions, their attention is now shifting to water conservation and maintenance of instream flows. Partners for Fish and Wildlife biologists invest significant time in educating landowners about the benefits of improving irrigation efficiency and then work with the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) to fund installation of more efficient irrigation technologies. In collaboration with a hydrologist from the University of Wyoming, the Service has been able to identify targets for instream flow restoration based on the estimated low flow state for a healthy river.

The Partners for Fish and Wildlife program is very active as well in western Montana's Blackfoot River basin, a local stronghold for bull trout and WCT. Through this program, the Service has worked with the State, conservation organizations, and over 200 landowners to assess habitat in all Blackfoot River tributaries, prioritize tributaries for restoration, and implement up to a million dollars' worth of restoration projects annually. As of 2018, completed projects had addressed riparian grazing practices on 36 streams, entrainment in irrigation systems on 18 streams, inadequate instream flows on 17 streams, and channel degradation on 27 streams (Pierce and Podner 2018).

Also in Montana, the Service has put significant effort into addressing habitat threats to the Upper Big Hole River population of arctic grayling through the Partners for Fish and Wildlife program, supported by a 2006 CCAA (MFWP and USFWS 2006). About 90% of the habitat occupied by this arctic grayling population is on private lands. Thirty-four landowners are currently enrolled in the CCAA and have management plans for their properties. A Partners for Fish and Wildlife biologist works on the design, permitting, and implementation of 15 to 20 projects annually to address issues of inadequate stream flows, barriers to fish passage, habitat degradation, and entrainment in irrigation systems. Both the Montana FWCO and the Bozeman FTC provide technical assistance as needed.

On the Service's Red Rock Lakes National Wildlife Refuge (NWR), Montana FWCO and NWR staff have worked extensively with the State of Montana to address the limiting factor of habitat

for the remnant arctic grayling population. Following a major winterkill in FY2015, the refuge began exploring options to address winter hypoxia in Upper Red Rock Lake. A mechanical aerator was unsuccessful under local weather conditions, so the refuge has begun experimenting with manipulating water levels flowing into the lake to temporarily increase dissolved oxygen. Additionally, the refuge is working with the State to assess the feasibility of piping oxygenated water into the bottom of the lake, although implementation would face major hurdles due to the lake's location within a designated wilderness area. To increase spawning habitat quantity and quality, the Montana FWCO worked with NWR staff and the State in FY2017 and FY2018 to reroute a tributary to Upper Red Rock Lake and improve habitat parameters. In FY2019, monitoring by the FWCO showed that very few grayling were entering the restored creek. NWR staff are planning further restoration work on Elk Springs Creek in FY2022.

The Bozeman FTC supports implementation of habitat improvements through research into fish movement and fish passage design, in collaboration with academic researchers and the State of Montana. Recent projects have included a study of arctic grayling swimming performance (Dockery et al. 2020), the development of small-scale fishways to fit smaller streams and diversions, a comparison of four methods used to verify passage through remediated culverts (Peterson and Neville 2019), and measurement of passage efficiency and attraction for arctic grayling in the Big Hole River basin (Triano 2020).

Theme 2: Secure native populations with conservation value

Three types of Service activities address this theme: activities that identify populations with conservation value, activities that address limiting factors for populations with conservation value, and activities to monitor populations and evaluate progress on securing their persistence.

Identifying Populations with Conservation Value

The task of identifying populations with conservation value is particularly complex for cutthroat trout, where only populations with a low level of hybridization have value for conservation of a lineage (UDWR 2000) and where hybrids may look very similar to genetically pure individuals (Meyer et al. 2017). Recently, the FAC program has been involved in several efforts to characterize the genetics of cutthroat trout in the Rockies. In Idaho, the Abernathy FTC has been monitoring rates of hybridization in WCT by sampling individuals captured below Cabinet Gorge Dam on the Clark Fork River. The Montana FWCO has worked with the Blackfeet Tribe to assess genetic purity of WCT populations and identify locations on which to focus WCT conservation within the Blackfeet Reservation. The Utah FWCO has been engaged in assessing the genetic status of native cutthroat trout populations in Utah, including BCT and CRCT subspecies. Finally, a recent NFHP grant has been awarded for a range-wide genetic analysis of YCT populations to assess both genetic integrity and relatedness of existing populations.

Population genetics are also important in understanding diversity across bull trout populations. Prior to the timeframe of this analysis, a collaboration between Abernathy FTC and the Montana FWCO found that there is significant genetic differentiation among populations within the Saint Mary Recovery Unit (DeHaan et al. 2011 in USFWS 2020), establishing the unique conservation value of each of these populations.

Addressing Limiting Factors

Habitat.—Habitat restoration is critical to securing native populations of arctic grayling, bull trout, and cutthroat trout in the Rockies, in addition to being a conservation goal in its own right. Many of the Service's activities to improve habitat are described above under Theme 1. Here, the discussion focuses specifically on ways in which the Service is combatting the impacts of habitat fragmentation and entrainment mortality on existing populations.

Abernathy FTC and Ecological Services in western Montana are each using active translocation of bull trout to mitigate the population demographic and genetic impacts of dams in the Columbia Headwaters Recovery Unit. At Cabinet Gorge Dam, Abernathy FTC conducts rapid genotyping and passes fish upstream only if they are native to upstream areas, helping to maintain the genetic integrity of spawning populations. Ecological Services has recently begun translocating bull trout between spawning habitat in Montana's Lower Clark Fork River basin and foraging and overwintering habitat in northern Idaho's Lake Pend Oreille. Fish traveling upstream from Lake Pend Oreille would have to traverse three dams to reach spawning tributaries, so this translocation effort increases the probability that the fish arrive in spawning areas. The population further benefits from the larger size and increased fecundity of individuals that forage and overwinter in larger and more productive water bodies.

Arctic grayling, bull trout, and cutthroat trout may all suffer direct mortality from entrainment in irrigation systems built in their habitats. The Montana FWCO has been particularly active in entrainment mitigation through its leadership role in the Saint Mary Recovery Unit for bull trout, where U.S. Bureau of Reclamation (BOR) water-control and delivery structures are the dominant threat to population persistence (USFWS 2015a, c). Based on two decades of data on bull trout population size and movement, the FWCO completed a comprehensive status assessment for bull trout in the recovery unit (Mogen 2020 in USFWS 2020). This document was the primary source of population status and trend information informing a 2020 Biological Opinion on BOR operations in the Saint Mary River system (USFWS 2020). FWCO data were also used to develop recently-published estimates of total annual entrainment of bull trout in the Saint Mary canal (Kaeding and Mogen 2020). The FWCO conducts an annual salvage operation in coordination with BOR and the Blackfeet Tribe to relocate entrained bull trout and, for the past two fiscal years, FWCO and Montana ES Field Office (ESFO) staff have participated in a multiagency team convened by BOR to develop minimization measures to reduce bull trout take (USFWS 2020).

Nonnative salmonids.—The Service's most common tools to address nonnative salmonids in occupied native salmonid habitat include barrier construction, direct removal, and introduction of sterile hybrids. Often, barrier construction and direct removal methods are used in combination. For example, a current barrier project on a tributary of the Little Snake River will enable partners in the Wyoming Landscape Conservation Initiative to eradicate brook trout above the new barrier without replacement immigration into the watershed. The Lander FWCO provided funding for this project in FY2021, but the entire effort to eliminate nonnative species and restore the habitat is expected to take 25 years or more. Barriers to fish movement are further discussed as a management tool under Theme 5, below.

Among the FWCOs in the Rocky Mountain region, the Lander FWCO is most active in nonnative species control, although other FWCOs assist State and Federal partners in control efforts as much as possible (see *4.2 Partner Activities*). The Lander FWCO fulfills the Service's Tribal trust responsibilities for fish and wildlife management—including aquatic invasive species (AIS) management—on the Wind River Reservation, current home of the Eastern Shoshone and Northern Arapahoe Tribes. The FWCO has stocked tiger trout (*Salmo trutta* × *Salvelinus fontinalis*) in seven alpine lakes on the reservation to reduce populations of lake trout and brook trout. Tiger trout is a sterile hybrid fish that competes well with other salmonids, and the stockings have had modest success. An earlier experiment in lake trout removal using gill nets suppressed one reservation lake's population by 50% but would likely never lead to lake trout extirpation from the lake. Because the FWCO has only two biologists, they are limited to management activities that can be accomplished by one or two people. Chemical treatment with rotenone would be the FWCO's preferred means of nonnative salmonid removal, but rotenone has not been used on the reservation since 1968 due to the financial and time demands of implementation.

In another direct removal effort, the Montana FWCO led targeted removal of introduced YCT-rainbow trout hybrids at Red Rock Lakes NWR between 2012 and 2016. The FWCO continued to monitor native and nonnative salmonid population trends into 2019 to detect any response by arctic grayling to the reduction of the hybrid YCT-rainbow trout population. Without a positive response from the arctic grayling population, the focus of conservation efforts shifted completely to the limiting factor of habitat at that time (discussed above under Theme 1).

The NFH system helps mitigate some impacts of nonnative salmonids by producing sterile sport fish for Federal, State, and Tribal stocking. Stocking sterile individuals prevents nonnative salmonid populations from growing organically or hybridizing with native species, but it does not remove the threat of competition and predation on native species. Jones Hole NFH in Utah rears the above-mentioned tiger trout stocked on the Wind River Reservation. Montana's Ennis NFH and Creston NFH both produce triploid rainbow trout that are effectively sterile and cannot hybridize with native salmonids. The share of triploids out of all rainbow trout produced by the hatcheries has increased over time, but the hatcheries still respect State and Tribal requests in distributing the type of fish desired by the recipient.

Beyond the FAC program, the Montana ESFO has been attempting to suppress the population of nonnative lake trout in Swan Lake, Montana, in collaboration with MFWP. Swan Lake is an important foraging site for nine bull trout populations and its value within the Columbia Headwaters Recovery Unit is highlighted under the Service's bull trout recovery plan (USFWS 2015a). Although this effort is a top priority for bull trout conservation in western Montana and regulatory requirements have been addressed, the project has been hindered for the past two years by lack of funding for necessary equipment.

Monitoring Populations and Assessing Status

The ES program tracks status and trends at the species, subspecies, or DPS level through 5-year status reviews of ESA-listed species and detailed Species Status Assessments for both listed species and species that are candidates for listing. For the ESA-listed bull trout and GBCT, the most recent 5-year status reviews were completed in 2015 and 2018, respectively. The program

announced initiation of a new 5-year status review for bull trout in March 2020, including statewide status assessments for each State where the species is listed as threatened. The next 5-year status review for GBCT is scheduled for completion in 2024. A Species Status Assessment is currently in progress for GBCT, co-authored by biologists from the Colorado ESFO and the Colorado FWCO. A separate Species Status Assessment is expected for the green lineage of CRCT once summary data on the lineage become available from the State of Colorado.

The Montana, Lander, Utah, and Colorado FWCOs are involved to varying degrees in tracking status and trends at the population level within their respective geographic areas. The Montana FWCO monitors bull trout populations in the Saint Mary Recovery Unit annually through redd count surveys, electrofishing surveys, and tracking fish implanted with Passive Integrated Transponder (PIT) tags. This monitoring effort enables the FWCO to track population trends, assess demographic stability, and detect PIT-tagged fish entrained in the Saint Mary Canal. These data also serve as a baseline against which to assess the impacts of future BOR work in the system, as was done in the 2020 Biological Opinion issued by the Montana ESFO (USFWS 2020). Until 2019, the Montana FWCO also led efforts to monitor spawning arctic grayling and their movement in response to habitat restoration on Red Rock Lakes NWR.

The Lander and Utah FWCOs focus their monitoring efforts on tribal lands as part of the Service's responsibility to the Tribes for fish and wildlife management. The Utah FWCO provides technical assistance to the Northern Ute Tribe for annual CRCT population assessment and to the Goshute Tribe for annual BCT population assessment. The Lander FWCO is responsible for YCT population monitoring on the Wind River Reservation. Over the past several years, the Lander FWCO has been conducting surveys of the reservation's lowland lake and stream YCT populations as well as the approximately 60 high mountain lake populations of YCT, many of which have not been surveyed in several decades due to their inaccessibility. The FWCO is seeking to determine where the range of the subspecies has changed in recent years, whether the reservation has an extant native strain of YCT, and the impacts of nonnative lake trout and crayfish on co-occurring YCT. The FWCO competed successfully for regional funding to support Student Conservation Association interns and an employee from Ennis NFH to help with surveys in FY2021 and FY2022. Sampling metrics focus on catch-per-unit-effort; there is insufficient capacity to do sufficient sampling to enable robust population modeling.

Although most population monitoring in Colorado is done by the State, the Colorado FWCO takes the lead in monitoring cutthroat trout in Rocky Mountain National Park. The park includes land on both sides of the Continental Divide; the native range of GBCT lies to the east of the divide (there are no extant populations within the park), and the native range of green lineage CRCT lies to the west of the divide. The Colorado FWCO conducts electrofishing, netting, and angling surveys within the park, with exact survey locations determined annually in collaboration with the National Park Service (NPS).

While FWCO monitoring relies primarily on traditional capture gear, the Abernathy and Bozeman FTCs are enhancing monitoring capabilities with genetic and histological tools. Over the last five FY, Bozeman FHC staff have conducted disease monitoring of salmonid populations in Rocky Mountain National Park, Yellowstone National Park, Glacier National Park, Utah's Green River Basin, and numerous sites in Montana, as well as in creeks near Jones Hole NFH

and Leadville NFH. In FY19 and FY20, Bozeman FTC used histological analysis to characterize the reproductive structure of the migratory population of WCT that spawns in western Montana streams and overwinters in Lake Pend Oreille. More recently, Abernathy FTC conducted genetic analyses on a sample of bull trout killed in lake trout suppression efforts to track which bull trout populations were most affected. Abernathy FTC is currently working to expand its existing genetic database for bull trout with samples from more locations and to update its bull trout genetic baseline for compatibility with a more cost-effective analytical method that will facilitate future analyses.

Theme 3: Restore or enhance populations within the native range

The Service and the FAC program, in particular, is heavily involved in spawning, rearing, and release of hatchery-raised fish to restore or enhance native bull trout and cutthroat trout populations. Although there was a very active Federal hatchery propagation program for arctic grayling historically (Kaya 1990), there is no current propagation of this species within Federal hatcheries. The Service also contributes to monitoring potential reintroduction sites, addressing limiting factors that could hinder restoration success, and post-reintroduction monitoring.

GBCT benefits from one of the most active reintroduction programs for Rocky Mountain native salmonids. In all areas outside Rocky Mountain National Park, the State of Colorado leads reintroduction efforts with support from the FAC and ES programs and other members of the GBCT Recovery Team (see *4.2 Partner Activities*). Within Rocky Mountain National Park, the Colorado FWCO and NPS co-lead GBCT reintroduction efforts. The FWCO and NPS recently teamed up to complete habitat surveys and determine priority sites for future reintroduction (Kennedy and Watry 2020). The FWCO has also been conducting mechanical removal of nonnative or hybrid trout from two streams within the park above existing barriers to prepare for future native species reintroductions.

Leadville NFH is a national leader in the propagation of GBCT for reintroduction, and the Colorado FWCO supports the hatchery in this effort by sharing approximately one month of a biologist's time annually. Leadville NFH maintains multiple year classes of GBCT as broodstock (see Theme 5) and provides between 200,000 and 350,000 eggs annually to a State of Colorado hatchery for rearing.

Leadville NFH also produces between 17,000 and 36,000 eggs annually from the Hayden Creek strain of the green lineage for CRCT restoration efforts. The hatchery produced up to 790,000 eggs annually of the Carr Creek strain of green lineage CRCT until FY2020, when the propagation program for the Carr Creek strain was discontinued and remaining broodstock were released. All eggs are transferred to Colorado Parks and Wildlife (CPW) facilities for rearing and stocking. In FY2019, Jones Hole NFH reared over 71,000 CRCT for stocking in two reservoirs in Wyoming, but the hatchery did not participate in CRCT propagation in either of the two years before or since.

CRCT are sometimes removed from streams on the east slope of the Continental Divide as the habitat is prepared for GBCT reintroduction. Although not native to the east slope, many of these CRCT populations are genetically pure. The Service and its partners have attempted to salvage

CRCT during stream reclamation operations and return these fish to streams on the western side of the divide where they are native.

To enhance YCT populations, Saratoga NFH rears the La Hardey Rapids strain of YCT and Jackson NFH rears the Bar BC Spring Creek strain of Snake River YCT, both from eyed eggs produced by State of Wyoming hatcheries. Jackson NFH periodically assists with spawning activities at the Auburn State Fish Hatchery (SFH), although this assistance was discontinued during the COVID-19 pandemic at the request of the State. Jackson NFH, Saratoga NFH, and Lander FWCO staff stock approximately 10,000 La Hardey Rapids YCT and between 10,000 and 18,000 Snake River YCT annually on the Wind River Reservation in locations requested by the local Tribes. Jackson NFH also stocks roughly 150,000 Snake River YCT annually in Palisades Reservoir, Idaho, in response to State stocking requests.

In Montana, Creston NFH is engaged in rearing and stocking 100,000 WCT annually as part of the fisheries mitigation plan for the Hungry Horse Dam on the Flathead River (MFWP and CSKT 1991; CSKT and MFWP 2004). These fish are distributed among at least five lakes on the Flathead Reservation and at least five lakes on the Blackfeet Reservation. Creston NFH also produces bull trout periodically. The hatchery conducted streamside spawning in FY2019, releasing adults back into the wild and rearing the resulting eggs at the hatchery. Between FY2019 and FY2020, Creston NFH translocated close to 2,000 bull trout into Glacier National Park. The next translocation project is scheduled to begin in FY2025.

Every year, Jones Hole NFH rears between 180,000 and 320,000 juveniles each of the Bear Lake and Bear River strains of BCT from eyed eggs produced by the States of Utah and Wyoming, respectively. Stocking numbers and locations are determined by the States (see *4.2 Partner Activities*) and are linked to Colorado River Storage Project mitigation. However, much of this stocking does not contribute directly to BCT restoration within its native range. Only one stocked reservoir, Sulphur Creek in Wyoming, is located within the native range of BCT on the Bear River. Utah's Strawberry and Scofield Reservoirs are located within the Colorado River basin, where CRCT is native, but are part of a trans-basin diversion of water that connects the reservoirs to waters within the BCT native range in the Great Basin.

Theme 4: Continue fostering a cooperative interagency work environment

Between FY2017 and FY2021, FAC offices working on arctic grayling, bull trout, and cutthroat trout conservation reported approximately 200 external partners on projects benefitting these species (Table A1). Partners included other Federal agencies, State agencies, Tribes, nonprofit organizations, Fish Habitat Partnerships, local government agencies, large corporations, small businesses, community groups, schools, and private landowners. The most common partners across all species were USFS, Trout Unlimited, WNTI, and State natural resource agencies. Other frequent partners for individual species and subspecies over the last five FY have included Montana State University and the U.S. Geological Survey for arctic grayling; NPS, Avista Corporation, and BOR for bull trout; NRCS for BCT; the Little Snake River Conservation District (WY), the National Fish and Wildlife Foundation, and the Wyoming Landscape Conservation Initiative for CRCT; NPS and the Friends of Leadville NFH for GBCT; CSKT for WCT; and the Eastern Shoshone and Northern Arapahoe Tribes for YCT.

Much of the coordination on arctic grayling, bull trout, and cutthroat trout conservation efforts is facilitated by species-specific interagency teams or working groups (Table 5). The Service is an active participant on these teams, although the teams are typically led by State agency representatives. For BCT, CRCT, and YCT, GMU-specific and State-specific teams are derived from the range-wide conservation teams. Both the Lander FWCO and the Montana FWCO engage with the Bighorn-Wind GMU working group for YCT, covering the easternmost portion of the native range of YCT. There is no range-wide conservation team for WCT, but the Service has participated in Montana's Statewide steering committee for cutthroat trout, which addresses both WCT and YCT conservation in the State.

Table 5. Major species-specific interagency teams for arctic grayling and cutthroat trout in which the Service participates. Species abbreviations: BCT = Bonneville cutthroat trout; CRCT = Colorado River cutthroat trout; GBCT = greenback cutthroat trout; WCT = westslope cutthroat trout; YCT = Yellowstone cutthroat trout.

Name	Focal Taxa	Partners
Montana Fluvial Arctic Grayling Workgroup	arctic grayling	11 (State, Federal, industry, nongovernmental, researchers)
Bonneville Cutthroat Trout Conservation Team	BCT	11 (State, Federal, Tribal, nongovernmental)
Colorado River Cutthroat Trout Conservation Team	CRCT	8 (State, Federal, Tribal)
Greenback Cutthroat Trout Recovery Team	GBCT	5 (State, Federal)
Montana Cutthroat Trout Steering Committee	WCT, YCT	20+ (State, Federal, Tribal, industry, nongovernmental, private landowners)
Yellowstone Cutthroat Trout Interagency Coordination Group	YCT	11 (State, Federal, nongovernmental)

To facilitate bull trout conservation activities, the ES program's regional bull trout recovery leads have established working groups for each bull trout core area. Working group members include State, Federal, and Tribal experts on one or multiple core areas who are tasked with prioritizing among conservation actions at the core area scale. Meetings for multiple core areas are often combined, allowing for useful comparison across core areas.

Outside of these teams, the FWCOs assist States, other Federal agencies, and Tribes with arctic grayling, bull trout, and cutthroat trout management on lands under those entities' jurisdiction. At the State level, for example, both the Colorado FWCO and the Utah FWCO assist their respective State partners with chemical reclamation projects (removal of nonnative salmonids with piscicides) up to three times annually. The Colorado FWCO has a strong relationship with NPS personnel at Rocky Mountain National Park, and annual work planning for CRCT and GBCT restoration and conservation activities in the park is a joint process. The Montana FWCO is furthering its relationship with Glacier National Park for better management of bull trout across the Saint Mary Recovery Unit.

Cooperation between FWCOs and Tribes occurs both at regular coordination meetings and through direct technical assistance. The Lander FWCO was created to fulfill the Service's Tribal trust responsibilities to the Eastern Shoshone and Northern Arapahoe Tribes on the Wind River Reservation, and nearly all of the FWCO's work is focused on fish and wildlife populations on the reservation. The Montana FWCO works with three Tribal entities: the Blackfeet, Crow, and CSKT. The Montana FWCO conducts bull trout population monitoring on the Blackfeet Reservation and is currently exploring options to create refugia populations of pure WCT on the reservation. On the Crow Reservation, the Montana FWCO conducts YCT population monitoring in two streams at the eastern edge of the subspecies range. Creston NFH rears WCT for stocking on the Flathead Reservation, current home of the CSKT, in accordance with the fisheries mitigation plan for the Hungry Horse Dam (MFWP and CSKT 1991). The Utah FWCO conducts biological inventory work on the Uintah and Ouray Reservation, current home of the Ute Indian Tribe, and supports the Ute Indian Tribe with CRCT management. The Utah FWCO has also worked extensively on the Confederated Tribes of the Goshute Reservation, on the Utah-Nevada border, to attempt BCT restoration in five reservation streams. Staff from multiple FWCOs stated that they are encouraging Tribal partners to engage more heavily in range-wide conservation teams for native salmonid conservation; the Tribes have been invited to participate but have not necessarily had the capacity to do so relative to other priorities.

Theme 5: Maintain sources of genetically pure cutthroat trout

FAC has taken action on maintaining genetically pure cutthroat trout in the wild through the construction of barriers or exploitation of existing barriers that limit nonnative salmonid spread. Since FY2019, the Montana FWCO has facilitated three barrier construction projects to prevent spread of rainbow trout and other nonnative species into the range of conservation populations of WCT in the Upper Missouri River basin. Similarly, the Lander FWCO has facilitated two barrier construction projects to protect CRCT in southwest Wyoming in collaboration with the Wyoming Landscape Conservation Initiative. In an opportunity to exploit an existing barrier, Abernathy FTC is analyzing genetic markers of WCT arriving at Cabinet Gorge Dam on the Clark Fork River in northern Idaho. The results of these analyses are used to determine hybrid status of cutthroat trout passed above the dam to access spawning areas.

To preserve sources of genetically pure cutthroat trout in hatcheries for future reintroduction efforts, Leadville NFH maintains captive broodstocks for GBCT and for the Hayden Creek strain of green lineage CRCT. The hatchery used to maintain a second green lineage CRCT broodstock but the propagation program was discontinued in FY2020 and the remaining broodstock were released. Captive broodstocks for other cutthroat trout subspecies and strains are maintained by the States, although NFHs often play a role in rearing the fish produced by these broodstocks (see *4.2 Partner Activities*).

Low genetic diversity has led to difficulties in propagating GBCT for reintroduction and broodstock refugia due to high rates of mortality in early stages of growth. In recent years, the Colorado FWCO has contributed around one month of a biologist's time annually to assist with propagation at Leadville NFH. The FWCO and NFH, in collaboration with the University of Wyoming, developed and implemented a strategy to facilitate specific mate pairings among the most distantly related individuals to maximize the genetic diversity of offspring. However, the

strategy had a limited effect on mortality and deformity rates and is no longer in use (C. Kennedy, personal communication, 2022).

4.2. PARTNER ACTIVITIES

The States have primary management authority over arctic grayling, BCT, CRCT, WCT, and YCT populations, and also play a very active role in conserving and managing bull trout and GBCT populations. State agencies lead each of the range-wide conservation teams for cutthroat trout (Table 5), taking action through those teams to improve habitat conditions, secure native populations, and restore or enhance populations. In addition to annual range-wide team meetings, States may host State-level meetings for partners working within State boundaries. Both the BCT and CRCT Conservation Teams maintain databases of all the projects conducted to benefit the focal subspecies.

Unless otherwise specified, information on partner activities described in this section is drawn from conversations with the partners themselves and with Service staff. This section is not a comprehensive survey of all partner efforts toward arctic grayling, bull trout, and cutthroat trout conservation in the Rockies. Instead, it presents a sample of the partner activities that complement current Service efforts. As in *4.1 Current Service Activities*, the following discussion emphasizes partner activities conducted within the past five years (FY2017-FY2021).

Theme 1: Improve habitat conditions

Numerous agencies and organizations are working to improve habitat conditions for arctic grayling, bull trout, and cutthroat trout in the Rockies. Aside from Federal agencies, WNTI operates on the largest spatial scale, covering twelve States and all three species. Individual States and Tribes make habitat improvements on lands under their respective jurisdictions, as do watershed and community organizations on a smaller scale.

As a Fish Habitat Partnership under the Service-administered NFHP, WNTI's primary goal is the protection and restoration of habitat for native trout and char species. Between FY2017 and FY2021, WNTI supported 22 NFHP-funded projects and an additional 28 alternatively-funded projects to benefit arctic grayling, bull trout, and cutthroat trout in the Rockies. WNTI relies on range-wide species conservation teams, where they exist, to help prioritize projects for a given species or subspecies and to assemble watershed-scale project portfolios. Since 2016, the partnership has been moving toward a more integrative, watershed-scale approach to conservation for subsets of species prioritized in three-year increments. WNTI's Steering Committee judged that three years is long enough to make progress in a watershed (although more time would be beneficial), and short enough to cycle through all 21 species of interest to WNTI within a reasonable length of time. BCT was one of the highlighted priorities for WNTI in 2018 through 2020, and WNTI project data reflect this prioritization: WNTI invested over $1 million—including Service-administered NFHP funds—in BCT habitat improvement and conservation projects active between FY2017 and FY2021. That investment in BCT was greater than WNTI's combined investment in arctic grayling, bull trout, and the other four cutthroat trout subspecies over the same period. A significant portion of this funding for BCT projects has come from private donations, although relationships with major donors took time to develop during the

prioritization period. At the direction of the BCT Conservation Team, WNTI focused its priority efforts specifically on BCT habitat within the Bear River basin. Between 2021 and 2024, WNTI will be prioritizing projects for CRCT, WCT, and YCT. The Yellowstone Cutthroat Trout Interagency Coordination Group has selected the Greybull River watershed in Wyoming for WNTI prioritization within the YCT native range.

Like WNTI, State agencies and their partners aim for project integration across watersheds. For example, the Utah Division of Wildlife Resources (UDWR), Utah Department of Transportation, irrigation companies, and private landowners have partnered to remove six barriers on Weber River tributaries and install fish ladders at mainstem barriers to increase the native fluvial BCT population's access to spawning habitat. After eight years of effort, the final fish ladder on the mainstem Weber River will be completed by the end of 2022 (UDWR 2019). A collaboration between the State of Montana and the local nonprofit Big Hole Watershed Committee provides another example of a whole-watershed approach, addressing the issue of stream flows in the Big Hole River basin for the benefit of arctic grayling. The Big Hole Watershed Committee sets flow and temperature targets in collaboration with the State, and when flows fall below specified targets according the U.S. Geological Survey's stream gage network, State agency staff contact the Big Hole Watershed Committee to communicate to water users and anglers and encourage voluntary conservation measures (Big Hole Watershed Committee 2016). Further examples of watershed-focused conservation include coordinated restoration of three major spawning tributaries for adfluvial Bear Lake BCT by the Idaho Department of Fish and Game (IDFG) and UDWR, and the Wyoming Game and Fish Department's (WGFD) current work to develop a focused strategy for CRCT habitat and population restoration in the Upper Green River.

Habitat restoration efforts in Montana and Wyoming benefit from State-based conservation funding opportunities available to government and nongovernmental applicants. In Montana, the Future Fisheries Improvement Program distributes several hundred thousand dollars annually for fish habitat restoration and protection of native fish populations. Any entity can apply for funding, including landowners, anglers, civic groups, conservation districts, and government agencies. The Future Fisheries Improvement Program is one of the mechanisms for funding projects that are part of landowner site-specific conservation plans under the Big Hole CCAA (MFWP 2021b), and it has funded the majority of water lease and riparian restoration projects for YCT on Montana's Yellowstone River tributaries. Over the past five years, the State of Montana has also contributed funding to nearly a dozen habitat improvement projects for bull trout in the Columbia Headwaters Recovery Unit (Upper Clark Fork River basin) through its Natural Resource Damage Program under the Montana Department of Justice. In Wyoming, the State legislature established the Wyoming Wildlife and Natural Resource Trust in 2005. The trust has now provided over $100 million in grants to government agencies and nonprofit organizations for on-the-ground conservation in Wyoming (Wyoming Wildlife and Natural Resource Trust 2021), including over 100 cutthroat trout projects in which the Service was also involved.

Agreements with hydroelectric dam owners and operators in the region have also funded significant habitat restoration for native trout, among other conservation efforts. In Idaho, a 2002 settlement agreement as part of Federal Energy Regulatory Commission relicensing of the Bear River Hydroelectric Projects gave IDFG additional resources to improve passage and reduce

entrainment for BCT on the Bear River. Parties to the settlement with power company PacifiCorp included the Service, IDFG, and ten other Federal, State, Tribal, and nonprofit interests (PacifiCorp 2002). The Bonneville Power Administration has also provided substantial funding to facilitate CSKT, MFWP, and IDFG work on bull trout and cutthroat trout, including but not limited to land acquisition, establishment of conservation easements, and habitat restoration (e.g., BPA 2022).

Several other Federal agencies are working to improve habitat conditions for native salmonids within their areas of authority and influence. USFS-managed lands comprise the majority of bull trout habitat in western Montana and northern Idaho, substantial amounts of habitat for CRCT and WCT, portions of the YCT range, and all of the habitat for the Bear Creek population of GBCT. USFS has been active in habitat restoration, including removing fish passage barriers resulting from earlier USFS road construction, and the agency has been particularly valuable to partners by handling National Environmental Policy Act (NEPA; 42 U.S.C. 4321 et seq.) requirements for habitat management activities on its land (GBCT Recovery Team 2019). BLM and USFS are leading habitat monitoring for BCT, collecting information on temperature, stream wetted width, streambed particle size, bank stability, and frequency of pool habitat at index monitoring sites. NPS engages in stream restoration activities within Rocky Mountain National Park for green lineage CRCT and potential future reintroduced GBCT populations, both of which are native to the park. Glacier National Park is working to ensure persistence of bull trout and WCT in waters under its jurisdiction and Yellowstone National Park has established a native fish conservation program intended to benefit cutthroat trout and arctic grayling. NRCS is active in the Big Hole River basin, where it is encouraging a shift to coordinated priorities to improve efficiency. In FY22, NRCS is planning to focus on projects that protect riparian areas from damage by livestock.

In the Blackfoot River watershed and other areas of the upper Columbia River basin, Trout Unlimited is leading habitat improvement work on private lands. The nongovernmental organization's biologists function similarly to the Service's Partners for Fish and Wildlife program biologists and are better received by private landowners who may be suspicious of government intervention.

Theme 2: Secure native populations with conservation value

As with Service activities, partner activities to secure native populations with conservation value can be divided into activities that identify those populations, activities that address limiting factors, and activities to monitor populations and evaluate progress on securing population persistence.

Identifying Populations with Conservation Value

Genetic tools are driving partners' work to identify and delineate bull trout and cutthroat trout populations with conservation value. Three examples come from the USFS Range-wide Bull Trout eDNA project, genetic testing and monitoring under the BCT range-wide monitoring plan, and an ongoing range-wide YCT genetic assessment.

The USFS Rocky Mountain Research Station initiated the Range-wide Bull Trout eDNA Project in 2016 to better clarify current bull trout distribution. The research station organizes partner organizations and volunteers to collect water samples and tests them for bull trout genetic material (environmental DNA [eDNA]). Sampling locations are determined based on designated critical habitat, the historic range of bull trout, and a climate model predicting spawning habitat suitability (USFS 2016). An earlier study in western Montana conducted by the research station showed that eDNA sampling was a fast, reliable, and sensitive method for detecting bull trout presence (McKelvey et al. 2016).

The BCT Conservation Team developed a range-wide monitoring plan as an action item from its range-wide conservation strategy (UDWR 2019). As part of the monitoring plan, the conservation team set a goal of completing genetic assessments by 2050 for all BCT-occupied watersheds with a history of nonnative salmonid introduction. At the time that the monitoring plan was written, 43 populations needed initial genetic testing and 14 needed follow-up testing. The monitoring plan specifies 15-year intervals for follow-up testing on populations with potential for introgression once they have completed the initial testing.

Currently, WNTI is funding a multiyear project through WGFD and NFHP to assess genetic integrity and relatedness of YCT across its entire native range and to develop genetic marker panels for long-term population monitoring. The results of the project will inform prioritization of conservation activities, population supplementation and translocation, and genetic rescue.

Addressing Limiting Factors

Nonnative salmonids.—Service partners in the Rockies have invested substantial resources into suppressing populations of piscivorous lake trout. NPS has removed over four million lake trout from Yellowstone National Park's Yellowstone Lake, where lake trout introduction led to a major decline in the YCT population. Since 2012, the removal effort has reduced the lake trout population to less than one-fifth of its prior size. However, compensatory increases in reproductive success of the remaining lake trout pose new challenges (Painter 2021). NPS and a variety of additional partners, including the Bozeman FTC, have been working on alternative control technologies including a pellet that can be applied at lake trout spawning sites to induce embryo mortality (Koel et al. 2020). IDFG has also invested substantial resources from dam mitigation to suppress the lake trout population on Lake Pend Oreille, and MFWP is partnering with the Service on lake trout suppression efforts in Swan Lake, Montana. In Flathead Lake, Montana, the CSKT have found a creative way to address both conservation and recreation priorities through the organization of biannual Mack Days. At Mack Days fishing events, lake trout anglers compete for hundreds of thousands of dollars in prize money, and since 2002, they have removed over 600,000 lake trout from Flathead Lake (CSKT 2015). The CSKT also conduct direct lake trout removal efforts outside of Mack Days events.

Management strategies are necessarily different when nonnative salmonids are capable of hybridizing with the native species because even very low abundance of a nonnative species can lead to undesirable impacts. The most common management strategy in this situation is to install migration barriers or shore up natural barriers, such as waterfalls, that isolate pure native populations (see further discussion under Theme 5).

Wyoming has a greater ability to regulate private fish stocking than many other States; individuals must have an approved application in order to stock fish. Through this authority, WGFD is working to eliminate private stocking of nonnative salmonids in waters where they could interact with native trout. Because native cutthroat trout are not available on the market for individuals to purchase, sometimes WGFD provides native fish for private stocking from their own hatcheries.

Part of Wyoming's efforts to address nonnative salmonid issues has included significant public engagement in the conservation planning process. Recently, WGFD and partners spent well over a year gathering the public's ideas on YCT restoration in the Big Horn River basin after conservation efforts stalled due to low public support. Through a series of public meetings and an opportunity for the public to submit restoration ideas, the collaboration generated a set of new restoration goals for YCT in the basin.

Finally, there have been a variety of efforts to encourage anglers to seek out native trout as an alternative to popular nonnative species. WGFD and UDWR have each partnered with Trout Unlimited to challenge anglers to catch, photograph, and release each of the respective States' native cutthroat subspecies in exchange for recognition and a nonmonetary prize (Trout Unlimited 2022; WGFD n.d.). WNTI expanded on this idea to raise money for native salmonid conservation through the multi-State Western Native Trout Challenge (WNTI 2019).

Harvest.—States have jurisdiction to regulate harvest of fishes not listed under the ESA. All Rocky Mountain region States with arctic grayling, bull trout, and cutthroat trout populations have enacted harvest restrictions to protect existing populations (Colorado Secretary of State 2020; IDFG 2020; MFWP 2021a; NDNH 2021; UDWR 2016; WGFD 2018). For example, the State of Colorado has used its regulatory authority to restrict angling in over 150 designated "Cutthroat Conservation and Recreation Waters" within the State. In these designated locations, anglers must use artificial flies and lures and immediately return any captured cutthroat trout to the water. In Wyoming, periodic monitoring of angler behavior suggests a high degree of compliance with catch-and-release regulations.

Because State natural resource agencies oversee recreational fishing within State boundaries, they have a degree of authority and responsibility with regard to ESA-listed species as well. Therefore, the State of Colorado has prohibited all fishing in Bear Creek in the vicinity of the GBCT population (Colorado Secretary of State 2020) and the State of Montana strictly regulates bull trout harvest through waterbody closures and enforcement patrols.

Other limiting factors.—State natural resource agency staff possess strong awareness of climate change impacts, including drought, fire, and rising temperatures, and are taking actions to mitigate these impacts for existing populations. The Climate Shield model developed out of the USFS Rocky Mountain Research Station (Isaak et al. 2015; USFS 2021) has been particularly influential in Montana. The State uses the Climate Shield's predicted locations for future cold-water refugia to prioritize those locations for restoration activities benefitting bull trout and cutthroat trout.

Major fires in Colorado have led CPW to conduct rescue efforts for San Juan lineage and green lineage populations of CRCT either in the path of a fire or downstream, where fire debris could damage the habitat. The CPW Aquatic Research Section has conducted modeling to determine collection rates to maximize population resiliency during salvage operations (Rogers 2020). WGFD has also made steps to prepare for salvage operations in the future, although it has not conducted any of these operations to date.

As part of their conservation efforts for YCT in Idaho's Upper Blackfoot River basin, IDFG manages American white pelicans (*Pelecanus erythrorhynchos*) to reduce predation impacts on YCT. Most of the management activities involve nonlethal deterrent measures at the Blackfoot Reservoir pelican colony and upstream. A limited amount of lethal take occurs under a Service-issued permit.

Monitoring Populations and Assessing Status

State agencies conduct the vast majority of population monitoring activities for arctic grayling, bull trout, and cutthroat trout in the Rockies. Colorado, Idaho, Montana, Utah, and Wyoming all track population trends for native salmonid populations within their borders. Monitoring for other population metrics (e.g., population size, survival, recruitment, dispersal, size class distribution, condition, and sex ratio) occurs for certain high priority populations in each State. Most monitoring efforts use traditional sampling methods such as electrofishing surveys and redd counts, but MFWP in particular has recently expanded its use of genetic tools including eDNA, finding that these tools improve monitoring efficiency. Genetic survey results now help guide restoration activities and decision-making for native salmonids in Montana.

The BCT range-wide monitoring plan has resulted in a particularly well-coordinated approach to population monitoring. Under the plan, 25 index sites are monitored every one to two years, while all other known BCT populations are monitored at variable frequency as determined by the agency managing each population (IDFG, UDWR, WGFD, Nevada Department of Wildlife, or Great Basin National Park). In some places, such as the Bear River basin in Idaho, sampling began at index sites many years prior such that some population metrics have been tracked for over three decades. Under the monitoring plan, management agencies can select their own monitoring techniques, but are encouraged to use consistent techniques from year to year to enable inter-annual comparison. Key metrics include overall abundance of salmonids of various sizes, presence and absence of individual species, and biomass of large BCT. For the State of Utah, this large investment in BCT monitoring was made possible by reallocating capacity from habitat restoration projects as those projects were completed. The State plans to implement a similar monitoring plan for CRCT eventually, but resources are currently tied up in active restoration efforts. In the meantime, CRCT population monitoring in Utah occurs on a seven to ten year cycle. The State of Utah also monitors its small number of YCT populations at three year intervals.

Among Tribal partners, CSKT tribal biologists conduct bull trout and cutthroat trout monitoring on the Flathead Reservation with resources that have become available to CSKT through hydroelectric dam mitigation. The Blackfeet Tribe employs a biologist who assists FWCO staff with bull trout and WCT monitoring in the Saint Mary River system. The Confederated Tribes of the Goshute Reservation do not have natural resource staff, but they assist Utah FWCO staff with

monitoring activities. Similarly, the Eastern Shoshone and Northern Arapahoe Tribes employ no biologists but the Tribes' fish and game wardens assist the Lander FWCO with monitoring activities as needed. In the San Juan basin, suitable cutthroat trout habitat is very limited on the lands of the Southern Ute Tribe and Ute Mountain Ute Tribe, and those Tribes have not been heavily involved in conservation activities.

CPW and WGFD have active research programs on various aspects of cutthroat trout conservation and management, including monitoring techniques and effectiveness. Recent work by WGFD addressed the adequacy of redd counts for population monitoring in Snake River YCT. Recent efforts by the Aquatic Research Division of CPW have included assessments of genetic purity and relatedness among Colorado native cutthroat trout populations, status of the green lineage of CRCT, and downstream movement rates of GBCT at Zimmerman Lake (Rogers 2020).

Theme 3: Restore or enhance populations within the native range

Like the Service, States and other Federal agencies are currently involved in both bull trout and cutthroat trout reintroductions and translocations, as well as addressing limiting factors beforehand. In some cases, these entities have a long history of involvement in reintroduction activities; Rocky Mountain National Park was the site of numerous "reintroductions" of GBCT in the latter half of the twentieth century, prior to the discovery that the fish being stocked were not true GBCT (GBCT Recovery Team 2019).

Today, CPW leads the GBCT Recovery Team and all reintroduction efforts outside of Rocky Mountain National Park (see *4.1 Current Service Activities* for more on reintroduction efforts within the park). Prior to releasing GBCT on the landscape, CPW and recovery team partners prepare sites by removing nonnative species and testing for whirling disease. Whirling disease is often detectable at sites that have been recently cleared of fish but it becomes undetectable over time as the whirling disease parasite dies off without piscine hosts. The GBCT Recovery Team also tracks stream temperatures at potential reintroduction sites to identify those locations where median summer temperatures exceed the 8°C (46°F) threshold for recruitment. Although higher-elevation streams are less likely to have been invaded by nonnative salmonids, these streams will be unsuitable for GBCT if the water is too cold. Where possible, the recovery team aims to reintroduce GBCT to locations where it had been known to exist in the past. At present, there are four sites being prepared for GBCT reintroduction and another three sites outside of Rocky Mountain National Park that meet requirements and will be targeted for future work.

As a member of the GBCT Recovery Team, USFS has long collaborated with CPW on GBCT reintroduction to lands under its management. The two agencies have recently jumped into restoration efforts for San Juan lineage CRCT as well. In 2021, the partners introduced San Juan lineage fish to two previously fishless streams. Although the habitat is currently judged to be marginal, the partners believe it will become increasingly suitable in the future due to climate change. CPW is also in the midst of removing nonnative salmonids from six miles of stream in a different location; so far, four miles of stream have been cleared of nonnative salmonids and two miles of stream have been stocked with San Juan lineage cutthroat trout. In the near future, the partners will work to extend the downstream distribution of two other populations of San Juan

lineage cutthroat trout on USFS lands by removing existing road crossing barriers and installing new barriers further downstream to exclude nonnative salmonids. CPW and USFS rely on WNTI grants to help fund barrier installation.

NPS is active in assessing and identifying potential cutthroat trout reintroduction sites within national parks. A central focus of the Native Fish Conservation Program at Yellowstone National Park is the restoration of fluvial native salmonids, including WCT, YCT, and arctic grayling. One recent project targeted the upper Gibbon River as a restoration site for native WCT and arctic grayling (Reichard 2017). NPS is supported in this work by the nonprofit Yellowstone Forever (NPS 2021). To the south and west, Great Basin National Park has been working to restore BCT within and adjacent to the park since 1999. At the time, BCT was believed to have been extirpated from the park, although one pure BCT population was later identified through genetic analysis. After pre-treatment surveys and nonnative fish removal, reintroduction of BCT to park streams began in 2000. Post-reintroduction monitoring beginning two years after reintroduction showed strong recruitment in each of four reintroduction sites as of 2008 (Baker et al. 2008).

MFWP and partners recently completed a large-scale restoration effort for WCT in the South Fork Flathead River basin. The State treated 16 alpine lakes over the course of 10 years to remove nonnative YCT and rainbow trout, and then restocked the lakes with native, genetically pure WCT. One of these lakes was also stocked with Red Rock Lakes arctic grayling in 2017 to establish a genetic reserve brood for the Centennial Valley lineage; the lake is outside the species native range but previously hosted a self-sustaining population of introduced arctic grayling (Gander et al. 2019). MFWP is now beginning a second, similar effort in Glacier National Park to restore WCT and eventually also bull trout.

MFWP previously attempted to reintroduce arctic grayling to a lake in the Centennial Valley that the species inhabited until the 1990s. The reintroduction would have provided redundancy for the declining Red Rock Lakes population. Stocking occurred between 2012 and 2018 and then was discontinued because no natural reproduction was observed and spawning habitat was likely inadequate under current conditions (Gander et al. 2019).

Additionally, MFWP has introduced pure YCT into previously fishless waters above existing barriers in at least three streams in the Yellowstone River basin, sometimes using YCT gametes from a population below the barrier to introduce above the barrier. In other streams, reintroduction efforts were preceded by nonnative species removal and barrier installation and two lake populations have been restored or enhanced through stocking (MFWP 2019).

The States of Utah and Wyoming consider habitat restoration largely complete for BCT in the Bear River in Wyoming and throughout its Utah range, and for blue lineage CRCT in the Yampa River basin. These determinations were reached following years of work to remove nonnative salmonids, install barriers as needed, and successfully reintroduce native cutthroat trout. Although the populations in these locations are secure, the State agencies continue to monitor them for changes in population trend and to ensure that they remain isolated from nonnative salmonids. In other areas of these States, restoration is ongoing. Utah has planned a series of high priority restoration projects for CRCT through 2030. WGFD is currently engaged in a large-

scale restoration effort for blue lineage CRCT on LaBarge Creek in southwestern Wyoming. The agency has struggled with poor establishment of hatchery fish despite experimenting with a number of stocking variables, so the next step is translocation of wild fish into the creek. Planning for future restoration projects is underway in the Upper Green River basin for CRCT and the Big Horn River basin for YCT.

Nonprofit organizations provide volunteers to assist with large reintroduction events. In Colorado, Trout Unlimited has recruited volunteers to hike with backpacks of fish out to reintroduction sites, and the Back Country Horsemen of Nevada are helping to transport BCT to reintroduction sites within Great Basin National Park (Prettyman 2021). The additional capacity provided by volunteers allows for a more dispersed stocking pattern which is expected to increase survival.

Theme 4: Continue fostering a cooperative interagency work environment

Range-wide conservation teams are the foundation of interagency cooperation on cutthroat trout conservation and management (Table 5). Although Federal partners including the Service are involved in these teams, the teams are typically led by State agency staff. For some teams, leadership responsibility rotates among the involved States. GMU-specific conservation teams operate in a similar manner, led by State agency staff local to the GMU. Both range-wide conservation teams and GMU-specific teams meet annually.

WNTI is the primary entity engaged in multi-species interagency coordination to benefit native salmonids in the Rockies. The Steering Committee includes 12 State and 3 Federal agency representatives, a nonprofit fisheries conservation organization representative, a Western Association of Fish and Wildlife Agencies representative, a Tribal representative, and a Canadian provincial representative. The nonprofit representative seat has been filled every year to date by Trout Unlimited; the Tribal and Canadian provincial representative seats are currently empty. In recent years, WNTI has been fostering connections with other higher-level conservation groups, such as the Migratory Bird Joint Ventures and the sage grouse (*Centrocercus* spp.) conservation community. Collaboration with avian conservation organizations unlocks significant resources for riparian habitat protection and restoration that can benefit both birds and fishes.

Theme 5: Maintain sources of genetically pure cutthroat trout

Where genetically pure cutthroat trout populations still exist on the landscape, MFWP, WGFD, CPW, Trout Unlimited, and other partners are working to identify “isolation streams” where these populations can be protected from future genetic mixing with nonnative salmonids through barrier installation or maintenance. CPW is working with USFS on barrier installations in two streams in southwestern Colorado to protect pure populations of San Juan lineage CRCT in their headwaters. Similarly, MFWP has already installed some barriers to protect conservation populations of YCT and has additional projects that are shovel-ready but need funding to proceed.

State-run fish hatcheries maintain broodstocks for nearly all major cutthroat trout lineages in the Rockies (Table A2). Most lineages also have an established wild broodstock. The number of broodstocks per lineage varies and genetic diversity within lineages has been prioritized to different extents by the different States. At one end of the spectrum, the Durango SFH in Durango, Colorado, maintains three separate brood populations of the rare San Juan lineage CRCT in its facility. The State of Colorado has interest in increasing the number of broodstocks for other CRCT lineages as well, although facility space is a barrier at present. In contrast, the Cabinet Gorge Fish Hatchery in northern Idaho houses WCT broodstock whose offspring get distributed throughout the State, mostly for recreational purposes.

In 2018, the CPW Aquatic Research Division conducted a spawn matrixing experiment, crossing both related and unrelated parents, in an attempt to determine if genetic relatedness was responsible for high variability in offspring survival of Hayden Creek green lineage CRCT in captivity (Rogers 2020). Crossing unrelated parents did not consistently improve offspring survival, similar to the results obtained by Leadville NFH and the Colorado FWCO in their attempt at spawn matrixing of GBCT.

Some States continue to stock nonnative salmonids in locations where native cutthroat trout are also present due to their economic and recreational value. Montana, Utah, and Idaho sterilize nonnative salmonids prior to stocking if they could come in contact with native cutthroat trout after release (Knight et al. 1999; IDFG 2021) or else stock them in closed basins. The State of Wyoming does not sterilize nonnative salmonids (T. Trimble, WGFD, 2021) but does avoid stocking them in locations with native cutthroat trout conservation populations. Wyoming and Montana both require permits for private stocking and can stipulate the use of native species.

5. GAP ANALYSIS: ASSESSMENT OF CONSERVATION NEEDS

5.1. CONSERVATION GAPS

Theme 1: Improve habitat conditions

The Service and its partners have made significant progress on improving habitat conditions for arctic grayling, bull trout, and cutthroat trout in the Rocky Mountain region. One of the clearest examples of progress comes from the Big Hole River basin, where habitat restoration under the 2006 CCAA has played a major role in keeping the species from being listed under the ESA (85 FR 44478). Since the CCAA was initiated, stream flows have increased, entrainment has declined, and the arctic grayling population in the Big Hole River has increased measurably. As another example, the successful implementation of three major fish passage projects on the Pend Oreille River is an important achievement because it sets the stage for restoration of bull trout in that river.

Projects conducted under NFHP, NFPP, and other funding sources have improved habitat quality for native salmonids in several areas of the Rockies by increasing connectivity, restoring degraded riparian zones, reducing entrainment, and preventing nonnative species spread. Over the past five years, NFHP and NFPP projects have been most concentrated in the Bear River GMU for BCT, in the Yampa and Upper Green GMUs for CRCT, and in the Upper Snake GMU

for YCT (Figure 2; see *Appendix* for GMU maps). As a result, State biologists now consider habitat restoration for cutthroat trout to be complete in the Bear River and the Yampa GMUs. WCT have also benefitted from a concentration of bull trout habitat improvement projects where the fishes overlap in distribution in the Clark Fork GMU. However, some GMUs where cutthroat trout populations are especially imperiled—such as the San Juan GMU for CRCT and the West Desert GMU for BCT—hosted no NFHP or NFPP projects between FY2017 and FY2021. UDWR considers habitat restoration work in the West Desert GMU to be complete, but the lack of San Juan GMU projects is due to lack of capacity rather than lack of need.

In some locations, there are robust strategies in place for prioritizing among habitat improvement projects to achieve species conservation goals. A good example on the watershed scale comes from the partnership in Montana's Blackfoot River basin, where all streams in the watershed were assessed and scored to determine priorities for native trout conservation before implementing any habitat improvements. An example on a larger scale comes from the range-wide BCT conservation strategy, which uses the Conservation Portfolio and Conservation Success Index approaches developed by Trout Unlimited (Williams et al. 2007; UDWR 2019) to prioritize among possible restoration activities.

The Service still lacks specific and measurable habitat goals for cutthroat trout in many locations (Table 2) as compared to goals for securing or restoring native populations, which are more often quantitative (Tables 3, 4). Additionally, habitat and population monitoring is inconsistent following habitat restoration activities, which limits the Service's and partners' ability to assess whether these activities have had the desired effect or how to make habitat improvements more effective.

Theme 2: Secure native populations with conservation value

Despite significant effort on the part of the Service and its partners, existing populations of arctic grayling, bull trout, and cutthroat trout remain vulnerable in many locations. Notable examples include the St. Joe River bull trout population in Idaho and the Bear Creek GBCT population in Colorado, both of which have declined substantially despite ESA protections, as well as the Red Rock Lakes arctic grayling population, for which managers have attempted various habitat improvements with little to no population response. Although the specific combination of factors involved in each of these declines may be different, conversations with Service staff and partners suggest a few consistent barriers to securing native populations with conservation value across the Rocky Mountain region.

One consistent barrier to securing native populations is interaction of these native populations with nonnative salmonids. Popular introduced sport fishes like rainbow trout, brook trout, brown trout, and lake trout pose threats to native bull trout and cutthroat trout through competition, hybridization, and predation. Nonnative salmonids can likely coexist with bull trout to the degree that competition and predation on bull trout can be minimized. On the other hand, hybridization between native cutthroat trout and introduced salmonids often produces offspring with increased fitness relative to the parent species. There can be no tolerance for coexistence when the goal is to maintain genetic integrity of the native cutthroat trout subspecies.

Although interviewees for this report consistently ranked nonnative salmonids among the top threats to cutthroat trout persistence, addressing the threats posed by nonnative salmonids is quite difficult. Nonnative salmonids have significant economic value, and they continue to be stocked in popular recreational fisheries despite awareness of how they affect native species and concurrent efforts to cultivate native cutthroat trout fisheries. Between FY2017 and FY2021, NFHs released over 5 million juvenile and adult rainbow trout outside their native range within the geographic area of this gap analysis and transferred over 10 million rainbow trout eggs to State and Tribal hatcheries in Colorado, Montana, and Utah. About 10% of the released or transferred fish were triploid and effectively sterile according to notes in FIS distribution records, although FIS has no standardized tracking for triploids. Even if the proportion of triploids is a significant underestimate, these data indicate the Service is involved in introducing many fertile nonnative fish onto the landscape at the request of States or Tribes.

The methods used to limit nonnative salmonid impacts also pose unique challenges. There has been so much success in selling the concept of fish passage to the public and potential funders that it is now difficult to change the message and advocate for barrier installation. Communication about chemical reclamation efforts can be even more challenging, as there is often a strong negative public response to the removal of prized sport fish populations and to the idea of chemicals being released into waterways. A recent WNTI collaboration fell apart after some of the partners realized what a chemical reclamation effort would entail. Unlike NFPP support for fish passage activities, there is no designated Federal funding source to support barriers or other means of nonnative salmonid control, and private donors are less interested in funding such projects.

Two additional barriers to progress on securing native populations are more procedural in nature. First is the lack of specific, measurable population goals for some species and subspecies. Setting measurable objectives or targets is recognized as best practice for conservation goal-setting because broad, qualitative goals do not provide adequate guidance on when, where, and how to implement management actions (Tear et al. 2005; Carwardine et al. 2009). The recent BCT range-wide conservation plan update provides an excellent example of measurable objectives based on the principles of representation, redundancy, and resilience (Tables 3, 4; UDWR 2019). In contrast, the CRCT and YCT range-wide conservation plans provide broad, qualitative goals on which progress is not easily assessed (CRCT Conservation Team 2006; Range-wide YCT Conservation Team 2008). There is no range-wide conservation strategy for either arctic grayling or WCT; this gap is particularly problematic for WCT, whose range spans multiple jurisdictions in the United States and Canada.

Even where specific and measurable conservation objectives do exist, inadequate population monitoring limits the ability to assess progress. Most population monitoring for arctic grayling, bull trout, and cutthroat trout in the Rockies is done by State agencies, although the Service takes an active role in population monitoring on Tribal lands. The extent of monitoring varies spatially and by species, depending on local capacity (see *4.2 Partner Activities*). In many remote areas, more effort is needed simply to delineate the extent of native trout populations, including in the Wind River Range of Wyoming, the Uinta Mountains of northeastern Utah, and the San Juan and central Rocky Mountains of Colorado. Even though the Lander FWCO spends nearly all of its

time on the Wind River reservation, its dwindling number of biologists has delayed progress on YCT conservation relative to other parts of the subspecies range.

Theme 3: Restore or enhance populations within the native range

Where reintroduction is a significant feature of conservation efforts for ESA-listed species, the Service and its partners are making slow but steady progress toward restoration goals. This progress is perhaps most apparent for GBCT, which existed as a single wild population ten years ago. There are now four populations on the landscape, although only one of the reintroduced populations has met the size threshold of 500 adults and none have yet met the threshold of two recruiting age classes every five years, as laid out in the recovery outline (GBCT Recovery Team 2019). The Service and its partners have also made substantial progress on bull trout reintroduction to the Pend Oreille River basin, where they have been all but extirpated downstream of Albeni Falls Dam since approximately the year 2000. Two major fish passage projects have been completed in recent years to support bull trout reintroduction, with the third and final major project in the implementation phase. The implementation plan for putting fish in the water is now being developed, informed by completed reintroduction feasibility and risk assessments.

As with Theme 2, measuring accomplishments related to Theme 3 depends on the availability of quantitative targets. The GBCT recovery outline provides the most quantitative targets seen for any of the focal taxa. The recovery outline specifies population size and recruitment frequency necessary to consider a reintroduction as successful, and also describes a target spatial distribution for populations on the landscape (GBCT Recovery Team 2019). The BCT range-wide conservation plan sets overall targets for the number and distribution of populations, to be achieved by either protecting existing populations or introducing new ones. Although this approach is practical and less prescriptive than the approach used for GBCT, it can be confusing if monitoring is inadequate to determine the number and status of existing populations, as is the case in parts of the BCT native range.

Monitoring of reintroduction efforts appears to be more thorough than monitoring of habitat or extant populations. Again, most monitoring activity is conducted by State agencies rather than the Service. Post-reintroduction monitoring may be given higher priority because reintroduction requires such a significant investment in resources.

Finally, it is noteworthy that the Service continues to stock some cutthroat trout subspecies and strains in locations outside and even far from their native ranges. The provision of BCT for reservoir stocking and Snake River YCT for stocking on reservation lands is part of the Service's responsibility to States and Tribes. However, it is important to recognize that not all of these stocking programs contribute to species conservation goals and it would be worthwhile to consider whether alternative stocking plans could fulfill State and Tribal trust responsibilities and native species conservation goals simultaneously.

Theme 4: Continue fostering a cooperative interagency work environment

The Service engages directly with a large number of partners in native salmonid conservation in the Rockies. Agency employees participate actively in range-wide conservation teams as well as local conservation teams organized around GMUs, watersheds, or populations. During interviews conducted for this report, most State agency staff were quick to state that the Service was aware of unmet State needs and willing to help when asked. Some existing unmet needs include technical assistance with nonnative species removal and barrier installation, assistance in coordinating with the U.S. Bureau of Indian Affairs to implement Tribe-supported projects on reservation lands, assistance from Service hatcheries with short-term housing of fish during translocation and salvage operations, and assistance with public outreach to increase understanding and positive valuation of native salmonids. When the Service is unable to meet States' needs, it is most often a result of inadequate time or funding as long as the request is communicated at the appropriate level. For example, MFWP has asked Creston NFH to reduce escapement of nonnative rainbow trout from their raceways; the hatchery is engaging with the State, patching leaks as they are discovered, and has made the $2.5 million demolition and rebuild of the raceways a priority deferred maintenance project, but the project will not be fully implemented for another two years or more.

However, improving internal communication could make the Service an even better partner, with better outcomes for species conservation. Conversations with Service employees suggested that the level of communication and coordination between programs and across regional boundaries is highly dependent on individual investment and geographic proximity. Anecdotally, individuals working within office spaces shared by multiple Service programs appear to have stronger working relationships across programs and are more knowledgeable about the activities of those programs. These cross-programmatic relationships result in meaningful collaboration on projects and efficient partitioning of work according to each program's strengths. For example, the co-location of the Lander FWCO and the Wyoming state coordinator for the Partners for Fish and Wildlife program has facilitated coordination between the two programs on NFPP projects so that the Lander FWCO can focus its limited capacity almost exclusively on the Wind River Reservation. However, in other locations, lack of communication and coordination between Service programs and regions is a source of frustration. Some of these coordination issues are tied up in budget allocations, such as the ability of the Partners for Fish and Wildlife program to spend hundreds of thousands of dollars in one watershed while the local ESFO cannot afford gill nets for a single project to benefit high priority populations of the same species in a different watershed. There is very limited communication between the Idaho FWCO (in Legacy Region 1) and the FWCOs in neighboring States (in Legacy Region 6), even though the ranges of bull trout, WCT, YCT, and BCT all cross those State and Regional boundaries. Service employees in other programs as well as external partners expressed frustration at the lack of FAC leadership and investment in monitoring and management of bull trout in the Columbia Headwaters Recovery Unit.

Theme 5: Maintain sources of genetically pure cutthroat trout

For the five subspecies of cutthroat trout in the Rockies, four (BCT, CRCT, GBCT, YCT) have specific and measurable goals for maintaining sources of genetically pure individuals that can be

used in population augmentation and reintroduction efforts. State natural resource agencies and the Service have made progress on these goals, with over 20 broodstock populations currently established across the four subspecies (Table A2). Most populations exist in hatchery settings; the remainder live in natural lakes, often with restrictions on recreational access.

For GBCT, the goal to maintain both a hatchery broodstock and a wild broodstock has been met. However, both populations remain plagued by low reproductive success despite continued research into improving egg and juvenile survival. The genetic diversity to be conserved in the case of GBCT is very clear because only a single population was known prior to reintroduction efforts in the 2010s.

For other subspecies, goals for broodstock establishment have been partially met to date. The BCT, CRCT, and YCT range-wide conservation strategies call for at least one broodstock per GMU as a heuristic for representation of genetic diversity across the subspecies (GMUs do not necessarily represent evolutionarily distinct lineages). Considering both hatchery and wild broodstocks, the States and the Service are no more than halfway to that goal for the eight CRCT GMUs and the four YCT GMUs, while broodstocks are currently established for three of four BCT GMUs. Capacity to house and manage additional populations was identified by one State agency as a barrier to further progress.

Perhaps the biggest barrier to adequate representation of genetic diversity is the lack of understanding or consensus on the breadth of cutthroat trout diversity and its distribution across the landscape. The Service and the States are still learning about the genetic status and relatedness of wild cutthroat trout populations. It has been only a decade since the identification of three distinct lineages of cutthroat trout native to the Colorado River basin (Metcalf et al. 2012) and there may be new revelations about lineages of YCT resulting from the ongoing WNTI-funded genetics assessment. At a special workshop convened by the Western Division of the American Fisheries Society in 2015, cutthroat trout experts determined that the existing classification of cutthroat trout subspecies is no longer supported, but failed to come to a consensus on a new, improved classification system (Trotter et al. 2018). Clarity on cutthroat trout taxonomy may not be necessary for on-the-ground management as long as stocking and translocations use the nearest neighboring strain to the stocking location. However, taxonomy becomes much more significant where it interacts with both regulatory language and outreach efforts. Without the ability to clearly name and describe the fish the Service and partners are seeking to conserve, it is hard to communicate to the public, potential funders, and decision makers about their importance and the need for conservation.

5.2. CONCLUSIONS AND RECOMMENDATIONS

This section describes recommended actions for the Service to address conservation gaps for arctic grayling, bull trout, and cutthroat trout in the Rockies. These recommendations are given with the expectation that any action will be undertaken in partnership with the States, recognizing that they hold primary management authority in many situations.

Conclusion 1: Several cutthroat trout subspecies have an outdated or absent range-wide conservation plans.

Recommendation 1.1: Publicly advocate to reconvene a range-wide coordination team for WCT conservation. There has not been an active range-wide coordination team focused on WCT for years. For BCT, CRCT, GBCT, and YCT, range-wide coordination teams have been very effective in syncing priorities across management agencies and developing consistent approaches to monitoring and management that improve managers' ability to assess conservation progress range-wide.

Recommendation 1.2: Propose writing or updating range-wide conservation and management strategies as needed. There is no range-wide conservation and management strategy for WCT, and the range-wide strategies for CRCT and YCT are more than a decade old and contain few specific, measurable objectives for conservation efforts. The CRCT conservation strategy also predates the identification of three distinct genetic lineages within the upper Colorado River basin. The Service does not lead any of the range-wide conservation teams, but as a participant in those teams, it can propose updating existing range-wide plans to the other team members. It is recommended that the Service contribute funding or personnel support for this effort, as development of strategic documents is often a long and intensive process. As conservation plans are developed or updated, FAC should further ensure that it understands its responsibilities under the plans and incorporates fulfillment of those responsibilities into annual work planning.

Conclusion 2: Significant barriers exist in addressing the threats posed by nonnative salmonids to native salmonids in the Rockies.

Recommendation 2.1: Increase funding for non-passage fish habitat restoration. NFPP has made significant contributions to fish habitat restoration by removing barriers to fish movement, and it is poised to make an even greater contribution thanks to recent funding increases (e.g., in the Bipartisan Infrastructure Law). However, a habitat that supports healthy native fish populations requires more than connectivity, and the Service has minimal resources currently that can be used to prioritize other habitat restoration goals. In the Rockies, flexible habitat funding would be especially valuable in addressing nonnative salmonid presence in native cutthroat trout streams because barrier installation, an important element of many nonnative salmonid removal projects, has an opposite goal to that of existing NFPP funding.

Recommendation 2.2: Increase technical capacity in FWCOs or the AIS program to better support States and Tribes with nonnative salmonid removal projects. The need for additional capacity to plan and carry out nonnative salmonid removal projects was a common theme across Service and State agency employees. These projects are often the most direct method of increasing habitat available to native salmonids. However, they involve extensive front-end work to communicate with relevant land management agencies and other local stakeholders and to obtain regulatory approval from State and Federal authorities for piscicide application. If the removal project is conducted in conjunction with a barrier installation to prevent recurrence of nonnative salmonids in the area, there are additional technical needs for effective barrier design and implementation. Much of this technical expertise already exists

within FAC (FWCOs and AIS program) or among other Service staff (e.g., NWR staff working with pesticides, ES staff writing NEPA documents), but time and other priorities limit current contributions.

Recommendation 2.3: Include a rapid risk assessment for nonnative species spread in the evaluation of potential NFPP projects. The benefits to genetic diversity, life history diversity, and population resiliency from barrier removal can be substantial, but there can be substantial biological costs as well with respect to the spread of nonnative species, including but not limited to nonnative salmonids. These costs should be weighed against the benefits before existing barriers are removed. FAC's AIS program, the U.S. Geological Survey, and the U.S. Department of Agriculture have expertise in rapid risk assessment for nonnative plants and animals that could be applied to NFPP.

Recommendation 2.4: Conduct a review and evaluation of Service practices for rearing and stocking nonnative salmonids. In response to State and Tribal stocking requests, NFHs rear large numbers of salmonids for release into waters to which they are not native. Although measures are being taken to minimize impacts of nonnative salmonids, the present analysis was unable to evaluate in detail the adequacy of these measures to meet native salmonid conservation goals. The Service should internally review its current rearing and stocking practices, and then work with the States and Tribes to evaluate whether current practices are sufficient to minimize impacts to bull trout and cutthroat trout. If not sufficient, it will be important to identify better management practices as well as any barriers to their implementation. Outcomes of this evaluation may include new Service policies, the addition of suggested best management practices to partner grants that support nonnative salmonid stocking, or outreach efforts to bolster the valuation of native salmonids where public opposition remains a barrier to alternative stocking practices.

Conclusion 3: Monitoring effort to assess habitat improvement and population status and trends is inadequate to guide adaptive conservation strategies and priorities.

Recommendation 3.1: Prioritize or require completion of a minimum amount of post-project monitoring for NFPP projects. NFPP funding can be used to support all phases of a fish passage project, from design to implementation to monitoring. Minimum post-project monitoring could be as simple as verifying that fish are present on both sides of a former barrier to movement, for which the field work could be completed in a day or less. As simple as such a metric would be, it would help to validate the contributions of NFPP to native fish habitat availability and connectivity, and it would help identify need for further monitoring or follow-up action where projects may have been unsuccessful.

Recommendation 3.2: Invest in additional capacity for FWCOs to conduct monitoring activities. It will be impossible for the Service to accurately assess progress on its conservation goals if data on populations and their habitats are not collected. The FAC program should grow its monitoring capacity in close collaboration with other Service programs, States, Tribes, and other Federal agencies, realizing that monitoring gaps vary geographically and across species. FWCOs should follow the Service's data management policy in sharing these data as openly as possible and encourage partners to share their monitoring data as well.

Conclusion 4: Inadequate communication and collaboration—both interagency and intra-agency—can hinder conservation progress.

Recommendation 4.1: Build or enhance structures for intra-agency communication and collaboration. The Service does not have adequate institutional structures to ensure communication across programs and regions at the field level; coordination at this level is largely a function of individual interest and investment, as well as geographic proximity. To improve intra-agency communication, FAC should consider structural changes such as further co-location of program offices, stationing remote FWCO employees in a different program's office, or establishing official check-ins or meetings between programs or regions if they do not already exist. Existing examples of cross-regional or cross-programmatic meetings within the Service include annual NWR-FAC coordination meetings in Legacy Region 1 and annual FAC coordination meetings between Legacy Regions 3 and 5 on Great Lakes issues.

Recommendation 4.2: Provide specialist support for Fish Habitat Partnerships. Under the NFHP program, Fish Habitat Partnerships have unique flexibility to address emerging native species habitat needs and to solicit private donations to stretch Federal habitat restoration funding. For WNTI, the most significant capacity constraint is the time of the partnership's coordinator and the wide range of duties to be performed including data management and outreach; other Fish Habitat Partnership coordinators are stretched similarly. Support for the NFHP program in the form of one or more data managers, mapping specialists, or outreach specialists who could assist all existing partnerships would free up coordinator capacity to accomplish more on the ground, leverage individual technical expertise for better results, and facilitate data sharing.

Conclusion 5: The Service's regulatory and reporting mechanisms are not always compatible with current species concepts.

Recommendation 5.1. Convene a summit among Service staff at various levels with the goal to define the Service's position on cutthroat trout lineages and introgression. New genetic distinctions among cutthroat trout populations and the high rate of occurrence of genetically introgressed populations raise questions about the appropriate biological unit on which to focus conservation efforts, as well as the value of introgressed populations for conservation. To date, the Service has followed the leadership of the States, but the lack of Service leadership or position on these issues is confusing for States due to the Service's role in regulating species, subspecies, and distinct populations under the ESA.

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APPENDIX

Table A1. List of Fish and Wildlife Conservation Office partners on arctic grayling, bull trout, and cutthroat trout conservation, according to the number of projects where collaboration was reported between FY2017 and FY2021. Only bull trout projects within the Columbia Headwaters and Saint Mary Recovery Units were counted (Figure A1). Only westslope cutthroat trout projects within the Missouri River, Clark Fork, Flathead, and Coeur d'Alene-Pend Oreille Geographical Management Units were counted (Figure A2).

Number	Partner name
>120	Trout Unlimited (national and local chapters), U.S. Forest Service, Wyoming Game and Fish Department, Western Native Trout Initiative, Wyoming Wildlife and Natural Resource Trust
60-120	Montana Fish, Wildlife, and Parks
40-59	National Fish and Wildlife Foundation, National Park Service, Natural Resources Conservation Service
20-39	Colorado Parks and Wildlife, Eastern Shoshone and Northern Arapaho Tribes, Idaho Department of Fish and Game, Little Snake River Conservation District, Utah Department of Wildlife Resources, U.S. Bureau of Reclamation, Wyoming Game and Fish Trust Fund, Wyoming Landscape Conservation Initiative
10-19	Avista Corporation, Bureau of Land Management, Desert Fish Habitat Partnership, Eastern Idaho Resource Advisory Committee, Friends of Leadville National Fish Hatchery, Friends of the Teton River, Jackson Hole One Fly Foundation, Montana State University, Natural Resource Damage Assessment Montana, PacifiCorp, The Nature Conservancy, U.S. Geological Survey, Wyoming Water Development Commission
<10	Agrium, Albert and Bertha Markstein Foundation, Arctic Grayling Restoration Workgroup, Back Country Horsemen, Bear Lake County Commission, Bear Ranch LLC, Big Hole River Foundation, Big Horn County Resources Advisory Committee, Biota Research and Consulting, Bitterroot Ranch, Blackfeet Nation, Bonner County Road and Bridge, Bonneville Environmental Foundation, Bonneville Power Administration, Boy Scouts of America, Burbot Committee, Bureau of Indian Affairs, Canyon Creek Canal Company, Caribou County, Carl M. Johnson Foundation, Central Utah Project Completion Act Office, CH2M Hill, Chevron Mining, Church Universal and Triumphant, City of Colorado Springs (CO), City of Leadville (CO), Clark Fork Coalition, Colorado Big Country Resource Conservation and Development Council Inc., Colorado Mountain College, Colorado Outward Bound, Colorado Water Conservation Board, Colorado Workforce, Confederation Salish and Kootenai Tribes, Contech Bridge Solutions, Creston Hatchery Partners, Crow Tribe, Department of the Interior, Earth Corps, Utah Endangered Species Mitigation Fund, Federal Emergency Management Agency, Fremont County, Goshute Indian Tribe, Great Plains Fish Habitat Partnership, Green Mountain Conservation District, Henry's Fork Foundation, Henry's Lake Foundation, Idaho Department of Environmental Quality, Idaho Department of Lands, Idaho Department of Parks and Recreation, Idaho Department of Transportation, International Federation of Fly Fishers, Intralox, Jackson Hole Community Foundation, Kalispel Tribe of Indians, Knobloch Family Foundation,

Number	Partner name
	Kootenai Tribe of Idaho, Kootenai Valley Resource Initiative, Lake County (CO), Land Owner Incentive Program, Leadville-Lake County Sports Hall of Fame, Leigh Creek Canal Company, Lincoln County Conservation District, Long Draw Reservoir Mitigation, Lower Clark Fork Watershed Group, Lux Foundation Inc., Marathon Oil, Marine Ventures Foundation, Milk Creek Ranch, Montana Chapter of the American Fisheries Society, Montana Department of Environmental Quality, Montana Department of Natural Resources and Conservation, Montana Department of Transportation, Montana Future Fisheries Improvement Program, Montana Pacific Power and Light, Nance Petroleum, National Forest Foundation, North Idaho Fly Casters, Northern Ute Indian Tribe, Old Bill's Fun Run, Open Rivers Initiative, Orvis Company, Park County Conservation District, Patagonia, PC Construction, Pitchfork Ranch, Plains and Prairie Potholes Landscape Conservation Cooperative, Portneuf Soil and Water Conservation District, Rocky Mountain Bird Observatory, Sanders County Resource Advisory Committee, Shell Oil Company, Shoshone-Bannock Tribes, Snake River Fund, Southeast Idaho Fly Fishers, Southern Ute Indian Tribe, Sublette County Conservation District, Swan Ecosystem Center, TE Ranch, Teton Conservation District, Teton County 4-H Sportfishing Club, Teton County Weed and Pest District, Teton Creek Flood Control District, Teton Regional Land Trust, Town of Gypsum, Tri-County Resource Advisory Committee, Trout and Salmon Foundation, Trust for Public Lands, Turner Enterprises Inc., U.S. Air Force Academy, U.S. Army Corps of Engineers, Uinta County Conservation District, University of Colorado, University of Wyoming, Upper Blackfoot Confluence, Upper Colorado River Basin Fish and Wildlife Mitigation Program, Utah Department of Transportation, Westmoreland Kemmerer Inc., White River Conservation District, Wind River K-12 schools, Wyoming Big Game License Coalition, Wyoming Department of Transportation, Wyoming Department of Environmental Quality, X-X Ranch LLC, Yampa Valley Fly Fishers

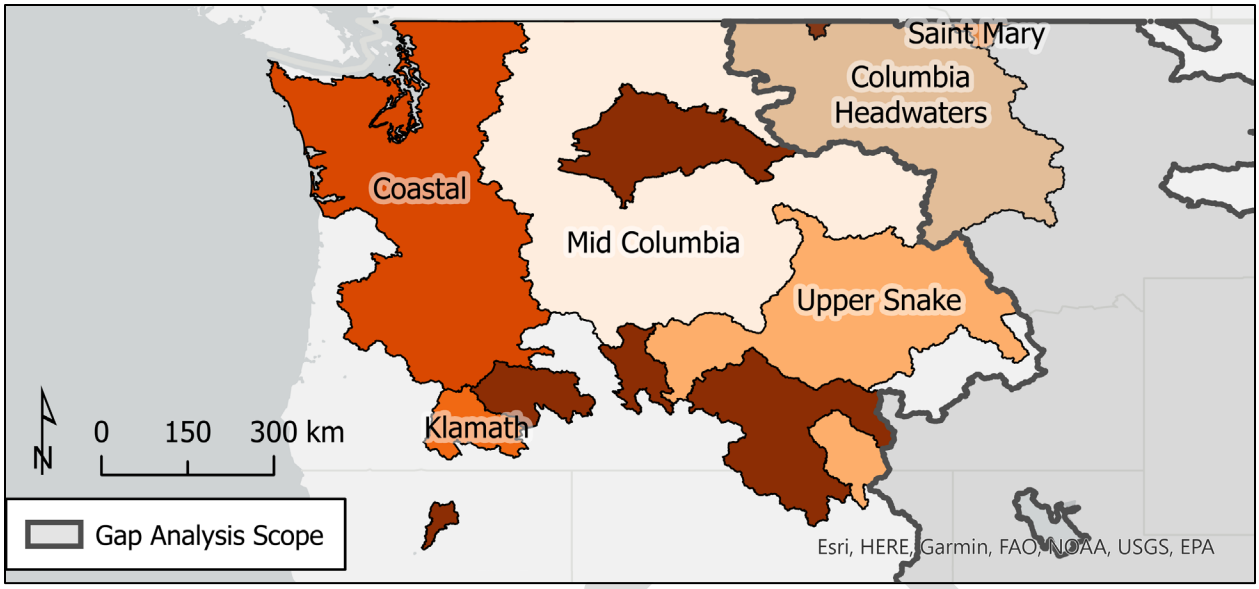

Figure A1. Map of the six recovery units defined for bull trout (*Salvelinus confluentus*) in the coterminus United States (USFWS 2015a), and their intersection with the geographic scope of the Rockies gap analysis. Unlabeled dark brown areas were part of the historic native range of bull trout but are no longer occupied. Native range data from Daniel and Neilson (2020), adapted with additional data from USFWS (2015a).

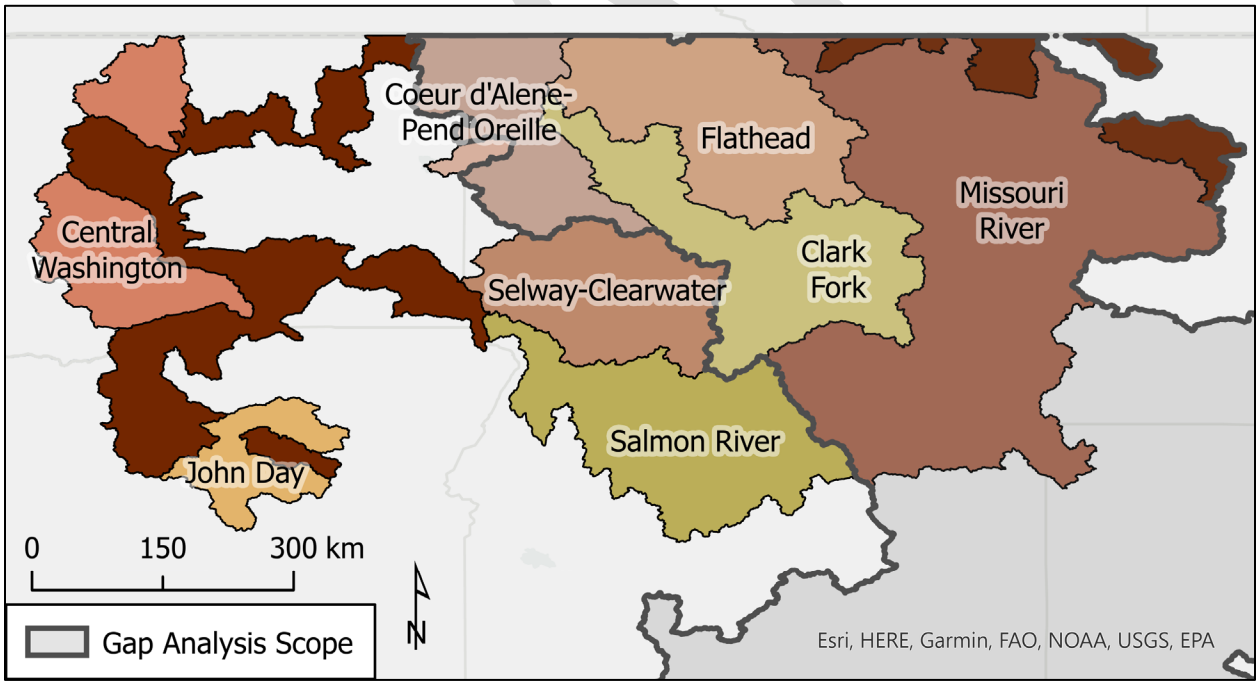

Figure A2. Map of the eight geographic management units defined for westslope cutthroat trout (*Oncorhynchus clarkii lewisi*; IDFG 2013) and their intersection with the geographic scope of the Rockies gap analysis. Unlabeled dark brown areas were part of the historic native range of the subspecies but are no longer occupied. Native range data from Daniel and Neilson (2020).

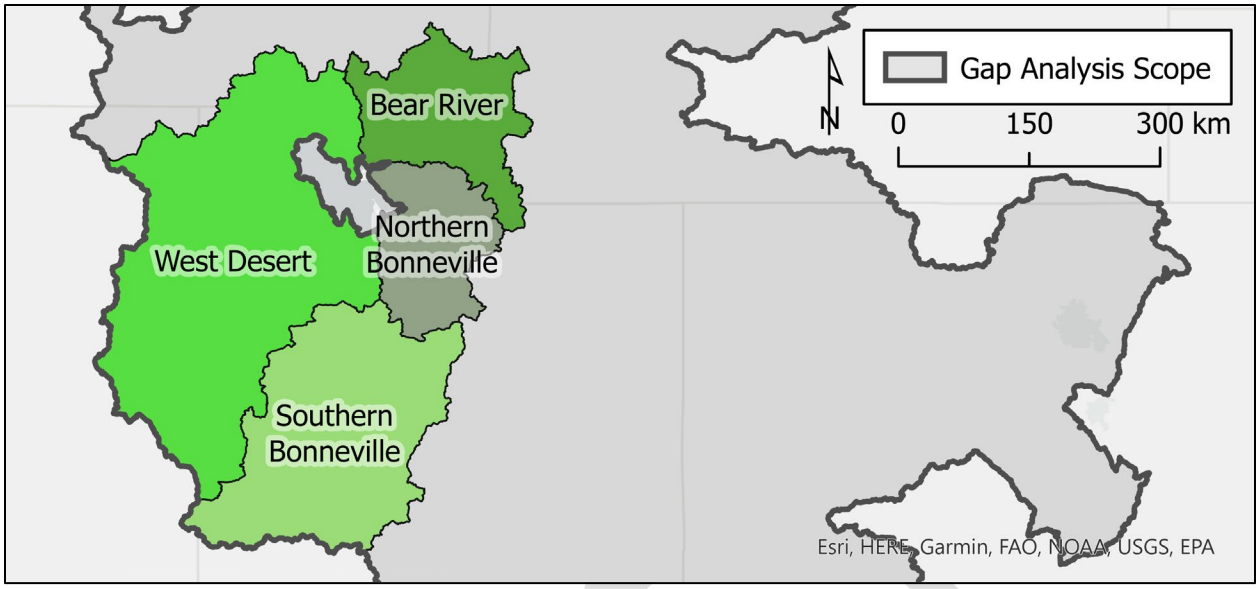

Figure A3. Map of the four geographic management units defined for Bonneville cutthroat trout (*Oncorhynchus clarkii utah*; UDWR 2019) and their intersection with the geographic scope of the Rockies gap analysis. Native range data from Daniel and Neilson (2020).

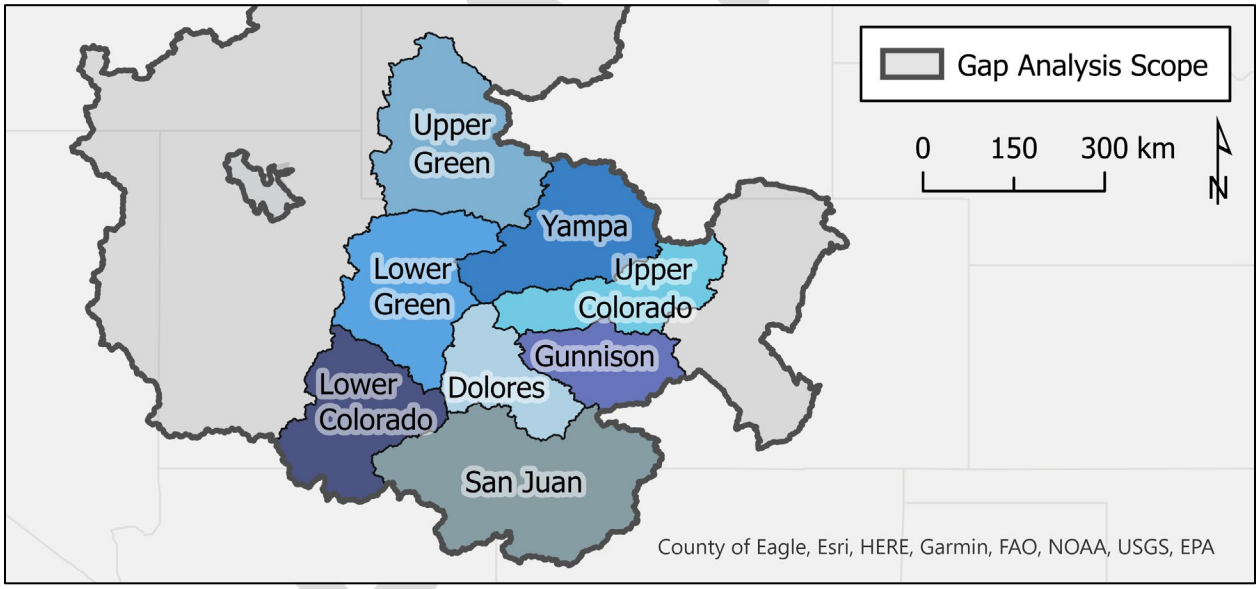

Figure A4. Map of the eight geographic management units defined for Colorado River cutthroat trout (*Oncorhynchus clarkii pleuriticus*; CRCT Coordination Team 2006) and their intersection with the geographic scope of the Rockies gap analysis. Native range data from Daniel and Neilson (2020), adapted with additional data from Hirsch et al. (2013).

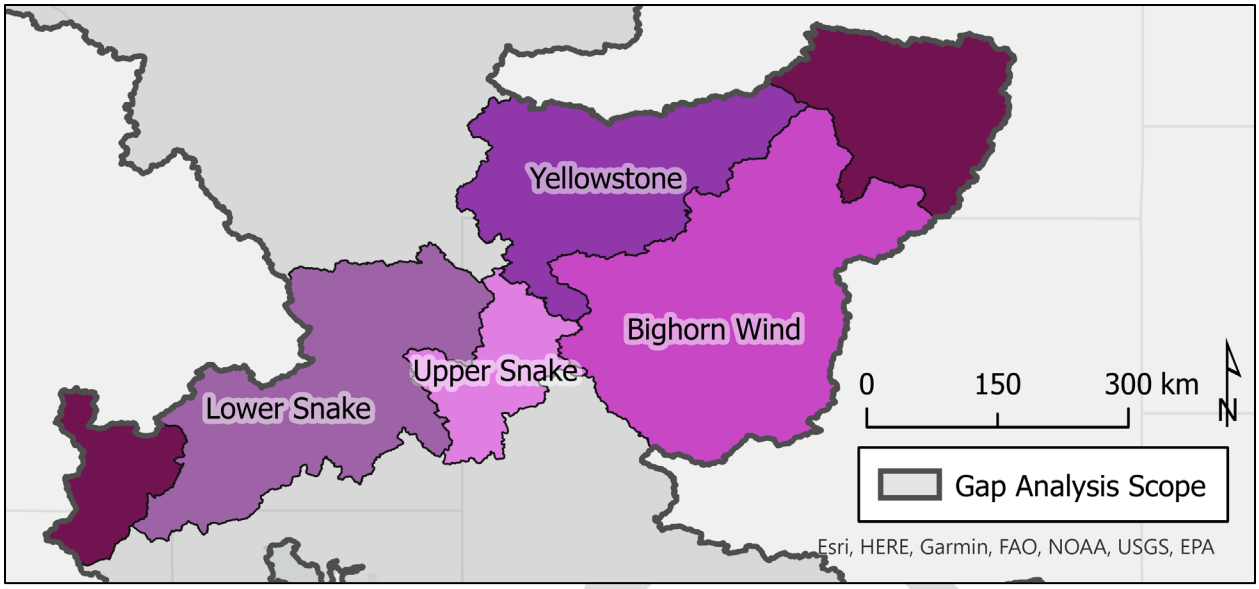

Figure A5. Map of the four geographic management units defined for Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri*; May et al. 2007) and their intersection with the geographic scope of the Rockies gap analysis. Unlabeled dark purple areas were part of the historic native range of the subspecies but are no longer occupied. Native range data from Daniel and Neilson (2020), adapted with additional data from MNHP and MFWP (2021).

Table A2. Locations of hatchery and wild broodstocks of cutthroat trout subspecies and major genetic lineages. Abbreviations: BCT = Bonneville cutthroat trout; CRCT = Colorado River cutthroat trout; GBCT = greenback cutthroat trout; NFH = National Fish Hatchery; SFH = State Fish Hatchery; WCT = westslope cutthroat trout; YCT = Yellowstone cutthroat trout. Information from conversations with State and Federal agency staff and the following published sources: Young et al. 2018; UDWR 2019; CPW 2021; IDFG 2021.

Subspecies, lineage	Hatchery broodstocks	Wild broodstocks
BCT	Mammoth Creek SFH, UT; Mantua SFH, UT; Wigwam SFH, WY	Manning Meadow Reservoir, UT; Bear Lake, UT; Little Dell Reservoir, UT; Cottonwood Creek, ID
CRCT "blue"	Glenwood Springs SFH, CO	
CRCT "green"	Leadville NFH, CO; Daniel SFH, WY	Woods Lake, CO
CRCT "San Juan"	Durango SFH, CO	multiple lakes in southwestern CO
GBCT	Leadville NFH, CO; Poudre Rearing Unit, CO	Zimmerman Lake, CO
WCT	Creston NFH, MT; Cabinet Gorge SFH, ID	King's Lake, WA
YCT	Ten Sleep SFH, WY	
YCT "Snake River"	Auburn SFH, WY	