RECOVERY OUTLINE

for the

Greenback Cutthroat Trout (*Oncorhynchus clarkii stomias*)

Photo Credit: K. Rogers, Colorado Parks and Wildlife

Prepared by the

Greenback Cutthroat Trout Recovery Team

Summer 2019

I. INTRODUCTION

This recovery outline provides an overview of the known information for the greenback cutthroat trout (*Oncorhynchus clarkii stomias*) (GBCT) and serves to guide recovery efforts. This outline is also intended to inform consultation and permitting activities until a revised comprehensive recovery plan for the species is approved. This document was prepared by the members of the Greenback Cutthroat Trout Recovery Team (Recovery Team), consisting of representatives from Colorado Parks and Wildlife (CPW), U.S. Forest Service (USFS), National Park Service (NPS), U.S. Bureau of Land Management (BLM), and the U.S. Fish and Wildlife Service (USFWS or Service).

The Service originally listed the GBCT as an endangered species in 1967 under the Endangered Species Preservation Act of 1966 (32 FR 4001). The GBCT was listed as endangered under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). The Service downlisted the GBCT to a threatened status in 1978, recognizing recovery efforts that removed non-native trout from suitable habitat, established captive broodstocks, reintroduced GBCT, developed stable populations, and initiated catch-and-release fisheries (43 FR 16343).

The original recovery plan was written in 1978, revised in 1983, and was replaced with the 1998 recovery plan (USFWS 1998). Since then, new information from genetic and meristic studies (Metcalf et al. 2012; Rogers et al. 2018; Bestgen et al. 2019) has significantly revised our understanding of the native range and current distribution of the GBCT to the extent that the existing recovery plan is not sufficient to direct the current and future recovery of the GBCT. This document supersedes all prior recovery planning documents for the GBCT and will remain in effect until a revised recovery plan is in place. In the interim, the Recovery Team will continue to plan and implement recovery actions to restore this species and increase its viability. This recovery outline only addresses the GBCT and does not include any of the other cutthroat trout subspecies present in Colorado.

Listing and Contact Information:

Scientific Name:	*Oncorhynchus clarkii stomias*
Common Name:	Greenback cutthroat trout
Listing Classification:	Threatened throughout range in Colorado
Original Listing:	Endangered (1967) under the Endangered Species Preservation Act of 1966
Revised Listing:	Threatened (1978)
Lead Agency, Region:	U.S. Fish and Wildlife Service, Region 6
Lead Field Office:	Colorado Ecological Services Field Office, Lakewood
Contact Biologist:	Leslie Ellwood, 303-236-4747, Leslie_Ellwood@fws.gov

III. RECOVERY STATUS ASSESSMENT

A. Biological Assessment

1. Taxonomy

When the GBCT was first listed, morphological and meristic analyses were the predominant method for cutthroat trout subspecies delineation, based on phenotypic expression that included spotting patterns, number of scales, coloration, and number of basibranchial teeth (Behnke 1992, 2002; Trotter 2008. Behnke (2004) has argued that genetics should not be the sole factor in determining taxonomic distinctions, and that morphological traits may sometimes be distinguishing factors.

Until recently, delineations of subspecies of cutthroat trout in the southern Rocky Mountains were believed to follow geographic boundaries within several states, with GBCT on the east side of the Continental Divide and the Colorado River cutthroat trout (*O. c. pleuriticus*) on the west side. In a 2007 study, Metcalf et al. used molecular markers from the mitochondrial and nuclear genomes to analyze individuals from greenback and Colorado River cutthroat trout (*O. c. pleuriticus)* populations from the major river basins in Colorado. Phylogenetic analysis of the combined cytochrome oxidase 1 (CO1) and nicotinamide adenine dinucleotide dehydrogenase 2 (ND2) mitochondrial gene sequences (n=1530 base pairs) revealed two divergent lineages within the ranges of greenback and Colorado River cutthroat trout, consisting of 10 unique haplotypes. Metcalf et al. (2007) determined that these two lineages corresponded with the two described subspecies. However, the divergent evolutionary lineages defined by mitochondrial and nuclear DNA markers did not separate geographically on either side of the Continental Divide as expected. The study identified five populations with what the authors believed were Colorado River cutthroat trout genetic markers on the east side of the Continental Divide, and one population with what they believed were GBCT genetic markers occurring on the west slope of Colorado (Rogers 2010), which has historically been considered Colorado River cutthroat trout habitat.

Additional genetic research was commissioned by the Recovery Team to elucidate the taxonomic uncertainty of native cutthroat subspecies in Colorado. Led by researchers from the University of Colorado (Metcalf et al. 2012), this study compared mitochondrial DNA of extant cutthroat trout populations from Colorado with DNA extracted from cutthroat trout museum specimens collected in the late 1800s, thereby providing an understanding of the native ranges of cutthroat trout in the Southern Rocky Mountains prior to major fish stocking efforts. Several significant conclusions resulted from this study, with the most significant finding being that only a single extant population of GBCT remained, occupying Bear Creek near Pikes Peak in El Paso County, Colorado, in the Arkansas River drainage. This study also determined that GBCT appear to be native only to the South Platte River drainage and not the Arkansas River basin, as was

velocity flow and protective cover); and adult (juxtaposition of slow water areas for resting and fast water areas for feeding, with protective cover provided by boulders, logs, overhanging vegetation or undercut banks) (Behnke 1992). Both water quality and quantity are important. High sediment loads, pollution, and diversion of streams for agricultural or municipal purposes can adversely affect cutthroat trout habitat (see *Threats* section below).

Diet - Cutthroat trout are opportunistic feeders preying on a wide range of organisms, including macroinvertebrates, but a large percentage of their diet can be also be terrestrial insects, which may comprise over half of the diet of trout populations (Saunders and Fausch 2007). Fausch and Cummings (1986) found that GBCT in Hidden Valley Creek (Rocky Mountain National Park) fed opportunistically on a wide variety of organisms. Analysis of stomach contents revealed that terrestrial invertebrates comprised a relatively constant proportion of the diet during summer months but the proportion of terrestrial invertebrates in the diet declined rapidly in October as temperatures declined. In this study, none of the stomachs contained young-of-the-year GBCT (Fausch and Cummings 1986).

Water Temperature - Cutthroat trout spawning is generally initiated in the spring when water temperatures reach 5 - 8.3° C (41-47° F). Field studies conducted on factors limiting cutthroat trout recruitment success into translocation streams in Rocky Mountain National Park and several national forests suggest that low water temperatures (averaging 7.8°C [46° F] or below in July) may have an adverse effect on GBCT fry (young fish) survival and recruitment (Harig and Fausch 2002; Coleman and Fausch 2007a, 2007b). They also found that stream flows may influence recruitment and growth of cutthroat fry. Coleman and Fausch (2007a, 2007b) found that streams that accumulate 900 - 1200° C days (1652 - 2192° F days) cumulatively during the growing season afforded the best opportunity for cutthroat trout recruitment and translocation success.

Two temperature parameters are considered especially critical for cutthroat survival and persistence. The first is the Maximum Weekly Maximum Temperature (MWMT). This metric is used to evaluate when habitat is too warm for survival and is calculated by taking the average of maximum daily temperature for the warmest consecutive 7-day period during the year. This limit is unknown for GBCT, but for Colorado River cutthroat trout, the subspecies geographically closest to the GBCT, this limit has been defined as a MWMT ≥26.0 °C (78.8 °F) (Roberts et al. 2013).

The second parameter of interest is the maximum 30-day average temperature (M30AT). This metric is used to evaluate the optimal conditions for growth and recruitment and includes a range of conditions. The M30AT is calculated by taking the average maximum temperature for the warmest consecutive 30-day period within a year. Roberts and collaborators (2013) summarized the body of literature on M30AT for cutthroat trout for the following states: no recruitment <8

B. Vulnerability and Threats Assessment

The 1998 Greenback Cutthroat Trout Recovery Plan listed the following reasons for the historic decline of the GBCT: 1) introduction of non-native fish; 2) hybridization; 3) competition; and 4) angler harvest. Following the preparation of 1998 Greenback Recovery Plan, additional threats and vulnerabilities have been identified.

Our current understanding of threats to the GBCT has been revised and updated since the 1998 Recovery Plan. Some threats have declined while additional threats and vulnerabilities have surfaced. For example, angler harvest is currently considered to be less of a threat to cutthroat trout due in large part to the catch-and-release ethic that has become well established in the angling community. Specific to the GBCT, waters receiving reintroduced fish are designated as either catch-and-release fishing or are closed to fishing (i.e., Bear Creek). Other threats identified in the 1998 Recovery Plan relating to non-native fish are also currently reduced from 1998 due to improved construction and management of barrier structures.

Our understanding of current threats to and vulnerabilities of, the GBCT, and southern cutthroat trout in general, is provided in the following discussion. We have identified the threats and vulnerabilities as follows in the order of relative current concern (high to low): population numbers and sizes; non-native fish invasion; genetic diversity; habitat fragmentation; habitat degradation; wildfire; fire management; water quantity; disease; climate change; water quality; overutilization for commercial, recreation, scientific or educational purposes. We also evaluate existing regulatory mechanisms and their impacts on these stressors. Additionally, Table 2 in the *Preliminary Recovery Strategy* section below discusses threats and vulnerabilities and provides a general assessment of the current level or severity of the threats. Table 2 also identifies mitigation actions and measures to address the threats and vulnerabilities.

1. Population Numbers and Sizes

Despite an aggressive recovery effort that has reintroduced new GBCT populations in the five years following our understanding of the importance of the Bear Creek population, the small number of extant GBCT populations remains a high level of concern in terms of the redundancy of the subspecies. At this writing (Spring 2019), pure GBCT populations are present in only three streams (Bear Creek, Herman Gulch, and Dry Gulch) and one lake (Zimmerman Lake).

In addition to concerns relating to the small number of populations, small population sizes are of concern in terms of resiliency, as small population sizes decrease the likelihood of continued persistence of the subspecies. Small populations (less than 500 adults) usually have low effective population sizes and are more likely to experience genetic drift and inbreeding depression (Allendorf and Luikart 2007), which may make them less able to adapt to changing

Creek fish exhibit deformities consistent with a low genetic diversity. Analysis of both microsatellite and AFLP nuclear markers suggest that these fish are the least genetically diverse of any cutthroat trout examined in Colorado to date (K. Rogers 2017, pers. comm.).
In summary, the low genetic diversity of GBCT populations is a wide-spread, high level threat to the GBCT populations due to reduced fitness (resiliency) and reduced representation.

4. Habitat Fragmentation

Habitat Fragmentation – Anthropogenic habitat fragmentation has developed from numerous sources including: culverts; stream desiccation or vertical barriers associated with water diversions; thermal or chemical barriers (or long reaches of unsuitable habitat) due to habitat degradation; and downstream biotic barriers consisting of non-native species (Fausch et al. 2002; Young 2009; Fausch et al. 2009). Most streams with cutthroat populations on the Front Range are small and isolated. Small, isolated populations are particularly vulnerable to catastrophic events, such as drought, floods, and fires. Stream barriers, while maintaining the GBCT populations by keeping out the downstream non-natives, also act to isolate GBCT populations. In all cases, isolation prevents the natural demographic rescue of declining populations or the natural reestablishment of previously extirpated cutthroat populations (Fausch et al. 2009; Young 2009). Streams shorter than 2.7 km (1.7 miles) are unlikely to have enough habitat variability for a population to be able to survive stochastic events (Harig and Fausch 2002), although we recognize that high quality habitat may provide sufficient resources in shorter stream patches (Peterson et al. 2014). Streams longer than about 9.7 km (6 miles) are generally assumed to be long enough to encompass the habitat complexity necessary for the population to survive deleterious stochastic events (Hilderbrand and Kershner 2000; Cowley 2007; Roberts et al. 2013; Peterson et al. 2014).

Harig and Fausch (2002) noted that introductions of Rio Grande cutthroat trout and presumptive GBCT were more likely to be successful in larger watersheds (greater than 14.7 km^2; 3,632 acres). Watersheds this size or greater are expected to encompass low-elevation habitat that provides warmer summer temperatures and to have relatively wide stream channels of sufficient length to provide an adequate number of deep pools (Harig and Fausch 2002). Restoration of GBCT populations over larger, connected portions of stream networks should be considered a key management goal. Non-fragmented habitats increase the persistence of individual populations that are otherwise threatened by local catastrophes (e.g., fire or flash floods). In addition, connectivity and larger habitat segments maintain genetic diversity and adaptability to environmental change (representation) through migration and gene flow within a metapopulation (Fausch et al. 2002; Coleman 2007; Fausch et al. 2009).

In summary, fragmentation of GBCT habitat has resulted in a moderate to high level of threat to GBCT populations in terms of resiliency (smaller, less stable populations) and redundancy (reduced number and distribution of populations).

Bear Creek on Pikes Peak experiences high sedimentation issues due in large part to the naturally occurring movement of Pikes Peak decomposed granite into the stream channel, but also related to increased erosion from the presence and use of trails and roads within the Bear Creek drainage.

A quantitative review of cattle grazing from multiple studies found significantly greater soil loss due to erosion on grazed areas when compared to ungrazed areas (Jones 2000). The results of numerous studies and literature reviews (Armour et al. 1994; Elmore and Kauffman 1994; Ohmart 1996; Belsky et al. 1999) serve to validate Platts' (1982) conclusion that livestock grazing is the major cause of impaired stream and riparian environments and reduced fish populations throughout the arid western United States.

In summary, alteration of habitat and degradation due sedimentation issues in GBCT streams, and cutthroat trout streams in general, currently result in a generally widespread moderate to high level of threat but, where present at higher levels, sedimentation can result in significant impacts to GBCT populations in terms of resiliency (smaller, less stable populations) and redundancy (reduced distribution of populations).

6. Wildfire

Wildfire-related impacts to cutthroat populations may be direct or indirect and can include changes in stream channel stability, greater and more variable discharge, altered debris load, increased nutrient availability, turbidity, increased temperature, disease introduction, changes in pH, dissolved oxygen and release of dissolved organic carbon, iron, manganese and mercury (Dunham et al. 2003). Effects of fire to cutthroat trout populations can be severe, including toxic effects from smoke and ash deposits (Brown et al. 2001; Howell 2006). Generally the immediate effects of fires are of less concern than post-fire storm events, as storm events can result in severe and large scale erosion and sedimentation (Rinne 1996; Burton 2005). Sedimentation during spring runoff is especially problematic for GBCT whose spring-spawning coincides with these events and whose eggs can be smothered during this critical timeframe. Land management agencies, such as the USFS, NPS, and BLM, are conducting fuels reduction forest treatments in montane and upper montane forests to reduce the risk of wildfires and to return forest conditions to their normal fire regimes.

In summary, wildfires can adversely affect cutthroat trout populations and post-fire storm events present a high level of threat to cutthroat streams in drainages that have experienced recent wildfires, affecting resiliency (smaller, less stable populations) and redundancy (reduced distribution).

9. Disease and Aquatic Nuisance Species (ANS)

Remaining native cutthroat trout populations are found in isolated headwater habitats, therefore, common ANS, such as quagga mussels and New Zealand mudsnails that affect lower elevation waters, are not usually present in these cutthroat trout habitats. Whirling disease, which is caused by the *Myxobolus cerebralis* parasite, represents the greatest disease threat to native cutthroat trout (Nehring and Walker 1996; Thompson et al. 1999; Nehring 2006). Whirling disease results in nerve damage in the spinal area and head of the fish and causes the fish to "whirl', which makes them susceptible to predation and starvation. Many of the occupied cutthroat trout habitat patches are also home to *Tubifex tubifex*, the parasite's intermediate host (Nehring et al. 2014) although none of the GBCT occupied streams are currently infected with whirling disease. Warming stream temperatures will facilitate range expansion of the asymptomatic host, brown trout, which poses an additional threat for whirling disease expansion.

An additional ANS concern is bacterial kidney disease (BKD), a slow-growing, chronic infection that is most commonly observed in older, stressed fish. Salmonid fish are more susceptible than other fish species. Population-level impacts from BKD have not been observed in trout in the wild in Colorado. However, in hatcheries, BKD outbreaks can produce significant mortality and clinical symptoms, sometimes necessitating depopulation of the hatchery unit. Transmission of BKD can be vertical via eggs or sperm, or horizontal by direct contact with infected fish or water. Management strategies for BKD in hatcheries include good hygiene, reducing stress, quarantine of infected stocks, culling of infected broodstock and/or total hatchery depopulation followed by disinfection (Fish Resources Services 2018). BKD is a moderate to high threat to salmonid fish in hatchery settings in general. Neither the Mt. Shavano State Fish Hatchery or the Leadville National Fish Hatchery (NFH) have experienced a BKD infection although several state fish hatcheries within Colorado have experienced some BKD infections in the past (H. Crockett 2018, pers. comm.).

In summary, whirling disease continues to remain a moderate to high level threat to cutthroat trout populations in general, and would be a high level of threat if present within drainages where GBCT are present, affecting resiliency (smaller, less stable populations) and redundancy (reduced distribution of populations). At this time, whirling disease is not known to occur within drainages with GBCT populations. BKD would be considered a moderate level threat if present in a hatchery containing GBCT. In wild settings, the impact of BKD remains unknown but represents at least a low level threat given its long-term persistence in the environment once introduced.

10. Climate Change

The western United States is witnessing a major alteration in climatic conditions, coinciding with a dramatic increase in greenhouse gases (see review in Rieman and Isaak 2010; IPCC 2014).

published for GBCT and describe the effects of low (acidic) pH and aluminum (Woodward et al. 1991), and five other chemicals commonly found in the environment due to domestic, industrial, or agricultural uses (Sappington et al. 2001). These studies show that larval GBCT are more sensitive to low pH and elevated aluminum than eggs and embryos (Coleman 2007). In addition to impacting water quality, various types of stream-based mining (sluicing, dredging) have significantly degraded stream channel morphology and, in some cases, led to immense changes in sediment loads (Young 2009).

The rising price of gold has led to renewed interest in small scale recreational hydraulic mining, which creates localized degradation of stream substrate and increases in suspended sediments. Today, mining activities are not as prevalent and are under environmental permitting and reclamation restrictions that minimize polluted runoff from mine sites. However, the legacy of past mining activities still degrades water quality and accidental releases do occur and render some streams uninhabitable that might otherwise serve recovery efforts.

In summary, the current threat of low water quality due to mining impacts is considered to be low as it is not wide spread throughout cutthroat trout streams, but would be considered a high threat where present, affecting resiliency (smaller, less stable populations) and redundancy (reduced distribution of populations).

12. Overutilization for Commercial, Recreation, Scientific or Educational Purposes

Ever since the subspecies was reclassified as a threatened species in 1978, sport angling for the GBCT has been regulated under section 4(d) of the ESA. The 4(d) rule for GBCT allows sport angling under applicable State law. Accordingly, some waters currently containing GBCT are currently designated as either catch-and-release fishing or are closed to fishing (i.e., Bear Creek). GBCT populations at most reintroduction sites are managed under 'catch and release' and 'artificial flies and lures' regulations, which requires that any fish caught be immediately returned to the water and minimizes hooking injuries to the fish, respectively. Hooking mortality for a catch and release fishery is considered to be low (4 percent) and poses little threat to the sustainability of a population (Gresswell et al. 1997; Gresswell 2011). Fishing pressure in many headwater streams is very low, making angler harvest a nominal threat. Posted signs and education of anglers as to the value of recovery efforts further reduces the risk by encouraging careful and respectful handling of fish. Risks to GBCT from commercial, scientific, or educational purposes are also very low.

In summary, the risk to GBCT populations from commercial, recreation, scientific or educational purposes continues to remain a low-level threat in terms of resiliency (smaller, less stable populations) and redundancy (reduced distribution of populations).

- 2012 University of Colorado (CU) genetic study (Metcalf et al. 2012) concluded that the cutthroat native to the South Platte basin (GBCT) is represented solely by the Bear Creek (Pikes Peak) population.
- 2013 USFS (Pike National Forest) initiated NEPA analysis of management alternatives in Bear Creek for purpose of improving GBCT habitat conditions in Bear Creek.
- 2013 Colorado State University (CSU) study of cutthroat meristics concluded that phenotypic attributes of extant cutthroats support the CU genetic lineages and provides additional resolution about relatedness (Bestgen et al. 2013).
- 2013 Sediment mitigation activities.
- 2014 Population assessment conducted (electrofishing).
- 2014 Sediment mitigation activities.
- 2015 Sediment mitigation activities.
- 2016 USFS completed NEPA analysis and initiated implementation of selected alternative to improve GBCT habitat conditions within Bear Creek.
- 2016 Sediment mitigation activities.
- 2017 Sediment mitigation activities.
- 2017 Bear Creek Roundtable awarded the 2017 Rise-to-the-Future Award for Collaborative and Integrated Aquatic Stewardship by the USFS.
- 2017 Population assessment conducted (electrofishing).
- 2018 Sediment mitigation activities.

Bear Creek has significant issues with respect to sediment delivery of decomposed Pikes Peak granite into the stream channel, resulting in reduced pool depths, especially the critically important over-wintering pools. Sediment mitigation activities are improving instream habitat; however sedimentation will continue to be a challenge due to large areas of unstable decomposed granite within the Bear Creek drainage.

b) State and Federal Hatcheries

The production of GBCT for stocking at reintroduction efforts occurs through the coordinated and combined efforts of the Mt. Shavano State Fish Hatchery (Salida Isolation Unit) and the Leadville NFH. In 2008, approximately 66 adult fish were removed from Bear Creek to initiate founding of a captive broodstock at the Mt. Shavano State Fish Hatchery. Those fish were spawned in 2010 and progeny were split among hatcheries until a wild broodstock could be established in Zimmerman Lake (headwaters of the Cache la Poudre drainage) in 2014. Currently, the broodstock is split between the Leadville NFH and Zimmerman Lake. Each year, spawn operations at both sites produce eggs that are transported back to the Salida Isolation Unit for rearing under warmer water conditions to foster improved growth and survival, then returned to Leadville NFH or Zimmerman Lake as Age 1 fish. Each year, milt (and if possible, fertilized eggs) from wild spawn operations on Bear Creek are brought in to enhance genetic diversity in

State Agencies

Colorado Parks and Wildlife (CPW) - CPW has implemented laws and stocking regulations to aid in the recovery of the GBCT. Fishing for GBCT is managed by CPW; the final listing rule for the GBCT contains language under ESA section 4(d) whereby fishing is managed by CPW in accordance with state regulations outlined in their fishing brochure (and in Chapter 1, Article 2, Regulation #108 of state regulations). CPW has used this authority to close streams to angling at some sites, such as Bear Creek on Pikes Peak, and to allow catch-and-release fishing with artificial flies and lures only at some of the other reintroduction sites, such as Zimmerman Lake. Where catch-and-release fishing is allowed, any GBCT that are caught must be immediately returned to the water. These laws and regulations have been effective in minimizing direct take of the subspecies, decreasing the introduction of non-native species such as brook trout, and in preventing the spread of invasive species, such as whirling disease.

Federal Agencies

Since most of the available GBCT habitat is located on federally managed lands, land management practices and regulations provide some level of conservation and protection of GBCT habitats, such as the Clean Water Act, Fish and Wildlife Coordination Act, Wilderness Act, section 7 of the ESA, and NEPA. These regulations ensure that actions implemented by Federal agencies are analyzed and that conservation measures are implemented to minimize and mitigate their potential negative impacts on GBCT populations and their habitat.

Forest Service (USFS) - USDA regulation (9500-1), agency policies (Forest Service Manual chapters 2620 and 2670), and National Forest Plan direction exist to guide the USFS to avoid actions that would cause a species to become endangered or threatened and to implement programs for their conservation and recovery within existing authorities.

Pike and San Isabel National Forests and Comanche and Cimarron National Grasslands (PSICC) Land and Resource Management Plan (LMRP) (1984) contains guidance that provides for conservation of the GBCT and its habitat. Section FSM 2670 of the LMRP addresses management of habitat for the recovery of endangered wildlife and threatened species. FSM 2670.21 states that "The Forest Service will manage National Forest System habitats and activities for threatened and endangered species to achieve recovery objectives so that special protection measures provided under the Endangered Species Act are no longer necessary and will promote recovery efforts through Research and Development and State and Private Forestry Programs." Additional language within this section provides guidance regarding the development of recovery objectives and strategies as well as guidance for cooperation with State Agencies to inventory, protect, manage, and plan for threatened, endangered, proposed, and sensitive species.

maintain listed species' habitats; control detrimental nonnative species; manage detrimental visitor access; and reestablish extirpated populations as necessary to maintain the species and the habitats upon which they depend." Lastly, the NPS will *"...participate in the recovery planning process, including the provision of members on recovery teams and recovery implementation teams where appropriate."*

Numerous reintroduction projects were conducted earlier in Rocky Mountain National Park using cutthroat trout that were considered to be GBCT at that time. Subsequently, the NPS conducts stream restoration and protection projects and continues to evaluate areas of suitable habitat for future GBCT reintroductions.

Fish and Wildlife Service (USFWS) - Although the recent genetic and meristic studies have significantly revised our knowledge of the range and distribution of the GBCT, the 1998 Recovery Plan continued to be in effect and provides guidance for the management and conservation of this subspecies. To ensure continued survival of the subspecies after delisting, the 1998 Recovery Plan required development of a long-term management plan and cooperative management agreements for the GBCT. This plan would be approved and adopted by all participating recovery and management agencies "to ensure that adequate regulatory mechanisms and management programs remain in existence after delisting to ensure that adequate populations of GBCT are maintained" (USFWS 1998). This long-term management plan has not been developed to date, due in large part to the significant effort to evaluate the identity of the GBCT and to implement reintroduction projects. We intend to revise the GBCT Recovery Plan in the near future, and the revised Plan will provide a new long-term management plan.

In summary, the existing regulatory mechanisms provide the means to implement actions likely needed for recovery of the GBCT; agencies responsible for the management of GBCT continue to manage and support the conservation of this subspecies.

D. Summary Statement of Recovery Needs

Recovery needs for the GBCT include the establishment of conservation populations through stocking efforts into streams and lakes with suitable habitat throughout the South Platte River drainage, and possibly within adjacent drainages east of the Continental Divide. Populations need to be sufficiently robust (i.e. resilient and redundant) to withstand stochastic, catastrophic, and anthropogenic influences such that they can persist into the future. Meeting these goals will require that threats be sufficiently understood and abated, and range-wide monitoring will be required.

The USFWS's 5-year Review is the appropriate document in which to evaluate the Recovery Priority Number and to provide a recommendation for a revised number; therefore, we are not evaluating the Recovery Priority Number further in this recovery outline. The Service completed a 5-year Review on October 12, 2018, in which we concluded that because we are in the initial stages of several large-scale, multi-year reintroduction efforts, we did not have sufficient information to fully assess the GBCT as it relates to the five factors under the Endangered Species Act, and we were not able to provide an updated recommendation of the status of the species at that time. We will continue to assess the status of the species as we are better able to evaluate the success of the reintroduction projects. Therefore, we recommended no change in the status of the GBCT and will re-evaluate its status in the 5-year Review in 2023.

B. General Recovery Strategy

The general recovery strategy for the GBCT at this time includes: 1) continuation of reintroduction projects; 2) management of existing populations; 3) monitoring of existing populations; and 4) research towards improving conservation of the GBCT.

1. Continuation of Reintroduction Projects

The primary recovery strategy for the GBCT at this time is to continue to reintroduce populations into the wild, primarily within the South Platte River drainage and secondarily within adjacent drainages east of the Continental Divide.

In the short-term, our emphasis for recovery has been focusing on increasing the number (redundancy) of populations in the wild from Bear Creek progeny. Although habitat that is conducive to long-term persistence (including recruitment) is preferred, the more immediate concern is undertaking actions to avoid loss of the Bear Creek genetic lineage by reintroducing Bear Creek progeny in suitable habitat at multiple sites to further reduce the risk of loss of this unique genetic lineage.

On the longer-term, our emphasis will be shifting towards improving the broodstock to more fully represent the genetic diversity (representation) within the Bear Creek population as well as the use of reintroduction sites that provide high quality habitat in larger-scale, interconnected areas for multiple self-sustaining populations (i.e., metapopulations).

In order to improve the successes of our reintroduction program, we will to continue to implement the following: a) general guidance for reintroduction projects; b) broodstock development; and c) selection criteria and considerations for reintroduction sites.

a) General Guidance for Reintroduction Projects

c) Selection Criteria and Considerations for Reintroduction Sites (Biological and Physical)

The potential for survival and recruitment of reintroduced GBCT will be assessed at the watershed, reach, and site level by the Recovery Team. The following describes the attributes that are considered to be important for establishing long-term, self-sustaining populations at reintroduction sites:

1) Patch Size
   a) Reintroduction sites should be large and complex enough to be resilient to environmental perturbations that are expected to occur with increasing frequency in the future.
   b) The recommended minimum stream length for reintroduction sites is between 2.8 to 7 km (1.7 - 4.3 miles). Streams shorter than 2.8 km (1.7 miles) are unlikely to have enough habitat variability for a population to be able to survive stochastic events (Harig and Fausch 2002), although we recognize that high quality habitat may provide sufficient resources in shorter streams (Peterson et al. 2014). Streams longer than about 9.7 km (6 miles) are generally assumed to be long enough to encompass the habitat complexity necessary for the population to survive stochastic events (Hilderbrand and Kershner 2000; Cowley 2007; Roberts et al. 2013; Peterson et al. 2014).
   c) The recommended minimum drainage area for reintroduction sites is 14.7 km^2 (3,632 acres) (Harig and Fausch 2002). Watersheds this size or greater are expected to encompass low-elevation habitat that provides warmer summer temperatures and to have relatively wide stream channels of sufficient length to provide an adequate number of deep pools (Harig and Fausch 2002).

2) Water Temperature
   a) Reintroduction sites should have water temperatures that provide for the survival and growth of translocated fish. Based on known thermal requirements (see "*Habitat and Life History*" section above), reintroduction sites will be considered that have a MWMT below 26 °C (78.8 °F) and M30AT between 8 and 20 °C (46.4 to 68 °F), while preferred sites will have a M30AT between 9.1 and 18.0 °C (48.4 to 64.4 °F) (Roberts et al. 2013).

3) Barrier to Non-native Fish
   a) Reintroduction sites must have a barrier to restrict non-native fish immigration. Barriers may be in the form of existing natural barriers, or may be constructed, provided that suitable conditions (i.e., topography) are present at the site. Barriers may be provided by anthropogenic features, such as diversion structures or

pure cutthroat subspecies, rare alleles) or other adaptive characteristics (such as high elevation reproduction).

c) Relocation, rather than lethal removal of existing cutthroat trout populations, will be considered when warranted. Other options, such as collecting genetic material through eggs and milt, may also be considered when relocation is not feasible.

8) Landownership and Management

a) Private Lands - Some of the future sites considered for reintroduction projects may occur, in part, on private lands. Planning efforts for reintroduction projects that involve private lands would likely benefit from the use of USFWS's Safe Harbor Agreement to facilitate the reintroduction of GBCT on private lands. The Safe Harbor Agreement is a tool under Section 10 of the ESA that facilitates a working relationship between the private landowner(s) and the USFWS for such situations. This agreement is a voluntary agreement involving private or other non-Federal property owners whose actions contribute to the recovery of species listed as threatened or endangered under the ESA. In exchange for actions that contribute to the recovery of listed species on non-Federal lands (such as reintroductions), participating property owners receive formal assurances from the USFWS that if they fulfill the conditions of the Safe Harbor Agreement, the USFWS will not require any additional or different management activities by the participants without their consent.

b) Federal Lands – Resource management on federal lands is subject to compliance with laws, regulations, and policies. As it relates to conservation projects and fish reclamations for GBCT, internal and external scoping provides agency decision-makers feedback from multiple constituents on proposed projects, including reintroductions of GBCT into previously unoccupied waters. Land managers of potential GBCT reintroduction sites will need to be aware that recreational fishing at these sites will be limited to catch-and-release fishing. Furthermore, future actions that may adversely affect the GBCT would require an ESA consultation prior to implementation of that action. The USFS is currently conducting a programmatic consultation that addresses USFS activities in areas of potential future GBCT reintroduction sites.

2. Management of Existing Populations

Management of existing GBCT populations includes the maintenance of both the Bear Creek population as well as the other populations that have been reintroduced. Maintenance of existing populations includes abating threats to these populations, which is expected to further improve the success of our recovery efforts. Table 2 includes an evaluation of threats to GBCT and the anticipated effectiveness of measures to mitigate those threats.

			Areas that are degraded but could be improved can be considered for future reintroductions; however, watersheds that are severely damaged with low chance of restoration should be a lower priority. Identify areas that are priorities for restoration, and incorporate BMPs. In Bear Creek, implement the USFS's Bear Creek Restoration Project.	
Wildfire	Low/ Moderate	Loss of streamside vegetation, loss or reduction of populations via increased water temperatures and flash floods.	Vegetation management, fuels treatments, and prescribed burning to reduce fire risk. Immediate post-fire control of streambank erosion and runoff into adjacent waters will address changes in major and trace elements that may negatively affect cutthroat trout and will decrease sedimentation. Avoidance of site for reintroductions based on fire risk, riparian resiliency, and active vegetation management.	Low/Moderate Erosion control structures are expected to be moderately to highly effective when installed in a timely manner and designed for expected precipitation events.
Wildfire management actions (water operations and use of fire chemicals)	Low	Loss of populations, introduction of disease or introduction of ANS. Fire chemicals can be toxic in the aquatic environment. Additionally, fire chemicals applied away from waterways can maintain toxicity for several weeks and can be mobilized by precipitation events.	Fire Chemicals – The National Interagency Fire Coordination Center (NIFC) has developed a policy for Delivery of Wildland Fire Chemicals Near Waterways. This policy provides specific guidance for pilots as well as on the ground fire fighters to prevent chemicals from entering waterways. Spread of Disease – Avoid using water from whirling disease positive areas; disinfect/decontaminate aerial delivery systems (e.g., buckets, tanks, hoses, pumps) before/after use and between fire assignments. Pre-planning by land management agencies that includes written procedures for disinfection as well as known locations of whirling disease positive waters is critical for information dissemination during emergency fire events.	Fire Chemicals – when NIFC guidance is followed, these mitigation measures are highly effective. Spread of Disease – where clear guidance and delineation of threats are in place, preventative factors are moderately to highly effective.
Water depletions, diversions, and water storage facilities	Moderate	Loss or diminishment of existing populations.	Work with regulatory agencies to time releases to maintain minimum flows and maintain bypass flows.	Low – difficult to obtain minimum bypass flows, although few reintroduction sites have upstream diversions.

We have identified the following ongoing research studies aimed at improving our knowledge and understanding of the ecology of the GBCT, ultimately leading to improved conservation and recovery:

a) Comparison of extant population in Bear Creek to museum specimens to determine if they are morphologically similar to what was in the South Platte basin historically. This study could influence future discussions on population supplementation (by other subspecies) if necessary (ongoing).
b) Evaluation of genetic diversity in Bear Creek fish relative to museum specimens using whole-genome sequencing technology. This study could influence future discussions on population supplementation (by other subspecies) if necessary (ongoing).
c) Evaluation of fitness of developing broodstocks with both lab and field based studies to determine viability of reintroduction stock (ongoing).
d) Conduct stocking in lower elevation habitats to provide for comparative studies of reproduction, fecundity, and survival over a wider range of conditions to help delineate the key attributes of optimal GBCT habitat (ongoing).
e) Synthesize inventory and monitoring information to understand "thresholds", limiting factors and key characteristics for restoration success (ongoing).
f) Investigate diversity in existing broodstock and develop a strategy to maintain and increase heterozygosity in hatchery populations (ongoing).
g) Monitor incidence of deformities in Zimmerman Lake and hatchery-reared GBCT (ongoing).

V. PREPLANNING DECISIONS FOR PREPARATION OF RECOVERY PLAN

A. Planning Approach

A revised recovery plan will be prepared for the GBCT pursuant to section 4(f) of the Act. The recovery plan will include objective, measurable criteria which, when met, will result in a determination that the species will be removed from the Federal List of Threatened and Endangered Species. A Species Status Assessment will be prepared for the GBCT, which will be used in preparation of the revised recovery plan. The Species Status Assessment will provide an opportunity for stakeholder involvement. Recovery criteria will address all threats meaningfully impacting the species. The recovery plan will estimate the time and costs required to carry out those measures needed to achieve the goal of recovery and delisting.

The recovery plan will be under the stewardship of the Colorado Ecological Services Field Office. The Service will coordinate recovery efforts with the Recovery Team and involved parties (see *stakeholder involvement* below).

B. Information Management

Stakeholder Involvement Strategy: Early in the recovery planning process, we will hold a meeting of individuals working with GBCT to exchange status information and identify recovery issues. The information resulting from this discussion will help to shape the initial draft of the recovery plan. We will reach out to the above potential stakeholder groups to facilitate involvement of all interested parties. When needed, we will hold additional meetings and/or conference calls to discuss particular issues.

Development of recovery plans is a public process that includes several key opportunities to provide input, including commenting on the draft recovery plan. Stakeholders will be contacted to encourage their involvement in the plan development process.

Deputy Approve: _____ Date August 23, 2019
Regional Director, Region 6

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