Endangered Species Act - Section 7 Consultation

BIOLOGICAL OPINION
for
Effects to Bull Trout
and Designated Bull Trout Critical Habitat
from the
Helena-Lewis and Clark National Forest 2021 Forest Plan

(Land Resource Management Plan)

U.S. Fish and Wildlife Service Reference: 06E11000-2020-F-0443

Action Agency:	U.S. Forest Service Helena-Lewis & Clark National Forest Helena, Montana
Consultation Conducted by:	U.S. Fish and Wildlife Service Montana Ecological Services Office
Date Issued:	October 1, 2021

Table of Contents

List of Tables

List of Figures

Appendix Tables

I. Introduction

The Helena National Forest and Lewis and Clark National Forest were administratively combined in 2015 to form the Helena-Lewis and Clark National Forest (HLC Forest). Currently, each Forest has its own Land and Resource Management Plan, both completed in 1986, that is directing management on the separate parts of the combined HLC Forest. Combining the two Forests has created a need to develop a single Land and Resource Management Plan for the entire administrative area as well as updating management direction due to changes in social, economic, and ecological needs and new scientific information that has become available since the current plans were developed in 1986.

In their letter dated March 12, 2021, the HLC Forest requested formal consultation from the Service for a determination that their proposed Land and Resource Management Plan (2021 HLC Plan) *may affect and is likely to adversely affect* bull trout and designated bull trout critical habitat in some instances, even if the Plan's net effect is to improve conditions and contribute to the conservation and recovery of bull trout. This biological opinion analyzes effects to the threatened bull trout (*Salvelinus confluentus*) and designated bull trout critical habitat from implementing the 2021 HLC Forest Plan.

The 2021 HLC Forest Plan covers the entire HLC Forest, but bull trout only occur west of the continental divide on the Helena National Forest portion of the HLC Forest in the Blackfoot and Upper Clark Fork core areas of the Columbia Headwaters Recovery Unit. Designated critical habitat for bull trout on the HLC Forest only occurs within the portion of the Forest in the Blackfoot core area. Further description of the area of influence for the 2021 HLC Forest Plan is provided in **Section II**, below.

Current management strategy for bull trout on the HLC Forest is directed by the Inland Native Fish Strategy (INFISH; U.S. Forest Service 1995). INFISH was adopted to the Helena Forest Plan in July 1995 as an interim strategy designed to provide additional protection for existing populations of native trout, outside the range of anadromous fish, on 22 National Forests in the Pacific Northwest, Northern, and Intermountain Regions. INFISH does not provide management direction on the Helena National Forest east of the continental divide or the entire Lewis and Clark National Forest that were combined to form the Helena-Lewis and Clark National Forest.

INFISH was expected to be 18-month interim guidance to halt degradation caused by land management practices at that time and would be replaced by a decision document from the Interior Columbia Basin Ecosystem Management Project (ICBEMP). Although INFISH has been documented to be effective in protecting aquatic resources at a broad scale through ongoing PACFISH/INFISH biological opinion (PIBO) effectiveness monitoring (Meredith et al. 2011, Roper et al. 2019, U.S. Forest Service 2018), it lacked a clearly stated aquatic restoration goal as stated by the Service in its 1998 Biological Opinion for the INFISH amendment (U.S. Fish and Wildlife Service 1998a) that has yet to be formally adopted into a decision (U.S. Forest Service 2021).

The purpose of the plan is to guide management toward the attainment of long-term desired conditions and communicate the concepts of strategic guidance and adaptive management for the HLC Forest (U.S. Forest Service 2012). Rather than separate management direction where bull trout may occur, the 2021 HLC Forest Plan integrates management direction for bull trout and all other aquatic resources into plan components encompassing a single management direction for the entire HLC Forest. Analysis of effects in this biological opinion include effects to bull trout and designated bull trout critical habitat from the change in management strategy from INFISH to the 2021 HLC Forest Plan.

The U.S. Fish and Wildlife Service (Service) prepared this biological opinion in accordance with the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Section 7(b)(3)(A) of the Act requires that the Secretary of Interior issue biological opinions on federal agency actions that may affect listed species or critical habitat. Biological opinions determine if the action proposed by the action agency is likely to jeopardize the continued existence of listed species or destroy or adversely modify critical habitat. Section 7(b)(3)(A) of the Act also requires the Secretary to suggest reasonable and prudent alternatives to any action that is found likely to jeopardize the continued existence of listed species or result in an adverse modification of any designated critical habitat. If the Secretary determines "no jeopardy," then regulations implementing the Act (50 C.F.R. § 402.14) further require the Director to specify "reasonable and prudent measures" and "terms and conditions" necessary or appropriate to minimize the impact of any "incidental take" resulting from the action(s).

The Service based this biological opinion on our review of the revised biological assessment (BA) for the 2021 HLC Forest Plan (U.S. Forest Service 2021), additional information provided during consultation, and information in our files. This biological opinion only addresses impacts to federally listed bull trout and bull trout critical habitat. It does not address the overall environmental acceptability of the proposed action.

Consultation History: Significant events during the consultation period for this project are summarized below. A complete project file of this consultation is on file at the Helena, Montana office of the Service.

2018 - 2020: Early discussions on the 2021 HLC forest Plan occurred between the Forest and the Service

February 4, 2020: Written comments on a draft BA were provided to the HLC Forest.

March 13, 2020: The HLC Forest initiated formal consultation on bull trout and submitted a final BA to the Service.

July 2, 2020: Draft biological opinion was completed and reviewed internally by the Service.

July 24, 2020: Draft biological opinion was submitted to the HLC Forest for review.

September 2, 2020: The HLC Forest provided comments on the draft biological opinion.

March 12, 2021: The HLC Forest submitted a revised BA to the Service.

July 20, 2021: A draft revised biological opinion was submitted to the HLC Forest for review.

August 17, 2021: The acting Forest supervisor provided comments to the Service.

September 13, 2021: A draft revised biological opinion was submitted to the HLC Forest for review.

September 16-29, 2021: The USFS provided the Service with additional information stemming from their objection process; specifically the disposition of CWN and how prioritizations are made.

II. Description of the Proposed Action

The proposed action is the implementation of the 2021 HLC Forest Plan. The purpose of the plan is to guide management toward the attainment of long-term desired conditions and communicate the concepts of strategic guidance and adaptive management for the HLC Forest (U.S. Forest Service 2012). The 2021 HLC Forest Plan is a Federal *action* that approves a framework for the development of future *action(s)* that are authorized, funded, or carried out at a later time (50 CFR §402.02). Subsequent actions under the 2021 HLC Forest Plan would be addressed in separate section 7 consultations, as appropriate.

A. Action Area

Implementing regulations for the Act define *action area* as "all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action" (50 C.F.R. § 402.02). It is based upon the geographic extent of the physical, chemical, or biological effects to land, air, and waters resulting from the proposed action, including direct and indirect effects.

Located in central Montana, the HLC Forest extends over 150 miles north to south, 200 miles east to west, and encompasses approximately 2.9 million acres (U.S. Forest Service 2020). By definition (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1998), the action area for the 2021 HLC Forest Plan encompasses the entire 2.9 million acres of HLC Forest land east and west of the continental divide and adjacent lands where effects may occur. However, bull trout in the coterminous United States only occur west of the continental divide except for the Saint Mary headwaters in northwest Montana (U.S. Fish and Wildlife Service 2915). Effects to bull trout under management direction of the 2021 HLC Forest Plan would only occur on lands west of the continental divide.

Relative to aquatic ecosystems, management direction of the 2021 HLC Forest Plan may influence areas within the HLC Forest boundary and extend downstream. To account for effects extending beyond the immediate area involved in the action, twelve code hydrological unit code (HUC) boundaries are typically used to define the presence of bull trout, baseline conditions, and areas that directly or indirectly affect bull trout (e.g., U.S. Fish and Wildlife Service 1998, U.S. Forest Service 2013). Therefore, the action area for bull trout in this biological opinion is defined as any twelve code HUC west of the continental divide intersected by the HLC Forest boundary (Figure 1). Note that 12^{th} code HUCs are defined by 6^{th} level Hydrological Unit Boundaries and will be further referred to in this document as "HUC6 watersheds".

HLC Forest lands in the action area occur on the Helena and Lincoln Ranger Districts. For these lands, the HLC Forest has designated two Geographic Areas (GA; Figure 1) as management units (Upper Blackfoot GA and Divide GA) to direct management decisions towards different needs across the landscape and focus on specific circumstances in each geographic area. Designated critical habitat for bull trout occurs within the Upper Blackfoot GA (Figure 1). Approximately 94% of land within the two Geographic Areas is land managed by the HLC Forest (Table 1).

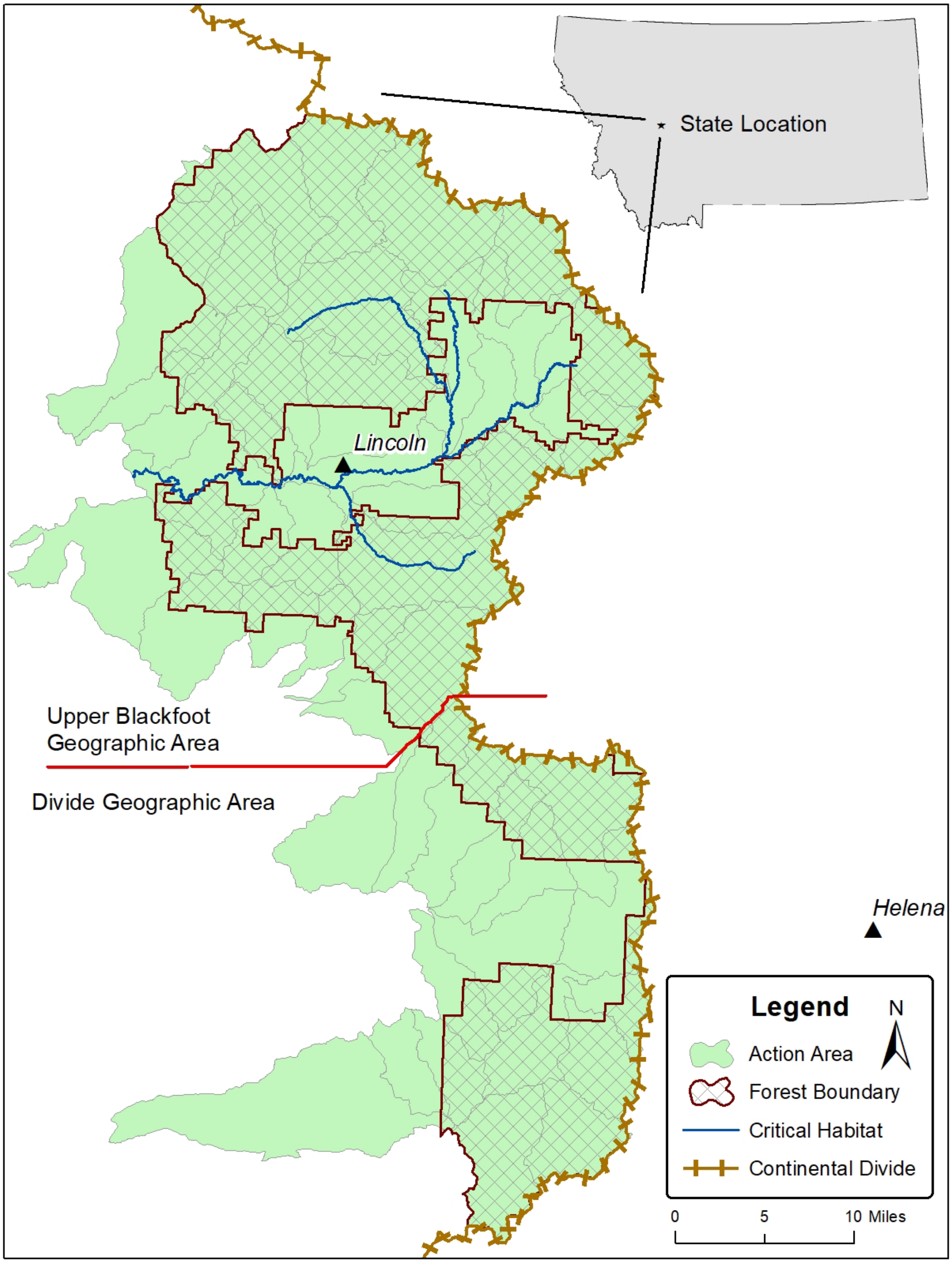

Figure 1. Bull trout action area defined by the intersection of the HLC Forest boundary with HUC6 watersheds and Geographic Units for the 2021 HLC Forest Plan.

Table 1. Ownership by acres and percent of HLC Forest land within the action area west of the Continental Divide.

Ownership	Acres	Percent
HLC Forest	396,803	94.3
Private	19,233	4.6
State	4,904	1.2
County	6	<0.0
City of Helena	6	<0.0
Water	28	<0.0
Total	420,980	100

B. Relationship of the Action Area to the Hierarchy of Bull Trout Analysis Units

1. Bull trout Demographic Units

The bull trout recovery plan considers a hierarchical order of demographic units extending from the entire range of bull trout within the coterminous United States down to designated local populations. This stepdown organization is important for implementing recovery, tracking consultation under section 7 of the Endangered Species Act, identifying and protecting critical habitat, and other aspects of planning and coordination.

Core areas represent the closest approximation of a biologically functioning unit for bull trout, containing habitat that could supply all elements for the long-term security of one or more local bull trout populations (U.S. Fish and Wildlife Service 2015). Designated local populations are considered the smallest group of fish that are known to represent an interacting reproductive unit. The combination of core habitat and a core population (one or more designated local bull trout populations that exist within core habitat) constitutes the basic unit on which to gauge recovery within a recovery unit. The hierarchical order of bull trout demographic units for the 2021 HLC Forest Plan action area is provided in Table 2.

2. Critical Habitat Units

The proposed action would occur in the Blackfoot River subunit of the Clark Fork River Basin Critical Habitat Unit (CHU 31). CHU 31 contains 5,356.0 km (3,328.1 mi) of streams and 119,620.1 ha (295,586.6 ac) of lakes and reservoirs designated as critical habitat. The unit is located in northwestern Montana and northern Idaho.

C. Elements of the 2021 HLC Forest Plan Relevant to Bull Trout

The 2021 HLC Forest Plan was developed in compliance with the 2012 National Forest System Land Management Planning rule (2012 Planning Rule; 36 CFR § 219) and all other applicable requirements.

1. 2012 Planning Rule Required Components

Forest Plans require five specific components (desired conditions, objectives, standards, guidelines, and suitability of areas). The BA (Appendix B, page 59-61) provides a list of these Plan components as they relate to bull trout. Definitions of these required elements under the 2012 Planning Rule (36 CFR 219.7(e)) and their implementation in the 2021 HLC Forest Plan relative to bull trout are provided below.

Desired Conditions

A desired condition is a description of specific social, economic, and/or ecological characteristics of the plan area, or a portion of the plan area, toward which management of the land and resources should be directed. Desired conditions must be described in terms that are specific enough to allow progress toward their achievement to be determined but must not include completion dates (36 CFR 219.7(e)(1)(i)).

Desired conditions on the HLC Forest relative to bull trout are described in the BA (U.S. Forest Service 2021) as:

> *The intent of these desired conditions is to create a proactive commitment to the recovery of bull trout within the Helena-Lewis and Clark National HLC Forest. These desired conditions make the commitment to implement the 2015 Bull Trout Recovery Plan. Making bull trout recovery a focus is the most effective way to benefit bull trout and minimize adverse effects due to ongoing management*.

The HLC Forest expresses their commitment to achieve these desired conditions under the 2021 HLC Forest Plan for the Divide (DI-FAH-DC-02) and Upper Blackfoot geographic areas (UB-FAH-DC-02) as follows. Note that the "Bull Trout Conservation Strategy" in the following desired condition, other plan components, and this biological opinion refers to the document *Conservation Strategy for Bull Trout on USFS lands in Western Montana* (U.S. Forest Service 2013).

> *The bull trout population trends towards recovery and is supported through the Bull Trout Conservation Strategy, the Bull Trout Recovery Plan, and the Columbia Headwaters Recovery Unit Implementation Plan or the latest guiding documents.*

Table 2. Hierarchy of bull trout demographic units for the 2021 HLC Forest Plan.

Bull Trout Analysis Metric	Hierarchical Relationship
Coterminous United States (DPS)	Range of bull trout
Columbia Headwaters Recovery Unit	One of 6 Recovery Units in the range of the species within the coterminous United States
Upper Clark Fork Geographic Region	One of 5 Geographic Regions in the Columbia Headwaters Recovery Unit
Blackfoot River Core Area and Upper Clark Fork (Section 1) Core Area	Two of 7 Core Areas in the Upper Clark Fork Geographic Region
Landers Fork, North Fork Blackfoot Monture Cottonwood Belmont, Gold), Warm Springs Twin Lakes, and Boulder Designated Local Populations	9 Local Populations designated by the 2015 recovery plan occur within these two core areas
Landers Fork (Copper Creek and Lower Landers Fork HUC6 watersheds)	1 designated Local Population in the HLC Forest Action Area
Poorman, Blackfoot River-Anaconda Creek, Blackfoot River-Hardscrabble Creek, Lower Landers Fork, Blackfoot River-Lincoln, Arrastra, Blackfoot River-Little Moose Creek, Lower Alice, Hogum Creek, Headwaters of Nevada Creek, Larabee Gulch, Hat Creek, Ontario Creek, Mineral Creek, Meadow Creek	15 HUC6 watersheds designated as "other remnant populations" by the HLC Forest Service within these two core areas (see page 10 for designation criteria)

Objectives

An objective is a concise, measurable, and time-specific statement of a desired rate of progress toward a desired condition or conditions. Objectives should be based on reasonably foreseeable budgets (36 CFR 219.7(e)(1)(ii)).

Although the 2021 HLC Forest Plan does not include Objectives specific to bull trout or the geographic areas occupied by bull trout, many Forest-wide desired conditions for other resources (e.g., watersheds, riparian management zones, fisheries and aquatic habitat, conservation watershed networks) provide descriptions of desired ecological characteristics that are beneficial towards bull trout recovery. The following Forest-wide objectives, especially the first two directed towards the CWN, are most relative in meeting desired conditions towards recovery of bull trout in the Divide and Upper Blackfoot geographic areas.

FW-CWN-OBJ-01: Repair 2 road/stream crossings every five years at locations where chronic sediment sources are found (for example, up-size culverts, reduce sediment delivery to waterways from roads, realign stream constraining road segments, improve livestock stream crossings and trailing, etc.). Give precedence to priority watersheds.

FW-CWN-OBJ-02: Stormproof at least 15% percent of the roads in the conservation watershed network prioritized for restoration to benefit threatened, endangered, proposed, and candidate aquatic species, aquatic species of conservation concern, and municipal watersheds.

FW-RMZ-OBJ-01: Improve at least 500 acres of riparian habitat during the life of the HLC Forest plan. Improvement can be actions such as, but are not limited to, road obliteration, riparian planting, and reconstructing floodplains by removing road prisms or berms.

FW-FAH-OBJ-01: Improve the habitat quality and hydrologic function of at least 20 miles of aquatic habitat during the life of the plan, focusing on streams with listed species or species of conservation concern. Activities include, but are not limited to, berm removal, large woody debris placement, road decommissioning or stormproofing, riparian planting, and channel reconstruction.

FW-FAH-OBJ-03: Reconnect at least 10 miles of habitat in streams disconnected by roads or culverts where aquatic and riparian-associated species' migratory needs are limiting distribution of those species during the life of the plan.

FW-RT-OBJ-01: Decommission or place into storage (maintenance level 1) at least 50 miles of roads. Priorities shall include roads causing resource damage in priority watersheds and/or where roads chronically fail.

FW-RT-OBJ-02: Complete at least 100 miles of reconstruction or road improvement projects. Priorities shall include reducing effects on: desired aquatic and riparian conditions from chronic sediment delivery or potential future road prism failures, and conservation watershed networks that have westslope cutthroat or bull trout habitats.

As broad statements of intent typically related to process or interactions with the public, Goals are not required and do not include completion dates. However, the 2021 HLC Forest Plan includes the following two goals specifically related to bull trout.

FW-FAH-GO-01: Work with Montana Fish, Wildlife, and Parks to contribute to the expansion of core populations of bull trout as outlined in the Bull Trout Conservation Strategy (or the latest guiding document).

DI-FAH-GO-01and **UB-FAH-GO-01**: Bull trout population recovery is supported through the Bull Trout Conservation Strategy, the Bull Trout Recovery Plan, and the Columbia Headwaters Recovery Unit Implementation Plan or the latest guiding documents through cooperation and coordination with the USFWS, tribes, state agencies, other federal agencies, and interested groups.

Standards

A standard is a mandatory constraint on project and activity decision-making, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (36 CFR 219.7(e)(1)(iii)). Appendix A Table A1 provides standards related to management of bull trout, as identified in the BA (U.S. Forest Service 2021). Standards will be addressed as they relate to their intended management activities.

Guidelines

A guideline is a constraint on project and activity decision-making that allows for departure from terms of the guideline, as long as the purpose of the guideline is met. Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (36 CFR 219.7(e)(1)(iv)). Appendix A Table A1 provides all guidelines related to management of bull trout, as identified in the BA (U.S. Forest Service 2021). Guidelines will be addressed as they relate to their intended management activities.

Suitability of Lands

Specific lands within the HLC Forest are identified as suitable for various multiple uses or activities based on the desired condition applicable to those lands. The plan identifies lands within the HLC Forest as not suitable for uses that are not compatible with desired conditions for those lands. The suitability of lands is not identified for every use or activity. Suitability identifications may be made after consideration of historic uses and of issues that have arisen in the planning process. Every plan must identify those lands that are not suitable for timber production (§ 219.11). (36 Code of Federal Regulations 219.7(e)(1)(v)). In part, the Suitability of Lands component identifies lands within the HLC Forest as not suitable for uses that are not compatible with desired conditions for those lands. The 2021 HLC Forest Plan provides one Suitability of Lands component influential towards bull trout:

FW-RMZ-SUIT-01: RMZs are not suitable for timber production, but harvest for other multiple use values is allowed as appropriate under the RMZ plan components.

Priority Watersheds

The Planning Rule requires land management plans to identify watershed(s) that are a priority for maintenance or restoration (36 Code of Federal Regulations 219.7(f)(i). Under the 2012 Planning Rule, the Forest Service 2011 national Watershed Condition Framework (WCF) must be used in all plan revisions for identifying priority watersheds unless the Responsible Official coordinates with the Washington Office, Director, Watershed, Fish, Wildlife, Air & Rare Plants staff, provides written justification, and obtains concurrence from the Regional Forester for using an alternate approach (FSH 1909.12, chapter 20, section 22.31).

WCF provides a comprehensive approach composed of six steps; (a) classify watershed condition, (b) prioritize watersheds for restoration, (c) develop watershed restoration action plans, (d) implement integrated projects, (e) track restoration accomplishments, and, (f) verify and monitor watershed condition class (U.S. Forest Service 2011). All HUC6 watersheds on U.S. Forest Service (USFS) lands were classified using the national watershed condition framework in 2011 (2021 HLC Forest Plan, Appendix E).

The 2021 HLC Forest Plan designates four "Priority Watersheds" (as explicitly defined by the USFS Land Management Planning Handbook, FSH 1909, Section 22.31). One of them is west of the continental divide and of significance to bull trout (Telegraph Creek in the Divide GA of the Plan); it is located in the Little Blackfoot bull trout core area, but bull trout are thought to be extirpated. The three others (Headwaters Sheep Creek, Cabin Gulch, Upper Tenmile) are east of the continental divide in the Missouri River Drainage and are not in bull trout range. Future "priority watersheds" as defined above will be determined throughout the life of the plan, usually on a 10-year rotation (2020 HLC Forest Plan, Appendix E), changes in designation of priority watersheds can occur as conditions require.

Bull trout are given additional consideration and prioritization in designated Conservation Watershed Network waters and other plan components described below.

Monitoring Program

In addition to the five required components above, the proposed action also includes a monitoring program in accordance with the 2012 planning rule (36 CFR 219.12(a1). Monitoring information should enable the HLC Forest to determine if a change in plan components or other plan content that guide management of resources on the plan area may be needed. The plan monitoring program sets out the plan monitoring questions and associated indicators. Monitoring questions and associated indicators must be designed to inform the management of resources on the plan area, including by testing relevant assumptions, tracking relevant changes, and measuring management effectiveness and progress toward achieving or maintaining the plan's desired conditions or objectives. Each plan monitoring program must contain one or more monitoring questions and associated indicators addressing the status of a select set of the ecological conditions required under §219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern (36 CFR 219.12(a)(5)(iv). The HLC Forest shall conduct a biennial evaluation of new information gathered through the plan monitoring program and relevant information from the broader scale strategy and shall issue a written report of the evaluation and make it available to the public (36 CFR 219.12(d)(1). Appendix A Table A2 contains a summary table of the monitoring program for aquatic ecosystems in the 2021 HLC Forest Plan. Additional information on the monitoring plan and adaptive management is available in Appendix B of the 2021 HLC Forest Plan.

As such, the Service will adopt the results of Forest Plan monitoring in partial fulfillment of the reporting requirements for this BO.

2. 2012 Planning Rule Optional Components

Goals

A plan may include goals as plan components. Goals are broad statements of intent, other than desired conditions, usually related to process or interaction with the public. Goals are expressed in broad, general terms, but do not include completion dates. (36 Code of Federal Regulations 219.7(e)(2)). Appendix A Table A1 identifies all goals related to management of bull trout, as identified in the BA (U.S. Forest Service 2021). Of particular significance to bull trout, the goals for the Divide Geographic Area (DI-FAH-GO-01) and Upper Blackfoot Geographic Area (UB-FAH-GO-01) emphasize cooperation and coordination to help recover bull trout as identified in desired conditions DI-FAH-DC and UB-FAH-DC 01 and 02.

3. Forest Service Regional Requirements

Conservation Watershed Networks (CWN)

The Northern Region of the Forest Service requires the identification of conservation watersheds, collectively known as conservation watershed networks (CWN) as a requirement of

Forest plans. The purpose of the CWN is to create a network of watersheds where management helps support the maintenance and recovery of aquatic at risk and listed species (U.S. Forest Service 2021). They are considered native fish strongholds with appropriately functioning aquatic habitats that are intended to protect stronghold populations of native salmonids and complement restoration efforts. CWN watersheds are designated HUC5 or HUC6 watersheds based on direction in the ICBEMP Framework (ICBEMP 2014). ICBEMP also summarized the best available information that led to a framework for amending Forest plans.

The main difference between WCF priority watersheds and CWN watersheds is that CWN watersheds help support maintenance and recovery of aquatic species while WCF "priority watersheds" concentrate restoration activities with the explicit goal of maintaining or improving conditions of the entire watershed but are not necessarily related to the support of aquatic species. The CWN designation alone will not direct any management action but instead allows for the identification of priority restoration within a project area boundary. CWN watersheds containing bull trout receive the highest priority for these restoration actions (2021 HLC Forest Plan, Appendix E). Emphasis on bull trout for restoration in CWN watersheds is carried forward in plan components, including Objective FW-CWN-OBJ-01 which states:

> *Repair at least two road/stream crossings every five years at locations where chronic sediment sources are found (for example, up-size culverts, reduce sediment delivery to waterways from roads, realign stream constraining road segments, improve livestock stream crossings and trailing, etc.). Give precedence to bull trout watersheds.*

The 2021 HLC Forest Plan identifies 91 CWN watersheds east and west of the continental divide. In addition to watersheds where the Service has designated "local populations" of bull trout occurring (U.S. Fish and Wildlife Service 2015, 2015a) or Service data indicates bull trout may be present, the HLC Forest delineated "other remnant populations" of bull trout as part of the CWN. "Other remnant populations" of bull trout were defined by the following criteria (U.S. Forest Service 2021):

- *(a) a known patch in a sub-watershed that has been surveyed and found to have bull trout eDNA present, or,*
- *(b) a sub-watershed where bull trout are known to have occurred historically and are now extirpated, the habitat patch has to have a reasonable likelihood to support bull trout in 2040 under a moderate warming scenario, and the cause for extirpation should be a factor that could be remedied by restoration, such as barrier removal or channel reconnection, or,*
- *(c) identified as critical habitat.*

Table 3 identifies 16 watersheds within the action area that are included in the CWN of the 2021 HLC Forest Plan and their basis for inclusion. At least 27% of the land is managed by the HLC Forest in all watersheds (Table 3). One additional HUC6 watershed in the action area (Humbug Creek with 20% of the land under HLC Forest management) also contains designated critical habitat but was not included in the CWN.

Bull trout are not present in four of the HUC6 watersheds in the CWN; they have been extirpated from Nevada Creek Headwaters and have never been documented in three headwater watersheds that are located in the Scapegoat Wilderness Area (East Fork North Fork Blackfoot, Meadow Creek, and Mineral Creek). However, the Climate Shield model (Isaak et al. 2017) predicts the persistence of cold water in these four HUC6 watersheds.

D. Replacement of the INFISH Aquatic Conservation Strategy

In keeping with the 2021 planning rule [§ 219.8(a)], the 2021 HLC Plan includes plan components, such as standards or guidelines, to maintain or restore the ecological integrity of aquatic ecosystems and watersheds in the plan area, and to maintain or restore their structure, function, composition, and connectivity (U.S. Forest Service 2012). Collectively, these components are referred to as the "aquatic conservation strategy". The HLC Forest currently uses the INFISH amendment to the Helena Forest Plan as the aquatic conservation strategy for the management of bull trout watersheds west of the continental divide and a separate aquatic conservation strategy for the management of other watersheds. The proposed action replaces these separate aquatic conservation strategies with a single aquatic conservation strategy applicable to the management of all aquatic resources across the entire HLC Forest.

E. Applicability to Existing Consultations and Ongoing Projects

Some programmatic and project-level section 7 consultations for bull trout have occurred on the HLC Forest and would remain active upon implementation the 2021 HLC Forest Plan and this associated BO. Bull trout do not occur on the former Lewis and Clark National Forest portion of the combined HLC Forest; therefore, all of these affected consultations occur on the former Helena National Forest portion of the combined HLC Forest.

This biological opinion only supersedes the existing biological opinion for the 1986 Helena Forest Plan, as amended by INFISH (U.S. Fish and Wildlife Service 1998a) and the 2018 biological opinion *Effects of Ongoing U.S. Forest Service Implementation of 26 Land Resource Management Plans, as Amended by Five Aquatic Conservation Strategies, on the Threatened Bull Trout (Salvelinus confluentus) and Bull Trout Critical Habitat in Oregon, Washington, Idaho, Montana* (U.S. Fish and Wildlife Service 2018). Ongoing projects that have completed consultation prior to signing the record of decision for the 2021 HLC Forest Plan and programmatic consultations that would not be superseded by this biological opinion are part of the baseline in this biological opinion. They are discussed in **Section VI, Environmental Baseline**.

F. Term of the Proposed Action

As defined in the 2012 Planning Rule, the 2021 HLC Forest Plan is intended to provide management direction for approximately 15 years.

Table 3. CWN watersheds delineated by the 2021 HLC Forest Plan in the action area with percent land under Forest management and their basis for inclusion in the CWN.

Name (Last 4-Digits of HUC Code)	% Forest Management	Basis for Inclusion in CWN
Divide Geographic Area		
Little Blackfoot-Larabee Gulch (0502)	100	Bull trout eDNA present
Ontario Creek (0501)	99	Bull trout eDNA present
Little Blackfoot-Hat Creek (0507)	68	Bull trout eDNA present
Upper Blackfoot Geographic Area		
Copper Creek (0103)	97	FWS designated as local population
Lower Landers Fork (0104)	36	FWS designated as local population
Poorman Creek (0302)	92	Bull trout may be present
Arrastra Creek (0309)	58	Bull trout may be present
Hogum Creek (0205)	90	Bull trout may be present
Lower Alice Creek (0204)	60	Bull trout may be present
Blackfoot-Little Moose Crk (0310)	45	Bull trout may be present and mainstem critical habitat
Blackfoot-Hardscrabble Crk (0206)	27	Bull trout may be present and mainstem critical habitat
Blackfoot-Anaconda Creek (0202)	77	Bull trout may be present and mainstem critical habitat
Nevada Creek Headwaters (0401)	71	Bull trout extirpated but predicted persistence of cold water
East Fork North Fork Blackfoot (0603)	100	No occurrence of bull trout but predicted persistence of cold water
Meadow Creek (0601)	100	No occurrence of bull trout but predicted persistence of cold water
Mineral Creek (0602)	100	No occurrence of bull trout but predicted persistence of cold water

III. Status of Bull trout and Designated Critical Habitat

A. Species Status

1. Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (U.S. Fish and Wildlife Service 1999, 64 FR 58910). The 1999 final listing rule consolidated five disjunct and geographically isolated Distinct Population Segments (DPS) into one listed taxon for purposes of consultation under Section 7 of the Endangered Species Act (Act), but recognition of each DPS was maintained by treating each DPS as an interim recovery unit until an approved recovery plan was developed. Based on new information that confirmed a need to ensure a resilient, redundant, and representative distribution of bull trout populations throughout the range of the listed entity, six draft recovery units were identified (U.S. Fish and Wildlife Service 2010, 75 FR 63898). The final bull trout recovery plan (U.S. Fish and Wildlife Service 2015) formalized these six recovery units.

2. Reasons for Listing and Emerging Threats

The 1999 final rule identified threats to bull trout throughout its range from the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality; incidental angler harvest; entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels; and introduced non-native species (U.S. Fish and Wildlife Service 1999, 64 FR 58910). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats. The final recovery plan (U.S. Fish and Wildlife Service 2015) and associated recovery unit implementation plans (RUIP) (U.S. Fish and Wildlife Service 2015a-f) further identified primary threats affecting bull trout as historic habitat loss and fragmentation, interaction with non-native species, and fish passage.

The 2015 recovery plan also summarized the threat of climate change and acknowledged that some extant bull trout core area habitats will likely change (and may be lost) over time due to anthropogenic climate change effects (U.S. Fish and Wildlife Service 2015, U.S. Fish and Wildlife Service 2015a-f). Mote et al. (2014) summarized climate change effects to include rising air temperature, changes in the timing of streamflow related to changing snowmelt, increases in extreme precipitation events, lower summer stream flows, and other changes. A warming trend in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, reduce summer stream flows, and increase summer water temperatures (Poff et al. 2002, Nelson and Palmer 2007, Koopman et al. 2009). Lower flows as a result of smaller snowpack could reduce habitat, which might adversely affect bull trout reproduction and survival. Warmer water temperatures could lead to physiological stress and could also benefit non-native fishes that prey on or compete with bull trout. Increases in the number and size of forest fires could also result from climate change (Westerling et al. 2006) and could adversely affect watershed function by resulting in faster runoff, lower base flows during the summer and fall, and increased sedimentation rates. Lower flows also may result in increased groundwater withdrawal for agricultural purposes and resultant reduced water availability in certain stream reaches occupied by bull trout (U.S. Fish and Wildlife Service 2015c).

Although all salmonids are likely to be affected by climate change, bull trout are especially vulnerable given that spawning and rearing are constrained by their location in upper watersheds and the requirement for cold water temperatures (Battin et al. 2007, Rieman et al. 2007). Climate change is expected to reduce the extent of cold-water habitat (Isaak et al. 2015), and increase competition with other fish species (e.g., lake trout, brown trout, brook trout, and northern pike) for resources in remaining suitable habitat. Several authors project that brook trout, a fish species that competes for resources with and predates on the bull trout, will continue increasing their range in several areas (an upward shift in elevation) due to the effects from climate change (e.g., warmer water temperatures) (Wenger et al. 2011, Isaak et al. 2010, 2014, Peterson et al. 2013).

3. Conservation Status and Needs

The 2015 recovery plan for bull trout established the primary strategy for recovery of bull trout in the coterminous United States as: (1) conserve bull trout so that they are geographically widespread across representative habitats and demographically stable in six recovery units; (2) effectively manage and ameliorate the primary threats in each of six recovery units such that bull trout are not likely to become endangered in the foreseeable future; (3) build upon the numerous and ongoing conservation actions implemented on behalf of bull trout since their listing in 1999, and improve our understanding of how various threat factors potentially affect the species; (4) use that information to work cooperatively with our partners to design, fund, prioritize, and implement effective conservation actions in those areas that offer the greatest long-term benefit to sustain bull trout and where recovery can be achieved; and (5) apply adaptive management principles to implementing the bull trout recovery program to account for new information (U.S. Fish and Wildlife Service 2015).

To implement the recovery strategy, the 2015 recovery plan establishes four categories of recovery actions for each of the six Recovery Units (U.S. Fish and Wildlife Service 2015):

1. Protect, restore, and maintain suitable habitat conditions for bull trout.

2. Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity.

3. Prevent and reduce negative effects of non-native fishes and other non-native taxa on bull trout.

4. Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change.

The 2015 bull trout recovery plan considers a hierarchical order of demographic units extending from the entire range of bull trout within the coterminous United States down to "designated local populations". A "designated local population" is a group of bull trout that spawn within a particular stream or portion of a stream and is considered to be the smallest group of fish that is known to represent an interacting reproductive unit system (U.S. Fish and Wildlife Service 2015). For most waters where specific information is lacking, a designated local population may be represented by a single headwater tributary or complex of headwater tributaries. Gene flow may occur between designated local populations (e.g., those within a core population), but is assumed to be infrequent compared to gene flow within a designated local population. Generally smaller, more adjunct resident populations of bull trout that do not meet the criteria as designated local populations by the U.S. Fish and Wildlife Service may also occur within watersheds.

Core areas represent the closest approximation of a biologically functioning unit for bull trout, containing habitat that could supply all elements for the long-term security of one or more local bull trout populations (U.S. Fish and Wildlife Service 2015). The combination of core habitat and a core population (one or more designated local bull trout populations that exist within core habitat) constitutes the basic unit on which to gauge recovery within a recovery unit.

Each of the six recovery units contain multiple bull trout core areas, 116 total, which are non-overlapping watershed-based polygons, each including one or more designated local populations. Currently there are 109 occupied core areas, which comprise 611 designated local populations (U.S. Fish and Wildlife Service 2015). There are also six core areas where bull trout historically occurred but are now extirpated, and one research needs area where bull trout were known to occur historically, but their current presence and use of the area are uncertain (U.S. Fish and Wildlife Service 2015).

Core areas can be further described as complex or simple (U.S. Fish and Wildlife Service 2015). Complex core areas contain multiple local bull trout populations, are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat (SR) and foraging, migration, and overwintering habitats (FMO). Simple core areas are those that contain one bull trout designated local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genetic or life history adaptations.

This stepdown organization is important for implementing recovery, tracking consultation under section 7 of the Endangered Species Act, identifying and protecting critical habitat, and other aspects of planning and coordination. A viable recovery unit should demonstrate that the three primary principles of biodiversity have been met: representation (conserving the genetic makeup of the species); resiliency (ensuring that each population is sufficiently large to withstand stochastic events); and redundancy (ensuring a sufficient number of populations to withstand catastrophic events) (U.S. Fish and Wildlife Service 2015).

4. Life History and Population Dynamics

Life history and population dynamics for bull trout are provided in Appendix B.

B. Critical Habitat

1. Legal Status

Subsequent to litigation in 2005, the Service published a proposed critical habitat rule on January 14, 2010 (U.S. Fish and Wildlife Service 2010, 75 FR 2270) and a final rule on October 18, 2010 (U.S. Fish and Wildlife Service 2010a, 75 FR 63898). The rule became effective on November 17, 2010. A justification document supporting the rule is available on our website (http://www.fws.gov/pacific/bulltrout).

Critical habitat does not include: (1) waters adjacent to non-federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended (Act), in which bull trout is a covered species on or before the publication of the final rule; (2) waters within or adjacent to

Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or (3) waters where impacts to national security have been identified (U.S. Fish and Wildlife Service 2010a, 75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant text, as identified in paragraphs (e)(8) through (e)(41) of the final rule. It is important to note that the exclusion of water bodies from designated critical habitat does not negate or diminish their importance for bull trout conservation. Because exclusions reflect the often-complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

The final rule designating critical habitat for bull trout uses the term Primary Constituent Element (PCE). The new critical habitat regulations (CFR 402.01 and 402.12) eliminated the term PCE and use the Act's phrase Physical or Biological Features (PBF). The change does not alter the approach used in conducting a ''destruction or adverse modification'' analysis. In this biological opinion, we maintain the use of the term PCE as identified in the final rule for designated bull trout critical habitat.

2. Conservation Role and Description of Critical Habitat

The Service designated reservoirs/lakes and stream/shoreline miles in 32 critical habitat units (CHU) across the species' coterminous range as bull trout critical habitat (Table 4). In addition to occupied critical habitat, approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat were designated to address bull trout conservation needs in specific geographic areas not occupied at the time of listing. Using the best available scientific information, the Service determined unoccupied areas were essential for restoring functioning migratory bull trout populations. Unoccupied areas often include lower mainstem river environments that can provide seasonally important migration habitat for reestablishing bull trout in currently unoccupied areas.

In determining areas to propose as critical habitat, the Service considered the physical and biological features that are essential to the conservation of bull trout that may require special management considerations or protection. These features are the PCEs laid out in the appropriate quantity and spatial arrangement for conservation of the species. The PCEs for bull trout are habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering (U.S. Fish and Wildlife Service 2010a, 75 FR 63898). Designated bull trout critical habitat is of two primary use types: (1) spawning and rearing; and (2) foraging, migrating, and overwintering (FMO).

The conservation role of bull trout critical habitat is to support viable core area populations (U.S. Fish and Wildlife Service 2010a, 75 FR 63943). The core areas reflect the metapopulation structure of bull trout and are the closest approximation of a biologically functioning unit for the purposes of recovery planning and risk analyses. CHUs generally encompass one or more core areas and may include FMO habitat outside of core areas that are important to the survival and recovery of bull trout.

The primary function of individual CHUs is to maintain and support core areas, which (1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993), (2) provide for persistence of strong designated local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, Rieman and McIntyre 1993); (3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (MBTSG 1998, Rieman and McIntyre 1993); and (4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (MBTSG 1998, Rieman and Allendorf 2001, Rieman and McIntyre 1993.

The condition of bull trout critical habitat varies across the range from poor to good. There is widespread agreement in the scientific literature that past and present human activities contribute to the degradation of bull trout. The primary land and water management activities impacting the physical and biological features essential to the conservation of bull trout include timber harvest and road building, agriculture and agricultural diversions, livestock grazing, dams, mining, urbanization and residential development, and non-native species presence or introduction (Wildlife Service. 2010, 75 FR 2282). Effects of land and water management activities include:

1. Fragmentation and isolation of local populations due to the proliferation of dams and water diversions that have eliminated habitat, altered water flow and temperature regimes, and impeded migratory movements (Dunham and Rieman 1999, Rieman and McIntyre 1993).

2. Degradation of spawning and rearing habitat in upper watershed areas, especially alterations in sedimentation rates and water temperature from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, MBTSG 1998).

3. The introduction and spread of non-native fish, particularly brook trout and lake trout, due to fish stocking and degraded habitat conditions. Non-native fish compete with bull trout for limited resources and, in the case of brook trout, hybridize with bull trout (Leary et al. 1993, Rieman et al. 2006).

4. In the Coastal-Puget Sound region where amphidromous bull trout occur, degradation of mainstem river FMO habitat, and the degradation and loss of marine nearshore foraging and migration habitat due to urban and residential development.

5. Degradation of FMO habitat from reduced prey base, roads, agriculture, development, and dams.

Over a period of decades, climate change may exacerbate habitat degradation both physically (e.g., decreased base flows, increased water temperatures) and biologically (e.g., increased competition with non-native fishes). Climate change also directly threaten the integrity of the essential physical or biological features described in PCEs 1,2, 3, 5, 7, 8, and 9. Protecting bull trout strongholds and cold water refugia from disturbance and ensuring connectivity among populations were important considerations in addressing this potential impact. Therefore, one objective for delineating critical habitat was to identify and protect habitats that provide resiliency for bull trout in the face of climate change.

Table 4. Stream/shoreline distance and area of reservoir/lake designated as bull trout critical habitat by state.

	Stream/Shoreline Distance		Reservoir/Lake Area	
	Miles	Kilometers	Acres	Hectares
Idaho	8,771.6	14,116.5	170,217.5	68,884.9
Montana	3,056.5	4,918.9	221,470.7	89,626.4
Nevada	71.8	115.6	--	--
Oregon	2,835.9	4,563.9	30,255.5	12,244.0
Oregon/Idaho	107.7	173.3	--	
Washington	3,793.3	6,104.8	66,308.1	26,834.0
Washington (marine)	753.8	1,213.2	--	--
Washington/Idaho	37.2	59.9	--	--
Washington/Oregon	301.3	484.8	--	--
Total	19,729.0	31,750.8	488,251.7	197,589.2

IV. Analytical Framework for Jeopardy and Adverse Modification Determinations

Effects to the species and/or designated critical habitat from programmatic direction that has not been consulted on are not included in the jeopardy or adverse modification determination. In situations where programmatic consultation has been completed for one but not the other, this biological opinion provides an independent analysis for the species or designated critical habitat that does not rely on effects of the programmatic consultation to the other.

A. Jeopardy Determination

In accordance with policy and regulation, the jeopardy *analysis* in this biological opinion relies on four components:

1. The *Status of the Species*, which evaluates the bull trout's range-wide condition, the factors responsible for that condition, and its survival and recovery needs.
2. The *Environmental Baseline*, which evaluates the condition of the bull trout in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the bull trout.
3. The *Effects of the Action*, which are all consequences to bull trout or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action.
4. *Cumulative Effects*, which evaluates the effects of future, non-federal activities reasonably certain to occur in the action area on the bull trout.

In accordance with policy and regulation, the jeopardy *determination* is made by evaluating the effects of the proposed federal action in the context of the bull trout's current status, taken together with the environmental baseline and cumulative effects, to determine if implementation of the proposed action is likely to jeopardize the continued existence of bull trout. Regulations for section 7 (50 CFR 402) define “jeopardize the continued existence of” as “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species.” In the context for this determination, the Endangered Species Consultation Handbook (Handbook; U.S. Fish and Wildlife Service. National Marine Fisheries Service, 1998) defines “survival” and “recovery” as:

> *Survival* - For determination of jeopardy/adverse modification: the species' persistence as listed or as a recovery unit, beyond the conditions leading to its endangerment, with sufficient resilience to allow for the potential recovery from endangerment. Said another way, survival is the condition in which a species continues to exist into the future while retaining the potential for recovery. This condition is characterized by a species with a sufficient population, represented by all necessary age classes, genetic heterogeneity, and number of sexually mature individuals producing viable offspring, which exists in an environment providing all requirements for completion of the species' entire life cycle, including reproduction, sustenance, and shelter. [Clarification of usage]

> *Recovery* - Improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act (50 CFR 402.02).

Recovery Units (RU) for the bull trout were defined in the final Recovery Plan for the Coterminous United States Population of [the] Bull Trout (U.S. Fish and Wildlife Service 2015). Pursuant to Service policy, when a proposed federal action impairs or precludes the capacity of a RU from providing both the survival and recovery function assigned to it, that action may represent jeopardy to the species. When using this type of analysis, the biological opinion describes how the proposed action affects not only the capability of the RU, but the relationship of the RU to both the survival and recovery of the listed species as a whole.

The jeopardy analysis for the bull trout in this biological opinion considers the relationship of the action area and affected core areas (discussed below under the Status of the Species section) to the RU and the relationship of the RU to both the survival and recovery of the bull trout as a whole as the context for evaluating the significance of the effects of the proposed federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Within the above context, the Service also considers how the effects of the proposed federal action and any cumulative effects would impact bull trout local and core area populations in determining the aggregate effect to the RU(s). Generally, if the effects of a proposed federal action, taken together with cumulative effects, are likely to impair the viability of a core area population(s) such an effect is likely to impair the survival and recovery function assigned to a RU(s) and may represent jeopardy to the species (70 C.F.R. 56258).

B. Adverse Modification Determination

The adverse modification analysis in this biological opinion relies on four components: (1) The status of critical habitat, which evaluates the condition of critical habitat that has been designated for the species in terms of physical or biological features, the factors responsible for that condition, and the intended conservation role of the critical habitat overall; (2) the environmental baseline, which evaluates the current condition of the critical habitat in the action area, the factors responsible for that condition, and the relationship of the affected critical habitat in the action area to the entire critical habitat with respect to the conservation of the listed species; (3)

the effects of the action, which includes the direct and indirect effects of the action (and the effects of any interrelated or interdependent activities) and describes how those effects alter the value of critical habitat within the action area; and (4) cumulative effects (as defined at 50 C.F.R. § 402.02), which evaluates the effects of future, non-federal activities in the action area and describes how those effects are expected to alter the value of critical habitat within the action area.

For purposes of the adverse modification determination, the effects of the proposed federal action on bull trout critical habitat are evaluated in the context of the range-wide condition of the critical habitat, together with any cumulative effects, to determine if the critical habitat range-wide would remain functional (or would retain the current ability for the PCE to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the bull trout.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of bull trout critical habitat, especially in terms of maintaining and/or restoring habitat conditions that are necessary to support viable core area populations, and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

V. Analytical Framework for the Environmental Baseline and Effects of the Action

This section describes the analytic framework and methods used for analysis in this biological opinion

A. Indicators of Baseline Habitat Conditions and Effects to Habitat and Species

The Service developed *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale* (Matrix of Indicators) to specifically facilitate and standardize determinations of effects to bull trout for Endangered Species Act conferences, consultations, and permits (U.S. Fish and Wildlife Service 1998). Since its inception, the Matrix of Indicators has formed the backbone for bull trout consultation; use of the Matrix of Indicators or a similar approach is specified as a reasonable and prudent measure in the biological opinion implementing INFISH into land management plans (U.S. Fish and Wildlife Service 1998a), the bull trout recovery plan (U.S. Fish and Wildlife Service 2015) acknowledges the use of the Matrix of Indicators for Section 7 consultation, and assemblages of indicators from the Matrix of Indicators are used to fully describe all physical or biological feature of the PCEs of bull trout critical habitat (Appendix C Table C1).

In addition to the Matrix of Indicators, use of PIBO and WCF that are incorporated into the aquatic conservation strategy of the 2021 HLC Forest Plan also provide information on conditions of bull trout habitat. These three methods are described below. PIBO and step "A" of WCF (classify watershed condition) are further evaluated for their efficacy in assessing bull trout habitat conditions and effects of the action either individually or in conjunction with the Matrix of Indicators.

1. **Matrix of Pathways and Indicators (Matrix of Indicators)**

The objective of the Matrix of Indicators is to integrate Species Diagnostics and Habitat Pathways to arrive at a determination of the potential effect of land management activities on bull trout (U.S. Fish and Wildlife Service 1998). The single Species Diagnostic is defined by the Subpopulation Characteristics that contains four Subpopulation Indicators. The six Habitat Pathways contain 19 Habitat Indicators (Table 5). The Matrix of Indicators does not replace comprehensive watershed analysis nor attempt to define data standards (U.S. Fish and Wildlife Service 1998). However, it meets its intended use by identifying and providing an understanding of both habitat conditions and subpopulation status when proposing activities that will change the environmental baseline and potential risk to the species.

Indicators within the Matrix of Indicators identify specific attributes important for the maintenance and recovery of bull trout. They were also developed to address habitat conditions at the appropriate scale for each indicator: e.g., *substrate embeddedness* should be addressed at the reach level, *pool frequency and quality* at the grouped reach level, *off-channel habitat* for the entire stream length, and *refugia* for the entire watershed. Metrics for indicators have either numeric values (e.g., 2 - 5°C for *temperature*) and/or are descriptive (e.g., “adequate habitat refugia do not exist” for *refugia*). The metrics are uses to place the indicators in one of three condition categories, either *Functioning Appropriately* (FA), *Functioning at Risk* (FAR), or *Functioning at Unacceptable Risk* (FUR).

Indicators in a watershed are rated FA when they provide habitat that maintains strong and significant populations, are interconnected, and promote recovery of a proposed or listed species or its critical habitat to a status that will provide self-sustaining and self-regulating populations. When indicators are rated FAR, they provide conditions for persistence of the species but in more isolated populations and may not promote recovery of a proposed or listed species or its habitat without active or passive restoration efforts. FUR indicates the proposed or listed species continues to be absent from historical habitat or is rare or being maintained at a low population level; although the habitat may maintain the species at this low persistence level, active restoration is needed to begin recovery of the species.

Ratings for Indicators of Subpopulation Characteristics can be subjective, generally relying on redd counts, juxtaposition between subpopulations, presence of migratory fish, and connectivity of habitat. Because the 19 habitat metrics cannot be measured at the scale of their intended use across the range of bull trout in western Montana, the USFS developed a Geographical Information System (GIS) modeling approach to provide surrogate ratings of each habitat indicator for an entire HUC6 watershed and to describe the relationships between indicators (Appendix 2, 3, 4; U.S. Forest Service 2013). The modeling approach helps achieve the three-fold purpose of the Bull Trout Conservation Strategy (U.S. Forest Service 2013) for both the USFS and the Service, identified as:

1. Provides a standard process for updating bull trout habitat and population baselines that can be documented in the consultation process.
2. Provides a structured assessment of fish populations and habitat conditions, stressors, needs.
3. Identifies opportunities that will further guide the location, type, and extent of projects on FS lands intended to conserve, restore, and ultimately contribute to bull trout recovery.

Table 5. Matrix of Indicators

Category Diagnostic or Pathway *indicators*
Species
Subpopulation Characteristic Diagnostic
subpopulation size
growth & survival
life history diversity & isolation
persistence and genetic integrity
Habitat
Water Quality Pathway
temperature
sediment
chemical contamination/nutrients
Habitat Access Pathway
physical barriers
Habitat Elements Pathway
substrate embeddedness
large woody debris
pool frequency & quality
large pools
off channel habitat
refugia
Channel Condition & Dynamics Pathway
wetted width/depth ratio
streambank condition
floodplain connectivity
Flow Hydrology Pathway
change in peak/base flows
drainage network increase
Watershed Conditions Pathway
road density & location
disturbance history
riparian conservation areas
disturbance regime

Limiting aspects of the modeling approach are: (1) lack of field data as input or verification to the model, (2) ratings summarize conditions for an entire HUC6 watershed rather than the intended scale for each Indicator, and (3) high correlation with the limited data that is available across the range of bull trout in Montana. However, model results provide a consistent estimate and starting point of important habitat attributes across the landscape and the model methodology provides a documented ability to override model estimates when field data is available.

Bull trout require Cold, Clean, Complex, and Connected habitat, often referred to as "the four Cs" of bull trout habitat (U.S. Fish and Wildlife Service 2015). The Bull Trout Conservation Strategy considers the indicators *temperature*, *barriers*, *sediment*, and *pool frequency and quality* to be the four key indicators of habitat conditions (U.S. Forest Service 2013) because they correspond to the four Cs; *temperature* directly corresponds to Cold, *barriers* directly corresponds to Connected, while *sediment* and *pool frequency and quality* provide close approximations of Clean and Complex, respectively. The importance of these four indicators is provided below.

a) *Temperature*

Water temperature is particularly important to bull trout and is probably the most innate primary habitat indicator; bull trout have been repeatedly associated with the coldest water within river basins (Quigley and Arbelbide 1997). Stream temperature can be increased by decreasing vegetation in riparian areas that increases the amount of sunlight reaching the stream (Moore and Wondzell 2005) and by excessive sediment deposition in pools that reduces water depths and takes less solar energy to heat. The resulting increases in stream temperature can reduce salmonid survival in systems where temperatures are already high (Beschta et al. 1987). Bull trout are specifically adapted to cold water, and in addition to physiological stress, warmer water allows occupancy by non-native species (e.g. northern pike, brown trout) that prey on juvenile bull trout.

b) *Sediment*

In addition to direct effects to bull trout from sediment, *sediment* is the one key indicator with the potential to affect the other key indicators. Habitat requirements for bull trout include clean water that is relatively free of sediment and contaminants. High levels of sediment in the water column can result in direct mortality to fish by damaging delicate gill structures while lower levels can cause behavioral changes, acts as a barrier that impedes movement by bull trout, and results in physiological stress. Increased turbidity can also result in decreases in distance of prey capture and prey capture success (Bash et al. 2001, Berg and Northcote 1985).

Increased fine sediment affects developing bull trout eggs by filling interstitial spaces within stream substrate that reduces or eliminates the flow of water through the redd, thus limiting the supply of oxygen to developing eggs and removal of waste products. Elevated fine sediment (<6.4 mm) in spawning gravels can lead to reduced egg survival (Rieman and McIntyre 1993), reduced emergence success of bull trout (Weaver and White 1985 as cited in Rieman and McIntyre 1993), and limit access to substrate interstices that provide important cover during rearing and over-wintering periods (Goetz 1994, Jakober et al. 1998). Greater and more persistent mortality of salmonid embryos can occur from chronic sediment delivery compared to pulse events (Maturana et al. 2013).

Sediment decreases pool habitat quality, an essential rearing and cover component for bull trout which provides protection from predators and the elements. Fine sediments may reduce the availability of wintering habitat for adult and juvenile fish by increasing substrate embeddedness. Everest et al. (1987) concluded trout species can cope with natural variability in sediments, but population viability can be reduced by persistent sedimentation that exceeds the natural background levels they evolved in.

Sediment can also have an effect on bull trout through impacts or alterations to the macroinvertebrate communities or populations. Aquatic insect abundance can decline by approximately 50 percent when substrate embeddedness reaches a level of one-third (Waters 1995). Decreased growth rates can occur when increased substrate embeddedness leads to a reduction in aquatic insect production (Bjornn et al. 1977, Weaver and Fraley 1991, Bowerman et. al 2014). Higher turbidity and suspended sediment can reduce primary productivity by decreasing light intensity and periphytic (attached) algal and other plant communities (Anderson et al. 1976, Henley et al. 2000, Suren and Jowett 2001). Sedimentation can alter the habitat for macroinvertebrates, changing the species density, diversity and structure of the area (Waters 1995, Anderson et al. 1976, Reid and Anderson 1999, Shaw and Richardson 2001).

The magnitude of sediment effects to bull trout is related to location and amount of sediment delivery, duration, and proximity of sediment delivery to spawning/rearing habitat and other important areas of use. Bull trout are most sensitive to changes in habitat that occur in headwater areas encompassing important spawning and rearing habitats for fluvial and adfluvial stocks as well as remnant resident populations (Quigley and Arbelbide 1997). McCaffery et al. (2007) found that the number of stream crossings in a watershed is an important factor when considering the overall impact.

Downstream distance and duration of sediment increases is variable. Sediment pulses from activities in unoccupied tributaries can extend to occupied streams depending on the amount of sediment, distance, and gradient. In some situations, sediment will be deposited in floodplains and low velocity areas. Large woody debris can influence the location and duration sediment is stored (Faustini and Jones 2003). Flushing flows during high water may or may not remove additional sediment deposited in the streambed. Beschta and Jackson (1979) reported that stream energy may be used to transport and embed additional sediment occurring during high flows instead of flushing existing fines from the gravels. Quantitative estimates and effects of changes to the overall sediment budget are difficult to accurately determine.

Effects to bull trout are also potentially greater and more likely to occur in streams where baseline conditions for *sediment* and *substrate embeddedness* are rated FUR. Additional sediment combined with high baseline levels creates a greater potential for total concentrations to reach harmful severity levels described by Muck (2010). Similarly, it is easier for additional sediment to increase embeddedness beyond optimal levels for spawning, rearing, and macroinvertebrate production when *substrate embeddedness* is rated FUR.

c) *Barriers*

The *barriers* indicator refers to man-made barriers and does not consider natural barriers to fish passage such as waterfalls and natural dewatering (dewatering not influenced by human activities such as irrigation diversions). It is, therefore, the only key indicator that is influenced solely by management activities.

Barriers can limit fish movement to habitats required for spawning, growth, and as refuge from harsh conditions or disturbance events. The size of habitat networks and migratory connections may be the key to population persistence as climate change progresses (Rieman and Isaak 2010). Isolated populations are at a higher risk of extinction due to loss of genetic variability, loss of resilience, and both demographic and environmental stochasticity. Connected stream systems allow bull trout to recolonize stream reaches after disturbance events at a more rapid rate than those that are fragmented by physical barriers (Rieman et al. 1997, Gresswell 1999).

Sub-watersheds rated FAR or FUR for the *barrier* indicator contain partial or complete fish passage barriers. A FAR rating indicates that a sub-watershed contains fish passage barriers in the road system on first and second order streams, while a FUR rating indicates the sub-watershed contains a fish passage barrier in the road system on a third order or larger stream. These barriers, typically culverts, can delay migration and or limit access to refugia habitat.

d) *Pool Frequency and Quality*

Cover provided by pools and habitat complexity is an important component of bull trout habitat (Quigley and Arbelbide 1997), providing shelter from predators, thermal refugia, and habitat for prey. The presence of large woody debris (LWD) is one of the primary means by which pools are formed in many stream channel types (Quigley and Arbelbide 1997) and therefore influences the *pool frequency and quality* indicator.

2. Watershed Condition Framework (WCF)

Unlike the Matrix of Indicators that utilizes indicators to assess specific attributes of bull trout habitat within HUC6 watersheds, the watershed condition classification of WCF (step A of the 6-step framework) is a process-based approach to characterize the overall condition of entire HUC6 watersheds. It establishes a nationally consistent reconnaissance-level approach using a comprehensive set of 12 indicators that are surrogate variables representing the underlying ecological, hydrological, and geomorphic functions and processes that affect watershed condition (U.S. Forest Service 2011).

The watershed condition classification step of the WCF process uses 12 indicators that are grouped according to four major process categories: (1) aquatic physical, (2) aquatic biological, (3) terrestrial physical, and (4) terrestrial biological (Figure 2). Each of the 12 indicators is evaluated using a defined set of attributes. For example, the Roads and Trails indicator that is part of the Terrestrial Physical process is composed of the four attributes: (1) open road density, (2) road and trail maintenance, (3) proximity to water, and (4) mass wasting. A numerical rating of 1 (good), 2 (fair), and 3 (poor) is assigned to each attribute that are then summed and averaged to produce a numeric score for each indicator, indicator scores are then summed and averaged to produce a numeric value for each of the four process categories, and the overall watershed condition score is computed as a weighted average of the four process category scores (U.S. Forest Service 2011a). Numerical scores for the overall watershed rating and each of the 12 indicators are also converted to a rating category as either Functioning Properly, Functioning at Risk, or Impaired Function.

WCF is designed to be a consistent, comparable, and credible process for improving the health of watersheds across USFS lands (2021 HLC Forest Plan, Appendix E). Relative to assessing baseline conditions and assessing effects to bull trout and bull trout habitat, it provides an integrated rating of the aquatic and terrestrial processes ultimately influencing bull trout habitat. Many of the attributes used in WCF (e.g. large woody debris, open road density, water quality problems (303d listed), flow characteristics) are the same or analogous to indicators of the Matrix of Indicators. Integrated values for the 12 WCF indicators also address many similar indicators as the Matrix of Indicators. However, WCF does not allow a direct assessment of baseline conditions or effects to the most important attributes of bull trout habitat (the four Cs); Cold and Clean are integrated into the Water Quality indicator while Connected and Complex are integrated into the Aquatic Habitat Indicator (Figure 2). Changes to the specific attributes of WCF that directly affect feeding, breeding, and sheltering of bull trout are further diluted at the level of the *overall* watershed rating. WCF can be helpful in conjunction with an assessment of important individual habitat attributes but is insensitive by itself for analyzing effects of an action undergoing Section 7 consultation.

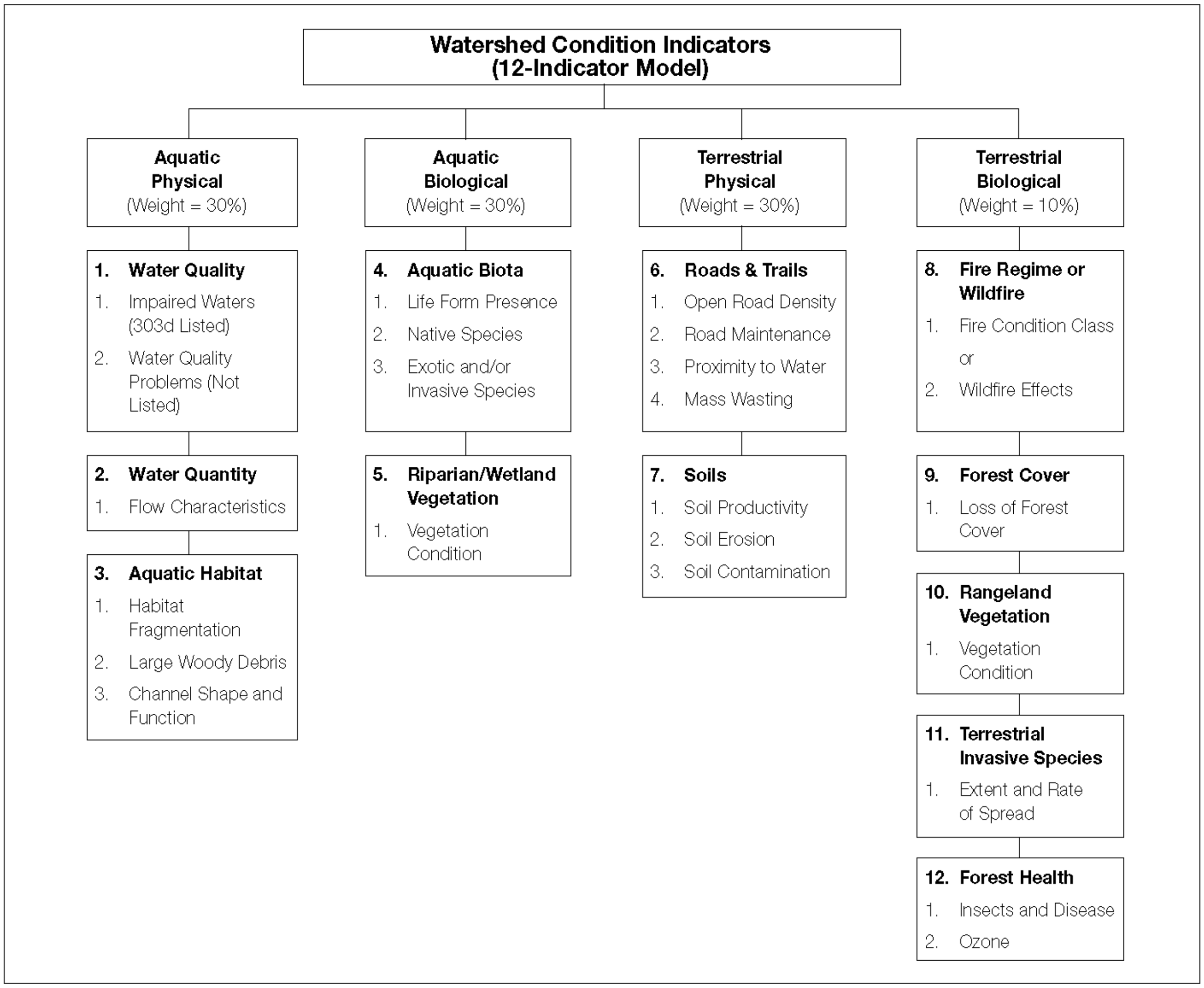

Figure 2. WCF attributes, indicators, and processes for determining national watershed condition ratings.

3. PACFISH/INFISH Biological Opinion (PIBO) Effectiveness Monitoring Data

The PIBO Effectiveness Monitoring Program was developed in response to monitoring needs addressed in the Biological Opinions for bull trout (U.S. Fish and Wildlife Service 1998a) and steelhead (National Marine Fisheries Service 1998) to provide a consistent framework for monitoring aquatic and riparian resources within the range of the Pacific Anadromous Fish Strategy (PACFISH) and the Inland Fish Strategy (INFISH; Henderson et al. 2005). PIBO began collecting stream habitat data at the reach scale (160-400 m stream lengths) within the interior

Columbia River and Upper Missouri River basins in 2001 and expanded sampling within the Upper Missouri River Basin of Montana in 2006.

Typically sampling at a 5-year interval for most sites, PIBO measures seven attributes to assess *status* and nine attributes to assess *trend* (Table 6). Because all streams are affected by natural disturbance, the assessment of *status* is interested in how the range of stream habitat conditions expressed at managed sites compares to what would be expected if the stream had experienced only natural disturbance. Sites receiving only natural disturbance are defined as "reference sites", primarily located in wilderness areas or sub-watersheds without obvious mining, recent grazing (within 30 years), minimal timber harvest (< 5%) and minimal road density (< 0.5 km/km2).

Table 6. Stream attributes measured by PIBO for determining status and trend.

STREAM HABITAT ATTRIBUTES	STATUS	TREND
Average bank angle (º)	*	*
d_{50} (median substrateparticle size)	*	*
Percent fine sediment (<6 mm diameter, in pool tails)	*	*
Large Wood frequency (pieces /km)	*	*
Residual pool depth (m)	*	*
Percent pool habitat	*	*
Bank stability (% bank covered with plants or rock)		*
Percent of bank with undercuts (bank angle <90º)		*
Macroinvertebrate taxa (Observed/Expected)	*	*

To account for natural variability among sites, PIBO assesses *status* by combining stream habitat attributes indicated in Table 8 into an index. An index may work well for determining *status* but may be less sensitive when detecting *trend* in habitat condition because it averages conditions of several attributes that may be more individually responsive. Therefore, PIBO assesses *trend* by measuring changes in individual stream habitat metrics, such as bank stability or large wood frequency, at a site over the duration of PIBO sampling (2001-2021).

PIBO is intended to provide effectiveness monitoring over large spatial extents using a large sample size. Status and trend data are useful at the planning area scale or in broader contexts, such as sub-basin, basin, or ecoregion (Archer and Ojala 2017, Saunders et al. 2020). Sample size analysis for detecting change suggests that given a sample size of 1,300 sites, PIBO should be able to detect small changes for most stream habitat attributes over the entire sample area, should be able to detect a 20% change for at least half the attributes at the scale of individual National Forests containing an expected 35-90 sample sites, and that it is unlikely to detect meaningful changes at the scale of an individual Ranger District (Henderson et al. 2005).

Although there are numerous sample sites on the HLC Forest within the interior Columbia River and Upper Missouri River basins, there are currently only seven sample sites in the HUC6 watersheds comprising bull trout habitat of the action area.

PIBO may provide strong inference at the large spatial scale (Al-Chokhachy et al. 2010) it was intended but assessing habitat at a finer spatial scale may be problematic. Over the past 25 years, research has shown that a large amount of the variation in stream habitat conditions is driven by site-to-site-variation within streams (Anlauf et al. 2011, Larsen et al. 2004, Urquart et al. 1998), suggesting that habitat conditions measured at one site are not indicative of habitat conditions at other locations within the stream or throughout the watershed. Studies that have explicitly compared reach-based habitat assessments with stream-wide assessments have reported significant bias from reach-level inferences (Dolloff et al. 1997). Results from a recent study (Clark 2019) found status information from one reach poorly inferred stream-level habitat status for most of the habitat attributes important for bull trout (e.g., sediment, large woody debris, pools; Al-Chokhachy et al. 2010). The spatial variation in habitat conditions within streams are driven by the non-uniform and stochastic geomorphic drivers of instream habitat (e.g., large woody debris; Kraft and Warren 2003). In addition, stream power, another important factor affecting instream habitat (e.g., Knighton 1984), changes dramatically within streams as catchment area and gradient change from headwater reaches downstream. Together, the within-stream differences in the drivers of stream habitat and consequent site-to-site variation in stream habitat highlights the problems of using inferences from one reach (~200-400 m) to characterize habitat status of an entire stream systems. Ultimately, the high site-to-site variability (even within streams) may result in erroneous assessments of habitat status without ample sample sizes to overcome spatial variation in habitat status.

PIBO also has limitations on the extent of stream habitat components it addresses. According to Framework Component 5 of the Framework developed by ICBEMP (ICBEMP 2014), land management plans should consider and include a set of indicators that encompasses key characteristics of fish habitat that include but are not limited to:

- Water quality (temperature, fine sediment, nutrients)
- Habitat access (connectivity/barriers – culverts, diversion dams)
- Habitat elements (substrate, pools, large woody debris, off-channel habitat, refugia)
- Channel condition and dynamics (channel width, width/depth, or greenline-greenline width, stream bank stability, thalweg depth/max depth)
- Flow/hydrology (flow regime)
- Watershed conditions (disturbance regimes)
- Riparian vegetation (species composition, succession)

As identified by ICBEMP, habitat indicators and default ranges for their proper function relative to bull trout are found in the document for the Matrix of Indicators (U.S. Fish and Wildlife Service 1998). As noted in the Matrix Indicators and verified through PIBO monitoring, there is considerable variability in the numeric values of these indicators across unmanaged areas and the default ranges may not be appropriate for a particular area, therefore, locally derived information should be used where possible to develop riparian and aquatic objectives or desired conditions for plans (ICBEMP 2014).

Overall, PIBO provides long-term effectiveness monitoring for sample metrics across large spatial extents, as is intended. At the site level, it can still be helpful by indicating trends in a sample reach or be integrated with local monitoring information. But it does not meet the needs for assessing baseline habitat conditions at the HUC6 scale or effects of an action due to; (1) limitations on the number of sample sites to address conditions of HUC6 watersheds, (2) the number and type of metrics PIBO addresses relative to suggested metrics for assessing bull trout habitat, and (3) the potential inappropriate use of default ranges calculated across large areas relative to specific action areas.

4. Selected Metrics for Assessing Habitat Condition and Effects

The 2021 HLC Forest Plan provides guidance and direction in the context of a broad framework for management of all activities across the entire extent of the HLC Forest for a period extending 15 years or longer. The combined effects for all management categories (e.g., access management, vegetation management, fuels management) sets the stage for changes in habitat conditions over the life of the plan that occur slowly, are difficult to track, and cannot be readily modified. Analysis needs to address effects to important habitat requirements specifically, such as those influencing Cold, Clean, Complex, and Connected habitat, but it also becomes increasingly important to address the underlying ecological processes influenced by the 2021 HLC Forest Plan and how it relates to the overall watershed condition and viability of bull trout. Therefore, this biological opinion uses a combination of information and methods from the Matrix of Indicators and WCF to define existing baseline conditions and assess effects of implementing the 2021 HLC Forest Plan. Due to the limited number of sample sites and habitat attributes collected, PIBO is used to describe conditions at the site or reach scale where applicable.

Modeled values of the indicators from the Matrix of Indicators (U.S. Forest Service 2013) provide baseline conditions for important specific attributes within each HUC6 watershed and the basis for assessing effects. The four key elements (*temperature*, *sediment*, *barriers*, and *pool frequency and quality*) are predominately used because they represent the four "Cs" of bull trout habitat. Other indicators are referenced when they are applicable to the management activity analyzed (e.g., *road density and location* for addressing effects of access management.

Watersheds that are functioning properly have five important characteristics (Williams et al. 1997 *in* U.S. Forest Service 2011, 2011a):

1. They provide for high biotic integrity, which includes habitats that support adaptive animal and plant communities that reflect natural processes.
2. They are resilient and recover rapidly from natural and human disturbances.
3. They exhibit a high degree of connectivity longitudinally along the stream, laterally across the floodplain and valley bottom, and vertically between surface and subsurface flows.
4. They provide important ecosystem services, such as high-quality water, the recharge of streams and aquifers, the maintenance of riparian communities, and the moderation of climate variability and change.
5. They maintain long-term soil productivity.

The five characteristics referenced above for properly functioning watersheds are equally important to bull trout. The watershed condition classification of WCF provides the metrics to rate the baseline functions for the entire HUC6 watershed and analyze effects of the 2021 HLC

Forest Plan on watershed function. The final watershed condition class of WCF is predominately used but the 12 indicators of WCF are referenced when they are applicable to the management activity analyzed (e.g., the Roads and Trails indicator for addressing effects of access management). WCF may not be specific to bull trout, but offers the following benefits when used in conjunction with the Matrix of Indicators:

1. WCF incorporates many of the same attributes, indicators, and metrics as the Matrix of Indicators. For example, the *sediment* indicator from the Matrix of Indicators is highly influenced by road density and location due to the production and delivery of sediment to streams from road networks. Metrics for rating categories of road density and location for the Roads and Trails indicator of WCF were implemented from the Matrix of Indicators (U.S. Forest Service 2011a).
2. The combination of these rating systems provides a multi-scale approach for analysis. The Matrix of Indicators addresses four important attributes of bull trout habitat individually within a watershed, while WCF integrates additional attributes into a broad-scale overall rating for the watershed.
3. WCF provides a framework for assessing effects to the underlying ecological processes within watersheds.
4. WCF is incorporated into the aquatic strategy of the 2021 HLC Forest Plan, and although it lacks the specificity of the Matrix of Indicators to address section 7 analysis for bull trout at the project level, requirements for annual updates provide a method to track change and condition across the large spatial extent, long temporal period, and complexity of management strategies for the programmatic action of a HLC Forest Plan.

B. Primary Constituent Elements (PCE) of Critical Habitat

Designated critical habitat for bull trout is comprised of the nine PCEs described below. During project-level analysis, assemblages of multiple indicators from the Matrix of Indicators (Appendix C Table C1) are typically used to address effects to each PCE because one metric cannot describe the ability of each PCE to provide required habitat components. As with the analysis for the species described above, analysis for critical habitat also needs to address how the plan aligns with long-term, broad-scale life history/habitat requirements for bull trout critical habitat. Therefore, analysis of effects for critical habitat address the ***intent*** of each PCE as described below.

PCE1 - Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.

PCE2 - Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.

PCE3 - An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

PCE4 - Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

PCE5 - Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

PCE6 - In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

PCE7 - A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

PCE8 - Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

PCE9 - Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

C. Project Effects Codes

Project Effects Codes (Appendix C Tables C2-C5) provide a standardized rating scale of effects to bull trout in consistent, relevant, biological terms. There are two sets of codes, one for effects to bull trout or their habitat and the other for effects to individual PCEs of critical habitat. Type of effects are either adverse (A) or beneficial (B), followed by number indicating the magnitude of effect. In all cases, a higher number indicates a stronger influence than a lower number. For example, the following definition equates to Project Effects Code A3:

A3 = Effects to habitat or individuals that will result in short-term behavioral effects but no ongoing disruption of normal behavior (including but not *limited to spawning, incubation, rearing, foraging, sheltering, migration etc.).*

The 2021 HLC Forest Plan is a framework programmatic action that provides management direction but does not in itself authorize, fund, or carry out any actions that directly affect bull trout or bull trout habitat. Project Effects Codes are intended to rate the magnitude and duration of specific activities and are not applicable for assessing programmatic direction of the 2021 HLC Forest Plan. However, they were used to rate effects of ongoing projects in the action area that have completed Section 7 consultation and are included in the description of those projects relative to the environmental baseline.

VI. Environmental Baseline

Under the provisions of section 7(a)(2), when considering the "effects of the action" on listed species and designated critical habitat, the Service is required to consider the environmental baseline. Regulations implementing the Act (50 C.F.R. § 402.02) define the environmental baseline as the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in progress. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

For this biological opinion, environmental baseline conditions for bull trout were assessed using information in the biological assessment (U.S. Forest Service 2021), the 2021 HLC Forest Plan (U.S. Forest Service 2020), Bull Trout Core Area Templates (U.S. Fish and Wildlife Service 2009), Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (U.S. Fish and Wildlife Service 2015b), Conservation Strategy for Bull Trout on USFS lands in Western Montana (U.S. Forest Service 2013), watershed baseline conditions for the Blackfoot River section 7 watershed (U.S. Forest Service 2010), the USFS Biological and Physical Resources (https://www.fs.fed.us/naturalresources/watershed/condition_framework.shtml) and additional information in our files.

A. Conditions and Status of Bull Trout in the Columbia Headwaters Recovery Unit

The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. It is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene Geographic Regions (U.S. Fish and Wildlife Service 2015b). The recovery unit contains 15 complex cores and 20 simple cores. Fish passage improvements within the recovery unit have reconnected some previously fragmented habitats (U.S. Fish and Wildlife Service 2015b), while others remain fragmented. Unlike the other recovery units in Washington, Idaho and Oregon, the Columbia Headwaters Recovery Unit does not have any anadromous fish overlap. Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (U.S. Fish and Wildlife Service 2015b).

The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, historical mining and contamination by heavy metals, expanding populations of non-native fish predators and competitors, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g., irrigation, livestock grazing), and residential development. Conservation measures or recovery actions implemented include habitat improvement, fish passage, and removal of non-native species. The Columbia Headwaters Recovery Unit Implementation Plan further describes the threats to bull trout and the site-specific management actions necessary for recovery of the species within the unit (U.S. Fish and Wildlife Service 2015b).

1. Previous Consultations in the Columbia Headwaters Recovery Unit

This section summarizes previously consulted actions and subsequent effects that have been analyzed through section 7 consultation as reported in a Biological Opinion. These effects are an important component of objectively characterizing the current condition of the species in the recovery unit. To assess consulted-on effects to bull trout, we analyzed all Biological Opinions received by the Region 1 and Region 6 Forest Service Offices, from the time of listing until August 2003; this totaled 137 Biological Opinions. By demographic units in the interim recovery plan, 124 Biological Opinions (91 percent) applied to activities affecting bull trout in the Columbia Basin population segment, 12 Biological Opinions (9 percent) applied to activities affecting bull trout in the Coastal-Puget Sound population segment, 7 Biological Opinions (5 percent) applied to activities affecting bull trout in the Klamath Basin population segment, and one Biological Opinion (< 1 percent) applied to activities affecting the Jarbidge and St. Mary-Belly population segments (Note: these percentages do not add to 100 because several Biological Opinions applied to more than one population segment). The geographic scale of these consultations varied from individual actions (e.g., construction of a bridge or pipeline) within one basin to multiple-project actions occurring across several basins.

The 2015 Bull Trout Recovery Plan modified the previous demographic units used in the interim recovery plan. Based on the 2015 Recovery Plan, there have been 79 Biological Opinions issued that included "take" in the Upper Clark Fork Geographic Region of the Columbia Headwaters Recovery Unit from August 2003 until now. Most of the Biological Opinions have included mandatory terms and conditions and reporting requirements, which are binding on the action agency, in order to reduce the potential impacts of anticipated incidental take to bull trout.

B. Conditions and Status of Bull Trout in the Blackfoot River Core Area

The Blackfoot River Core Area extends from the headwaters of the Blackfoot River near the continental divide to the confluence of the Clark Fork River near Bonner, Montana (Figure 3) Incorporating a watershed of approximately 1,984 square miles, the core area contains the Blackfoot River and all tributaries to the Blackfoot River, with the exception of the Clearwater Lakes and River which form a separate core area). Land ownership in the Blackfoot River Subbasin is approximately 54% federal (U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management), 10% state (Montana Department of Natural Resources and Conservation, Montana Fish, Wildlife, & Parks, University of Montana), 31% private and 5% corporate timber company. Most of the middle and high elevation forested lands within the subbasin are administered by the U.S. Forest Service (USFS). Private lands are concentrated in the low elevation portions of the subbasin.

Glaciers strongly influenced the landscape and hydrology of the Blackfoot River basin. When the glaciers receded, large deposits of glacial till, glacial outwash, and glacial lakebed sediments were left behind. Due to the highly permeable nature of coarse outwash sediments, streams generally lose water through infiltration and often go dry where they cross outwash plains. As a result, many streams or stream reaches in the Blackfoot River basin are intermittent. Streams in confined valleys are usually perennial but have intermittent reaches when the valley widens or enters a larger valley. The lower end of intermittent reaches often provides ideal spawning habitat for bull trout where the water resurfaces or upwells and is typically clean and cold.

Anthropogenic factors such as mining, logging, and ranching have influenced the Blackfoot River Core Area. Beginning in the late 1800's, typically small-scale placer mining disrupted fish habitat and stream function in area bull trout streams. Streams rarely have the ability to naturally recover from placer operations. Ranching and homesteading began in the late 1800's and early 1900's, resulting in water diversions that reduced flows and the ability to provide adequate fish habitat. Water diversions were typically not screened, which likely led to entrainment of various age classes of bull trout. Clearing of riparian shrubs and damage to streambanks from over-grazing affected stream geomorphology and introduced high amounts of sediment where erosion occurred. Significant timber harvest and road building took place from the 1930's through 1980's. From the start of the logging era until the late 1920's, log drives down the Blackfoot River and major tributaries removed log jams, pools, and large woody debris that created adult bull trout habitat and spawning habitat. Road building cleared riparian and upland vegetation that led to increased water temperature and sediment delivery to streams. Undersized culverts created fish barriers. Construction of the Milltown Dam in 1906 isolated bull trout populations from other core populations in the Clark Fork Basin until the dam was removed in 2008.

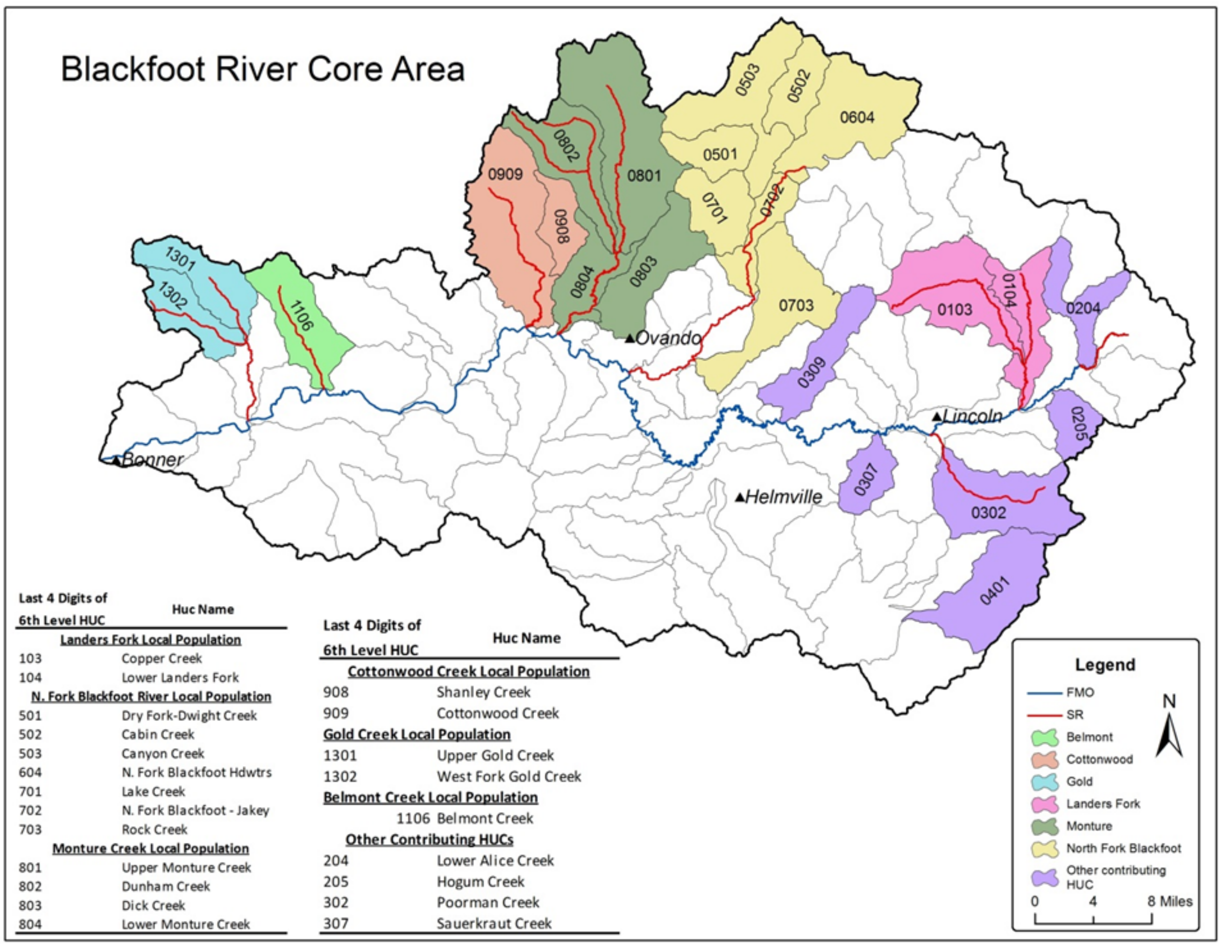

Figure 3. Blackfoot River Core Area boundary, watersheds containing designated local populations, other important watersheds contributing to bull trout, and location of designated critical habitat.

Many restoration actions targeting the recovery of bull trout in the Blackfoot River watershed have occurred since 1990 (Pierce and Podner 2016). These activities include: (1) enhancing instream flows and improving fish passage by screening major irrigation canals, (2) flow enhancement, livestock fencing and improved irrigation for fish passage, (3) placement of conservation easements on segments of several spawning streams, and (4) fish passage enhancement on two low-head dams on the mainstem Clearwater River. Recent purchases of timber company lands also have the potential to benefit bull trout. In 2003, the Blackfoot

Challenge and The Nature Conservancy initiated the Blackfoot Community Project, which involved the purchase and re-sale of 89,215 acres of Plum Creek Timber Company lands from the Blackfoot River headwaters near Rogers Pass to the Clearwater drainage. Approximately 75% of the lands have been or will be transferred into federal or state ownership. In 2008, The Nature Conservancy and The Trust for Public Land entered into an agreement with Plum Creek Timber, referred to as the Montana Legacy Project, to purchase 312,500 acres of timberland in western Montana. As part of the Montana Legacy Project, a total of 71,754 acres in the Clearwater and Potomac valleys of the Blackfoot Subbasin will be purchased and resold to public agencies and/or private buyers. The majority of these lands are intended to be re-sold to the HLC and LNF National Forest Service and DNRC.

1. Recent Actions Affecting Bull Trout within the Blackfoot River Core Area

Wildfires are stochastic events with the potential to alter bull trout habitat and directly influence the number of individuals in local populations. Fires burning in riparian areas may increase sediment delivery to streams until vegetation becomes re-established and increases water temperature due to reductions in streamside shading and increased solar gain. Direct mortality may occur when intense fires along streams increase water temperature at a greater rate than bull trout can tolerate. Increases in peak and base flows may occur if fires reduce large amounts of forest canopy cover within watersheds. In the long term, beneficial increases in the number and quality of pools may result from the addition of large-woody debris into streams.

The number, size, and intensity of wildfires in the Blackfoot River Core Area during 2017 influenced bull trout habitat and subpopulation characteristics. The entire perimeter or portions of five wildfires (Rice Ridge, Park Creek, Liberty, Monahan, and Alice Creek fires) totaling approximately 121,000 acres burned predominately on USFS lands within this core area in 2017. Fire and related fire suppression activities from these five fires occurred in 22 6th level HUC watersheds. Within these watersheds, fires burned approximately 18,425 acres within a 300-foot buffer of all streams and approximately 4,167 acres within a 300-foot buffer of streams designated as bull trout critical habitat.

A minor “degrade” to the sediment and substrate embeddedness indicators occurred in 12 of the 22 6th level watersheds and a minor degrade to riparian conservation areas occurred in 8 of the watersheds. A functional reduction in temperature occurred in one of the 6th level watersheds and a functional reduction in peak and base flows occurred in three. There were nine misapplications of fire retardant on the Rice Ridge Fire. Seven of the nine misapplications were determined to likely have significant adverse effects to bull trout and/or designated bull trout critical habitat ranging from 15.1 to 43.4 miles downstream of the misapplication site depending on methods used. Mortality likely occurred to bull trout near misapplication sites for three occurrences and was observed on one occasion. Consultation on effects of retardant misapplications is currently ongoing with the Service.

2. Population Abundance and Trend

The Blackfoot River Core Area is one of 15 complex core areas in the Columbia Headwaters Bull Trout Recovery Unit, containing multiple local bull trout populations, encompassing a large watershed, containing multiple life history forms, and having migratory connectivity between spawning and rearing habitat (SR) and foraging, migration, and overwintering habitats (FMO). The fluvial life history form is considered dominant in the core area because linkage to the formerly connected adfluvial source in Lake Pend Oreille (Idaho) has been severed by dams since 1906. Occurrence of the resident life history form is relatively rare. The six designated local populations within the core area are the Landers Fork, North Fork Blackfoot River, Monture, Cottonwood, Belmont, and Gold (Figure 2). Other important cold-water streams that contribute to rearing capacity in the core include Poorman Creek, Arrastra Creek, Lower Alice Creek, Sauerkraut Creek, and Hogum Creek.

In general, geographically smaller core areas have lower population numbers and large adult populations (1,000 adults or more) tend to occur in larger core areas where the habitat is well connected and well distributed throughout the core. The quality and quantity of the habitat and its relative degree of connectivity play a major role in determining population size (U.S. Fish and Wildlife Service 2005). The current estimated number of adult bull trout in the Blackfoot River Core Area is 500-1,000 (U.S. Fish and Wildlife Service 2009).

Trends in bull trout populations within basins can be reliably estimated using redd counts (Al-Chokhachy et. al 2005). Redd counts have been conducted on eight stream reaches within the core area since bull trout were listed in 1999 but have only been conducted every year on four of the eight reaches (Lower Copper Creek, Upper Copper Creek, Monture Creek, and North Fork Blackfoot River). Therefore, redd surveys for these four reaches are the only surveys that provide an unbiased estimate of trend due to differences in sampling effort. The combined number of redds from these four surveys (Figure 4) has ranged from a low of 117 in 2004 to a high of 270 in 2011 (Montana Fish, Wildlife, and Parks unpublished data). Historically, it is hypothesized that up to 1,000 bull trout redds may have been present in the core area (U.S. Forest Service 2013).

3. Primary Threats to Bull Trout in the Blackfoot River Core Area

As defined in the Columbia Headwaters Recovery Unit Implementation Plan (U.S. Fish and Wildlife Service 2015b), "Primary threats are those factors known or likely (i.e., non-speculative) to negatively impact bull trout populations at the core area level, and accordingly require management actions to assure bull trout persistence to a degree necessary that bull trout will not be at risk of extirpation within that core area in the foreseeable future".

a. Habitat Threats

Upland/Riparian Land Management: Active livestock grazing combined with forest practices and the ongoing use and management of roads and transportation corridors impacts bull trout habitat in the lower Blackfoot River mainstem FMO habitat and downstream reaches of some SR tributaries by causing riparian and instream degradation, loss of large woody debris LWD, and pool reduction.

Water Quality: Dewatering in the upper Blackfoot River mainstem FMO habitat and some tributaries contributes to seasonally high summer water temperatures, often aggravated by instream flow depletion. Dewatering of numerous reaches, collectively extending over 100 miles of waterway, has been documented. This reaches critical levels in the lower mainstem. Bull trout become isolated in pockets of thermal refugia at the confluence of a few cold-water tributaries, where they are very vulnerable to anglers and predators. Contamination from mine runoff, mostly from historical sources (e.g., Mike Horse Mine), has been an ongoing threat to water quality, although water quality is improving.

b. Demographic Threats

Small Population Size: Small Population Size and fragmentation may be limiting factors in key SR tributaries in the lower drainage (e.g., Gold and Belmont Creeks, where redd counts were routinely double digits prior to 2000, but now seldom exceed low single digits).

c. Non-native Threats

Non-native fishes: Brook trout occurrence and hybridization is high in some SR tributaries, especially in the lower watershed. Brown trout dominate the lower mainstem and lower portions of some tributaries.

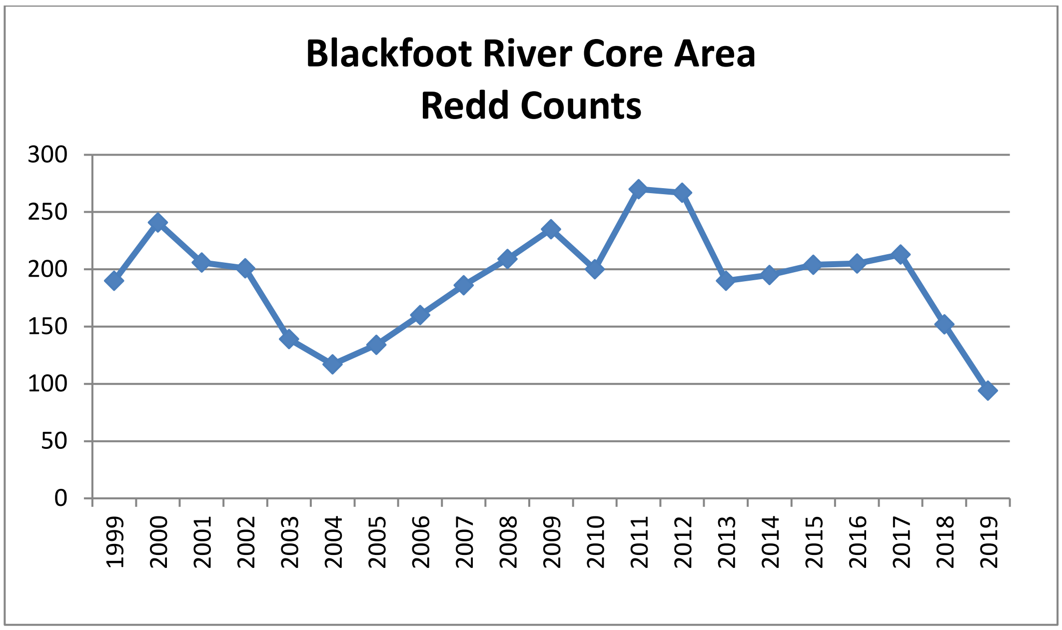

Figure 4**.** Total annual redds counted in the 4 stream reaches sampled every year between 1999 and 2019.

4. Risk of Extirpation

The Service ranked the extirpation risk of bull trout in each core area of the Columbia Headwaters Recovery Unit using a modification of the Natural Heritage Program's ranking model (Master et al. 2003). Rankings (defined below) are based on population abundance, distribution, population trend, and threats to bull trout as described in the Core Area Templates document (U.S. Fish and Wildlife Service 2009).

High Risk – Core area at high risk because of extremely limited and/or rapidly declining numbers, range, and/or habitat, making the bull trout in this core area highly vulnerable to extirpation.

At Risk – Core area at risk because of very limited and/or declining numbers, range, and/or habitat, making the bull trout in this core area vulnerable to extirpation.

Potential Risk – Core area potentially at risk because of limited and/or declining numbers, range, and/or habitat even though bull trout may be locally abundant in some portions of the core area.

Low Risk – Bull trout common or uncommon, but not rare, and usually widespread through the core area. Apparently not vulnerable at this time, but may be cause for long-term concern.

The 2015 Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout concluded little had changed in regard to individual core area status in the interim between the year rankings were calculated and completion of the current Recovery Unit Implementation Plan (U.S. Fish and Wildlife Service 2015b). The Blackfoot River Core Area received a final ranking of *Potential Risk* (U.S. Fish and Wildlife Service 2008).

C. Conditions and Status of Bull Trout in the Upper Clark Fork Core Area

The Upper Clark Fork Core Area includes all of the Clark Fork River and all tributaries upstream of the Blackfoot River (Figure 5). This core area was previously described as everything upstream of Milltown Dam, however, with the removal of the dam in 2008, the new lower boundary is the Blackfoot River. Milltown Dam, constructed in 1906, isolated bull trout populations in the Upper Clark Fork from the rest of the basin for over a century. Bull trout in the Upper Clark Fork probably originated historically as adfluvial spawning fish from Lake Pend Oreille in northern Idaho. Following construction of Milltown Dam, bull trout stocks in the Upper Clark effectively became either fluvial or resident.

Currently, there are believed to be approximately 100-200 adult bull trout in the Upper Clark Fork River system. Most of the bull trout in the core area are resident, and there is a high degree of fragmentation between populations. Much of the main stem of the river as well as the lower reaches of many tributaries are unsuitable for bull trout (warm and dewatered) in midsummer. There are also numerous barriers and irrigation diversions which further isolate remaining populations. The proximity of local populations to each other and the condition of migratory corridors is also a concern. However, efforts are underway to arrest and clean up metal contamination in the upper reaches, which will reduce impacts to aquatic organisms in the upper Clark Fork River.

The Upper Clark Fork River Core Area is an example of a watershed where systematic decline of the migratory life history form of bull trout has resulted in the increased prominence of isolated and fragmented residual populations of resident fish. The fluvial migratory component of this population exists at low abundance, although documentation is poor. Adult bull trout to 21 inches total length are occasionally still observed in the core area, which may indicate a remnant migratory component that is too small to reliably monitor. Bull trout have essentially been reduced to resident populations in the headwaters of Warm Springs, Boulder, and Harvey Creek drainages. Twelve bull trout were sampled in the upper Clark Fork River between 1989 and 1994; eight of these fish were found in the vicinity of Warm Springs Creek and Racetrack Creek. Intensive sampling by the HLC Forest Service in headwater reaches of the Little Blackfoot River between 2008 and 2010 yielded two adult bull trout. These fish were later determined to have been hybridized with brook trout. Montana FWP initiated electro-shocking in the Little Blackfoot River in 2007; no bull trout were found in those efforts.

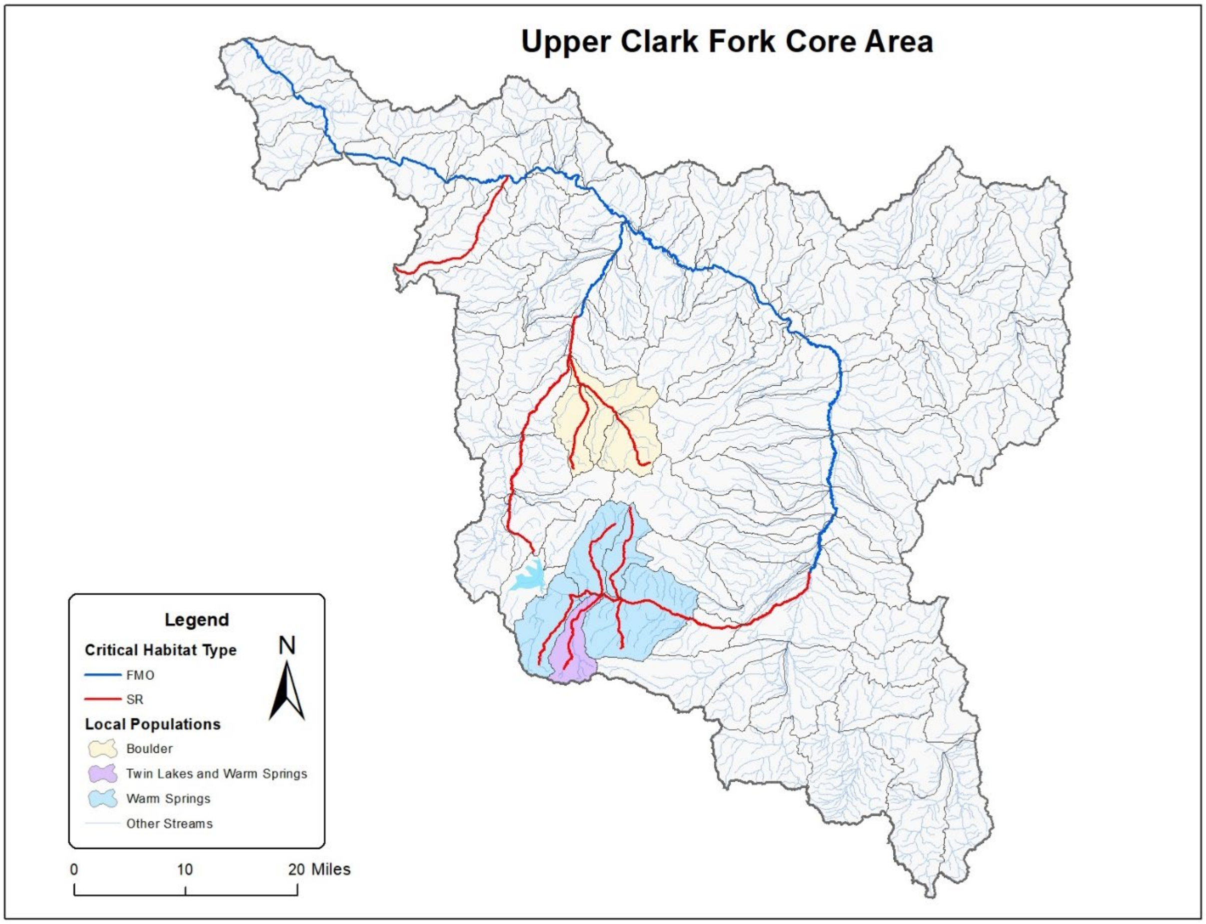

Figure 5. Upper Clark Fork Core Area boundary, watersheds containing designated local populations, other important watersheds contributing to bull trout, and location of designated critical habitat.

Some bull trout likely out-migrate from tributary streams into the main channel of the upper Clark Fork River. The degree to which this occurs or is influenced by the level of metals and arsenic in the principal channel of the Clark Fork River is speculative. Results of population monitoring completed by MFWP in the lower portion of the core area (near Harvey Creek) indicate that migratory bull trout numbers are low (less than 1 fish per mile). For the Little Blackfoot River, migratory bull trout may be extirpated. No bull trout have been identified as of 2013 in recent shocking efforts. If any bull trout are still present, they are likely resident forms in headwater reaches that haven't been sampled.

Bull trout populations in the Upper Clark Fork Core Area were likely first exposed to human-caused impacts in the late 1800's/early 1900's in the form of mining-related impacts, ranching, and some fishing. Human population growth also increased substantially in this period, resulting in increased exploitation of bull trout. Between 1887 and 1908, six major floods routed silt-sized tailings down Silver Bow and Warm Springs creeks to the upper Clark Fork River. The 1908 flood lasted ten days and transported mine waste in sufficient quantity to substantially reduce the long-term storage capacity of Milltown.

Three sedimentation ponds were completed in Silver Bow Creek near the confluence of Warm Springs Creek between 1918 and 1959. Sedimentation ponds intercepted much of the mine tailings routed down Silver Bow Creek immediately prior to flowing into the upper reach of the Clark Fork River. Since the mid-1970's, contaminant contribution to the principle channel of the Clark Fork River has occurred primarily through the redistribution of previously deposited sediment and tailings within the channel and floodplain.

Widespread livestock ranching in the Butte/Deer Lodge valley began in the early 1900's and has pervasive impacts on bull trout habitat to this day. Many stream channels have been straightened, and riparian corridors have been overgrazed in the wide upper valley of the Upper Clark Fork River Core Area for over a century. Unnaturally wide stream channels and poor riparian vegetation conditions, combined with irrigation diversions that reduce mid-summer flows, have created disconnected stream segments and warm water temperatures. Lack of instream flows in the lower reaches of tributaries is a major limiting factor for bull trout in the core area.

The expansion of transportation systems from the 1960's through the 1980's also had a large impact on the Upper Clark Fork River Core Area. Interstate 90 confines much of the main river channel for approximately 40 miles between Missoula and Garrison, cutting off meanders and creating unnaturally straightened channel segments that have eliminated large amounts of juvenile rearing habitat and healthy riparian zones that provide shade and moderate water temperatures. Emergency riprap repairs on the interstate, railroad, and access roads results in frequent localized impacts to the channel as well. For the Little Blackfoot portion of the core area, U.S. Highway 12 and the railroad confine the stream along a substantial portion of the reach between Garrison and Elliston.

During the 1970's and early 1980's, the next significant era impacting Upper Clark Fork River bull trout came about when extensive road building and timber harvest in tributary watersheds resulted in higher sediment levels, less stream cover, and higher water temperatures throughout the system. Finally, a decade of successive drought years in the late 1990's caused even warmer water temperatures that facilitated the upstream expansion of brown trout into the upper watershed and tributary streams, further impacting bull trout populations. The degree to which warm water temperatures, non-native species, or synergistic effects of both have impacted bull trout is unclear, although it seems reasonable to presume the impacts of habitat and species changes to bull trout have been major.

As of 2018, adult bull trout have not been observed in the Upper Clark Fork River mainstem beyond the town of Phosphate on the Clark Fork River. Confirmed bull trout populations do persist in several tributaries that feed directly into the Clark Fork River, including Warm Springs Creek, Boulder Creek, Harvey Creek, Rock Creek, and the Blackfoot River. While bull trout have not been documented in the Upper Clark Fork in nearly a century, the presence of these nearby populations has led to the designation of the Upper Clark Fork River, as critical FMO habitat. In March of 2014, one adult bull trout was caught by an angler just below a pond spillway in Silver Bow Creek approximately 1 mile upstream from the confluence of Warm Springs Creek and Silver Bow Creek which form the start of the Clark Fork River. This discovery suggests that bull trout at least use the Upper Clark Fork as FMO habitat. Of the three local populations in the core area, Warm Springs Creek and Twin Lakes Creek currently support the majority of bull trout spawning. Barker Creek (tributary to Warm Springs Creek) also supports high densities of bull trout within the Warm Springs Local Population. Warm Springs Local populations consists of adfluvial (Twin Lakes, Silver Lake), fluvial (Warm Springs Creek, Barker Creek, Foster Creek), and resident (Upper Warm Springs Creek) populations. This concentration of bull trout and life history forms provide a unique opportunity to expand and or increase numbers of migratory bull trout to the Upper Clark Fork River.

1. Recent Actions Affecting Bull Trout in the Upper Clark Fork Core Area

As stated previously, contamination from mine tailings from the Anaconda and Butte mines has had significant impacts on the ecosystem within the Upper Clark Fork River Core Area. As such, beginning in 2004, a 22-phase (each phase being a section of the Clark Fork River) remediation plan was proposed by the United States Environmental Protection Agency, from the section of the Clark Fork River beginning at the confluence of Mill-Willow bypass downstream to the town of Drummond. The purpose of the remediation is twofold: to remove or treat tailings and impacted soils, and to remediate and stabilize the streambanks and the floodplain. At this time, 4 of the 22 phases have been completed, and the other 18 phases are expected to be completed at a rate of one per year with completion expected in 2036. The removal and remediation of contaminated soils and degraded streambanks will aid in the recovery of native species such as bull trout in the long run.

2. Population Abundance and Trend

The Upper Clark Fork River Core Area is one of 15 complex core areas in the Columbia Headwaters Bull Trout Recovery Unit, once containing multiple local bull trout populations, encompassing a large watershed, containing multiple life history forms, and having migratory connectivity between SR and FMO. It is believed that the Upper Clark Fork Core Area may have supported 1,000 to 1,500 redds prior to the 1850's. As with most bull trout populations, overall numbers were likely highly variable from year to year, based on natural climatic and disturbance patterns. Streams in the Upper Clark Fork River basin support an abundance of low-gradient spawning habitat and are high elevation, suggesting that the area was historically prime habitat for bull trout.

Currently, there are believed to be approximately 100 to 200 adult bull trout in the Upper Clark Fork River system. Most of the bull trout in the core area are resident, and there is a high degree of fragmentation between populations. Much of the mainstem of the river as well as the lower reaches of many tributaries are unsuitable for bull trout (warm, dewatered, and occupied by high densities of non-natives). There are also numerous barriers and irrigation diversions which further isolate populations. Connectivity is a major concern in the core area. The proximity of local population to each other and the condition of migratory corridors (Clark Fork River) is one of the primary threats limiting recovery. The three designated local populations within the core area are the Warm Springs, Twin Lakes and Creek, and Boulder populations (Figure 4). Other important cold-water streams historically contributed to rearing capacity in the core area including Lost Creek, Flint Creek, Racetrack Creek, Schwartz Creek, Harvey Creek, and the Little Blackfoot River.

Trends in bull trout populations within basins can be reliably estimated using redd counts (Al-Chokhachy et. al 2005). Redd counts have been conducted on four stream reaches within the core area since bull trout were listed in 1999 but have only been conducted fairly consistently on three of the four reaches (Foster Creek, Twin Lakes Creek, and Warm Springs Creek). Surveys conducted on all three of these reaches for any given year are the ones that provide an unbiased estimate of trend due to differences in sampling effort. The combined number of redds from these three surveys (Figure 6) has ranged from a low of 16 in 2000 to a high of 64 in 2008 (Montana Fish, Wildlife, and Parks unpublished data).

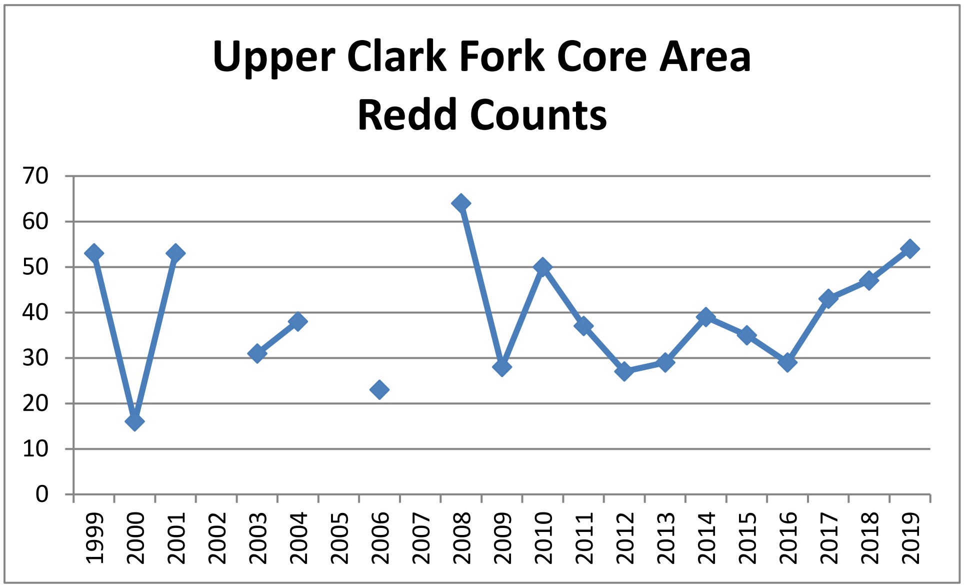

Figure 6. Total annual redd counts in 3 stream reaches sampled between 1999 and 2019. Gaps in data indicate all 3 reaches were not sampled that year.

Current densities of bull trout are likely much lower than their historic levels (HLC Forest Service Biologists estimate an overall 90-95% reduction). The distribution of populations throughout the core area is probably significantly different from historic patterns, as many streams which may have historically contained bull trout now have none, or if they do have bull trout they are typically limited to a very short reach of the stream system. Life form expression is different than historically existed, although the 2008removal of Milltown Dam and passage projects at the lower Clark Fork River dams now provides limited potential for adfluvial access from Lake Pend Oreille (Idaho).

3. Primary Threats to Bull Trout in the Upper Clark Fork Core Area

As defined in the Columbia Headwaters Recovery Unit Implementation Plan (U.S. Fish and Wildlife Service 2015b), "Primary threats are those factors known or likely (i.e., non-speculative) to negatively impact bull trout populations at the core area level, and accordingly require management actions to assure bull trout persistence to a degree necessary that bull trout will not be at risk of extirpation within that core area in the foreseeable future". The three categories of primary threats are "Habitat", "Demographic", and "Non-natives".

a) Habitat Threats

Upland/Riparian Land Management: HLC Forest practices (roads, sediment) and livestock grazing are causing riparian and instream degradation, loss of LWD, and pool reduction in FMO habitat and some SR habitat in tributaries.

Water Quality: Agricultural practices (including irrigation) and residential developments reduce and fragment suitable habitat and migration corridors. Irrigation, industrial, and municipal uses result in further dewatering of some habitat.

Runoff from mining in the early 20th century resulted in toxic conditions for aquatic species in large portions of the mainstem FMO habitat and some headwater tributaries due to concentrations of heavy metals and other contaminants. Low water quality is still affecting bull trout in some areas, though it is slowly improving.

b) Demographic Threats

Connectivity Impairment: Fragmentation of tributary SR habitat, as well as mainstem Clark Fork River FMO habitat by dams and diversions combined with major loss of bull trout distribution in occupied tributaries, is limiting recovery potential, even if other threats are resolved. This threat is aggravated by dewatering and entrainment in irrigation systems, especially in lower reaches of tributaries.

c) Non-native Threats

Non-native fishes: Brook trout are abundant and high rates of hybridization with bull trout have been documented in some SR tributaries (e.g., Warm Springs Creek).

4. Risk of Extirpation

The Service ranked the extirpation risk of bull trout in each core area of the Columbia Headwaters Recovery Unit using a modification of the Natural Heritage Program's ranking model (Master et al. 2003). Rankings (defined below) are based on population abundance, distribution, population trend, and threats to bull trout as described in the Core Area Templates document (U.S. Fish and Wildlife Service 2009).

High Risk – Core area at high risk because of extremely limited and/or rapidly declining numbers, range, and/or habitat, making the bull trout in this core area highly vulnerable to extirpation.

At Risk – Core area at risk because of very limited and/or declining numbers, range, and/or habitat, making the bull trout in this core area vulnerable to extirpation.

Potential Risk – Core area potentially at risk because of limited and/or declining numbers, range, and/or habitat even though bull trout may be locally abundant in some portions of the core area.

Low Risk – Bull trout common or uncommon, but not rare, and usually widespread through the core area. Apparently not vulnerable at this time but may be cause for long-term concern.

The 2015 Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout concluded little had changed in regard to individual core area status in the interim between the year rankings were calculated and completion of the current Recovery Unit Implementation Plan (U.S. Fish and Wildlife Service 2015b). The Upper Clark Fork River Core Area received a final ranking of *High Risk* (U.S. Fish and Wildlife Service 2008).

D. Population Status in the Action Area

1. Bull Trout Occurrence in the Action Area

Bull trout population status and habitat conditions for the 16 watersheds of the CWN and seven other watersheds bull trout may be present are described below. Population and habitat conditions in these HUC6 watersheds define the environmental baseline of the action area for analysis of effects. These HUC6 watersheds provide the best bull trout habitat in the action area because bull trout are currently present, have been present in the past, or they are predicted to maintain cold water that make them conducive for bull trout occupancy under a warming climate scenario. Most are headwater watersheds that contain SR habitat important to the viability of the species in the core area. These HUC6 watersheds are the proverbial canary in the coal mine for assessing effects of the 2021 HLC Forest Plan.

Bull trout are considered as "may be present" by the Service in 12 of the 16 HUC6 watersheds of the CWN and seven additional watersheds (Figure 7). As previously stated for the four watersheds where bull trout aren't considered currently present, bull trout have been extirpated from Nevada Creek Headwaters and have never been documented in the three headwater watersheds located in the Scapegoat Wilderness Area (East Fork North Fork Blackfoot, Meadow Creek, and Mineral Creek), but the Climate Shield model (Isaak et al. 2017) predicts the persistence of cold water in these areas. The Landers Fork designated local population occurs in the Lower Landers Fork and Copper Creek HUC6 watersheds. Arrastra Creek, Hogum Creek, and Lower Alice Creek within the CWN and Sauerkraut Creek outside the CWN contribute to recovery of the Blackfoot River core area (U.S. Forest Service 2013). Rock Creek is a contributing headwater stream for the North Fork Blackfoot designated local population on the Lolo National Forest. Because the area within this watershed under HLC Forest management is limited, primarily roadless, and does not affect a designated local population within the action area, effects to this watershed would be discountable and it will not be further considered. Baseline habitat conditions in the Rock Creek watershed are provided for reference only.

2. Population Status in the Action Area

a. Upper Blackfoot Geographic Area

Tables 7, 8, 9, and 10, from the Bull Trout Conservation Strategy (U.S. Forest Service 2013) and BA (U.S. Forest Service 2021) summarize spawning, population trends, and other population attributes of bull trout subpopulations in the Upper Blackfoot Geographic Area where information is available.

The Landers Fork Local Population (Table 9) is the only designated local population of bull trout entirely within the 2021 HLC Forest Plan action area. The highest redd count in the combined Copper Creek and Snowbank Creek complex was 120 in 2008. Thirty-five redds were counted in 2018 and 28 in 2019. Poorman Creek (Table 8) was not considered a local population under the 2015 recovery plan (U.S. Fish and Wildlife Service 2015). Habitat conditions, nonnative species, and barriers to movement, including dewatering on private lands has contributed to the population status in this watershed.

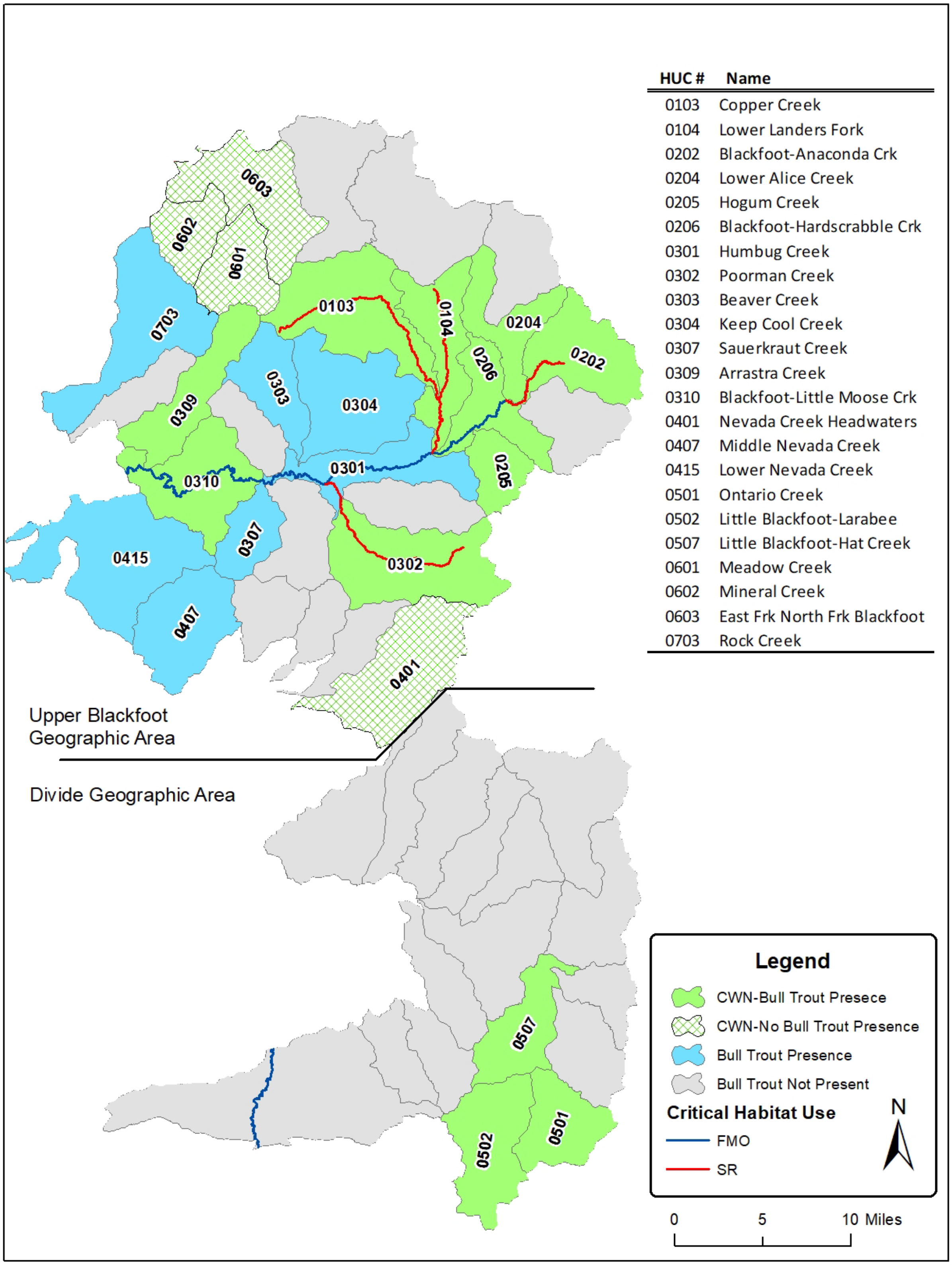

Figure 7. Bull trout occurrence in the action area. Within this action area, one designated local population occurs in the Copper Creek and Lower Landers Fork watersheds.

Table 7. Population status summary of Landers Fork Local Population.

# spawning adults	Short-term (5-year) population trend	Life history, connectivity	# known spawn reaches	Non-native species, threat
70-240.	Decreasing	Fluvial, connected.	Three—two in Copper Creek and one in Snowbank Creek. No spawning reaches identified to date in Landers Fork. Some spawning likely just below Silver King Falls based on anecdotal information.	Brown trout. Low threat with a few found in lower Landers Fork by MDFWP. None currently found in Copper Creek based on sampling by MDFWP and HLC Forest Service fishery personnel.

Significance of geographical location	Vulnerability to climate warming	Unique population attributes
High significance. This is a moderate-sized drainage and the primary spawning tributary to the Upper Blackfoot River above Nevada Creek.	Low vulnerability due to high-elevation headwaters and groundwater upwelling of cold water.	None known other than the high magnitude of recruitment provided to the Blackfoot core population.

Table 8. Population status summary of bull trout in the Poorman Creek watershed.

# Spawning Adults	Short-Term (5yr) Pop Trend	Life History, Connectivity	# Known Spawn Reaches	Nonnative Species, threat
Unknown	Believed to be increasing	Resident and Fluvial -- Connected within the last 10 years	None currently confirmed but spawning is known to occur based on age classes present. Magnitude of spawning not confirmed	Brown trout and brook trout—Moderate in the lower reaches, brook trout –moderate to high in upper reaches. Brook bull trout hybrids noted during sampling effort by MDFWP. Additional evaluations need to be conducted to better assess threat.

Significance of geographical location	Vulnerability to Climate Change	Unique Population Attributes
High significance – This is a moderate sized drainage and the primary Blackfoot tributary south of highway 200 and upstream of Highway 141 still supporting moderate numbers of bull trout.	Moderate vulnerability, although some tributaries to Poorman Creek have cold summer water temperatures. Water temperatures to be collected in 2011.	None identified to date

Bull trout are considered extirpated from Nevada Creek Headwaters but predicted persistence of cold water would maintain the ability of this watershed to provide spawning and rearing habitat. However, migratory bull trout are unable to reach this watershed due to the dam creating Nevada Creek Reservoir. Table 9 contains a summary of the population status for this watershed.

Table 9. Population status summary of bull trout for Nevada Creek Headwaters.

Spawning adults	Short-term (5-year) population Trend	Life history, connectivity	Number of known spawn reaches	Non-native species, threat
None.	None	Possible adfluvial historically before creation of Nevada Reservoir below the Forest boundary (barriers on upper Nevada Creek were removed within the last 15 years).	No Bull trout genetic material present in surveys in 2019 (Western United States eDNA atlas)	Brook trout. Very high. Hybridization of bull trout with brook trout confirmed from samples collected and analyzed in 2010.

Significance of geographical location	Vulnerability to climate warming	Unique population attributes
High significance. Overall, Nevada Creek is a large drainage and historically likely provided substantial contribution of bull trout to the Blackfoot River prior to the presence of Nevada Creek Reservoir.	Moderate vulnerability below forest, but climate shield modeling for 2040 suggests headwaters of Nevada has a 75% probability of providing spawning and rearing habitat for bull trout if no brook trout are present.	None.

The four watersheds that contribute to the Blackfoot River core area (Arrastra Creek, Hogum Creek, Sauerkraut Creek, and Lower Alice Creek) support some rearing bull trout, likely from fluvial fish from the Blackfoot River. Of these four, only Arrastra Creek indicates reproduction as suggested by the presence of age-0 fish and a resident population (U.S. Forest Service 2021). Table 10 provides a summary for these four HUC6 watersheds.

Table 11 provides a summary of the importance of each HUC6 watershed affecting bull trout populations identified in Tables 9, 10, 11, and 12 and identifies the recommended conservation strategy for each watershed from the Bull Trout Conservation Strategy (U.S. Forest Service 2013). For example, the importance of the Copper Creek HUC6 watershed to spawning and rearing for the Landers Fork designated local population is high, habitat limitations of the watershed to the designated local population is moderate, and the recommended conservation strategy is a mix of active restoration to improve habitat conditions that are degraded or dysfunctional watershed processes and to conserve those habitat conditions and watershed processes that are functioning well.

<u>b. Divide Geographic Area</u>

The Little Blackfoot River was previously a designated local population but was removed in the 2015 bull trout recovery plan after extensive sampling in 2008-2010 indicated bull trout are nearly extinct in the drainage. However, positive eDNA results for bull trout in the last few years and observations of a bull trout on a redd in 2019 indicate some level of presence in the drainage. Table 12, from the Bull Trout Conservation Strategy (U.S. Forest Service 2013) summarizes the population status for the HUC6 watersheds in the Little Blackfoot drainage. Table 13 summarizes the importance of each HUC6 watershed affecting bull trout in the headwaters of the Little Blackfoot River and identifies the recommended conservation strategy for each watershed from the Bull Trout Conservation Strategy (U.S. Forest Service 2013).

Table 10. Population status summary of additional HUC6 watersheds contributing to the Blackfoot River core population.

Spawning adults	**Short-term (5-year) population trend**	**Life history, connectivity**	**Number of known spawn reaches**	**Non-native species, threat**
Unknown.	Unknown.	Fluvial. Connected in some streams and partially connected in others.	None currently confirmed on a yearly basis. However, sporadic redd searches have identified incidental redds on Alice Creek. Rearing by fluvial fish is believed to occur in some streams with spawning by resident bull trout likely to occur in others.	Brown trout and brook trout vary in density and distribution by stream and pose variable levels of risk to bull trout. See 6th level HUC assessments.

Significance of geographical location	**Vulnerability to climate warming**	**Unique population attributes**
Moderate significance when the 4 6th-level HUCs are taken as a whole. The streams are individual 6th-level HUCs and are distributed throughout the headwaters of the Blackfoot drainage (two streams north of highway 200 and two south of Highway 200), which helps reduce the risk of any single event affecting contribution of bull trout from this grouping of streams	Moderate vulnerability overall with some streams having low vulnerability and others having moderate to high vulnerability based on current water temperatures and overall elevation. The upper end of Arrastra Creek would have low vulnerability.	None.

Table 11. Summary of the importance of each HUC6 watershed to the population it influences and the recommended conservation strategy for the watershed.

Population Influenced	Name (last 4 digits of HUC6 code)	Significance to Population[1]	Habitat Limitations to Population[2]	Conservation Strategy[3]
Landers Fork designated local population	Copper Creek (0103)	High	Moderate	Active/ Conservation
	Lower Landers Fork (0104)	Low	Moderate	Passive
Bull trout in Poorman Creek	Poorman Creek (0302)	Moderate	Moderate	Active
Bull trout in this group of streams that contribute to the core area	Arrastra Creek (0309)	Low	Moderate	Active
	Sauerkraut Creek (0307)	Low	Moderate	Active
	Hogum Creek (0205)	Low	Low	Active
	Lower Alice Creek (0204)	Low	Moderate	Passive
Potential bull trout in Nevada Creek	Nevada Creek Headwaters (0401)	Low	Moderate	Active

[1] Importance of the HUC6 to spawning and rearing habitat for the population

[2] Importance of limitations in physical stream habitat condition affecting the population status

[3] **Active** restoration is management intervention focused on improving degraded habitat or dysfunctional watershed processes. **Passiv**e restoration is restoration typified by reducing or eliminating the sources of degradation to allow recovery. **Conservation** maintains existing populations, habitats and processes that are functioning well enough to provide a foundation from which other populations can anchor and reconnect.

Table 12. Population status summary of the Little Blackfoot Drainage.

# spawning adults	Short-term (5-year) population trend	Life history, connectivity	# known spawning reaches	Non-native species, threat
Less than 50.	Likely declining based on 2008-2010 survey.	Resident, barriers on many tributaries (culverts and/or diversions). However, some potential for an occasional fluvial fish remains, but potential is likely very low.	1 in the upper Little Blackfoot upstream from Ontario Creek confluence. Habitat is suitable in other reaches of the Little Blackfoot and Ontario Creek.	Brook trout, high threat throughout most of the drainage. Brown trout, threat is high but currently limited to the main stem of Little Blackfoot below Ontario Creek all the way to Garrison. Brown trout are also a threat on the following tributaries: Dog Creek, Lower Ophir Creek, Carpenter Creek, and Snowshoe Creek.

Significance of geographical location	Vulnerability to climate warming	Unique population attributes
Moderate significance. This is a large drainage that was thought to historically have several potential spawning and rearing tributaries. The Little Blackfoot in future climate scenarios is not likely to support bull trout based on higher temperatures, introduced non-natives, and challenges in the mainstem of the Clark Fork	Substantial vulnerability due to water temperatures that are currently less than optimum in all habitats within the local population except Ontario Creek. Very high vulnerability to climate change in the lower reaches of the Little Blackfoot River on nonfederal lands (both the mainstem and tributaries on private lands) due to water withdrawals and existing elevated water temperatures. High vulnerability on FS lands as well.	None, other than loss of the population would leave a substantial portion of habitat unoccupied in the core population area.

Table 13. Summary of the importance of each HUC6 watershed to the population it 3influences and the recommended conservation strategy for the watershed.

Population Influenced	Name (last 4 digits of HUC6 code)	Significance to Population[1]	Habitat Limitations to Population[2]	Conservation Strategy[3]
Bull trout in the Little Blackfoot headwaters	Little Blackfoot-Larabee Gulch (0502)	Moderate	Low	Conserve
	Ontario Creek (0501)	Low	Low	Active
	Little Blackfoot-Hat Creek (0507)	Moderate	Low	Conserve

[1] Importance of the HUC6 to spawning and rearing habitat for the population

[2] Importance of limitations in physical stream habitat condition affecting the population status

[3] **Active** restoration is management intervention focused on improving degraded habitat or dysfunctional watershed processes. **Passiv**e restoration is restoration typified by reducing or eliminating the sources of degradation to allow recovery. **Conserve** maintains existing populations, habitats and processes that are functioning well enough to provide a foundation from which other populations can anchor and reconnect.

E. Habitat Conditions in the Action Area

2. Baseline Habitat Conditions in the Action Area

Table 14 describes baseline habitat conditions using the four key indicators from the Matrix of Indicators and watershed condition from WCF for the HUC6 watersheds identified in Figure 7. Ratings of all 19 habitat indicators from the Matrix of Indicators and the 12 indicators of WCF used to determine watershed condition are provided for the watersheds in Appendix C Tables C6 and C7.

Habitat conditions for the ratings in Table 14 were determined using the best available information and are assumed to provide an accurate representation. However, the Service recognizes that mapping and calculation errors can occur. If the Forest finds there has been a mapping or calculation error in describing the existing condition and corrects the metrics, the Service does not expect any additional effects to bull trout related to those corrections. The intent of this analysis is to capture the existing habitat conditions and the potential effects to bull trout, including potential ongoing effects that may not be represented in the metrics described above due to errors. If, however, changes in the metrics occur due to Forest actions on-the-ground, site-specific consultation or reinitiation of this consultation would need to occur to determine the potential effects.

Table 14. Key indicators from the Matrix of Indicators and overall watershed condition from the Watershed Condition Framework (WCF).

HUC6 Name (last 4 digits of HUC6 code)	% Forest Owned	Key Matrix Indicators				Watershed Condition
		Temp	Barriers	Pools	Sediment	
Divide Geographic Area						
Little Blackfoot-Larabee Gulch (0502)	100	FA	FAR	FUR	FUR	Functioning at risk
Ontario Creek (0501)	99	FA	FA	FUR	FUR	Impaired function
Little Blackfoot-Hat Creek (0507)	68	FAR	FA	FUR	FUR	Impaired function
Upper Blackfoot Geographic Area						
Copper Creek (0103)	97	FA	FUR	FAR	FAR	Functioning properly
Lower Landers Fork (0104)	36	FA	FA	FUR	FA	Functioning at risk
Poorman Creek (0302)	92	FA	FUR	FAR	FUR	Impaired function
Arrastra Creek (0309)	58	FA	FAR	FA	FAR	Functioning at risk
Blackfoot-Little Moose Creek (0310)	45	FAR	FA	FUR	FAR	Functioning at risk

Table 14. (continued)

Hogum Creek (0205)	90	FA	FAR	FUR	FUR	Functioning at risk
Lower Alice Creek (0204)	60	FAR	FA	FUR	FUR	Functioning at risk
Blackfoot-Hardscrabble Creek (0206)	27	FAR	FA	FUR	FUR	Functioning properly
Blackfoot-Anaconda Creek (0202)	77	FAR	FA	FUR	FUR	Impaired function
Nevada Creek Headwaters (0401)	71	FA	FA	FAR	FUR	Functioning at risk
East Fork North Fork Blackfoot (0603)	100	FA	FA	FAR	FA	Functioning properly
Meadow Creek (0601)	100	FA	FA	FAR	FA	Functioning properly
Mineral Creek (30602)	100	FA	FA	FA	FA	Functioning properly
Humbug Creek (0301)	20	FA	FA	FAR	FUR	Functioning at risk
Beaver Creek (0303)	76	FA	FAR	FAR	FUR	Functioning at risk
Keep Cool Creek (0304)	59	FA	FA	FAR	FUR	Functioning at risk
Sauerkraut Creek (0307)	58	FA	FA	FUR	FUR	Functioning at risk
Middle Nevada Creek (0407)	23	FAR	FA	FUR	FUR	Impaired function
Lower Nevada Creek (0415)	14	FA	FA	FUR	FUR	Functioning at risk
Rock Creek (0703)	53	FAR	FA	FUR	FAR	Functioning properly

The Clean Water Act requires each state to set water quality standards to protect designated beneficial water uses and to monitor the attainment of those uses. Streams and lakes that do not meet the established standards are called “impaired waters”. These waters are identified on the 303(d) list, named after Section 303(d) of the Clean Water Act, which mandates the monitoring, assessment, and listing of water quality limited waterbodies. Table 15 contains a list of impaired streams, causes of impairment, and HUC6 watersheds where these stream reaches occur within the HUC6 watersheds identified in Figure 7 for the Blackfoot Geographic Area (MTDEQ et al. 2004) and Divide Geographic Area (MTDEQ 2011).

Table 15. List of 303(d) waterbodies within the HUC6 watersheds defining baseline conditions of the action area.

Waterbody Name and Extent	HUC6 Watersheds Included	Cause of Impairments
Divide Geographic Area		
Little Blackfoot River from headwaters to Dog Creek	Little Blackfoot - Hat Creek (0507), Little Blackfoot - Larabee Gulch (0502)	Sediment, Metals
Ontario Creek from headwaters to Little Blackfoot River	Ontario Creek (0501)	Metals
Upper Blackfoot Geographic Area		
Blackfoot River from headwaters to Landers Fork	Blackfoot - Annaconda Creek (0202), Lower Alice (0204), Blackfoot - Hardscrabble (0206)	Metals
Blackfoot River from Landers Fork to Nevada Creek	Humbug Creek (0301), Blackfoot - Little Moose (0310)	Sediment
Arrastra Creek	Arrastra Creek (0309)	Sediment
Poorman Creek	Poorman Creek (0302)	Sediment, Metals, Dewatering, Flow alteration, Riparian degradations

Resource element C11 of the monitoring requirements in the existing 1986 Forest Plan for the Helena National Forest requires monitoring of intra gravel sediment for determining the quality of spawning gravel (U.S. Forest Service 1986). Substrate fines by depth in spawning gravels that are less than ¼ inch in diameter are evaluated. Sampling is conducted using a McNeil core sampler to collect stream substrates from likely spawning sites followed up with drying the samples, sieving the samples, and then weighing the samples by size class of substrate. The results are used to determine the percentage of the sample by weight that is less than ¼ inch in diameter. Values above a reference value of 30% is considered to be having an adverse effect to spawning gravels on the Helena National Forest (U.S. Forest Service 2016). Table 16 summarizes McNeil core samples for the HUC6 watersheds identified in Figure 7 for the Divide Geographic Area (U.S. Forest Service 2015) and the Upper Blackfoot Geographic Area (U.S. Forest Service 2016). The McNeil core sampler is considered the most accurate method to determine the true substrate composition (Young et al 1991).

In comparison to McNeil core samples that determine percent fines within the substrate, PIBO sampling determines the amount of fine sediment that is on the streambed surface. PIBO sampling records the number of intersections with fine sediment <6 mm in diameter for a 14 x 14 inch metal grid with 49 evenly distributed intersections (the top right corner is included to provide a total of 50 intersections) that is placed along the pool tail crest at a distance of 25, 50, and 75% of the distance across the wetted channel (Heitke et al. 2008). Therefore, McNeil core samples and grid sampling for surface fines are not directly comparable

Tables 17 and 18 provide percent fine sediment and percent pool habitat at PIBO sites in managed and unmanaged watersheds, respectively, for the HUC6 watersheds identified in Figure 7. The target value for the stream types that occur in the Divide Geographic area (B and C types) is ≤ 9% (MTDEQ 2011). Poorman Creek is the only stream with a target value (≤ 6%) for streams in the Upper Blackfoot Geographic area. Pool frequency is an indicator of sediment loading that relates to changes in channel geometry and is an important component of a stream's ability to support fisheries (Muhlfeld et al. 2001) but is dependent on channel geometry. It is included in Tables 12 and 13 for representative purposes.

Table 16. Summary of percent fine sediment less than ¼ inch in spawning gravels (McNeil core samples) for streams sampled in the Divide and Upper Blackfoot Geographic Areas.

HUC6 Name (last 4 digits of HUC6 code)	Percent Fines in Spawning Gravel (McNeil Core Samples)
Divide Geographic Area	
Little Blackfoot-Larabee Gulch (0502)	35.4% mean fines
Ontario Creek (0501)	37% mean fines
Little Blackfoot-Hat Creek (0507)	37.8% mean fines
Upper Blackfoot Geographic Area	
Copper Creek (0103)	Sediment averaging between 24% and 35% between 1986 and 2005
Lower Landers Fork (0104)	37% Seven Up Pete, 29% Landers (Lower)
Poorman Creek (0302)	Sediment averages varying between 24 and 39% from 1986 to 2005
Arrastra Creek (0309)	34% in the North Fork Arrastra, and 30% on middle Arrastra
Blackfoot-Little Moose Creek (0310)	44% Moose Creek, 54% Little Moose 34% in the Blackfoot River
Hogum Creek (0205)	Averages varying between 24 and 39% from 1986 to 2005. Hogum Cr- 31% to 35% average between 1988 and 2005
Lower Alice Creek (0204)	Alice 31%, Bartlett 43%, Toms Gulch 30%
Nevada Creek Headwaters (0401)	Clear Creek-44%, Buffalo 26%, Sheldon Cr- 43%

Table 17. Percent fine sediment and pool habitat at PIBO sites (site number and type) for managed watersheds within the action area of the 2021 HLC Forest Plan.

HUC6 Name (last 4 digits of HUC6 code)	Site # (Type)	Year	% Fine Sediment <6mm	% Pool Habitat
Divide Geographic Area				
Little Blackfoot-Larabee Gulch (0502)	233 (I)	2002	17.6	32.7
		2007	3.3	22.2
		2012	7.9	36.2
Ontario Crk (0501)	2142 (I)	2007	5.9	75.1
		2012	5.9	65.2
Upper Blackfoot Geographic Area				
Copper Crk (0103)	220 (I)	2004	24.1	27.6
		2009	22.0	45.6
	3482 (I)	2014	19.9	77.0
	3483 (I)	2014	7.0	37.2
Poorman Crk (0302)	3345 (I)	2013	7.6	37.8
	3346 (I)	2013	9.3	14.2
	3348 (I)	2013	23.2	19.3
	3349 (I)	2013	10.7	23.9
	3352 (I)	2013	19.8	26.4
	3358 (I)	2013	21.5	15.5
	3431 (I)	2013	28.2	29.8
Blackfoot-Little Moose Crk (0310)	1321 (I)	2005	60.2	21.6
		2010	34.6	23.7
		2015	37.6	44.6
	1322 (K)	2005	n/a	n/a
		2010	n/a	32.7
		2015	81.3	52.2
Nevada Creek Headwaters (0401)	1327 (I)	2005	11.0	27.3
		2010	4.7	16.8
		2015	18.9	22.5
	1328 (K)	2010	n/a	66.9
		2015	17.3	22.8

Extensive effort has gone into the sample design of the PIBO effectiveness monitoring program to provide reliable results for its intended use to assess large spatial extents (Henderson et al. 2005). However, Tables 12 and 13 illustrate several limitations of PIBO specifically to the HLC Forest. Sample size is limited for two reasons; (1) the relatively small area where bull trout are present on the HLC Forest (23 HUC6 watersheds), especially for reference watersheds that require limited management actions, and (2) the initiation of sampling in 2002 and the five-year sampling interval to compare managed and reference watersheds further limits sample size.

Additionally, the seven sites on Poorman Creek that were all sampled in 2013 (Table 14) indicate the variability that may occur among reaches within the same stream and the 12 samples taken for the same site on Meadow Creek between 2001 and 2014 (Table 15) indicate variability that can occur among years.

Table 18. Percent fine sediment and pool habitat at PIBO sites (site number and type) for reference watersheds within the action area of the 2021 HLC Forest Plan.

HUC6 Name (last 4 digits of HUC6 code)	Site # (Type)	Year	% Fine Sediment <6mm	% Pool Habitat
Meadow Creek (0601)	210 (IS)	2001	n/a	57.7
		2002	24.8	52.2
		2003	5.7	54.0
		2004	13.2	58.5
		2005	9.0	55.9
		2006	6.9	50.9
		2008	13.4	51.1
		2009	6.0	51.1
		2010	3.2	62.0
		2011	11.1	48.7
		2012	25.3	60.2
		2014	4.9	58.5
East Fork North Fork Blackfoot (0603)	216 (I)	2004	23.8	61.2
		2009	10.0	38.8
		2014	9.4	56.4

Baseline habitat conditions may be better or trending towards improvements from the ratings and data presented above due to improvements since ratings were calculated and/or sampling occurred. Improvements to the transportation network that have and will continue to occur under the two 2016 travel plans for each geographic area have not been incorporated into ratings and are occurring after sampling dates in the tables above. Additional improvements have occurred from stream restoration and culvert replacement as defined for the Telegraph Vegetation Project (U.S. Forest Service 2016a), the Poorman Restoration Project (U.S. Forest Service 2019), relocation of a road in the Copper Creek HUC6 watershed, and any other projects that may improve conditions. Information provided above is the best available information for conditions in the action area is used with the following project consultations to define the environmental baseline for effects of the 2021 HLC Forest Plan.

4. Fire, Fire Suppression, and Burned Area Emergency Response (BAER) Activities

The 2017 Park Creek fire burned approximately 18,000 acres in seven the bull trout watersheds (Arrastra Creek, Beaver Creek, Copper Creek, Keep Cool Creek, Lower Alice Creek, Lower Landers Fork, and Rock Creek; Figure 7). Adverse effects from fire suppression activities (e.g., construction of fire line, heavy road use, motorized stream crossings) and Burned Area Emergency Response (BAER) occurred in five of these watersheds (Arrastra Creek, Beaver

Creek, Keep Cool Creek, Lower Alice Creek, Lower Landers Fork; U.S. Forest Service 2018a). Adverse effects for two of the five watersheds where adverse effects occurred (Beaver Creek and Keep Cool Creek) were analyzed and incorporated into the environmental baseline during consultation on the Stonewall Vegetation Project (U.S. Fish and Wildlife Service 2021). Adverse effects from fire suppression and BAER activities occurred in Arrastra Creek, Lower Alice Creek, and Lower Landers Fork HUC6 watersheds, and the indicator ratings from the Matrix of Indicators for the environmental baseline reflect these activities. Analysis of fire suppression and BAER for watersheds not addressed during the Stonewall Vegetation Project consultation will occur at the project level when actions occur there.

5. Ongoing Actions Affecting Baseline Conditions in the Action Area

Consultation on the following projects have completed review by the Service under section 7 consultation. These projects began implementation under the existing Forest Plan and will continue under the 2021 HOC Forest Plan. They are considered part of the environmental baseline during analysis of effects for the 2021 HLC Forest Plan.

a. Travel Plans

Location and status of roads and trails in the action area is directed by the 2016 Divide Travel Plan, the 2016 Blackfoot Non-Winter Travel Plan, and 2009 Blackfoot-North Divide Winter Travel Plan. Other than minor differences along their common boundary, the Divide Travel Plan corresponds to the Divide Geographic Area and the Blackfoot Non-Winter Travel Plan and Blackfoot-North Divide Winter Travel Plan correspond to the Upper Blackfoot Geographic Area. Ongoing effects of roads and trails are considered part of the environmental baseline because consultation has been completed on the travel plans.

Generally, watersheds that are considered aquatic strongholds occur in areas of low road density (Baxter et al. 1999). An assessment of fish populations in the Interior Columbia River Basin found that bull trout are less likely to use streams for spawning and rearing in highly road systems (Quigley and Arbelbide 1997). The Montana Bull Trout Restoration Team (2000) ranked forest practices (including road construction and use of secondary forest roads) as the greatest risk to restoration of bull trout in Montana.

Threats from roads include increased erosion and sedimentation, alterations in stream channel morphology, changes in flow regimes, barriers to movement, and increased human access (Furniss et al. 1991, Lee et al. 1997). High road densities can increase the amount of fine sediment in streams (Opperman et al. 2005) and can influence stream hydrology by altering the routing of surface and subsurface flow and the timing and magnitude of flow events (Moore and Wondzell 2005).

Road /stream crossings may influence stream geomorphology, act as barriers to fish movements, fragment stream habitat, and be a source of sediment delivery to streams. Unnatural channel widths, slope, and streambed form occur upstream and downstream of stream crossings (Heede 1980). Riprapping roads adjacent to streams can channelize stream sections, accentuate the delivery of sediment to streams during road maintenance, and trigger fill slope erosion and failure. Erosion of channel fill may occur around culverts that adds sediment and leads to crossing failures (Furniss et al. 1991).

Improper culverts can reduce or eliminate fish passage (Belford and Gould 1989); therefore, road crossings are a common migration barrier to fish (Evans and Johnston 1980, Furniss et al. 1991, Clancy and Reichmuth 1990). Many culverts on U.S. Forest Service lands have high constriction ratios that limit the ability of culverts to pass 100-year flow events, increase the potential for culvert failure over time, and are either a total or partial barrier for juvenile salmonids (U.S. Forest Service 2008). Plugged culverts and fill slope failures often lead to catastrophic increases in stream channel sediment, especially on old abandoned or unmaintained roads (Weaver et al. 1987).

Recent information concerning climate change indicates that fish passage barriers and undersized culverts can exacerbate climate impacts (Rieman and Isaak 2010). As stream temperatures increase, access to first and second order streams (higher elevation and cooler) becomes more important. In addition, the likelihood of road crossing failures increases as rain-on-snow events become more frequent or intense.

Poorly placed roads can encroach on stream channel and floodplain areas. Many historic roads were constructed close to stream channel areas, often in the floodplain. In some cases, streams were straightened to accommodate road placement. Roads can affect stream channels directly if they are located on active floodplains or directly adjacent to stream channels. Indirect effects include chronic sources of sediment delivery.

Proper design provides stable cut and fill slopes and adequate drainage that allows water to filter through vegetated strips or sediment traps before entering the stream channel. The effectiveness of vegetative strips generally increases with increased width and lower hillslope gradient, but the effects of chronic road problems may still impact streams even when streams are protected by wide and intact vegetative strips (Trombulak and Frissell 2000). Other design elements used to mitigate road interception and runoff are the addition of gravel surfacing and seasonal road closures

Roads that are at high risk of failure and have the potential to cause extensive resource damage are candidates for relocation or decommission. Preferred locations for roads are away from stream channels, riparian areas, steep slopes, high-erosion-hazard areas, and areas of high mass movement. Realignment of roads so they traverse riparian areas and streams at perpendicular angles rather than parallel angles can also improve the quality of riparian and aquatic habitats in presently impacted stream reaches by reducing chronic sediment sources.

Removal or closure of roads adjacent to streams can have short- and long-term positive effects on soil hydrologic function, soil productivity, and stream water temperature. Trees and other riparian vegetation can recolonize a ripped roadbed and help provide shade. The magnitude of these improvements can depend on a variety of factors, including existing stream shade that blocks solar radiation and water temperature, stream size, and how much riparian road is removed or closed.

Improvements in road management on the HLC Forest have occurred since the mid-1990's, starting with the amendment of the Helena National HLC Forest Management Plan by INFISH in 1996. Standards and guides in INFISH slowed new road construction and modified or eliminated practices that could harm riparian and aquatic habitat. INFISH was followed by the 2001 Roadless Rule, and the 2005 Access and Management Travel Rule. The HLC Forest has reduced road miles since the early 2000's and addressed roads in some locations important to bull trout, such as Copper Creek and Poorman Creek. Storage, relocation, and obliteration of roads have occurred under the Divide and Blackfoot Non-Winter Travel Plan Decisions. However, effects of roads can be long-term (Gucinski et al. 2001).

The Helena National Forest made a determination of *may affect, likely to adversely affect* bull trout in all three travel plans and *may affect, likely to adversely affect* bull trout critical habitat for the Blackfoot Non-Winter Travel Plan and Blackfoot-North Divide Winter Travel Plan. For all three travel plans, the Service issued biological opinions that the travel plans would not jeopardize the continued existence of bull trout and not adversely modify bull trout critical habitat where applicable (U.S. Fish and Wildlife Service 2009a, U.S. Fish and Wildlife Service 2016, U.S. Fish and Wildlife Service 2016a). Incidental take statements were included in all three biological opinions.

The Divide Travel Plan established management direction and decision but not the actual implementation of activities outlined in the travel plan. Site-specific actions have and will continue to implement activities in the plan. Based on reporting provided by the HLC Forest under terms and conditions of the incidental take statement in the biological opinion, all activities scheduled for completion by the date of this biological opinion have been completed and the majority of all proposed actions have been implemented. Full implementation of the Divide Travel Plan would continue under the 2021 HLC Forest Plan but remain under direction of the travel plan decision.

The Blackfoot Non-Winter Travel Plan and Blackfoot-North Divide Winter Travel Plan included implementation of activities outlined in the plan. Incidental take statements in both travel plans included timelines for completing specific activities to reduce incidental take of bull trout. For the Blackfoot Non-Winter Travel Plan, reports required by the incidental take statement indicate many activities intended for completion by the end of 2019 have been completed. Completion of activities outlined in terms and conditions of the Blackfoot-North Divide Winter Travel Plan are unknown. Both travel plans continue to provide access management direction under the 2021 HLC Forest Plan.

Implementation of the travel plans will improve baseline habitat conditions described above for bull trout during the life of the 2021 HLC Forest Plan. Road density and location is one of the 19 habitat indicators of the Matrix of Indicators that strongly influences the *sediment* indicator and is an attribute of the Roads and Trails indicator for WCF. Relative to habitat conditions described above, it should be realized that ratings for the Matrix of Indicators and WCF are modeled values that can be updated as effects of actions are incorporated into the modeled ratings. Results from field methods (e.g., core sampling and PIBO sediment data) will also improve during implementation of the 2021 HLC Forest Plan but may take time for improvements to be actually expressed in sampling or monitoring reports.

The Service also issued a biological opinion on effects to bull trout and bull trout critical habitat from road-related maintenance activities on federal lands west of the Continental Divide in Montana, including the 2021 HLC Forest Plan action area (U.S. Fish and Wildlife Service 2015g). The programmatic-level consultation only covers maintenance activities and does not address potential effects to bull trout from the existence of the road network on federal lands or travel management decisions that occur under the travel plan decisions. However, many of these maintenance activities can reduce sediment production and delivery to streams by improving road condition and drainage. The Service concluded the proposed road-related maintenance actions would not jeopardize the continued existence of the coterminous population of the bull trout. Maintenance activities under this programmatic consultation are reported to the Service annually. The biological opinion for road maintenance activities remains active under the 2021 HLC Forest Plan, subject to renewal as required by the biological opinion.

b. Stonewall Vegetation Project

Consultation and issuance of a biological opinion on the Stonewall Vegetation Project (U.S. Fish and Wildlife Service 2016b) in the Upper Blackfoot Geographic Area was completed in 2016 with a conclusion that the project would not jeopardize the continued existence of bull trout or adversely modify bull trout critical habitat. Initiation of the project was delayed due to litigation and major fires in the project area during 2017. The Forest notified the Service in fall 2019 of reductions to harvest units and roads for the project due to effects from the 2017 fires. After a review of the project, the Service determined that conditions for reinitiation of consultation would not be met and the project would not result in additional effects other than those analyzed in the 2016 biological opinion.

Subsequent to litigation, consultation was reinitiated and a revised biological opinion was issued April 28, 2021. For effects to bull trout from the Stonewall Vegetation Project, the Effects Code is *A4*. For designated critical habitat, the Effects Code is *A1* for PCE1 and *UN* for the remaining PCEs (see Section V. part C for definition and use of Effects Codes). This project would proceed under the 2021 HLC Forest Plan and all terms and conditions in the incidental take statement for the Stonewall Vegetation Project would apply. Analysis of effects from the fire, fire suppression, and BAER activities resulting from the 2017 Park Creek fire within the Stonewall Vegetation Project action area were consulted on and included in the environmental baseline. Expected starting date is summer or fall 2021.

c. Telegraph Vegetation Project

Consultation and issuance of a biological opinion on the Telegraph Vegetation Project (U.S. Fish and Wildlife Service 2017) in the Divide Geographic Area was completed in 2017 with a conclusion that the project would not jeopardize the continued existence of bull trout. Reporting requirements under terms and conditions of the incidental take statement and site visits have shown that the majority of activities have been completed, including stream restoration and 41 habitat improvements to a portion of the upper Little Blackfoot River and Ontario Creek. The biological opinion for this project remains active under the 2021 HLC Forest Plan to allow completion of remaining activities benefitting bull trout by 2027 as stated in the incidental take statement of the biological opinion.

d. Hogum Vegetation Project

Consultation and issuance of a biological opinion on the Hogum Vegetation Project (U.S. Fish and Wildlife Service 2021a) in the Upper Blackfoot Geographic Area was completed in 2021 with a conclusion that the project would not jeopardize the continued existence of bull trout. For effects to bull trout from the Stonewall Vegetation Project, the Effects Code is *A4*. For designated critical habitat, the Effects Code is *A1* for PCE1 and PCE2 and *UN* for the remaining PCEs (see Section V. part C for definition and use of Effects Codes). This project would proceed under the 2021 HLC Forest Plan and all terms and conditions in the incidental take statement for the Hogum Vegetation Project would apply. Expected starting date is fall 2022.

6. Climate Change

Global climate change and the related warming of our climate have been well documented. Evidence of global climate change/warming includes widespread increases in average air and ocean temperatures, accelerated melting of glaciers, and rising sea level. Given the increasing certainty that climate change is occurring and is accelerating (IPCC 2007, Battin et al. 2007), we can no longer assume that climate conditions in the future will resemble those in the past.

Model runs in the Northern Region of the USFS indicate average temperatures will continue to become warmer during the first half of the 21st century (Joyce et al. in press). Some locations in the region are expected to become drier and have more periods of drought; while overall precipitation is expected to range from 5 percent less to an increase of up to 25 percent, with a mean increase expected to be 6 to 8 percent (Joyce et al. in press). Climate is expected to reduce stream flows (Luce and Holden 2009), reduce the storage capacity associated with snowpack (Luce et al. 2014), and shift the timing of run-off in some locations (Luce et al. 2012, Luce 2018). Collectively, the Blackfoot River core area (containing the Upper Blackfoot Geographic area) is one of the three core areas that are projected to contain over 50% of the suitable cold water SR habitat for bull trout by 2080 in the Columbia Headwaters Recovery Unit and is arguably very important bull trout SR habitat that should be protected as a highest priority in the recovery unit (U.S. Fish and Wildlife Service 2015b). Additional information on climate change is provided in Section III and can be found in the 2015 recovery plan (U.S. Fish and Wildlife Service 2015).

E. Condition and Status of Critical Habitat in the Action Area

As part of the Clark Fork River Basin CHU, critical habitat in the 2021 HLC Forest Plan action area is essential for maintaining bull trout distribution within this unique geographic region that represents the evolutionary heart of the migratory adfluvial form of bull trout (U.S. Fish and Wildlife Service 2009b). Flathead Lake and Lake Pend Oreille are the two largest lakes in the range of the species. Bull trout from those core areas historically grew large and migrated upstream up to 322 km (200 mi) to spawning and rearing habitats. These habitats are considerably fragmented by hydroelectric dams and other manmade barriers but are increasingly being reconnected with removal of dams (e.g., Milltown Dam in 2008) and improved fish passage (e.g., Cabinet Gorge Dam, Thompson Falls Dam). The resident life history form of bull trout is minimally present in this CHU and fluvial bull trout play a reduced role relative to adfluvial fish. The two major lakes (Flathead Lake and Lake Pend Oreille), and over 20 additional core areas established in smaller isolated headwater lakes, are the primary refugia for the naturally occurring adfluvial form of bull trout across their range.

All critical habitat in the 2021 HLC Forest Plan action area is located in the Upper Blackfoot Geographic Area. Total length of critical habitat in the action area is 40.1 km (24.9 mi), classified as 35.9 km (22.33 mi) of SR habitat and 4.2 km (2.6mi) of FMO habitat. SR habitat is located on Copper Creek (20.4 km), Landers Fork (0.9 km), Poorman Creek (14.0 km) and a small portion of the upper Blackfoot River (0.7 km). All FMO habitat in the action area occurs on the Blackfoot River (4.2 km). Habitat ratings for the four primary habitat indicators (above) provide general habitat conditions for critical habitat in the action area.

VII. Effects of the Action

Under section 7(a)(2) of the Act, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 C.F.R. § 402.02).

Effects of the actions depend on the type of action and baseline conditions. Effects are generally greater when conditions are degraded. For example, ecological process in a stream functioning appropriately may be able to flush additional sediment through the system and suspended sediment levels may not reach the threshold to affect individual bull trout or reduce survival at spawning sites. But the same amount of sediment could result in gill abrasion, reduced macroinvertebrate production, and reduced spawning and rearing success if it is added to a stream that is below the threshold level for effects to occur.

The 2021 HLC Forest Plan is a framework programmatic action that provides management direction for future actions that may be authorized, funded, or carried out by the HLC Forest. Typical factors used to assess effects at the project level (e.g., intensity and severity of disturbance, duration of disturbance, timing of disturbance) are not applicable for framework programmatic actions. In this situation, consequences of the 2021 HLC Forest Plan are habitat conditions affecting bull trout that are reasonably certain to occur later in time (lifetime of the plan) resulting from the additive effects (both positive and negative) of projects and activities conducted under management direction of the 2021 HLC Forest Plan.

A. Aquatic Conservation Strategy

The aquatic conservation strategy in bull trout watersheds for the HLC Forest has been directed since 1995 by the INFISH amendment to the 1986 Forest Plan. After the USFS and Bureau of Land Management (BLM) provided seven additional commitments in their June 19, 1998, amendment to the BA, the Service determined that amending INFISH to Land and Resource Management Plans would not jeopardize the continued existence of the bull trout (U.S. Fish and Wildlife Service 1998). The incidental take statement for the biological opinion included 14 terms and conditions addressing six reasonable and prudent measures to reduce incidental take of bull trout. Subsequently, the 2018 biological opinion on *Effects of Ongoing U.S. Forest Service Implementation of 26 Land Resource Management Plans, as Amended by Five Aquatic Conservation Strategies, on the Threatened Bull Trout (Salvelinus confluentus) and Bull Trout Critical Habitat in Oregon, Washington, Idaho, Montana* determined the current aquatic conservation strategies, including those plans still utilizing the INFISH amendment, are not likely to jeopardize the continued existence of the bull trout or to destroy or adversely modify bull trout critical habitat (U.S. Fish and Wildlife Service 2018).

The INFISH amendment placed constraints (standards, guidelines, etc.) on actions that could further degrade habitat conditions to allow passive restoration of degraded conditions at that time. Many of the requirements developed during the INFISH consultation have been incorporated into components of the 2021 HLC Forest Plan. However, many legacy actions (e.g., historic mining activities and transportation networks) were developed under obsolete standards and outdated management strategies without the benefit of contemporary knowledge.

These legacy actions have resulted in degraded conditions in some instances that require active restoration as the only alternative for improvement.

A strategy for active restoration was not included in the INFISH amendment due to the expected 18-month interim direction it was intended to provide. Under INFISH, "*It is expected that Forests would utilize the information from watershed analysis and project development to initiate restoration projects where appropriate and funds are available*" (U.S. Forest Service 1995). The HLC Forest has conducted a number of active restoration actions to meet this intent since incorporation of the INFISH amendment in 1995.

The INFISH amendment designated "priority watersheds" specific to watersheds containing bull trout with a high restoration potential but did not mandate improvement. Criteria for INFISH priority watersheds included: (1) watersheds with excellent habitat or strong assemblages of inland native fish, with a priority on bull trout populations, (2) watersheds that provide for meta-population objectives, and (3) degraded watersheds with a high restoration potential. Under the additional commitments in their June 19, 1998, amendment during consultation on amending INFISH to Land and Resource Management Plans, commitment #3 called for the identification of "*special emphasis watersheds (within 60 days of BO signing) to ensure a comprehensive refugia network for the protection and recovery of bull trout and listed suckers*" (U.S. Fish and Wildlife Service 1998a).

In addition to changes in designation of watersheds between the INFISH amendment and the 2021 HLC Forest Plan, changes in the presence of bull trout and the importance of HUC6 watersheds to the recovery of bull trout have also occurred. Table 19 indicates the designation of HUC6 watersheds under the INFISH amendment, the 2021 HLC Forest Plan, the contribution each HUC6 watershed currently provides toward recovery of bull trout, and whether tasks addressing primary habitat threats have been identified under the 2015 bull trout recovery plan (U.S. Fish and Wildlife Service 2015). Primary threats are defined as:

> *Threat factors known or likely (i.e., non-speculative) to negatively impact bull trout populations at the core area level, and accordingly require management actions to assure bull trout persistence to a degree necessary that bull trout will not be at risk of extirpation within that core area in the foreseeable future.*

Table C8 in Appendix C from the BA (U.S. Forest Service 2021) provides a generalized crosswalk of changes other than watershed designation between the aquatic conservation strategy under INFISH and the 2021 HLC Forest Plan.

The two watersheds designated as priority watersheds under the INFISH amendment (Copper Creek and Lower Landers Fork) are designated as CWN watersheds under the 2021 HLC Forest Plan, contain a designated local population, designated critical habitat, and tasks addressing primary habitat threats have been identified. For reference here (not an official designation), we refer to these two watersheds as HLC Category 1 watersheds.

Bull trout are present, designated critical habitat occurs, and tasks addressing primary threats have been identified in five HUC6 watersheds (Table 19; Poorman Creek, Blackfoot-Little Moose Creek, Blackfoot-Hardscrabble Creek, Blackfoot-Anaconda Creek, and Humbug Creek). A sixth watershed, Arrastra Creek, contains bull trout and is considered an important watershed contributing to recovery due to indications of bull trout reproduction and genetic analysis indicating the potential for designation as a local population. Tasks addressing primary habitat threats have not been identified for Arrastra Creek under the recovery plan, although barriers to fish movement on private lands likely provide habitat limitations for this watershed. With the exception of Humbug Creek, these six watersheds are designated as part of the CWN. Three of them, Poorman Creek, Arrastra Creek, and Blackfoot-Little Moose were previously designated as special emphasis watersheds under the INFISH amendment. For reference, we refer to these six watersheds collectively as HLC Category 2 watersheds.

The presence of bull trout has been documented in six additional watersheds identified in Table 19 (Little Blackfoot-Larabee Gulch, Ontario Creek, Little Blackfoot-Hat Creek, Hogum Creek, Lower Alice Creek, and Beaver Creek). Of these six, the greatest occurrence of bull trout is in Hogum Creek and Lower Alice Creek; occurrence of bull trout has only been documented by eDNA in three of these (Little Blackfoot-Larabee Gulch, Ontario Creek, Little Blackfoot-Hat Creek) and bull trout in Beaver Creek is generally limited to the lower section due to intermittent flows and irrigation removals higher up. Current designation under the 2021 HLC Forest Plan and previous designation under the INFISH amendment are provided in Table 19. For reference, we refer to these six watersheds as HLC Category 3 watersheds.

Bull trout are considered extirpated or have never occurred in the remaining eight watersheds identified in Table 19. Four of these (Nevada Creek Headwaters, East Fork North Fork Blackfoot, Meadow Creek, and Mineral Creek) are identified as CWN watersheds under the 2021 HLC Forest Plan due to their potential to maintain cold water conditions into the future. For reference, we refer to these four watersheds as HLC Category 4 watersheds. The remaining four watersheds where bull trout are considered extirpated and the persistence of cold water does not occur (Table 19; Telegraph Creek, Mike Renig Gulch, Upper Dog Creek, and Willow Creek), were all designated as special emphasis watersheds under the INFISH amendment. For reference, we refer to these as HLC Category 5 watersheds.

1. Passive and Active Restoration

As previously discussed, constraints reducing the potential for degradation of habitat and allowing passive restoration have been incorporated into plan elements for CWN watersheds and for passive restoration of all other aquatic resources in general. In addition to the 16 watersheds within the CWN where bull trout occur or have the potential to occur, the 2021 HLC Forest Plan identified 75 watersheds east of the continental divide as CWN watersheds that do not contain bull trout. However, within the CWN identified under the 2021 HLC Forest Plan, bull trout watersheds receive the highest priority for restoration.

Table 19. Classification of watersheds under the INFISH amendment, the 2021 HLC Forest Plan, their contribution to recovery, and identification of primary threats.

	1998 INFISH Classification	2021 HLC Plan Classification	Contribution to Recovery[1]	Primary Habitat Threats [2]
Divide Geographic Area				
Little Blackfoot-Larabee Gulch	none	CWN	P	No
Ontario Creek	none	CWN	P	No
Little Blackfoot-Hat Creek	none	CWN	P	No
Telegraph Creek	special emphasis watershed	none	extirpated	No
Mike Renig Gulch	special emphasis watershed	none	extirpated	No
Upper Dog Creek	special emphasis watershed	none	extirpated	No
Upper Blackfoot Geographic Area				
Copper Creek	priority watershed	CWN	LP, CH	Yes
Lower Landers Fork	priority watershed	CWN	LP, CH	Yes
Poorman Creek	special emphasis watershed	CWN	P, CH	Yes
Arrastra Creek	special emphasis watershed	CWN	P, I	No
Blackfoot-Little Moose Creek	special emphasis watershed	CWN	P, CH	Yes
Hogum Creek	special emphasis watershed	CWN	P	No
Lower Alice Creek	special emphasis watershed	CWN	P	No
Blackfoot-Hardscrabble Creek	none	CWN	P, CH	Yes
Blackfoot-Anaconda Creek	none	CWN	P, CH	Yes
Nevada Creek Headwaters	special emphasis watershed	CWN	extirpated PCW	No

Table 19 Continued

East Fork North Fork Blackfoot	none	CWN	never occurred PCW	No
Meadow Creek	none	CWN	never occurred PCW	No
Mineral Creek	none	CWN	never occurred PCW	No
Humbug Creek	none	none	P, CH	Yes
Beaver Creek	special emphasis watershed	none	P	No
Willow Creek	special emphasis watershed	none	extirpated	No

[1] P = presence of bull trout, LP = designated local population, CH = designated critical habitat, I = important population or watershed, PCW = potential cold water refugia.

[2] watersheds where recovery tasks under the 2015 recovery plan have been identified that address primary habitat threats.

Comparatively, WCF "priority watersheds" concentrate restoration activities with the explicit goal of maintaining or improving conditions of the entire watershed but are not necessarily related to the support of aquatic species. The four designated WCF priority watersheds on the HLC Forest currently do not include watersheds containing bull trout, although designation as WCF priority can be changed at any time to adjust for changes in conditions or priorities.

The Copper Creek watershed was previously identified as a WCF priority watershed. A Watershed Restoration Action Plan (WRAP) was completed for Copper Creek in 2011 (U.S. Forest Service 2011b). Activities identified in the WRAP were completed in September 2013 (https://usfs.maps.arcgis.com/apps/MapSeries/index.html?appid=f4332e5b80c44874952b57e1db0b4407). Although the watershed condition class is now rated *Functioning Properly*, the *Roads and Trails* indicator under WCF is still rated "poor" and several indicators under the Matrix of Indicators are rated "functioning at unacceptable risk". Improvements to the Copper Creek watersheds have undoubtedly benefited bull trout, but opportunities may still exist to improve some habitat metrics specifically important to bull trout.

2. Monitoring Bull Trout Habitat Conditions and Trends

Sample size and other constraints provided by the sampling design of PIBO (Section V, Part A3) limit the effectiveness of PIBO for monitoring habitat conditions and trends in the small area on the HLC Forest where bull trout occur. The limited number of attributes PIBO measures also do not address the many habitat metrics important for bull trout habitat.

Reasonable and prudent measure #2 from the biological opinion for the INFISH amendment (U.S. Fish and Wildlife Service 1998) stated:

> *"Utilize the Level 1 team consultation process and apply the "bull trout Matrix" or a similar approach as agreed to by the agencies (USFS, BLM, and the Service; Appendices 2, 3, and 6) to evaluate actions to determine the potential effects on bull trout, and to assure interagency*

coordination to complete the consultation process. In addition, update the environmental baseline at the section 7 watershed scale to include proposed actions once consultation is concluded."

Although PIBO, the watershed condition classification of WCF, and other methods can provide additional information, the Matrix of Indicators currently provides the most comprehensive method for addressing condition and trends of bull trout habitat. Any movement away from the Matrix of Indicators (or a method agreed upon by all agencies) would reduce the efficacy of the 2021 HLC Forest Plan relative to the INFISH amendment for assessing baseline conditions, effects of actions during section consultation, and improvements that have been made from active restoration actions.

3. Riparian Habitat Conservation Areas

Riparian Habitat Conservation Areas (RHCAs) under INFISH are now called Riparian Management Zones (RMZ). As designated by FW-RMZ-STD-01, the total width of RMZs remains the same for fish-bearing streams as do widths for most other categories. RMZs are split into an inner and outer zones compared to the single width of RHCAs. Some management activities are allowed in RMZs, but standards and guidelines of riparian management zones under the 2021 HLC Forest Plan (see Appendix A Table A1 and corresponding text in Appendix A) generally constrain activities similar to the intent of Riparian Management Objectives under INFISH.

4. Effects to Baseline Habitat Conditions

The 2021 HLC Forest Plan covers 296 HUC6 watersheds east and west of the continental divide. WCF watershed condition rates 103 as functioning properly, 159 functioning at risk, and 34 as impaired. Overall, the biggest sources of impairment are aquatic biota (nonnative species), road and trail issues, and water quality impairment (2021 HLC Forest Plan, Appendix E). Unlike many National Forests throughout the range of bull trout where bull trout occur in a high percentage of watersheds and all restoration actions ultimately benefit them, the majority of the HLC Forest does not contain bull trout; the 22 HUC6 watersheds used to address effects to bull trout in this biological opinion comprise approximately 8% of the 296 HUC6 watersheds covered by the plan. Plan components allowing passive restoration and priority for bull trout under CWN provide the framework for improvement to existing habitat conditions if utilized where needed.

Use of the Matrix of Indicators identifies conditions of specific habitat metrics that are important for the survival and recovery of bull trout. Identification of habitat metrics in sub-optimal conditions furthers the ability to assess where additional restoration actions would provide the most benefits, especially in HLC Category 1 and 2 watersheds (identified above) where bull trout occur, designated critical habitat or other important habitat occurs, and where tasks addressing primary habitat threats have been identified.

5. Effects to the Species

Habitat conditions have greatly improved since the INFISH amendment was incorporated into the Forest Plan, yet opportunities exist for additional improvements that will improve the potential for survival and recovery of bull trout on the HLC Forest. The 2021 HLC Forest Plan provides the framework for continued improvements through passive and active restoration. Actual improvements and effects to bull trout under the framework of the 2021 HLC Forest Plan will depend on the ability of the HLC Forest to identify and implement additional restoration actions during the lifetime of the plan.

B. Management as Designated Wilderness

Three of the watersheds in the CWN (East Fork North Fork Blackfoot, Mineral Creek, and Meadow Creek) are currently managed as designated wilderness and will remain so under the 2021 HLC Forest Plan. They contain headwater streams for the North Fork Blackfoot designated local population of bull trout that is within the Blackfoot River core area but outside the boundary of the HLC Forest. Bull trout have not occurred within these watersheds, but the watersheds are predicted to maintain cold water habitat under a warming climate scenario, which could allow the introduction of bull trout.

1. General Effects of Management as Wilderness

Management direction for wilderness is provided by the Wilderness Act of 1964, the Forest Service Manual, and other management plans that preserve wilderness character and limit management actions relative to non-wilderness designation. Management actions are generally limited to recreational management for livestock, non-motorized trail use, and management of wildfires.

2. Effects to Habitat Indicators and the Species

Continued management as wilderness under the 2021 HLC Forest Plan would not result in any changes over existing management strategy and would result in no effect to bull trout or habitat indicators. Wildfire may result in changes to specific indicators of bull trout habitat, but conditions would be within the range of natural variability under natural fire regimes. However, future introduction of bull trout into these expected watersheds of persistent cold water would be beneficial for bull trout.

C. Access Management (Roads)

Motorized access management is a key management activity because roads are a necessity for almost all other management activities. By far, adverse effects of roads are due to placement of roads near streams, stream crossings, legacy roads not meeting current standards, and improperly maintained roads. Properly maintained roads outside riparian areas that do not serve as vectors for sediment delivery to streams pose little effect to bull trout.

The 2021 HLC Forest Plan provides management direction for the existing road network, including new roads and temporary roads for project activities, but does not make overall management decisions concerning location, road density, and status of the transportation network. As previously discussed, (Section VI, Environmental Baseline) travel management in the action area currently remains under direction of the Divide Travel Plan, the Blackfoot Non-Winter Travel Plan and Blackfoot-North Divide Winter Travel Plan.

1. General Effects of Roads

Roads will continue to result in adverse effects to bull trout under the 2021 HLC Forest Plan. New permanent and temporary roads under the plan would increase sediment delivery during and after construction if they are built near streams or include stream crossings. Many existing roads are a chronic source of sediment to streams that adversely affect bull trout. The severity of ill effects (SEV) model developed by Newcombe and Jensen (1996) indicated that even low concentrations of increased sediment over long periods can adversely affect bull trout. Anderson et al. (1996) used the methods of Newcombe and Jensen (1996) to develop a similar model to estimate sediment impacts to salmonid habitat that indicated adverse effects to habitat from low concentrations over long periods.

Road density and location is the primary reason for FUR ratings for the *sediment* indicator in HUC6 watersheds. Ratings of FAR and FUR for barriers are directly related to stream crossings (typically in the form of culverts) that impede fish passage. Roads near streams reduce the rating of the *temperature* indicator because roads reduce vegetative cover, and thus stream shading and can decrease water depth of pools that can both lead to increased solar gain and water temperature increases. Roads can also reduce the amount of large woody debris in streams that is a precursor for pool formation, reducing the rating for the *pool frequency and quality* indicator.

2. Effects to Habitat Indicators and the Species

Under the 2012 HLC Forest Plan, the three guidelines specific to the CWN (FW-CWN-GDL-01, 02, 03) have the most potential to reduce road effects to bull trout and bull trout habitat. HLC Forest-wide objective FW-FAH-OBJ-01 that calls for improvement to habitat quality and function of at least 20 miles of aquatic habitat with a focus on streams with listed species or species of conservation concern can benefit bull trout if applied to bull trout occupied streams. Other HLC Forest-wide plan components, such as those specific to roads and trails, would also reduce adverse effects to bull trout from HLC Forest roads.

D. Vegetation Management

1. General Effects of Vegetation Management

Even though the 2021 HLC Plan limits vegetation management near streams, actions outside RMZ's can impair water quality and alter stream morphology by routing runoff and sediment onto bottomland streams when conducted too close to streams or on unstable grounds above streams. The loss of forest canopy in harvest sites can also alter the water balance of an aquatic ecosystem by reducing evapotranspiration, increasing soil moisture, and modify rain interception and snow accumulation patterns. In the Pacific Northwest, excess water from harvest areas influenced the peak and timing of stream flows (Keppeler and Ziemer 1990, Moore and Wondzell 2005, Stednick, 1996). In reviews, these cases depended largely on the extent of harvest and the climatic regime (Grant et. al 2008). The effect diminishes in time as vegetation re-establishes. Altering streamflow can also influence stream temperature (Swanston 1991), although the principal factor affecting stream temperature is a reduction in riparian vegetation along streams (Beschta et. al 1987, Gomi et. al 2006, Macdonald et. al 2003). Elliot et al. (2000) found that erosion after disturbance from timber harvest typically lasted 1 to 3 years.

Prescribed fire associated with timber harvests have varying effects on aquatic ecosystems. In addition to beneficial aspects, burned areas can accelerate runoff due to soil sealing from ash that lowers the infiltration capacity of soils (Doerr et al. 2006, Larsen et al. 2009). These conditions vary spatially and decrease over the first year as products of burning in the soil degrade (Doerr et al. 2006, Wondzell and King 2003). Other factors that increase runoff from harvest and burn areas are steep slopes, low groundcover, and long slope lengths (Elliot 2013). Runoff transports loose soil particles and deposits sediment down the slope proportional to runoff energy. The following section provides additional influences of prescribed fire.

Studies have documented increased sediment erosion associated with timber harvest, but the primary cause is sediment from roads (Bilby et al. 1999, Sugden and Woods 2007). Skid trails, yarding, construction of new and temporary roads and log hauling on established roads all contribute to potential sediment increases due to roads. See section B above on access management for additional effects of roads due to vegetation management.

2. Effects to Habitat Indicators and the Species

Effects from vegetation management were reduced when the 1986 Helena HLC Forest Plan was amended by INFISH in 1996. Development of standards, guidelines, and RHCAs under INFISH regulated the extent of upland timber harvest, applied best management practices (BMP's) to limit stream connectivity to the road system and landings, and required entries into RHCAs were to the benefit of the RHCA. Current vegetation management in harvest units generally has very low erosion rates outside of harvest units. When harvest activities and yarding are kept greater than 10 meters away from streams, 95% of sediment created in harvest units does not travel to the stream edge (Rashin et al. 2006).

The 2021 HLC Forest Plan would continue to limit timber harvest in the inner RMZ unless it restores or enhance aquatic and riparian-associated resources through non-mechanical treatments, (FW-RMZ-STD-02), limits treatment in outer RMZ to project activities that do not prevent attainment of desired conditions for wildlife in the inner RMZ (FW-RMZ-STD-03), and prevents salvage harvest in the inner RMZ (FW-RMZ-STD-06). Commercial-sized trees in the outer RMZ could still be removed, including the use of motorized machinery, but need to be for the benefit of other resources such as silviculture or terrestrial wildlife.

Although management direction under the 2021 HLC Forest Plan would reduce effects to the four key indicators from actual harvesting activities, increases in the *sediment* indicator would still occur from the hauling portion of vegetation management projects when roads occur near streams and at stream crossings. Depending on the amount of harvest and existing conditions, harvest activities could reduce the Forest Cover indicator of WCF that influences watershed condition through the terrestrial biological process.

Although guideline **FW-CWN-GDL-01** states "*net increases in stream crossings and road lengths should be avoided in RMZs*", guidelines allow for departure from terms of the guideline, as long as the purpose of the guideline is met. Any new permanent and/or temporary project roads would increase open road density and degrade associated indicators of the Matrix of Indicators and WCF indicators. The initial implementation of road BMP's at the start of project implementation also creates ground disturbance that increases sediment production and delivery to streams until vegetation becomes re-established. Effects to bull trout from additional sediment due to log hauling will be more pronounced where the environmental baseline is currently degraded due to sediment.

E. Fuels Management

1. General Effects of Fuels Management

Historically, wildfire created natural disturbances across USFS lands. Fire suppression activities that have occurred over the last century have altered the natural successional processes that occur, especially when combined with climate change. In many situations, suppression of natural fire regimes has resulted in forests with more trees and associated leaf area that results in higher evapotranspiration and interception levels. Lack of fire can also lead to the encroachment of woody species into other habitats that results in competitive exclusion of herbaceous species. Fire suppression causes unnatural levels of fuels to accumulate.

When wildfire does occur, the intensity and severity are often higher than they would be with more natural levels of fuels. The end result for aquatic systems is reduced flows under long-term fire suppression and major alterations to watersheds when they do occur. High intensity fire can change infiltration characteristics of soils and alter entire hydrologic characteristics of watersheds when they occur over large areas (Doerr et al. 2000, Cannon et al. 2010). Fires that remove riparian vegetation and ground cover cause soil erosion and sedimentation in nearby water bodies and loss of important transitional habitats for aquatic dependent species (Zwolinski 2000). Active fire suppression activities, such as retardant use, water drafting from streams, building containment lines, and heavy road use can also adversely affect bull trout.

The purpose and methods of fuels management have long been controversial, ranging from intensive HLC Forest-wide management to no fuel's management. As a compromise between these extremes, Rieman et al. (2000) stated; "By working strategically it may be possible to establish mosaics of fuel and forest conditions that reduce the landscape risk of extremely large or simultaneous fires without intensive treatment of every subwatershed." They also suggested recovery of function in some watersheds may not be possible without some human intervention. No matter the strategy, fuels management for resource protection will likely be a part of HLC Forest planning into the future.

Typical fuels management projects include combinations of thinning, harvesting, and burning to reduce dead and down fuels, total fuels, and ladder fuels. Although the 2021 HLC Forest Plan provides guidance for actively fighting fires when they do occur (e.g. FW-RMZ-GDL-02, 05, 06, 08, 10 addressing fire lines, camps, machinery, etc.), many decisions during fires occur on a case-by-case basis. Addressing effects to bull trout from firefighting activities is not part of this management action and strategy; it is covered under separate emergency consultation for each incident.

2. Effects to Habitat Indicators and the Species

Similar to vegetation management, HLC Forest plan components limit fuels management in the RMZ. When using prescribed burning, some burn units may have fireline constructed which exposes bare soil. Standard erosion control practices or BMP's are typically applied to minimize sediment production. Rare instances of storm-event erosion, channeling of water down soil depressions, or minor road surface erosion from equipment use may result in minor additional fine sediment loads in streams proximate to operations. The magnitude of the expected sediment increase is small, and the minor additional load that may result from prescribed fire treatments typically results in immeasurable and discountable effects to bull trout and bull trout habitat.

Fuels management would also not be expected to modify any of the key habitat indicators and could improve the Fire Regime or Wildfire indicator for the WCF rating.

F. Livestock Grazing

1. General Effects of Livestock Grazing

Livestock grazing takes place across much of the action area and is a substantial component of management on the HLC Forest west of the continental divide. There are currently twelve allotments in the Blackfoot River core area that total 87,709 acres and five allotments totaling 53,167 acres in the Upper Clark Fork core area or the Little Blackfoot drainage. While conditions in general have improved over the course of the 1986 Helena National Forest plan, there are likely localized adverse effects from current and past management activities.

Livestock grazing near low-gradient unconfined streams can result in changes in channel morphology (Platt 1991, Belsky and Gelbard 2000). Livestock trailing and general soil displacement along stream bank areas can result in collapse of undercut bank areas and an overall increase in bank angle, loss of bank cover, and stream widening along the entire stream reach. Over long periods of time, grazing can lead to an entire channel becoming down-cut to the point that gully erosion is initiated and a new channel is formed at the bottom of the gully. This type and extent of downcutting results in a change in channel type. Livestock trampling streambanks can increase ground exposure, surface erosion, and sedimentation. Concentrated livestock waste can contribute to eutrophication of lakes and ponds. Grazing directly in wetlands or immediately adjacent to them can cause soil compaction, hummocking, and loss of vegetation, ultimately inhibiting subsurface water flow. Trampling of redds can occur when grazing occurs along spawning reaches in the fall.

Perennial vegetation on or near the water's edge (greenline) in low-gradient stream reaches encounters the most erosional stress during floods. Flooding is a natural disturbance process that maintains heterogeneity in riparian and in-stream structure, function, and composition (Naiman and Decamps 1997). Riparian vegetation has the best opportunity to slow velocity and induce deposition of materials, stabilize banks, and re-create channel pattern, profile, and dimension appropriate for the landscape setting. Where streambank instability or changes in channel form may arise from channel widening or channel incision, vegetation along the greenline is most critical. This is particularly important for alluvial, or "self-forming" channels (Leopold et al. 1964). Depending on site potential, greenline, riparian, and floodplain plant communities also contribute wood and aid floodplain energy dissipation, sediment and nutrient sequestration, and aquifer recharge (Swanson et al. 2015).

2. Effects to Habitat Indicators and the Species

HLC Forest-wide guidelines FW-GRAZ-GDL-01, 02, 03, 04, 05, 06 and 07 are intended to reduce bank trampling and minimize livestock operations within RMZs, particularly when new or revised allotment management plans are implemented. However, localized degradation to *sediment*, *temperature*, and *pool frequency and quality* would likely occur whenever grazing occurs along streams.

Adaptive management and monitoring are key factors to achieving desired conditions. Grazing can either improve or degrade the Rangeland Vegetation indicator for the WCF classification depending on grazing practices and resulting conditions. Where problems exist or develop, reducing the length and timing of grazing in the RMZ would allow for more residual growth of grasses and forbs that capture overland flow, prevent rills from forming, prevent erosion from delivering sediment to water bodies, and reduce bank trampling. For pastures near spawning streams, ending the grazing season prior to the bull trout spawning season would reduce the potential for trampling of redds.

G. Recreation Outside Designated Wilderness

1. General Effects of Recreation

Permanent development and campground facilities in riparian areas can result in sediment increases to nearby streams, loss of stream bank vegetation, and reduced water infiltration. Associated human activities, such as off-highway vehicle use on trails and stream bank trampling, can also decrease ground cover and increased soil disturbances. Direct effects to channel morphology include the loss of pool volumes, habitat complexity, and decrease in the size of stream channel substrate. Recreational use, primarily from All Terrain Vehicles (ATV), can cause soil compaction and loss of vegetation in wetlands and/or directly adjacent to them, thereby reducing sub-surface water flow and increase surface runoff. Increases in surface runoff may contribute sediment to streams and associated aquatic habitats, depending on the proximity or connectivity to the hydrologic network.

Motorized recreation is a growing concern as use increases and off-road vehicle technology improves. Off-highway vehicles are becoming more powerful, have better suspension, and better traction than ever before. With the advent of improved technology, visitors will be able to legally access areas previously unattainable by off-highway vehicles, which may contribute cumulatively to effects on soils and aquatic resources. Off-road vehicle use is anticipated to increase even more into the future, as populations increase. Along with this increased use there may an associated increase in effects to soil and aquatic resources.

Non-motorized and motorized watercraft use can “disturb” or “stress” adult and juvenile fish. Typical activities associated with non-motorized use include floating, wading, and swimming in areas where fish are holding, rearing, or spawning. Studies conducted on the Rogue River in Oregon have shown that juvenile salmon and steelhead that were passed by non-motorized watercraft exhibited both behavioral and physiological signs of stress (Satterthwaite 1995). The energy expended by juvenile salmonids reacting to passing watercraft may result in a reduction in energy available for growth and development. A decrease in available energy stores may also reduce their effectiveness in competing for food, defending territories, or spawning.

2. Effects to Habitat Indicators and the Species

Recreational use will almost certainly increase in the coming decades. Desired conditions for recreational opportunities (FW-REC-DC-04) are for minimal impacts on resources, including aquatic species. Plan components limit recreational development near streams and travel plans limit road and trail access by motorized vehicles. However, recreation would likely result in isolated increases in sediment produced and delivered to streams, resulting in adverse effects to the *sediment* indicator. Reduction in stream shading from recreational development and activities and increased sediment could also increase water temperature.

H. Mining and Minerals Management

1. General Effects of Mining and Minerals Development

Mining and Minerals Development includes a wide range of activities. Hard rock minerals include deposits of gold, silver, copper, etc. There are no existing large-scale mining operations in the action area, but there is substantial activity with recreational and small-scale mining, including suction dredging, placer, and lode claims that may occur near and adjacent to bull trout habitat, especially in areas of historic lode or placer mining activities. Unless an authorized officer determines that an activity is or will cause a significant disturbance to surface resources, a Plan of Operations is not likely required. Recreational mining activities often do not require USFS authorization in advance, but factors such as access, scale, and duration may dictate otherwise. Suction dredging is regulated by federal and state mining laws and regulations.

Montana developed guidelines for instream mining in the early 1980's to help determine how to take stream class into account during permitting decisions. Guidelines include a list of streams that provides guidance for each stream classification based on the spawning and incubation periods for fish species present. Based on these guidelines, Class 1 and 2 streams are closed, Class 3 and 4 streams are seasonally restricted, and Class 5 streams are open year-round. Guidelines for known occupied bull trout streams identify them as closed to suction dredging to preclude impacts from mining in those streams.

Large increases in mining activity are not anticipated but cannot be ruled out. The 1872 Mining Law limits USFS authority over mining activities but allows the setting of terms and conditions to minimize impacts on USFS lands. Access to a mining operation on USFS lands must be reasonable as defined by law and statute. New roads, trails, or other types of access may be approved for a proposed mining operation if the proposal is incidental to mining and within the scope of the next logical phase of mining development.

Recommended Wilderness Areas (RWA) are open to mineral entry under the U.S. mining laws until such time as they are congressionally withdrawn from mineral entry, subject to valid existing rights. As of June 2018, there are over 100 unpatented mining claims within the Nevada Mountain RWA boundaries that result in a very high potential for future mineral prospecting, exploration, and development. Mining activities may still occur in designated wilderness areas if the proponent has valid existing rights.

There is no current exploration or development activity for oil or gas development in the action area and little occurrence for coal or other nonrenewable leasable minerals due to the geology of the area. The potential for exploration and leasing for geothermal development is low. Salable minerals include common varieties of sand, stone, gravel, cinders, pumice, rock, clay, petrified wood and other similar materials. In general, gravel pits are situated away from riparian areas and tend not to affect watersheds or riparian areas. There are no known active mineral leases for salable minerals on the HLC Forest in the action area.

2. Effects to Habitat Indicators and the Species

Adverse effects from mining and mineral extraction are likely to occur in the action at some point during the life of the 2021 HLC Forest Plan, especially for hard rock minerals. Existing laws (e.g. 1872 Mining Law) supersede the HLC Forests ability to restrict mining. The 2021 HLC Forest Plan would require actions to maintain, protect, and rehabilitate fish and wildlife habitat and soil and water resources if plan of operation permits are approved, similar to the 1986 HLC Forest plan as amended by INFISH. Direct and indirect adverse effects to all key habitat indicators, indicators of WCF, and associated adverse effects to bull trout could occur from mining and mineral development depending on the type of activity, extent and location of operation, and duration of activities.

I. Monitoring Program

As stated in the 2012 Planning Rule and reiterated in the biological opinion for the 2012 Planning Rule (U.S. Fish and Wildlife Service 2012), each plan monitoring program must contain one or more monitoring questions and associated indicators addressing the status of a select set of the ecological conditions required under §219.9 to contribute to the recovery of federally listed threatened and endangered species, conserve proposed and candidate species, and maintain a viable population of each species of conservation concern (36 CFR 219.12(a)(5)(iv)).

Monitoring questions MON-WTR-01, 05, 06, 07 and MON-FAH-02 (Appendix A Table A2) provide monitoring questions for all aquatic resources that are relevant to bull trout but do not specifically address the status of ecological conditions that would contribute to the recovery of bull trout.

Table C8 in Appendix C from the BA (U.S. Forest Service 2021) identifies use of PIBO at the HLC Forest scale for effectiveness monitoring of the aquatic conservation strategy. Although PIBO data at this scale would monitor the overall effectiveness of the aquatic conservation strategy on the entire HLC Forest, it will not accurately address watersheds specific to bull trout. As discussed for effects of the aquatic conservation strategy, the 2021 HLC Forest Plan covers 296 HUC6 watersheds, however bull trout only occur, or have the potential to occur, in 23 (8%) of the HUC6 watersheds on the HLC Forest. Effectiveness monitoring for bull trout watersheds would likely be biased by changes in the relatively numerous non-bull trout watersheds. Similarly, PIBO results at the national scale would also not address effectiveness monitoring specific to the HLC Forest.

Some past consultation monitoring requirements included core sampling and remain active under the 2021 HLC Forest Plan. Although core sampling provides a metric important for the recovery of bull trout, it is time and labor intensive and therefore difficult to collect enough samples to extrapolate across HUC6 watersheds or larger areas. Therefore, one of our conservation recommendations (#7) is to develop a revised and expanded sediment monitoring program to replace core sampling requirements.

Ratings from the Matrix of Indicators and WCF are specific to HUC6 watersheds that do not rely on trends or status of other watersheds. Although they are not as accurate as extensive watershed analysis can provide, they can be readily updated to reflect changes in metrics of attributes used in their calculation. Both methods address conditions important to bull trout; the Matrix of Indicators identifies specific habitat attributes and WCF address overall watershed condition and processes.

VIII. Population Response

A. Designated Local Populations

Designated local populations of bull trout are generally independent populations that represent discrete reproductive units. The Landers Fork local population in the Blackfoot Core Area is the only designated local population that could be affected by the 2021 HLC Forest Plan. It is one of six local populations in the core area but the only local population in the action area. The action area does not overlap any of the three designated local populations in the Upper Clark Fork Core Area. Although projects resulting in adverse effects to bull trout may occur under the 2021 HLC Forest Plan, the plan is a framework programmatic action that in itself would not result in adverse effects to bull trout or bull trout habitat. All projects proposed under the 2021 HLC Forest Plan would undergo separate section 7 consultation for specific effects to bull trout.

B. Other Remnant Populations

The HLC Forest designated other remnant populations in 12 HUC6 watersheds (Poorman, Blackfoot River-Anaconda Creek, Blackfoot River-Hardscrabble Creek, Lower Landers Fork, Arrastra, Blackfoot River-Little Moose Creek, Lower Alice, Hogum Creek, Headwaters of Nevada Creek, Larabee Gulch, Hat Creek, and Ontario Creek). All of these HUC6 watersheds are in the action area and could be affected by the 2021 HLC Forest Plan. Similar to designated local populations, other remnant populations may be adversely affected by projects conducted under the 2021 HLC Forest Plan. However, effects are considered separately from effects to designated local populations that are considered under the hierarchical order for the jeopardy determination.

C. Core Areas

The 2021 HLC Forest Plan would not directly affect any designated local population; therefore, it would not change the viability of the Blackfoot River Core Area or the Upper Clark Fork Core Area.

D. Recovery Unit

Because the 2021 HLC Forest Plan would not impair the viability of either core area, it would not impair or preclude the capacity of the Columbia Headwaters Recovery Unit from providing both the survival and recovery function assigned to it.

IX. Effects to Designated Critical Habitat

As previously stated, the 2021 HLC Forest Plan is a framework programmatic action that only provides management direction for future actions that may be authorized, funded, or carried out by the HLC Forest. Consequences of the 2021 HLC Forest Plan to designated bull trout critical habitat would occur later in time (lifetime of the plan) resulting from the additive effects of projects and activities conducted under management direction of the 2021 HLC Forest Plan. Similar to the previous analysis for effects to the species and bull trout habitat, effects to designated critical habitat for each management category are addressed. See Section V for a description of the PCEs that comprise critical habitat.

1. Aquatic Conservation Strategy

Management direction under the aquatic conservation strategy provides the potential to improve all PCEs of designated critical habitat.

2. Management as Designated Wilderness

The three HUC6 watersheds managed as designated wilderness to not contain critical habitat, therefore, there would be no effect to critical habitat for this management category to

3. Access Management (Roads)

Access management predominately affects critical habitat by increases in sediment, therefore this management activity could affect PCEs 1, 2, 3, 4 and 6. Effects to the PCEs of critical habitat from the transportation network were previously analyzed during consultation on the Blackfoot Non-winter Travel Plan (U.S. Fish and Wildlife Service 2016). Full implementation of the travel plan, including improvements to indicators not functioning appropriately due to road management will improve conditions in watersheds containing critical habitat. Additionally, components of the 2021 HLC Forest Plan that emphasize road decommissioning, regular road maintenance, removal of barriers at stream crossings, and motor vehicle use designations to move roads away from riparian areas would reduce but not eliminate additional effects to bull trout critical habitat during the life of the plan.

4. Vegetation Management

Similar to access management, vegetation management can generate sediment due to ground disturbing activities when harvest units are located near streams and from increased use of roads by log trucks for hauling. PCEs 1, 2, 3, 4 and 6 may be affected. Plan components that emphasize maintenance of RMZ functions, placement of temporary roads for log hauling, and regular road maintenance, will reduce but not eliminate effects to bull trout critical habitat.

5. Fuels Management

Prescribed fire and hand thinning for fuels management would have little effect to designated critical habitat and, if effective, would reduce temporary adverse effects that major fires can have on designated critical habitat. High-intensity fire can alter infiltration characteristics of soil and hydrologic characteristics in watersheds when they occur over large areas, resulting in increased erosion, higher peak flows, and the potential for mass wasting. Reduction in major fires would also reduce additional sediment from high road use during fire suppression activities and reduce the potential for misapplication of fire retardant.

6. Livestock Grazing

Grazing in riparian areas and trampling or trailing along streambanks may increase runoff, reduce sediment filtration of riparian vegetation, and reduce streambank stability and overhanging vegetation. These effects can reduce the function of PCEs 1, 2,3,4,5, and 6. If followed, plan components that limit grazing in riparian areas along bull trout critical habitat can limit these effects.

7. Recreation

High use of trails near streams and stream crossings, especially those allowing motorized access can result in increased erosion and sediment delivery to streams. Recreational fishing can result in trampling of redds and streambank vegetation. However, dispersed camping poses the greatest threat to designated critical habitat where continuous use compacts soils and degrades streambanks. Increased erosion, sediment, and effects to PCE6 may occur in these situations. Full implementation of the Blackfoot Non-winter Travel Plan will prohibit dispersed camping within 30 feet of riparian areas, including those containing designated critical habitat. FW-REC-OBJ-01 of the 2021 HLC Forest Plan calls for rehabilitation of at least 5 dispersed recreation sites HLC Forest-wide (development scale 1-2) but does not specifically address dispersed campsites along bull trout critical habitat. Continued effects to PCE6 from some recreational activities could continue to occur under the 2021 HLC Forest Plan.

8. Mining and Minerals Development

Mining and mineral develop covers a range of scenarios, from one-person suction dredges to multi-acre open pit and underground mines. Effects to critical habitat are more likely where the USFS authorities are limited such as with the 1872 mining law. Depending on the type and magnitude of activity, effects could occur to all PCEs except PCE 9 under the 2021 HLC Forest Plan.

X. Cumulative Effects

The implementing regulations for section 7 define cumulative effects as those effects of future state, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Generally, stream systems in the action area originate on the HLC Forest in protected headwaters and flow downstream onto lands owned or administered by private, state, local, or tribal entities. Many fish populations, whether they move off the HLC Forest during their life cycle or remain entirely on the HLC Forest, require stream interconnectivity to survive as a viable population over time. For almost all species, genetic interchange between subpopulations is necessary to maintain healthy fish stocks, particularly at low population densities. The more wide-ranging the species or the life history pattern, the more critical interconnectivity is in order for the fish to access habitat components critical to maintain the population. Thus, activities on state, tribal, local, or private lands that disrupt fish migration corridors can have significant impacts to populations upstream even when habitat is maintained and enhanced on the HLC Forest.

Activities on non-federal lands that cumulatively could affect bull trout and bull trout critical habitat include green tree timber harvest, salvage timber harvest, log hauling on unpaved county and private roads, use of private roads for accessing HLC Forest lands, road maintenance or reconstruction, domestic livestock grazing, construction or maintenance of power transmission corridors, maintenance of existing communication lines, use and maintenance of irrigation diversions, crop production, herbicide application for weed control, residential development, and incidental harvest of bull trout. At present, there are not any known foreseeable activities on these non-federal lands that would result in adverse effects to bull trout.

Non-native fish species are identified as a primary threat in both core areas (U.S. Fish and Wildlife Service 2015b). The extent to which non-native fish populations grow in both size and distribution is largely under the control of environmental factors and management direction of state natural resource agencies.

Angler harvest and poaching has been identified as one reason for bull trout decline (U.S. Fish and Wildlife Service 2015b). It is likely that recreational fishing, especially in known spawning streams in the fall, will increase as the human population in western Montana increases. Misidentification of bull trout has been a concern because of the similarity of appearance with brook trout. Although harvest of bull trout is illegal in this action area, incidental catch does occur. The fate of released bull trout is unknown, but some level of hooking mortality is likely due to the associated stress and handling of the fish (Long 1997). Unintentional and illegal harvest could have a direct effect on the resident bull trout population and possibly the migratory adfluvial component of bull trout populations in Montana. The extent of the effect is dependent on the amount of increased recreational fishing pressure, which is a function of the increased number of fishermen each season. Illegal poaching is difficult to quantify, but generally increases in likelihood as the human population in the vicinity grows (Ross 1997).

Cumulative effects within the action area are reflected in bull trout population numbers, life history forms, and habitat conditions. Both core areas are at risk of increased human population growth and increased activities that may affect bull trout. Concern for the viability and effects to bull trout populations are well documented (U.S. Fish and Wildlife Service 2015b). Activities occurring on private lands at the same time the proposed federal activities are occurring may result in additive adverse effects to bull trout, at least in the short-term. However, some non-federal activities will likely improve conditions for bull trout over the long-term and will work in conjunction with federal actions toward recovery of bull trout in some instances. Since the proposed action is programmatic in nature, it does not in itself mandate or approve future implementation of activities on the HLC Forest. Any future actions would undergo separate analysis and consultation related to the effects to listed species and/or critical habitat. Any site-specific information of future activities that will occur on non-federal land that may contribute to cumulative effects would be considered at that time.

XI. Conclusions

The Service agrees with the Forest's determination that the 2021 HLC Forest Plan *may affect and is likely to adversely affect* bull trout and designated bull trout critical habitat.

The Service finds that the 2021 HLC Forest Plan has the potential to temper the magnitude and duration of direct and indirect adverse effects and enhance the potential for beneficial effects of Forest land management actions on the bull trout and its critical habitat to an extent that these activities, taken together with cumulative effects, are not likely to (1) reduce appreciably the likelihood of both the survival and recovery of the bull trout in the wild by reducing reproduction, numbers or distribution, or (2) impair or preclude the capacity of critical habitat in the action area to serve its intended conservation function to an extent that appreciably diminishes the rangewide value of bull trout critical habitat for the conservation of the listed species.

Our jeopardy analysis for bull trout and adverse modification analysis for designated bull trout critical habitat follows.

A. Jeopardy analysis of the Coterminous Bull Trout Population

After reviewing the current status of bull trout, the environmental baseline (including effects of federal actions covered by previous biological opinions) for the action area, management direction provided by the 2021 HLC Forest Plan, and cumulative effects, it is the Service's biological opinion that the action as proposed is ***not likely to jeopardize the continued existence of the coterminous United Stated population bull trout***. This conclusion is based on the magnitude, timing, frequency, and duration of project effects to reproduction, distribution, and abundance in relation to the listed population. Implementing regulations for section 7 (50 CFR 402) defines "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species." Our conclusion is based on, but not limited to, the information presented in the 2021 revised biological assessment (U.S. Forest Service 2021), correspondence during this consultation process, information in our files, and informal discussions between the Service and the HLC Forest.

Jeopardy determinations for bull trout are made at the scale of the listed entity, which is the coterminous United States population (64 FR 58910). This follows the April 20, 2006, analytical framework guidance described in the Service's memorandum to Ecological Services Project Leaders in Idaho, Oregon and Washington from the Assistant Regional Director – Ecological Services, Region 1 (U.S. Fish and Wildlife Service 2006). The 2006 policy guidance indicates that a biological opinion should concisely discuss all the effects and take into account how those effects are likely to influence the survival and recovery functions of the affected [then] Interim Recovery Units [now final Recovery Units under the 2015 bull trout recovery plan], which should be the basis for determining if the proposed action is "likely to appreciably reduce both survival and recovery of the coterminous United States population of bull trout in the wild."

As discussed earlier in this biological opinion (see Part IV), the approach to the jeopardy analysis in relation to the proposed action follows a hierarchical relationship between units of analysis (i.e., geographical subdivisions) that characterize effects at the lowest unit or scale of analysis (the local population) toward the highest unit or scale of analysis (the Columbia Headwaters Recovery Unit). The hierarchical relationship between units of analysis (local population, core areas) is used to determine whether the proposed action is likely to jeopardize the survival and recovery of bull trout. As mentioned previously, should the adverse effects of the proposed action not rise to the level where it appreciably reduces both survival and recovery of the species at a lower scale, such as the local or core population, the proposed action could not jeopardize bull trout in the coterminous United States (i.e., range wide). Therefore, the determination will result in a no-jeopardy finding. However, should a proposed action cause adverse effects that are determined to appreciably reduce both survival and recovery of the species at a lower scale of analysis (i.e., local population or core area), then further analysis is warranted at the next higher scale.

The proposed action represents a programmatic decision that does not authorize, fund, or carry out specific future actions, and therefore, would have no direct effects on listed species or their habitats. The 2021 HLC Forest Plan provides the direction under which future management decisions would be made. Any direct or indirect effects would occur later, during individual project or program implementation when site-specific decisions are made based on Revised HLC

Forest Plan direction. All project level activities may be subject to consultation, as appropriate, under the Endangered Species Act prior to implementation.

Minimization of the effects of land management activities on bull trout and their habitats is controlled through the management direction provided for in the 2021 HLC Forest Plan. Baseline conditions are expected to improve where restoration actions (passive and active) are implemented in combination with conservation of watersheds currently in proper functioning condition. Adverse effects are expected to occur in both core areas as a result of forest management activities that would be reasonably expected to be implemented over the life of the 2021 HLC Forest Plan. Effects to bull trout and their habitat would primarily be attributable to short-term sediment generation through management activities authorized by the plan. The level of effects is not expected to result in discernible negative impacts to core area populations.

Our no-jeopardy determination is based on the conclusion that management direction provided by the plan would not rise to the level of appreciably reducing: (1) the survival of any designated local population or other important populations of bull trout, and, (2) the potential for recovery of a Core Area. Our rationale for this conclusion is based on the following:

> *Survival* – Survival is the condition in which a species continues to exist into the future while retaining the potential for recovery (U.S. Fish and Wildlife Service and National Marine Fisheries Service, 1998). Projects that appreciably reduce the survival of any designated local populations or other important populations of bull trout could potentially occur under management direction of the 2020 Plan. However, the plan itself does not authorize those projects and all projects resulting in adverse effects to bull trout would undergo separate project-specific analysis and section 7 consultation.
>
> *Recovery* – Recovery is improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in section 4(a)(1) of the Act (50 CFR 402.02). For bull trout, Core Areas are the basic unit to gauge recovery within a recovery unit (U.S. Fish and Wildlife Service 2015). The 2021 HLC Forest Plan would not prevent recovery of bull trout in the Blackfoot River Core Area or Upper Clark Fork Core Area for two reasons: (1) the plan provides direction that can improve habitat conditions that can promote recovery, and, (2) any project that could potentially limit recovery would undergo separate analysis and section 7 consultation.

Because the 2021 HLC Forest Plan would not appreciably reduce the survival of a designated local population or other important population, nor the recovery of the Blackfoot River Core Area or the Upper Clark Fork Core Area, the proposed action could not jeopardize bull trout at the next higher analysis units, the Columbia Headwaters Recovery Unit. Therefore, by extension, the Service concludes that the 2021 HLC Forest Plan would not appreciably reduce both the survival and recovery of the coterminous United States population of the bull trout in the wild.

B. Adverse Modification Analysis

Pursuant to current national policy and the statutory provisions of the Act, destruction or adverse modification is determined on the basis of whether, with implementation of the proposed action, the affected critical habitat would remain functional (or retain the current ability for the Primary Constituent Elements to be functionally established) to serve the intended conservation role for the species. After reviewing the current status of the Blackfoot River Critical Habitat Subunit and its relationship to the Upper Columbia River bull trout population, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's opinion the actions as proposed are not likely to destroy or adversely modify bull trout critical habitat.

Pursuant to current national policy and the statutory provisions of the Act, *destruction or adverse modification* means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR 402.02).

The approach to the adverse modification analysis in relation to the proposed action follows a hierarchical relationship between units of analysis. The hierarchical relationship between units of analysis (e.g., stream segment, critical habitat subunit) is used to determine whether the proposed action is likely to adversely modify designated bull trout critical habitat. Should the adverse effects of the proposed action not rise to the level where it appreciably diminishes the value of critical habitat at a lower scale, such as the individual stream segment or subunit, the proposed action could not adversely modify bull trout critical habitat at larger scales such as the critical habitat unit or the coterminous United States (i.e., range wide). Therefore, the determination will result in a no adverse modification finding.

The proposed action represents a programmatic decision that does not authorize, fund, or carry out specific future actions, and therefore, would have no direct effects on critical habitat. Any direct or indirect effects would occur later, during individual project implementation after site-specific decisions are made using the 2021 HLC Forest Plan direction. Many plan elements are designed to minimize or limit activities and effects in riparian areas. These plan elements combined with the small amount of designated critical habitat that would likely be affected are not expected to reduce the conservation value within the critical habitat unit as a whole. Because they are not expected to reduce the conservation value of an individual critical habitat unit, they would not adversely modify critical habitat on a range-wide basis. Therefore, the Service concludes that implementation of the proposed action is not likely to destroy or adversely modify designated critical habitat.

Incidental Take Statement

Section 9 of the Act, and Federal regulations pursuant to section 4(d) of the Act, prohibit the *take* of endangered and threatened species, respectively without special exemption. *Take* is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. *Harm* is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns, including breeding, feeding, or sheltering. *Harass* is defined by the Service as an intentional or negligent act or omission that creates the likelihood of injury to listed wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. *Incidental take* is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The direction contained in the 2021 HLC Forest Plan, when implemented, has the potential to adversely affect bull trout in some instances even if other aspects of the Plan will contribute to the conservation and recovery of bull trout. Thus, the Service anticipates that implementation of Plan will likely impart a level of adverse effects to individual bull trout to the extent that incidental take will occur when site-specific land management activities are implemented. The 2021 HLC Forest Plan is a framework programmatic action, meaning that it provides direction for future actions that may be authorized, funded, and/or carried out by the Forest and does not in itself mandate or approve future implementation of activities on the Forest. However, all site-specific land management activities must conform to the programmatic framework established in the Plan.

For a framework programmatic action, an incidental take statement may be provided but is not required at the programmatic level; as any incidental take resulting from any site-specific action subsequently authorized, funded, or carried out under the program will be addressed in subsequent section 7 consultation, as appropriate.

Because the 2021 HLC Forest Plan supplants the 1986 Helena National Forest Plan (as amended), this biological opinion supplants both the Service's consultation on that plan (USFWS 1998 BO for bull trout, and USFWS 2018 BO for bull trout critical habitat). The no jeopardy conclusion of the 1998 BO and the no jeopardy/no adverse modification conclusion of the 2018 BO relied, in part, on specified commitments by the Forests to avoid or minimize impacts to bull trout, and to reverse certain legacy effects. Although many improvements have occurred under the previous management direction, incidental take will continue to occur under management direction of the 2021 HLC Forest plan and where continued efforts combining active and passive restoration are needed to improve habitat conditions.

Consequently, management direction under the 2021 HLC Forest Plan may influence the rate and magnitude of progress in achieving desired conditions and proposed improvements for bull trout conservation; and could influence the amount of bull trout incidental take at the project level and from program elements. For these reasons, the Service is providing Reasonable and Prudent Measures and Terms and Conditions in order to reduce bull trout incidental take from implementation of the 2021 HLC Forest Plan.

The measures described below are non-discretionary and must be undertaken by the Forest so that they become binding conditions of any grant or permit issued, as appropriate, for the exemption in section 7(o)(2) to apply. The Forest has a continuing duty to regulate the activity that is covered by this incidental take statement. If the Forest (1) fails to assume and implement the terms and conditions or (2) fails to require an applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, the Forest must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 C.F.R. § 402.14(i)(3)].

Amount or Extent of Take Anticipated

With the exception of any potential incidental take reflected in the surrogate habitat indicators for bull trout as described above, other potential for incidental take that we are unable to anticipate at this time is deferred to future consultation on individual projects.

Take that may occur due to illegal activities by private citizens within the action area is not exempted.

Effect of the Take

In the accompanying biological opinion, the Service determined that based on the management direction provided by the 2021 HLC Forest Plan, and cumulative effects, it is the Service's biological opinion that the action as proposed is ***not likely to jeopardize the continued existence of the coterminous United Stated population bull trout***.

Reasonable and Prudent Measures and Terms and Conditions

Biological opinions provide *reasonable and prudent measures* that are expected to reduce the amount of incidental take. Reasonable and prudent measures refer to those actions the Director believes are necessary or appropriate to minimize the impacts, i.e., amount or extent, of incidental take resulting from proposed actions [50 CFR §402.02]. Reasonable and prudent measures are nondiscretionary and must be implemented by the action agency in order for the exemption in section 7(o)(2) to apply.

The Service concludes the following Reasonable and Prudent Measure (RPM) is necessary and appropriate to help guide future planning and consultation, and to minimize impacts of incidental take of bull trout caused by the subsequent actions under the Plan:

- As part of Forest Plan implantation, the Forest shall ensure consideration of, and apportion a subset of proposed projects and programs to, the protection and restoration of bull trout watersheds in furtherance of the Act.

To fulfill the reasonable and prudent measure (protect and restore bull trout watersheds), the following terms and conditions shall be implemented:

1. The Forest shall utilize the Level 1 team consultation process and apply the bull trout "Matrix of Indicators" - or a new approach developed by the interagency Regional Aquatic Consultation Technical Team - to evaluate actions and determine the potential effects on bull trout, and to assure interagency coordination in completing future project-specific consultations.

2. Building on previous efforts, the Forest shall provide a feasibility analysis (cost and practicality) within 18 months of signing the ROD for the Plan, for conceivably achieving FA and FAR ratings for all indicators of the Matrix of Indicators (or a new approach identified in #1 above) in watersheds where designated local populations of bull trout occur, watersheds containing designated critical habitat, or watersheds considered important for bull trout recovery (as listed in table 19).

3. In conjunction with the Service, the Forest shall develop a list of priorities for achieving an FA or FAR rating for watersheds where designated local populations of bull trout occur, watersheds containing designated critical habitat, or watersheds considered important for bull trout recovery (as listed in Table 19). Bull trout priorities will be reviewed and re-prioritized periodically by the Forest Level 1 team, in cooperation with the Regional Aquatic Consultation Technical Team, so as to consider new science and changes in bull trout status

and distribution. The results are for making recommendations to Forest Service line officers for consideration during project planning.

4. In addition to implementing stand-alone improvement projects in any watershed at any time, the Forest will consider opportunities for implementing restoration actions (identified in term and condition 3) during the planning process for projects that affect bull trout, and during section 7 consultation with the Service.

5. To allow passive recovery of both habitat conditions and/or bull trout age classes affected by projects that resulted in adverse effects to bull trout, project planning and consultations shall consider the necessity of post-project rest (e.g., 5 years), and what subsequent actions that may adversely affect bull trout would be permitted. Examples of permissible actions include, but are not limited to, actions that provide long-term benefits (e.g., >5 years) and no greater than 1 year of adverse effects (e.g., road decommissioning, culvert removal/upgrading, and implementation of road BMPs).

The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, the terms and conditions are not adhered to, the level of incidental take anticipated in the biological opinion may be exceeded. Such incidental take may represent new information requiring re-initiation of consultation and review of the reasonable and prudent measures provided. The Service retains the discretion to determine whether non-compliance with terms and conditions results in incidental take exceeding that considered here, and whether consultation should be re-initiated. The Forest must immediately provide an explanation of the causes of any non-compliance and review with the Service the need for possible modification of the reasonable and prudent measures.

Subsequent Project-Specific Consultation

This biological opinion considered the effects of the proposed framework of the 2021 HLC Forest Plan. However, this biological opinion does not provide a detailed analysis for effects of specific projects carried out under the direction of the 2021 HLC Forest Plan. It is the Service's expectation that future projects undertaken by the HLC NF will undergo site-specific analyses for effects on listed species and critical habitat, and subsequent section 7 consultation when appropriate.

Subsequent consultation, as appropriate, on the specific actions developed pursuant to the 2021 HLC Forest Plan will serve as the basis for determining if an additional exemption from the section 9 take prohibitions is warranted. If so, the Service will provide Reasonable and Prudent Measures and Terms and Conditions, as appropriate, to minimize the impacts of the take on bull trout in accordance with 50 CFR 402.14(i)

Reporting Requirements

To demonstrate that the 2021 HLC Forest Plan is adequately reducing the potential for and minimizing the effect of any incidental take that may result, and to ensure adequate integration of information about bull trout status, habitat conditions, and changes from existing conditions, the Forest shall fulfil its reporting requirements to the Service through the following mechanisms:

1. The Forest shall submit Forest Plan monitoring reports to the Service biennially starting in 2023, which will clearly identify report components that apply to bull trout habitats.
2. The Forest shall include a monitoring question on the status of bull trout on the HLC Forest and how the plan is contributing to the recovery of bull trout, similar to the existing monitoring question asking: "What is the status of westslope cutthroat trout?"

   Rationale for above two: The HLC Forest proposes to conduct a biennial evaluation of new information gathered through the plan monitoring program and relevant information from the broader-scale strategy and proposes to issue a written report of the evaluation. The plan monitoring program proposes to contain one or more monitoring questions and associated indicators addressing the status of a select set of the ecological conditions to contribute to the recovery of federally listed threatened and endangered species (in this case bull trout), conserve proposed and candidate species, and maintain a viable population of each species of conservation concern. In lieu of an independent and redundant report, monitoring and reporting of bull trout information for the 2021 HLC Forest Plan would satisfy the reporting requirements for the purposes of Section 7 consultation under this BO.
3. The Forest shall notify the Service upon completion of any products or reports related to the terms and conditions that are interim to the Forest Plan Monitoring Report (e.g., priority watershed designations, watershed restoration action plans, updates to WCF watershed condition and the 12 indicators used in the determination). Likewise, update the environmental baseline at least annually at the HUC6 watershed scale to include changes to the environmental baseline.

   Rationale: In order for the Service to be kept informed of Forest actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, and to assist the Service in utilizing such information in consultation with other agencies and stakeholders.

Conservation Recommendations

Section 7(a)(1) of the Act directs federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary recommendations that: (1) identify discretionary measures a federal agency can take to minimize or avoid the adverse effects of a proposed action on listed or proposed species, or designated or proposed critical habitat, (2) identify studies, monitoring, or research to develop new information on listed or proposed species, or designated or proposed critical habitat, and (3) include suggestions on how an action agency can assist species conservation as part of their action and in furtherance of their authorities under section 7(a)(1) of the Act. The Service provides the following recommendations:

1. When the Forest assesses watersheds for classification and prioritization per the national Watershed Condition Framework (WCF), watersheds identified in the revised land management plan's conservation watershed network (CWN) west of the Continental Divide shall rank as "high" in the prioritization process if assessment rates below properly functioning (from WCF step B, page 13). Essential projects identified in the associated Watershed Restoration Action Plan should first improve bull trout stream segments with

key process interruptions.

2. The Bull Trout Conservation Strategy on Forest Service lands (U.S. Forest Service 2013) was intended, in part, to "*help direct resources to the most important opportunities, where HLC Forest Service management has the potential to increase habitat quality and connectivity*". The Bull Trout Conservation Strategy should be reviewed for opportunities to improve habitat conditions that are conducive to the recovery of bull trout.
3. The HLC Forest should continue to work with private landowners, state and federal government agencies, and non-government organizations (e.g., Trout Unlimited and Blackfoot Challenge) to identify and improve bull trout habitat outside the HLC Forest boundary, especially in watersheds under little HLC Forest management.
4. The HLC Forest should continue all existing bull trout spawning surveys as historic methods of population monitoring.
5. In cooperation with the Service and Montana Fish, Wildlife and Parks, the HLC Forest should identify and pursue the introduction/reintroduction/or augmentation of bull trout into appropriate locations in order to ensure the long-term survival and recovery of bull trout.
6. When possible, the HLC Forest should consider conducting field surveys to verify or update indicator ratings of HUC6 watersheds. Accurate representation of indicator values (FA, FAR, or FUR) would improve project assessment and better identify areas where improvements are needed. Results of field surveys and changes to indicator ratings should be provided to the Service annually.
7. As previously discussed in the section on the monitoring aspects of the 2021 HLC Forest Plan, the Forest should develop a revised and expanded sediment monitoring program, possibly following PIBO methods, as an alternative to core sampling.
8. The HLC Forest should work cooperatively with the Service and Montana Fish, Wildlife, and Parks to determine the status of bull trout local populations in the action area; the importance of local populations to contribute to recovery and maintenance of bull trout in the core area and recovery unit, and both the short- and long-term effects of fires on the life history of bull trout.

In order for the Service to be kept informed of Forest actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, and to assist the Service in utilizing such information in consultation with other agencies and stakeholders, the Service requests notification of the implementation of any conservation recommendations.

Reinitiation Notice

This concludes formal consultation for bull trout on the 2021 HLC Forest Plan for the Helena-Lewis and Clark National Forest. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

Literature Cited in the Biological Opinion

Al-Chokhachy, R., P. Budy, and H. Schaller. 2005. Understanding the significance of redd counts: a comparison between two methods for estimating the abundance of and monitoring bull trout populations. N. Am. J. Fish. Manage. 25(4): 1505-1512.

Al-Chokhachy, R., B. B. Roper, and E. Archer 2010. Evaluating the status and trends of physical stream habitat in headwater streams in the Interior Columbia and Missouri River Basins Using an Index Approach. Transactions of the American Fisheries Society 139: 1041-1059.

Anderson, H.W., M.D. Hoover, and K.G. Reinhart. 1976. Forests and water: effects of forest management on floods, sedimentation, and water supply. U.S. Forest Service Gen. Tech. Rep. PSW-18. 115 pp., Pacific Southwest Forest and Range Exp. Stn., Berkeley, CA

Anderson, P. G., B. R. Taylor, and G. C. Balch. 1996. Quantifying the effects of sediment release on fish and their habitats.Canadian Manuscript Report of Fisheries and Aquatic Sciences 2346.

Anlauf, K. J.,W. Gaeuman, and K. K. Jones. 2011. Detection of regional trends in salmonid habitat in coastal streams, Oregon. Transactions of the American Fisheries Society 140:52–66.

Archer, E., and J. V. Ojala. 2017. Stream habitat condition for sites in the Helena National Forest, split by Missouri & Columbia River Basins. PacFish / InFish Biological Opinion (PIBO) Monitoring Program. USDA Forest Service, Logan, UT. 32p.

Bash, J.S., C. H. Berman, and S. M. Bolton. 2001. Effects of Turbidity and Suspended Solids on Salmonids. Washington State Department of Transportation. 92 pp.

Battin, J., M.W. Wiley, M.H. Ruckelshaus, R.N. Palmer, E. Korb, K.K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Sciences of the United States of America 104(16):6720-6725.

Baxter, C.V., C.A. Frissell, and F.R. Hauer. 1999. Geomorphology, logging roads, and the distribution of bull trout spawning in a forested river basin: implications for management and conservation. Transactions of the American Fisheries Society 128: 854-867.

Belford, D. A., and W. R. Gould. 1989. An evaluation of trout passage through six highway culverts in Montana. N. Am. J. Fish. Manage. 9: 437-445

Belsky, A. J. and J. L. Gelbard. 2000. Livestock grazing and weed invasions in the arid West. In Scientific Report, 31. Portland, OR

Berg, L. and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behaviour in juvenile coho salmon (*Oncohynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42: 1410-1417.

Beschta, R. L. and W. L. Jackson, 1979. The Intrusion of fine sediments into a stable gravel. Journal of Fisheries Research Board Canada. 36(2):204-21

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby and T.D. Hofstra. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. In: Streamside management: Forestry and fisheries interactions, E.O. Salo and T.W. Cundy (eds.), College of Forest Resources, University of Washington, Seattle WA. Contribution 75

Bilby, R. E., K. Sullivan and S. H. Duncan. 1989. The generation and fate of road-surface sediment in forested watersheds in southwestern Washington. Forest Science, 35, 453-468

Bjornn, T.C., Brusven, M. A., Molnau, M. P., Milligan, J. H., Klamt, R. A., Chacho, E. and Scbaye, C. 1977. Transport of granitic sediment and iu effects on insects and fish. Bulletin Number 17, College of Forestry, Wildlife, and Range Sciences, University of Idaho, Boise, ID, 43 p

Bowermann, T., B. T. Nielson, and P. Budy. 2014. Effects of fine sediment, hyporheic flow, and spawning site characteristics on survival and development of bull trout embryos.

Cannon, S.H., J.E. Gartner, M.G. Rupert, J.A. Michael, A.H. Rea, and C. Parrett. 2010. Predicting the probability and volume of postwildfire debris flows in the intermountain western United Sates. Geological Society of America Bulletin 122:127-144.

Clancy, C.G.; Reichmuth, D.R. 1990. A detachable fishway for steep culverts. North American Journal of Fisheries Management. 10(2): 244-246.

Clark, C. L. 2019. The influence of sampling design on the characterization of instream salmonid habitat. M. S. thesis Montana State University, Bozeman

Doerr, S. H., R.A. Shakesb

y, W.H. Blake, C.J. Chafer, G.S. Humphreys and P.J. Wallbrink. 2006. Effects of differing wildfire severities on soil wettability and implications for hydrological response. Journal of Hydrology 319:295-311.

Dolloff, C. A., H. E. Jennings, and M. D. Owen. 1997. A comparison of basinwide and representative reach habitat survey techniques in three Southern Appalachian watersheds. North American Journal of Fisheries Management. 17:339-374

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications. 9: 642-655.

Elliot, W.J. 2013. Erosion processes and prediction with WEPP technology in forests in the northwestern U.S. Transactions of the ASABE 56:563-579.

Elliot, W.J., D.E. Hall and D.L. Scheele. 2000. Forest Service interfaces for the Water Erosion Prediction Project computer model: Interface for disturbed forest and range runoff, erosion, and sediment delivery. U.S. Forest Service, Rocky Mountain Research Station and San Dimas Technology and Development Center, Moscow, Idaho.

Evans, W.A. and F. B. Johnston. 1980. Fish Migration and Fish Passage. A Practical Guide to Solving Fish Passage Problems. U.S. Department of Agriculture-Forest Service Region 5 report. June 1972. Revised March 1974. Revised 1980. 63 pages.

Everest, F. H., R. L. Beschta, J. C. Scrivener, K. V. Koski, J. R. Sedell, and C. J. Cederholm. 1987. Fine sediment and salmonid production: A paradox. Pages 98-142 *in* E. O. Salo and T. W. Cundy, editors. Streamside management: Forestry and fishery interactions. University of Washington Institute of Forest Resources Contribution 57.

Faustini, J. M., and J. Jones. 2003. Influence of large woody debris on channel morphology and dynamics in steep, boulder-rich mountain streams, western Cascades, Oregon. Geomorphology. 51:187-205.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63(4):133-143.

Furniss, M.J., T.D. Roelofs, and C.S. Yee. 1991. Road construction and maintenance. Pages 297-323 in W.R. Meehan, editor. American Fisheries Society Special Publication.

Goetz, F.A. 1994. Distribution and juvenile ecology of bull trout (Salvelinus confluentus) in the Cascade Mountains. M.S. thesis. Oregon State University, Corvallis.

Gomi, T., R.D. Moore and A.S. Dhakal. 2006. Headwater stream temperature response to clear-cut harvesting with different riparian treatments, coastal British Columbia, Canada. Water Resources Research 42.

Grant, G.E., S.L. Lewis, F.J. Swanson, J.H. Cissel and J.J. McDonnell. 2008. Effects of forest practices on peak flows and consequent channel response: A state-of-science report for western Oregon and Washington. U.S. Forest Service, Pacific Northwest Research Station, Portland, Oregon.

Gresswell, R. E. 1999. Fire and aquatic ecosystems in forested biomes of North America. Transactions of the American Fisheries Society. 128:193–221

Gucinski, H., M.J. Furniss, R.R. Ziemer, M. H. Brookes. 2001. Forest roads: a synthesis of scientific information. Gen. Tech. Rep. PNWGTR-509. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 103 pp.

Heede, B.H. 1980. Stream dynamics: an overview for land managers. Gen. Tech. Rep. RM-72. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 26 pp.

Heitke, J. D., E. J. Archer, D. D. Dugaw, B. A. Bouwes, E. A. Archer, R. C. Henderson, J. L. Kershner. 2008. Effectiveness monitoring for streams and riparian areas: sampling protocol for stream channel attributes. 91 pp.

Henderson, R. C., E. K. Archer, B. A. Bouwes, M. S. Coles-Ritchie, J. L. Kershner. 2005. PACFISH/INFISH biological opinion (PIBO): Effectiveness monitoring program seven-year status report 1998 through 2004. Gen. Tech. Rep. RMRS-GTR-162. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 16 pp.

Henley, W. F., M. A. Patterson, R. J. Neves, and A. D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: a concise review for natural resource managers. Reviews in Fisheries Science 8(2): 125-139.

ICBEMP 2014. Interior Columbia Basin Ecosystem Management Project https://www.fs.fed.us/r6/icbemp/html/ICBEMP_Frameworkmemorandum-and-strategy_2014.pdf

IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

Isaak, D.J., C.H. Luce, B.E. Rieman, D.E. Nagel, B.E. Peterson, D.L. Horan, S. Parkes, and G.L. Chandler. 2010. Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network. Ecological Applications 20:1350-1371.

Isaak, D.J., M.K. Young, D. Nagel, and D. Horan. 2014. Coldwater as a climate shield to preserve native trout through the 21st century. Pages 110-116 in: R.F. Carline and C. LoSapio (editors). Looking back and moving forward. Proceedings of the Wild Trout Symposium XI, Bozeman, Montana.

Isaak, D.J., M.K. Young, D. Nagel, D. Horan and M.C. Groce. 2015. The coldwater climate shield: Delineating refugia to preserve salmonid fishes through the 21st century. Global Change Biology 21:2540-2553.

Isaak, D. J., S. J. Wenger, E. E. Peterson, J. M. Ver Hoef, D. E. Nagel, C. H. Luce, S. W. Hostetler, J. B. Dunham, B. B. Roper, S. P. Wollrab, G. L. Chandler, D. L. Horan & S. Parkes-Payne (2017) The NorWeST summer stream temperature model and scenarios for the western U.S.: A crowd-sourced database and new geospatial tools foster a user community and predict broad climate warming of rivers and streams. *Water Resources Research,* 53**,** 1-25.

Isaak, D. J., M. K. Young, D. E. Nagel, D. L. Horan & M. C. Groce (2015) The

Jakober, M.J., T. E. McMahon, R. F. Thurow, and C. G. Clancy. 1998. Role of stream ice on fall and winter movements and habitat use by bull trout and cutthroat trout in Montana headwater streams. Transactions of the American Fisheries Society 127:223-235.

Joyce, L. A., M. Talbert, D. Sharp, J. Morissette & J. Stevenson. in press. Historical and projected climate in the Northern Rockies Adaptation Partnership Region. In *Climate change vulnerability and adaptation in the northern Rocky Mountains,* eds. J. E. Halofsky, D. L. Peterson, S. K. Dante- Wood, L. Hoang, J. J. Ho & L. A. Joyce, 58-65. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station.

Keppeler, E. T. and R. R. Ziemer. 1990. Logging effects on streamflow: Water yield and summer low flows at Caspar Creek in northwestern California. Water Resources Research, 26**,** 1669-1679.

Knighton, D. 1998. Fluvial forms and processes. Oxford University Press, New York.

Koopman, M.E., R.S. Nauman, B.R. Barr, S.J. Vynne, and G.R. Hamilton. 2009. Projected future conditions in the Klamath Basin of Southern Oregon and Northern California. National Center for Conservation and Science Policy, Climate Change Leadership Initiative, MAPPS Team of U.S. Department of Agriculture, Forest Service, Ashland, Ore.

Kraft, C. E. and D. R. Warren. 2003. Development of spatial pattern in large woody debris and debris dams in streams. Geomorphology 51:127-139.

Larsen, D. P., P. R. Kaufmann, T. M. Kincaid, and N. S. Urquhart. 2004. Detecting persistent change in the habitat of salmon-bearing streams in the Pacific Northwest. Canadian Journal of Fisheries and Aquatic Science. 61:283-291.

Larsen, I. J., L. H. MacDonald, E. Brown, D. Rough, M. J. Welsh, J. H. Pietraszek, Z. Libohova, J. de Dios Benavides-Solorio and K. Schaffrath. 2009. Causes of post-fire runoff and erosion: water repellency, cover, or soil sealing? Soil Science Society of America Journal, 73**,** 1393-1407.

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow and J.E. Williams. 1997. Chapter 4: Broadscale assessment of aquatic species and habitats. Pages 1057-1496 in Quigley, T.M. and S.J. Arbelbide, editors. An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins: Volume III. PNW-GTR-405. U.S. Forest Service, Portland, Oregon.

Leary, R.F.; F.W. Allendorf, and S. H. Forbes. 1993. Conservation genetics of bull trout in the Columbia and Klamath River watersheds. Conservation Biology. 7:856-865.

Leopold, L.B., M. G. Wolman and J. P. Miller. 1964. Fluvial processes in geomorphology. Dover publications, Inc. New York, NY

Long, M.H. 1997. Sociological implications of bull trout management in northwest Montana: illegal harvest and game warden efforts to deter. In: W.C. Mackay, M.K. Brewin, and M.

Monita, editors. Friends of the bull trout conference proceedings, Bull Trout Task Force (Alberta), c/o Trout Unlimited Canada, Calgary pp. 71-74.

Luce, C.H. 2018. Effects of climate change on snowpack, glaciers, and water resources in the Northern Rockies region. In: Halofsky, J.E.; Peterson, D.L.; Dante-Wood, S.K. [et al.], eds. 2018. Vulnerability and adaptation to climate change in the Northern Rocky Mountains. Gen. Tech. Rep. RMRS-374. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 48–86.

Luce, C. H. and Z. A. Holden. 2009. Declining annual streamflow distributions in the Pacific Northwest United States, 1948–2006. Geophysical Research Letters, 36**,** 6.

Luce, C. H., V. Lopez-Burgos and Z. Holden. 2014. Sensitivity of snowpack storage to precipitation and temperature using spatial and temporal analog models. Water Resources Research, 50**,** 9447- 9462

Luce, C., P. Morgan, K. Dwire, D. Isaak, Z. Holden and B. Rieman. 2012. Climate change, forests, fire, water, and fish: Building resilient landscapes, streams, and managers. 207. Fort Collins, CO.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout prepared for: The Montana Bull Trout Restoration Team, Montana Fish, Wildlife and Parks, Helena, MT

MTDEQ et al. (Montana Department of Environmental Quality, Confluence Consulting, Inc., DTM Consulting, Inc., Applied Geomorphology, Inc., and Blackfoot Challenge Habitat and Water Restoration Committee). 2004. Blackfoot headwaters planning area water quality and habitat restoration plan and TMDL for sediment. Helena, MT: Montana Department of Environmental Quality

MTDEQ (Montana Department of Environmental Quality). 2011. Little Blackfoot Watershed TMDLs and Framework Water Quality Improvement Plan. Montana Department of Environmental Quality, Helena, Montana.

Macdonald, J. S., P. G. Beaudry, E. A. MacIsaac and H. E. Herunter. 2003. The effects of forest harvesting and best management practices on streamflow and suspended sediment concentrations during snowmelt in headwater streams in sub-boreal forests of British Columbia, Canada. Canadian Journal of Forest Research-Revue Canadienne de Recherche Forestiere, 33**,** 1397-1407.

Master, L.L., L.E. Morse, A.S. Weakley, G.A. Hammerson, and D. Faber-Langendoen. 2003. NatureServe Conservation Status Assessment Criteria. Nature Serve, Arlington, VA, USA.

Maturana, O., Tonina, D., McKean, J. A., Buffington, J. M., Luce, C., Caamaño, D. 2013. Modeling the effects of pulsed versus chronic sand inputs on salmonid spawning habitat in a low-gradient gravel-bed river. Earth Surface Processes and Landforms, 39(7):877-889.

McCaffery, M. T. A. Switalski, and L. Eby. 2007. Effects of road decommissioning on stream habitat characteristics in the South Fork Flathead River. Transactions of the American Fisheries Society 136: 553-561.

Meredith, M. P., P. L. Woodworth, T. K. Chereskin, D. P. Marshall, L. C. Allison, G. R. Bigg, K. Donohue, K. J. Heywood, C. W. Hughes, A. Hibbert, A. M. Hogg, H. L. Johnson, L. Jullion, B. A. King, H. Leach, Y. D. Lenn, M. A. M. Maqueda, D. R. Munday, A. C. N. Garabato, C. Provost, J. Sallee & J. Sprintall. 2011. Sustained monitoring of the Southern Ocean at Drake Passage: Past achievements and future priorities. *Reviews of Geophysics,* 49

Montana Bull Trout Restoration Team. 2000. Restoration plan for bull trout in the Clark Fork River basin and Kootenai River basin, Montana. Montana Fish, Wildlife and Parks, Helena

Moore, R. D., and Wondzell, S. M. 2005. Physical hydrology and the effects of forest harvesting in the pacific northwest: A review. Journal of the American Water Resources Association. 41(4);763-784.

Mote, P., A.K. Snover, S. Capalbo, S.D. Eigenbrode, P. Glick, J. Littell, R. Raymondi, and S. Reeder. 2014. Chapter 21: Northwest. Pages 487-513 *in Climate Change Impacts in the United States: The Third National Climate Assessment*, J.M. Melillo, Terese (T.C.) Richmond, and G.W. Yohe, Eds., U.S. Global Change Research Programoi:10.7930/J04Q7RWX.

Muck, J. 2010. Biological effects of sediment on bull trout and their habitat – guidance for evaluating effects. USFWS, Lacey, Washington, July 13, 2010. 57 pp.

Muhlfeld, C. C., D. H. Bennett, and B. Marotz. 2001. Summer habitat use by Columbia River redband trout in the Kootenai River drainage, Montana. North American Journal of Fisheries Management 21:223-235.

Naiman, R. J. and H. Decamps. 1997. The ecology of interfaces: Riparian zones. Annual Review of Ecology, Evolution, and Systematics, 28**,** 621-58

Nelson, K. C. and M. A. Palmer. 2007. Stream temperature surges under urbanization and climate change: data, models, and responses. Journal of American Water resources Association 43(2):440-452.

Newcombe, C. P. and J. O. T. Jensen. 1996. Channel suspended sediment and fisheries: synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management 16(4): 693-727.

Opperman, J. J., Lohse, K. A., Brooks, C. B., Kelly, M., Merenlender, A. M. 2005. Influence of land use on fine sediment in salmonid spawning gravels within the Russian River Basin, California

Peterson, D.P., S.J. Wenger, B.E. Rieman, and D.J. Isaak. 2013. Linking climate change and fish conservation efforts using spatially explicit decision support tools. Fisheries 38:112-127.

Pierce, R., and C. Podner. 2016. Fisheries investigation in the Big Blackfoot River Basin, Montana, 2013-2015. Montana Fish, Wildlife, and Parks, Missoula, Montana. 273 pp.

Platt, W. S. 1991. Livestock grazing. In *Influences of forest and rangeland management on salmonid fishes and their habitats,* ed. W. R. Meehan, 389-423. Bethesda, MD: American Fisheries Society.

Poff, N.L., M.M. Brinson, and J.W. Day, 2002. Aquatic Ecosystems and Global Climate Change, Pew Center on Global Climate Change, Arlington, Virginia, 44 pp.

Quigley, T. M. and S. J. Arbelbide, tech. eds. 1997. An assessment of ecosystem components in the interior Columbia basin and portion of the Klamath and Great basins: volume III. Pages 1,057 - 1,713 in Quigley, T.M., editor. The Interior Columbia Basin Ecosystem Management Project: Scientific Assessment. PNW-GTR-405.U.S. Forest Service, Portland, Oregon.

Rashin, E. B., C. J. Clishe, A. T. Loch and J. M. Bell. 2006. Effectiveness of timber harvest practices for controlling sediment related water quality impacts. Journal of the American Water Resources Association, 42**,** 1307-1327

Reid, S. and P. Anderson. 1999. Effects of sediment released during open-cut pipeline water crossings. Canadian Water Resources Journal 24: 23-39.

Rieman, B.E. and F.W. Allendorf. 2001. Effective population size and genetic conservation criteria for bull trout. North American Journal of Fisheries Management 21:756-764

Rieman, B. E. and D. Isaak. 2010. Climate Change, Aquatic Ecosystems, and fishes in the Rocky Mountain West: Implications and Alternatives for Management. Gen. Tech. Rep. RMS-GTR-250. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 46p.

Rieman, B.E., D. Isaak, S. Adams, D. Horan, D. Nagel, C.H. Luce, and D. Myers. 2007. Anticipated climate warming effects on bull trout habitats and populations across the interior Columbia River Basin. Transactions of the American Fisheries Society 136(6):1552-1565.

Rieman, B. E., D.C. Lee, and R. F. Thurow. 1997. Distribution, status, and likely future trends of bull trout in the interior Columbia River basin and Klamath River basins. North American Journal of Fisheries Management 17:1111-1125.

Rieman, B. E. and J. D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. GTR-INT-302. U.S. Forest Service, Boise, Idaho.

Rieman, B. E., J. T. Peterson, and D. L. Myers. 2006. Have brook trout displaced bull trout along longitudinal gradients in central Idaho streams? Canadian Journal of Fisheries and Aquatic Sciences 63:63–78.

Rieman, B. E., D. C. Lee, R. F. Thurow, P. F. Hessburg and J. R. Sedell. 2000. Toward an integrated classification of ecosystems: defining opportunities for managing fish and forest health. Environmental Management*,* 25**,** 425-444

Roper, B. B., W. C. Saunders & J. V. Ojala. 2019. Did changes in western federal land management policies improve salmonid habitat in streams on public lands within the Interior Columbia River Basin? *Environ Monit Assess,* 191**,** 574

Ross, M.R.. 1997. Fisheries Conservation and Management. Chapter 4: The Human Factor in Fisheries Conservation and Management. Prentice Hall, New Jersey. 374pp.

Satterthwaite, T.D. 1995. Effects of boat traffic on juvenile salmonids in the Rogue River. State of Oregon Department of Fish and Wildlife, Portland, Oregon

Saunders, W. C., J. V. Ojala, and A. R. Van Wagenen. 2020. Stream habitat condition for sites in the Helena National Forest. PacFish / InFish Biological Opinion (PIBO) Monitoring Program. USDA Forest Service, Logan, UT. 73p.

Shaw, E. A. and J. S. Richardson. 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout (*Oncorhynchus mykiss*) growth and survival. Canadian Journal of Fisheries and Aquatic Science 58: 2213-2221.

Stednick, J. D. 1996. Monitoring the effects of timber harvest on annual water yield. Journal of Hydrology 176:79-95.

Sugden, B.D and S.W. Woods. 2007. Sediment production from forest roads in western Montana. Journal of the American Water Resources Association 43:193-206.

Suren, A. M. and I. G. Jowett. 2001. Effects of deposited sediment on invertebrate drift: an experimental study. New Zealand Journal of Marine and Freshwater Research 35: 725-537.

Swanson, S., S. Wyman and C. Evans. 2015. Practical grazing management to maintain or restore riparian functions and values on rangelands. Journal of Rangeland Applications, 2**:** 1-28.

Swanston, D.N. 1991. Natural processes. In: Meehan, W.R. (Ed.). Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society, Bethesda, Maryland.

Trombulak, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.

Urquart, N. S., S. G. Paulsen, and D. P. Larsen. 1998. Monitoring for policy-relevant regional trends over time. Ecological Applications 8(2):246-257.

U.S. Fish and Wildlife Service. 1998. A framework to assist in making endangered species act determinations of effect for individual or grouped action at the bull trout subpopulation watershed scale. Region 1, USFWS.

U.S. Fish and Wildlife Service. 1998a. Biological Opinion for the Effects to Bull Trout from the Continued Implementation of Land and Resource Management Plans and Resource Management Plans as Amended by the Interim Strategies for Managing Fish Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana and portions of Nevada (INFISH) and the Interim Strategy for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho and portions of California (PACFISH). Region 1, USFWS.

U.S. Fish and Wildlife Service. National Marine Fisheries Service, 1998. Final endangered species consultation handbook: Procedures for conducting consultation and conference activities under section 7 of the Endangered Species Act. U. S. Fish and Wildlife Service and National Marine Fisheries Service, Washington, D.C., March 1998. 315 pp.

U.S. Fish and Wildlife Service. 1999. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminous United States. Fish and Wildlife Service, Department of the Interior. 50 CFR 17, Vol. 64, No. 210, pp. 58910-58933.

U.S. Fish and Wildlife Service. 2005. Bull trout core area templates - complete core area by core area analysis. U.S. Fish and Wildlife Service, Portland, Oregon. 662 pp.

U.S. Fish and Wildlife Service. 2006. Jeopardy Determinations under Section 7 of the Endangered Species Act for the Bull Trout. Memorandum to Ecological Services Project Leaders - Idaho, Oregon, Washington from Region 1 Assistant Regional Director, U.S. Fish and Wildlife Service, Ecological Services. Portland, Oregon. April 20, 2006.

U.S. Fish and Wildlife Service. 2008. Bull trout (*Salvelinus confluentus*) 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. 2009. Bull trout core area templates - complete core area by core area re-analysis. W. Fredenberg and J. Chan, editors. U. S. Fish and Wildlife Service. Portland, Oregon. XX pp

U.S. Fish and Wildlife Service. 2009a. Biological opinion for bull trout; Helena National Forest north divide winter travel plan. U. S. Fish and Wildlife Service. Helena, Montana. 51 pp.

U.S. Fish and Wildlife Service. 2009b. Bull trout proposed critical habitat justification: rationale for why habitat is essential, and documentation of occupancy. U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 36 pp.

U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; Revised designation of Critical Habitat for bull trout in the coterminous United States; Proposed Rule, announcement of public hearing, and announcement of availability of draft economic analysis. Federal Register 75:2270-2431.

U.S. Fish and Wildlife Service. 2010a. Endangered and threatened wildlife and plants; revised designation of critical habitat for bull trout in the coterminous United States; final rule. October 18, 2010. Federal Register 75:63898-64070.

U.S. Fish and Wildlife Service. 2012. Biological opinion on the 2012 National Forest system land management planning rule. U.S. Fish and Wildlife Service, Washington, D. C. 8 pp.

U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

U.S. Fish and Wildlife Service. 2015a. Coastal recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Lacey, Washington, and Portland, Oregon. 155 pp.

U.S. Fish and Wildlife Service. 2015b. Columbia headwaters recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana, and Spokane, Washington. 179 pp.

U.S. Fish and Wildlife Service. 2015c. Klamath recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Klamath Falls, Oregon. 35 pp.

U.S. Fish and Wildlife Service. 2015d.Mid-Columbia recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 345 pp.

U.S. Fish and Wildlife Service. 2015e. St. Mary recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana. 30 pp.

U.S. Fish and Wildlife Service. 2015f. Upper Snake recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Boise, Idaho. 113 pp.

U.S. Fish and Wildlife Service. 2015g. Biological opinion on the effects to bull trout and bull trout critical habitat from the implementation of proposed actions associated with road-related activities that may affect bull trout and bull trout critical habitat in western Montana. U.S. Fish and Wildlife Service, Helena, Montana, 123 pp

U.S. Fish and Wildlife Service. 2016. Biological opinion of effects to bull trout from the divide travel plan. U.S. Fish and Wildlife Service, Helena, Montana, 63 pp.

U.S. Fish and Wildlife Service. 2016a. Biological opinion for effects to bull trout and bull trout critical habitat; Blackfoot non-winter travel plan. U.S. Fish and Wildlife Service, Helena, Montana. 84 pp

U.S. Fish and Wildlife Service. 2016b. Biological opinion for effects to bull trout and bull trout critical habitat; Stonewall vegetation project. U.S. Fish and Wildlife Service, Helena, Montana. 72 pp

U.S. Fish and Wildlife Service. 2017. Biological opinion for effects to bull trout; Telegraph vegetation project. U.S. Fish and Wildlife Service, Helena, Montana, 66 pp

U.S. Fish and Wildlife Service. 2018. Effects of ongoing U.S. Forest Service implementation of 26 land resource management plans, as amended by five aquatic conservation strategies, on the threatened bull trout *(Salvelinus confluentus)* and bull trout critical habitat in Oregon, Washington, Idaho, Montana. U.S. Fish and Wildlife Service, Pacific Region. 209 pp.

U.S. Fish and Wildlife Service. 2019. Biological opinion for effects to bull trout and bull trout critical habitat from the Poorman Creek River Mile 8 Placer Waste Rock and Stream Restoration Project. U.S. Fish and Wildlife Service, Helena, Montana. 77 pp.

U.S. Fish and Wildlife Service. 2021. Biological opinion for effects to bull trout and bull trout critical habitat from the Stonewall vegetation project. U.S. Fish and Wildlife Service, Helena, Montana. 69 pp.

U.S. Fish and Wildlife Service. 2021a. Biological opinion for effects to bull trout and bull trout critical habitat from the Hogum vegetation project. U.S. Fish and Wildlife Service, Helena, Montana. 72 pp

U.S. Forest Service. 1986. Forest plan, Helena National Forest. U.S. Forest Service, Helena, Montana. 290 pp.

U.S. Forest Service. 1995. Inland Native Fish Strategy Environmental Assessment (INFISH), Decision Notice and Finding of No Significant Impact, 1995, Intermountain, Northern, and Pacific Northwest Regions. U.S. Department of Agriculture, Forest Service. July 28. http://www.fs.fed.us/r6/fish/9506-infish.pdf.

U.S. Forest Service. 2008 Assessment of aquatic organism passage at road/stream crossings for the northern region of the USDA Forest Service. March 2008. Region 1 Forest Service, Missoula Montana. 13 pp.

U.S. Forest Service. 2010. Watershed baseline condition update: Little Blackfoot River portion of the Upper Clark Fork section 7 watershed. Helena National Forest supervisors office, Helena, Montana.

U.S. Forest Service. 2011. Watershed condition framework. Forest Service, Department of Agriculture. FS-977. 24 pp.

U.S. Forest Service. 2011a. Watershed condition classification technical guide. Forest Service, Department of Agriculture. FS-978. 41 pp.

U.S. Forest Service. 2011b. FY 2011 Watershed Restoration Action Plan. Lincoln Ranger District, Helena National Forest. 5 pp.

U.S. Forest Service. 2012. National Forest System Land Management Planning. Forest Service, Department of Agriculture. 36 CFR 219, Vol. 77, No. 68, p. 21162-21276.

U.S. Forest Service. 2013. Conservation Strategy for Bull Trout on USFS Lands in Western Montana. USDA Forest Service, Northern Region. Missoula, MT.

U.S. Forest Service. 2015. Biological assessment for bull trout, Divide travel plan, including supplemental information received during consultation. Helena Ranger District, Helena National Forest. U.S.D.A. Forest Service, Helena National Forest, Helena, Montana

U.S. Forest Service. 2016. Biological assessment for bull trout, Blackfoot travel plan, including supplemental information received during consultation. Lincoln Ranger District, Helena National Forest. U.S.D.A. Forest Service, Helena National Forest, Helena, Montana.

U.S. Forest Service. 2016a. Amended fisheries biological assessment, Telegraph Vegetation Project, including supplemental information received during consultation. Lincoln Ranger District, Helena-Lewis and Clark National Forest. U.S.D.A. Forest Service, Lincoln, Montana.

U.S. Forest Service. 2018. Biological assessment addressing the effects of ongoing implementation of 26 land resource management plans on the bull trout and bull trout critical habitat as amended by the 1994 Northwest Forest Plan, the interim strategies for managing anadromous fish-producing watersheds in Eastern Oregon, Washington, Idaho, and portions of California and the inland native fish strategy, and the Southwest Idaho ecosystem and the Beaverhead-Deerlodge Revised Forest Plans. 91. U.S. Department of Agriculture, Forest Service.

U.S. Forest Service. 2018a. Fire consultation 2017: Fire-related effects to bull trout and bull trout critical habitat. Lolo National Forest, U.S.D.A. Forest Service, Missoula, Montana

U.S. Forest Service. 2019. Fisheries biological assessment Poorman Creek River mile 8 placer waste rock and stream restoration project Helena – Lewis and Clark National Forest. U.S.D.A. Forest Service, Lincoln, Montana

U.S. Forest Service. 2020. Draft 2020 land management plan: Helena – Lewis and Clark National Forest. U.S.D.A. Forest Service, Helena, Montana

U.S. Forest Service. 2021. Aquatic biological assessment for bull trout: 2020 forest plan for the Helena Lewis and Clark National Forest. Revised on 03/12/2021. U.S. Forest Service, Helena, Montana. 121 pp.

Waters, T. F. 1995. Sediment in streams: Sources, biological effects, and control. American Fisheries Society, Monograph 7, Bethesda, Maryland

Weaver, W. E., M. M. Hektner, D. K. Hagans, L.J. Reed, R.A. Sonneville, and G.]. Bundros. 1987. An evaluation of experimental rehabilitation work, Redwood National Park. Technical report 19. Redwood National Park, Arcata, California

Weaver, T. and Fraley, J. 1991. Fisheries habitat and fish populations. Flathead basin forest practices, water quality and fisheries cooperative program. Kalispell, MT: Flathead Basin Commission. 47 pp.

Wenger, S.J., D.J. Isaak, J.B. Dunham, K.D. Fausch, C.H. Luce, H.M. Neville, B.E. Rieman, M.K. Young, D.E. Nagel, D.L. Horan, and G.L. Chandler. 2011. Role of climate change and invasive species in structuring trout distributions in the interior Columbia River Basin, USA. Canadian Journal of Fisheries and Aquatic Sciences 68:988-1008.

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase western U.S. forest wildfire activity. Science 313:940-943.

Wondzell, S.M. and J.G. King. 2003. Postfire erosional processes in the Pacific Northwest and Rocky Mountain regions. Forest Ecology and Management 178:75-87.

Young, M.K., W.A. Hubert, and T.A. Wesche. 1991 - Biases associated with four stream substrate samplers. Canadian Journal of Fisheries and Aquatic Sciences. 48:1882-1886.

Zwolinski, M.J. 2000. The role of fire in management of watershed responses. In: Folliott, P.F., M.B. Baker Jr., C.B. Edminster, M.C. Dillonand K.L. (Tech. coords.). Land Stewardship in the 21st Century: The Contributions of Watershed Management; 2000. U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado.

Appendix A. HLC Forest Plan Components Relative to Bull Trout

Table A1. Summary of plan components relevant to management decisions for bull trout and bull trout habitat in the 2021 HLC Forest Plan. Nomenclature for plan components and full text of each plan component identified in the table as relative to bull trout is provided after the table.

Desired Conditions	Goals	Objectives	Standards	Guidelines	Suitability
Aquatic Ecosystems – Watershed (WTR)					
FW-WTR-DC-01	FW-WTR-GO-01	FW-WTR-OBJ-01	FW-WTR-STD-01	FW-WTR-GDL-01	
FW-WTR-DC-02	FW-WTR-GO-02	FW-WTR-OBJ-02	FW-WTR-STD-02	FW-WTR-GDL-02	
FW-WTR-DC-03	FW-WTR-GO-03	FW-WTR-OBJ-03	FW-WTR-STD-03		
FW-WTR-DC-04	FW-WTR-GO-04				
FW-WTR-DC-05					
FW-WTR-DC-06					
FW-WTR-DC-07					
FW-WTR-DC-08					
FW-WTR-DC-09					
FW-WTR-DC-10					
FW-WTR-DC-11					
FW-WTR-DC-12					
FW-WTR-DC-13					
Aquatic Ecosystems – Riparian Management Zones (RMZ)					
FW-RMZ-DC-01		FW-RMZ-OBJ-01	FW-RMZ-STD-01	FW-RMZ-GDL-01	FW-RMZ-SUIT-01
FW-RMZ-DC-02			FW-RMZ-STD-02	FW-RMZ-GDL-02	
			FW-RMZ-STD-03	FW-RMZ-GDL-03	
			FW-RMZ-STD-04	FW-RMZ-GDL-04	
			FW-RMZ-STD-05	FW-RMZ-GDL-05	
			FW-RMZ-STD-06	FW-RMZ-GDL-06	
				FW-RMZ-GDL-07	
				FW-RMZ-GDL-08	
				FW-RMZ-GDL-09	
				FW-RMZ-GDL-10	
				FW-RMZ-GDL-11	
				FW-RMZ-GDL-12	

Desired Conditions	Goals	Objectives	Standards	Guidelines	Suitability
Aquatic Ecosystems - Fisheries and Aquatic Habitat (FAH)					
FW-FAH-DC-01	FW-FAH-GO-01	FW-FAH-OBJ-01	FW-FAH-STD-01	FW-FAH-GDL-01	
FW-FAH-DC-02	FW-FAH-GO-02	FW-FAH-OBJ-03		FW-FAH-GDL-02	
FW-FAH-DC-03	FW-FAH-GO-03			FW-FAH-GDL-03	
FW-FAH-DC-04	FW-FAH-GO-04			FW-FAH-GDL-04	
FW-FAH-DC-05	FW-FAH-GO-05			FW-FAH-GDL-05	
FW-FAH-DC-06	FW-FAH-GO-06				
FW-FAH-DC-07					
FW-FAH-DC-08					
Aquatic Ecosystems – Conservation Watershed Network (CWN)					
FW-CWN-DC-01		FW-CWN-OBJ-01		FW-CWN-GDL-01	
		FW-CWN-OBJ-02		FW-CWN-GDL-02	
				FW-CWN-GDL-03	
Soil (SOIL)					
FW-SOIL-DC-01					
Terrestrial Vegetation (VEGT)					
FW-VEGT-DC-01				FW-VEGT-GDL-01	
				FW-VEGT-GDL-02	
Recreation Opportunities (REC)					
FW-REC-DC-04		FW-REC-OBJ-01		FW-REC-GDL-01	
				FW-REC-GDL-03	
				FW-REC-GDL-04	
				FW-REC-GDL-05	
				FW-REC-GDL-06	
Recreation Access (ACCESS)					
				FW-ACCESS-GDL-01	
Land Status and Ownership, and Land Uses – Land Uses (LAND USE)					
				FW-LAND USE-GDL-03	
				FW-LAND USE-GDL-04	
				FW-LAND USE-GDL-05	
				FW-LAND USE-GDL-06	
Infrastructure: Roads, Trails, Bridges, and Facilities (RT)					
FW-RT-DC-02		FW-RT-OBJ-01	FW-RT-STD-01	FW-RT-GDL-01	
FW-RT-DC-04		FW-RT-OBJ-02	FW-RT-STD-02	FW-RT-GDL-02	

Desired Conditions	Goals	Objectives	Standards	Guidelines	Suitability
			FW-RT-STD-03	FW-RT-GDL-03	
			FW-RT-STD-04	FW-RT-GDL-04	
				FW-RT-GDL-05	
				FW-RT-GDL-06	
				FW-RT-GDL-07	
				FW-RT-GDL-08	
				FW-RT-GDL-09	
				FW-RT-GDL-10	
				FW-RT-GDL-11	
				FW-RT-GDL-12	
Benefits to people: Public Information, Interpretation, and Education (CONNECT)					
FW-CONNECT-DC-02					
Benefits to people: Livestock Grazing (GRAZ)					
FW-GRAZ-DC-03			FW-GRAZ-STD-01	FW-GRAZ-GDL-01	
FW-GRAZ-DC-04			FW-GRAZ-STD-02	FW-GRAZ-GDL-02	
				FW-GRAZ-GDL-03	
				FW-GRAZ-GDL-04	
				FW-GRAZ-GDL-05	
				FW-GRAZ-GDL-06	
				FW-GRAZ-GDL-07	
Benefits to people: Minerals and Energy (EMIN)					
				FW-EMIN-GDL-01	
				FW-EMIN-GDL-02	
Divide GA (DI)					
DI-FAH-DC-01	DI-FAH-GO-01				
DI-FAH-DC-02					
Upper Blackfoot GA (UB)					
UB-FAH-DC-01	UB-FAH-GO-01				
UB-FAH-DC-02					

All plan components have a series of four alpha-numeric identifiers for reference, as described below;

The first identifier indicates the level of direction (FW= forestwide, DI = Divide Geographic Area, UB= Upper Blackfoot Geographic Area.

The second identifier indicates the resource, e.g., WTR = Watershed, RMZ = Riparian Management Zones, and FAH = Fisheries and Aquatic Habitat.

The third identifier indicates the type of direction (DC = desired condition, OBJ = objective, GO = goals, STD = standard, GDL = guideline, SUIT = suitability).

The fourth identifier is a unique number (numerical order starting with "01") for each component within the constraints of the first three identifiers. For example, the first component for forest wide direction for desired conditions associated with watersheds would be identified starting with FW-WTR-DC-01.

I. Forestwide Desired Conditions.

A. Watershed Desired Conditions (FW-WTR-DC)

Properly functioning watersheds provide suitable conditions for sustainable clean water, healthy stable soils, timber growth, forage, aquatic and wildlife habitats, and the ability to withstand high intensity floods. Healthy watersheds contribute to local economies in the planning area including quality lands and water for, but not limited to, hunting, fishing, timber production, irrigation and ranching. Desired conditions provide a platform for future management actions.

01 National Forest System subwatersheds provide the distribution, diversity, and complexity of landscape-scale features including natural disturbance regimes and the aquatic, wetland, and riparian ecosystems to which native species, populations, and communities are uniquely adapted within those watersheds. Watersheds and associated ecosystems retain their inherent resilience to respond and adjust to disturbance without long-term adverse changes to the physical or biological integrity.

02 Spatial connectivity exists within or between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, groundwater, wetlands, upslope areas, headwater tributaries, and intact habitat refugia. These network connections provide chemically and physically unobstructed routes to areas critical for fulfilling the requirements of aquatic and riparian-associated plants and animals.

03 The timing, variability, and duration of floodplain inundation is within the natural range of variation. Floodplains are accessible to water flow and sediment deposits. Over-bank floods allow floodplain development and the propagation of flood-associated riparian plant and animal species.

04 In streams and floodplains with highly altered systems, the systems are stable or moving towards stability.

05 Upland areas surrounding wetlands that have the most direct influence on wetland characteristics, as well as stream segments that flow directly into wetlands, sustain the characteristics and diversity of those wetlands. Nonforested areas in and surrounding wetlands are composed of plant and animal communities that support and contribute to wetland ecological and habitat diversity.

06 Water quality, including groundwater, meets or exceeds applicable state water quality standards and fully supports beneficial uses, downstream users, municipal water supplies, and natural resources. Flow and habitat conditions in watersheds, streams, lakes, springs, wetlands, and groundwater aquifers fully support beneficial uses, and meet the ecological needs of native species (including species of conservation concern and threatened and endangered species).

07 The Forest has no documented lands or areas that are delivering water, sediment, nutrients, and/or chemical pollutants that would result in conditions that violate the state of Montana's water quality standards or is permanently above natural or background levels.

08 The sediment regime within water bodies is within the natural range of variation. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

09 Beavers are present in wetlands and riparian areas where they benefit and enhance groundwater, surface water, floodplain and riparian habitat complexity, and resilience to changing climate conditions.

10 In-stream flows are sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, and duration of peak, high, and low flows are retained. Stream flow regimes maintain riparian ecosystems and natural channel and floodplain dimensions. Stream channels transport sediment and woody material over time while maintaining reference dimensions (for example, bankfull width, depth, entrenchment ratio, slope, sinuosity, large woody material, percent pools, residual pool depth, median particle size, and percent fines).

11 Groundwater dependent ecosystems, including peatlands, fens, wetlands, wet meadows, seeps, springs, riparian areas, groundwater-fed streams and lakes, and groundwater aquifers persist in size, seasonal and annual timing, and water table elevation within the natural range of variation in order to maintain biodiversity of flora and fauna. Wetland and groundwater dependent ecosystem vegetation communities are resilient to drought, climate change, and other stressors. Also see Threatened, Endangered, Proposed, and Candidate Plant Species and Plant Species of Conservation Concern (PLANT).

12 Cave ecosystems exhibit natural hydrologic and environmental functions.

13 All stream crossing structures afford capacity for Q100 discharge and are properly aligned with the stream channel.

B. Riparian Management Zones Desired Conditions (FW-RMZ-DC)

Riparian Management Zones (RMZs) are portions of watersheds where riparian-associated resources receive primary emphasis, and management activities are subject to specific standards and guidelines. RMZs include traditional riparian corridors, wetlands, intermittent streams, and other areas that help maintain the integrity of aquatic ecosystems by 1) influencing the delivery of coarse sediment, organic matter, and woody debris to streams, 2) providing root strength for channel stability, 3) shading the stream, and 4) protecting water quality. Another critical function of RMZs is to provide for wildlife habitat use and connectivity.

Desired conditions for RMZs have been expanded to focus on key ecological processes and functions, highlight vegetation structure and composition, and provide suitable connected wildlife habitat rather than being fish-centric under the Inland Native Fish Strategy. Vegetation management within RMZs is allowed but riparian and aquatic conditions must be maintained, restored, or enhanced. Many activities that can cause soil compaction or soil erosion are restricted or minimized. RMZs are not “no management zones” since treatment may be necessary to achieve desired conditions. However, guidance is provided for activities within RMZs.

01 RMZs reflect a natural composition of native flora and fauna and a distribution of physical, chemical, and biological conditions appropriate to natural disturbance regimes affecting the area. The species composition and structural diversity of native plant communities in RMZs provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration. They will supply amounts and distributions of nutrients, coarse woody debris, and fine particulate organic matter sufficient to sustain physical complexity and stability. See the table under FW-RMZ-STD for typical width of a RMZ.

02 RMZs feature key riparian processes and conditions that function consistent with local disturbance regimes, including slope stability and associated vegetative root strength, wood delivery to streams and within the RMZs, input of leaf and organic matter to aquatic and terrestrial systems, solar shading, microclimate, and water quality. RMZs also provide an opportunity for riparian and terrestrial connectivity.

C. Fisheries and Aquatic Habitat Desired Conditions (FW-FAH-DC)

The intent of the fisheries and aquatic habitat plan components is to maintain or restore watershed conditions so that managed watersheds are moving towards or are in concert with reference watersheds when considered at a national forest scale. Changes between the 1986 plans, as amended, and the 2021 HLC Forest Plan are captured in the components below. Current threatened and endangered species and species of conservation concern are also included in this direction.

01 Watersheds and associated aquatic ecosystems retain their inherent resilience to respond and adjust to disturbances and climatic fluctuations without long-term, adverse changes to their biological integrity. Components of this biological integrity include supporting native fish, amphibians, birds, and invertebrates, as well as productive recreational fish populations. Essential characteristics of this resilience are healthy, functioning aquatic, riparian, upland, and wetland ecosystems.

02 Instream habitat conditions for managed watersheds move in concert with or towards those in reference watersheds. Aquatic habitats are diverse, with channel characteristics and water quality reflective of the climate, geology, and natural vegetation of the area. Stream habitat features across the forest, such as large woody material, percent pools, residual pool depth, median particle size, and percent fines are within reference ranges as defined by agency monitoring.

03 Aquatic systems and riparian habitats express physical integrity, including physical integrity of shorelines, banks, and bottom configurations, within their natural range of variation.

04 Connectivity between water bodies provides for movement between habitats associated with species' life stages (for example, fish migration to spawning areas, amphibian migration between seasonal breeding, foraging, and overwintering habitats), and for processes such as recolonization of historic habitats.

05 Habitats favor native aquatic species. Impacts of non-native fish species on native salmonids, such as hybridization, competition, replacement, and predation are minimal.

06 Aquatic ecosystems are free of invasive species such as zebra mussels, New Zealand mud snails, quagga mussels, and Eurasian milfoil. Non-native plant and amphibian species are not expanding into water bodies that support native amphibian breeding sites (for example, non-native bullfrogs, chytrid fungus, or reed canary grass are not expanding into boreal toad breeding sites).

07 Streams, lakes, and rivers provide habitats that contribute toward recovery of threatened and endangered fish species and address the habitat needs of all native aquatic species, as appropriate.

08 Increased availability of quality habitat reduces risk to the genetic diversity and population viability of aquatic threatened, endangered, or species of conservation.

D. Conservation Watershed Network (CWN) Desired Conditions (FW-CWN-DC)

The conservation watershed network is a specific subset of watersheds (10 or 12-digit hydrologic unit codes) where prioritization for long-term conservation and preservation of (1) bull trout, (2) westslope cutthroat trout, and (3) water quality. Restoration projects would be prioritized in bull trout habitat, followed by other watersheds where native fish viability is a concern. Additional restoration in municipal watersheds and watersheds with 303d listed segments or total maximum daily load listed stream segments will occur as a third priority due to potential impacts in connectivity if there is poor water quality/quantity anywhere between habitats. Evaluation of management activities in conservation watershed networks will follow appropriate levels of review prior to resource management (i.e., multiscale analysis). See appendix E for more information and tables listing the conservation watersheds.

01 Conservation watershed networks have functionally intact ecosystems that provide high-quality water and contribute to and enhance the conservation and recovery of threatened or endangered fish species and aquatic species of conservation concern.

E. Soil Desired Conditions (FW-SOIL-DC)

01 Soil quality and productivity are not impaired and support desired conditions for terrestrial and aquatic ecosystems.

Table of soil ecological functions with attributes, indicators, and desired conditions

Soil function[1]	Selected attributes	Soil quality indicator	Desired condition
Soil biology	Roots and aeration	Root growth	Root growth, both vertically and laterally, is unimpeded by compaction.
	Flora and fauna	Community composition	The soil is capable of supporting a distribution of desirable plant species by vegetative layer (trees, shrubs, herbaceous) as identified in the potential plant community (based on ecological site descriptions or equivalent). The site has not transitioned to an undesirable state.
		Canopy cover and ground cover	Soil temperature and moisture regimes are maintained in conditions to support desired plant communities.
Soil hydrology	Infiltration	Surfaces	Surface structure is as expected for the site (for example, granular, subangular blocky, single grain). Surface crusting and pore space are as expected for the site.
Nutrient cycling	Organic matter composition	Forest or rangeland floor	Forest and rangeland floor are appropriate for vegetation type and successional stage. Rangeland to be determined by field analysis and USDA-NRCS Soil Survey descriptions specific to soil type.
		Coarse woody material (greater than 3 inches)	Coarse woody material is on site in various stages of decay and size classes in amounts
			appropriate for habitat type. See FW-DC-VEGF-07 and FW-GDL-VEGF-05.
	Nutrient availability	Surface (A) horizon or mollic layer	"A" horizon is present, well distributed, not fragmented.
Support and stability	Stability	Surface erosion (wind, rill, or sheet)	Erosion is occurring at natural rates or not evident. Bare ground is within expected ranges base on USDA-NRCS Soil Survey descriptions for soil type.
		Site stability (mass erosion, landslide prone)	Site stability potential is unchanged or stability has been improved.

F. All Terrestrial Vegetation (VEGT) Desired Conditions (FW-VEGT-DC)

01 Vegetation conditions provide habitat requirements to support populations of species of conservation concern, threatened or endangered species, and other native and desired non-native species based upon the inherent capability of lands. Refer also to the Species at Risk sections of the Vegetation, Wildlife, and Aquatic Ecosystems resource sections.

G. Recreation Opportunities Desired Conditions (FW-REC-DC)

04 Recreation facilities, including trails and dispersed sites, and their use have minimal impacts on resources including at risk species, heritage and cultural sites, water quality, and aquatic species.

H. Roads and Trails (RT) Desired Conditions (FW-RT-DC)

02 Roads that are not needed to serve administrative and public needs are not present.

04 The transportation system has minimal impacts on resources including all wildlife, heritage and cultural sites, water quality, and aquatic species.

I. Public Information, Interpretation, and Education Desired Conditions (FW-CONNECT-DC)

02 Education programming promotes conservation, stewardship, and understanding of natural resources and ecological processes (such as watershed, fisheries, native plants, fire ecology, and wildlife) as well as cultural resources on public lands. Conservation education efforts are experiential, contemporary, and culturally and generationally relevant.

J. Livestock Grazing Desired Conditions (FW-GRAZ-DC)

03 Within grazing allotments, soil stability, and hydrologic and biotic integrity are maintained and are functioning in a manner that provide for resilience relative to site potential as described in ecological site descriptions or other classification.

04 Within grazing allotments, plant communities in wetlands, spring/seep ecosystems, and groundwater dependent ecosystems retain desired species composition, structure, and condition.

II. Geographic Area Desired Conditions (DI-FAH-DC and UB-FAH-DC)

01 Bull trout spawning, rearing, and migratory habitat is widely available and inhabited. Bull trout have access to historic habitat and appropriate life history strategies (for example, resident, fluvial, and adfluvial) are supported.

02 The bull trout population trends towards recovery and is supported through the Bull Trout Conservation Strategy, the Bull Trout Recovery Plan, and the Columbia Headwaters Recovery Unit Implementation Plan or the latest guiding documents.

III. Forestwide Goals

Goals are broad statements of intent, other than desired conditions, usually related to process or interaction with the public. Goals are expressed in broad, general terms, but do not include completion dates. (36 Code of Federal Regulations 219.7(e)(2)). Goals may be appropriate to describe a state between current conditions and desired conditions but without specific amounts of indicators. Goals may also be appropriate to describe overall desired conditions of the plan area that are also dependent on conditions beyond the plan area or FS authority.

A. Watershed Goals (FW-WTR-GO)

01 Under Montana Code Annotated 2015, 85-20-1301; the NF works with the USDA-FS-Montana compact to attain water rights to preserve instream flows for nonconsumptive water uses to provide for channel maintenance, water quality, aquatic habitats, and riparian vegetation.

02 Federal, tribal, state and local governments cooperate to identify and secure instream flows needed to maintain riparian resources, channel conditions, and aquatic habitat.

03 Work cooperatively with Montana Department of Environmental Quality on development of watershed restoration plans, total maximum daily load (TMDL) plans water quality issues, monitoring, as well as wetland characterization and mapping.

04 Work cooperatively with MT Fish, Wildlife, and Parks to use beavers to manage aquatic habitat quality.

B. Fisheries and Aquatic Habitat Goals (FW-FAH-GO)

01 Work with Montana Fish, Wildlife, and Parks to contribute to the expansion of core populations of bull trout as outlined in the Bull Trout Conservation Strategy (or the latest guiding document).

02 Work with Montana Fish, Wildlife, and Parks to contribute to the expansion of core populations of westslope cutthroat trout as outlined in the Westslope Cutthroat Trout Conservation Strategy (or the latest guiding document).

03 The Forest Service coordinates with federal agencies, state agencies, tribes, counties, interested groups, and interested private landowners to recover threatened and endangered species.

04 The Forest Service works with federal, state, tribal, and private land managers towards an all-lands approach to management and cooperation, including efforts to mitigate threats or stressors, provide for wildlife and fish habitat connectivity, and to provide social, economic and ecological conditions that contribute to mutual objectives.

05 The Forest Service cooperates with state agencies, federal agencies, tribes and other interested stakeholders to develop actions that lead to progress towards meeting other agencies' objectives for native and desired non-native fish and wildlife species.

06 Work with appropriate agencies including Montana Fish, Wildlife, and Parks to provide information and preventive measures to the public about aquatic invasive species at water-based recreation sites. Also see Public Information, Interpretation, and Education (CONNECT).

C. Geographic Area Goals (DI-FAH-GO and UB-FAH-GO)

01 Bull trout population recovery is supported through the Bull Trout Conservation Strategy, the Bull Trout Recovery Plan, and the Columbia Headwaters Recovery Unit Implementation Plan or the latest guiding documents through cooperation and coordination with the USFWS, tribes, state agencies, other federal agencies, and interested groups.

IV. Forestwide Objectives

An objective is a concise, measurable, and time-specific statement of a desired rate of progress toward a desired condition or conditions. Objectives should be based on reasonably foreseeable budgets (36 CFR 219.9(e)(1)(ii)).

A project or activity is consistent with the objectives of the Plan if it contributes to or does not prevent the attainment of any other applicable objectives. The project documentation should identify any applicable objective(s) to which the project contributes. If there are no applicable objectives, project documentation should state that fact. It should be noted that although desired conditions can be represented by unconstrained budgets, objectives under the proposed action are based upon current or anticipated available funding. Objectives that include work west of the continental divide would benefit recovery of bull trout in the Upper Clark Fork or Blackfoot Core Areas.

A. Watershed Objectives (FW-WTR-OBJ)

01 Within at least four priority watersheds, complete essential work as defined by the Watershed Restoration Actions Plans identified in the Watershed Condition Framework.

02 Improve soil and watershed function and resiliency on at an average of 500 acres/year with an emphasis on priority watersheds under the Watershed Condition Framework and Conservation Watershed Network.

03 Plan and implement restoration activities on at least two acres of groundwater dependent ecosystems every 5 years.

B. Riparian Management Zones Objectives (FW-RMZ-OBJ)

01 Improve at least 500 acres of riparian habitat during the life of the forest plan. Improvement can be actions such as, but are not limited to, road obliteration, riparian planting, and reconstructing floodplains by removing road prisms or berms.

C. Fisheries and Aquatic Habitat Objectives (FW-FAH-OBJ)

01 Improve the habitat quality and hydrologic function of at least 20 miles of aquatic habitat during the life of the plan, focusing on streams with listed species or species of conservation concern. Activities include, but are not limited to, berm removal, large woody debris placement, road decommissioning or stormproofing, riparian planting, and channel reconstruction.

03 Reconnect at least 10 miles of habitat in streams disconnected by roads or culverts where aquatic and riparian-associated species' migratory needs are limiting distribution of those species during the life of the plan.

D. Conservation Watershed Network (CWN) Objectives (FW-CWN-OBJ)

01 Repair at least two road/stream crossings every five years at locations where chronic sediment sources are found (for example, up-size culverts, reduce sediment delivery to waterways from roads, realign stream constraining road segments, improve livestock stream crossings and trailing, etc.). Give precedence to bull trout watersheds..

02 Stormproof at least 15% percent of the roads in the conservation watershed network prioritized for restoration to benefit threatened, endangered, proposed, and candidate aquatic species, aquatic species of conservation concern, and municipal watersheds. See appendix C for specific strategies for discussion of treatment options and for prioritization.

E. Recreation Opportunities Objectives (FW-REC-OBJ)

01 Rehabilitate at least 5 dispersed recreation sites (development scale 1-2) which have erosion or sanitation issues.

F. Roads and Trails Objectives (FW-RT-OBJ)

01 Decommission or place into storage (maintenance level 1) at least 50 miles of roads. Priorities shall include roads causing resource damage in priority watersheds and/or where roads chronically fail.

02 Complete at least 100 miles of reconstruction or road improvement projects. Priorities shall include reducing effects on: desired aquatic and riparian conditions from chronic sediment delivery or potential future road prism failures, and conservation watershed networks that have westslope cutthroat or bull trout habitats.

V. Forestwide Standards

Standards: A standard is a mandatory constraint on project and activity decision making, established to help achieve or maintain the desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (36 CFR 219.7(e)(1) (iii)).

There are several ways to constraint projects and activities: standards, guidelines, and other sources of constraints. A standard differs from a guideline in that a standard is a strict constraint, allowing no variation, whereas a guideline allows variation if the result would be equally effective. Examples of other sources of constraints on the design of projects and activities include congressional direction, regulations, timber sale contract clauses, and special use authorization standard clauses.

Standards are used when the requirement is absolute such as to ensure projects will not prevent achievement of a desired condition, or to ensure compliance with laws such as the timber requirements of sections 6(g)(3)(E) and (F) of the NFMA to protect aesthetics, fish, recreation, soil, watershed, and wildlife (16 U.S.C. 1604(g)(3)(E) and (F)), or to protect threatened or endangered species under the Endangered Species Act of 1973 as amended (16 U.S.C. 1531-1544). Standards can be used to limit disturbances from projects and activities to animal dens, perennial streams, and wildlife habitat. Standards can also be used to protect resources by restricting authorization of specific uses in appropriate circumstances. Such uses might include firewood gathering, grazing, motor vehicle use, road construction, timber harvest, removal of sand and gravel, sanitary waste facilities, storage of fuel, and surface occupancy in riparian areas.

A. Watershed Standards (FW-WTR-STD)

01 Projects that withdraw (i.e. pump) water from surface water features or groundwater must ensure that water is maintained at levels that will protect management uses and forest resources, including water quality and aquatic species and their habitat (including groundwater dependent ecosystems - fens, springs).

02 Best management practices (including both federal and the state of Montana Best Management Practices) shall be incorporated in all land use, transportation, infrastructure, and project plans as a principle mechanism for controlling nonpoint pollution sources to meet soil and watershed desired conditions and to protect beneficial uses.

03 Portable pump set-ups shall include containment provisions for fuel spills and fuel containers shall have appropriate containment provisions. Vehicles shall be parked in locations that avoid entry of spilled fuel into streams.

B. Riparian Management Zone Standards (FW-RMZ-STD)

01 RMZs shall be delineated as follows:

Category 1 Fish-bearing streams: RMZs consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet total, including both sides of the stream channel), whichever is greatest.

Category 2 Permanently flowing non-fish-bearing streams: RMZs consist of the stream and the area on each side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance (300 feet total, including both sides of the stream channel), whichever is greatest.

Category 3 Constructed ponds and reservoirs, and wetlands greater than 1 acre: RMZs consist of the body of water or wetland and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance from the edge of the wetland greater than 1 acre or the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest.

Lakes and natural ponds - RMZs consist of the body of water and: the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of unstable and potentially unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance, whichever is greatest.

Category 4 Seasonally flowing or intermittent streams, wetlands, seeps and springs less than 1 acre, and unstable and potentially unstable areas: This category applies to features with high variability in size and site-specific characteristics. At a minimum, the RMZs should include:

- ♦ The extent of unstable and potentially unstable areas (including earthflows).
- ♦ The stream channel and extend to the top of the inner gorge.

- ♦ The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation, extending from the edges of the stream channel to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest. A site-potential tree height is the average maximum height of the tallest dominant trees for a given site class.
- ♦ Intermittent streams are defined as any nonpermanent flowing drainage feature having a definable channel and evidence of annual scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two physical criteria. Fish-bearing intermittent streams are distinguished from non-fish-bearing intermittent streams by the presence of any species of fish for any duration. Many intermittent streams may be used as spawning and rearing streams, refuge areas during flood events in larger rivers, and streams or travel routes for fish emigrating from lakes. In these instances, the guidelines for fish-bearing streams would apply to those sections of the intermittent stream used by the fish.

The RMZ is broken into two areas called the inner and outer zones (see table below). As noted in footnotes of the table, the inner RMZ width can be extended beyond the length in the table in some special cases to whatever is greatest of the following: the top of the inner gorge, the outer edges of the 100-year floodplain, to the outer edges of riparian vegetation, or to a distance equal to the height of either one or two site-potential trees. Some activities are prohibited or restricted in the inner zone, whereas more active management can occur in the outer zone. RMZs are not intended to be "no touch zones," but rather "carefully managed zones" with an increase in protections in close proximity to water resources.

Table of typical widths[1] of inner and outer areas within RMZs

Stream type	Inner (ft)	Outer (ft)	Total width (ft)
Category 1 – Fish-bearing stream	100[2]	200	300[1]
Category 2 – Perennial, non-fish-bearing Stream	100[2]	50	150[1]
Category 3 – Natural Lakes and ponds, Constructed Ponds and Reservoirs, and wetlands greater than 1 acre	100	50	150
Category 4a – Intermittent steep (>35% side slope)	100[3]	0	100
Category 4b – Intermittent flat (<35% side slope) Disconnected intermittent MT State Class 3 and wetland <1 acre.	50	50	100

1. Widths listed are for each side of the stream, total width would be double the numbers listed.

2. Inner Riparian Management Zone widths extend on each side of the stream extending from the edges of the active stream channel either to the distance listed or to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site- potential trees, whichever is greatest.

3. Inner Riparian Management Zone widths extend on each side of the stream extending from the edges of the stream channel either to the distance listed or to the top of the inner gorge, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, whichever is greatest.

02 Vegetation management treatments shall only occur in the inner RMZ in order to restore or enhance aquatic and riparian-associated resources; only nonmechanical treatments shall be authorized.

03 Vegetation management may occur within the outer RMZs to meet desired conditions, so long as project activities within RMZs do not prevent attainment of desired conditions for wildlife and the inner RMZ.

04 Herbicides, pesticides, and other toxicants and chemicals shall only be applied within RMZs if needed to maintain, protect, or enhance aquatic and riparian resources or to restore native plant communities.

05 Storage and refueling sites shall be located outside of RMZs to minimize effects to aquatic resources. If refueling or storage is needed within RMZs, the locations must be approved by the FS and have an approved spill containment plan.

06 Salvage harvest shall not occur in the inner RMZ.

C. Fisheries and Aquatic Habitat Standards (FW-FAH-STD)

01 New stream diversions and associated ditches shall be screened to prevent capture of fish and other aquatic organisms.

D. Roads and Trails Standards (FW-RT-STD)

01 During dust abatement applications on roads, chemicals shall not be applied directly to watercourses, water bodies (for example, ponds and lakes), nor wetlands.

02 To maintain free-flowing streams, new, replacement, and reconstructed stream crossing sites (culverts, bridges and other stream crossings) shall accommodate at least the 100-year flow, including associated bedload and debris.

03 For new road construction and reconstruction of existing road segments within or adjacent to RMZs, fill material shall not be side-cast.

04 When installing new crossing structures on streams that have no fish, the structures shall accommodate a 1 percent probability (100-year) or higher flow, including associated bedload and debris. If site-specific conditions preclude that design, size the structure to the largest size the location will accommodate and provides for bankfull width.

E. Livestock Grazing Standards (FW-GRAZ-STD)

01 New or revised allotment management plans shall provide site-specific management prescriptions to meet or move toward applicable desired conditions.

02 Annual livestock use indicators within inner RMZs shall be set during the allotment management planning process at levels that move towards or maintain desired rangeland vegetation, riparian function, and wildlife habitat specific to the ecological site (or equivalent classification). Indicator values shall be adapted over time based on long-term monitoring and evaluation of conditions and trends.

VI. Forestwide Guidelines

Guidelines: A guideline is a constraint on project and activity decision making that allows for departure from its terms, so long as the purpose of the guideline is met (§ 219.15(d)(3)). Guidelines are established to help achieve or maintain a desired condition or conditions, to avoid or mitigate undesirable effects, or to meet applicable legal requirements (36 CFR 219.7(e)(1)(iv)). As with desired conditions, guidelines can be forestwide or specific to a GA. Guidelines serve the same purpose as standards but they differ from standards in that they provide flexibility in defining compliance, while standards are absolute constraints.

A. Watershed Guidelines (FW-WTR-GDL)

01 When conducting management activities, in order to support aquatic habitat quality and resiliency, beaver complexes should be enhanced or maintained.

02 Special use permits related to water uses should include provisions to ensure that water quality and beneficial uses are fully protected.

B. Riparian Management Zone Guidelines (FW-RMZ-GDL)

01 Trees felled inside RMZs should be left onsite to achieve aquatic and riparian desired conditions.

02 To maintain stream channel stability and aquatic habitat, large woody debris should not be cut and/or removed from stream channels unless it threatens critical infrastructure, such as mid-channel bridge piers or fire control breaks.

03 To avoid disturbing or compacting soil or damaging vegetation, management activities should be excluded within a minimum of 100 feet of peatlands, fens, and other groundwater dependent ecosystems.

04 To reduce the likelihood of sediment input to streams, new road and landing construction should be avoided, including temporary roads, in RMZs except where:

- necessary for stream crossings, or
- a road relocation contributes to attainment of aquatic and riparian desired conditions, or
- Forest Service authorities are limited by law or regulation.

05 To minimize sediment delivery and adverse effects to stream channels, construction of machine fireline in RMZs should be avoided, except where needed to cross streams. Following wildfire and prescribed fire operations, fire lines should be rehabilitated to limit the creation of new stream channels.

06 To reduce the likelihood of sediment input to streams and reduce adverse effects to stream channels and riparian areas, when conducting fire operations, the use of heavy equipment within RMZs should be minimized.

07 New sand and gravel borrow pit development or gravel mining should not occur within RMZs to minimize ground disturbance and sediment inputs.

08 To reduce the likelihood of sediment input to streams and reduce adverse effects to stream channels and riparian areas, temporary fire facilities (for example, incident bases, camps, wheelbases, staging areas, helispots, and other centers) for incident activities should be located outside RMZs. When no practical alternative exists, all appropriate measures to maintain, restore, or enhance aquatic and riparian dependent resources should be used.

09 New landings, designated skid trails, staging, and decking should be located outside RMZs to minimize effects to riparian and aquatic resources. If landings are needed inside of RMZs, the disturbance area footprint should be minimized, and the activities should be located outside the active floodplain.

10 Aerial application of chemical retardant, foam, or other fire chemicals and petroleum should be avoided in mapped aerial retardant avoidance areas (refer to latest regional avoidance map) in order to minimize impacts to the RMZ and aquatic resources.

11 To reduce the likelihood of sediment input to streams and reduce adverse effects to stream channels and riparian areas, clearcut harvest should not occur in RMZs.

12 To reduce the likelihood of sediment input to streams and reduce adverse effects to stream channels and riparian areas, all management activities in RMZs should protect key riparian features and processes, including maintenance of stream bank stability, input of organic matter, temperature regimes, water quality, and aquatic and terrestrial habitat connectivity.

C. Fisheries and Aquatic Habitat Guidelines (FW-FAH-GDL)

01 Prior to use in a water body or when moving between watersheds, equipment (including boats, rafts, drafting equipment, water tenders, and helicopter buckets) should be inspected and cleaned to reduce the potential for the introduction of aquatic invasive species, including aquatic pathogens.

02 When drafting water from streams, pumps should be screened to prevent capture of fish. During the spawning season for native fish, pumping sites should be located away from spawning gravels.

03 New and revised livestock management plans should be designed to maintain or improve water quality by minimizing impacts caused by livestock grazing in RMZs within active livestock allotments. Also see Benefits to People, Livestock Grazing (GRAZ).

04 Construction activities within the ordinary high-water mark that may result in adverse effects to native or desirable non-native aquatic species, or have the potential to directly deliver sediment to their habitats, should be limited to times outside of spawning and incubation seasons. Specific time periods should be coordinated through the permitting process with Montana Fish, Wildlife, and Parks.

05 Human created migration barriers to aquatic species should not be created unless they are needed to prevent invasions by non-native species.

D. Conservation Watershed Network Guidelines (FW-CWN-GDL)

01 For subwatersheds included in the conservation watershed network, net increases in stream crossings and road lengths should be avoided in RMZs, unless the net increase would improve ecological function in aquatic ecosystems. The net increase is measured from beginning to end of each project.

02 Roads in conservation watershed networks should be prioritized for road decommissioning, closure, relocation or other strategies to reduce sediment delivery to benefit aquatic species (for example, bull trout). See appendix C for specific strategies for discussion of treatment options and for prioritization.

03 During project planning, conservation watershed networks should be the highest priority for restoration actions for the aquatic environment.

E. All Terrestrial Vegetation Guidelines (FW-VEGT-GDL)

01 Removal of native vegetation during nonvegetation management activities (for example, road maintenance) should be limited to the extent needed to achieve the project purpose and need.

02 Livestock grazing practices should be modified as necessary to ensure that revegetation and/or reforestation is successful after management activities or natural disturbances, as defined in site- specific prescriptions.

F. Recreation Opportunities Guidelines (FW-REC-GDL)

01 Management of developed recreation facilities should be responsive to environmental changes such as but not limited to changes in water flows, snow levels, snow elevation, fish and wildlife habitats, vegetative conditions, and seasonal recreation use.

03 To maintain quality and quantity of water flows to, within, or between groundwater dependent ecosystems, groundwater use facilities at recreation and administrative sites should not: a) be developed in RMZs (unless no alternatives exist); b) measurably lower river flows, lake levels, or flows to wetlands or springs (for example change springs from perennial to intermittent, or eliminate springs altogether); and/or c) discharge pollutants directly to groundwater.

04 To reduce potential impact to fishery resources, avoid placing new facilities or infrastructure within expected long-term channel migration zone. Where new activities inherently must occur in RMZs (for example road stream crossings, boat ramps, docks, and interpretive trails), locate them to minimize impacts on riparian associated resource conditions.

05 Where existing recreation facilities are located within RMZs and degrading aquatic or riparian resources, consider removing or relocating such facilities outside of RMZs or use other means practicable to reduce effects. In RMZs, areas where developed recreation facilities have been removed should be rehabilitated to a natural state.

06 To protect resources, new and reconstructed solid and sanitary waste facilities should not be located within inner RMZs.

G. Recreation Access Guidelines (FW-ACCESS-GDL)

01 To protect natural and cultural resources, projects and other management activities should be designed to prevent the creation and/or use of unauthorized recreation routes, and to rehabilitate existing ones to the extent practicable.

H. Land Uses Guidelines (FW-LAND USE-GDL)

03 When authorizing new lands special uses or reauthorizing existing uses, pre-approved clauses that contain terms and conditions to avoid or minimize adverse effects to resources should be included.

04 If adverse effects to inland native fish, species of conservation concern, impaired water bodies, or stream habitat conditions are unavoidable, land use authorizations should require actions that result in re-establishment, restoration, mitigation, or improvement of conditions and processes to ensure that projects that degrade conditions also include measures to incrementally improve conditions. At the time of reauthorization, existing authorizations should be adjusted to mitigate adverse effects to fish, water, and riparian resources as practicable.

05 New hydropower support facilities should be located outside of riparian management zones (RMZs) to reduce effects to fish, water, and riparian resources. Support facilities include any facilities or improvements (e.g., workshops, housing, switchyards, staging areas, transmission lines) not directly integral to its operation or necessary for the implementation of prescribed protection, mitigation, or enhancement measures.

06 If existing support facilities are located within the RMZs, at time of permit reissuance, pre-approved clauses that contain terms and conditions to reduce impacts on aquatic and riparian resources should be included. Also consider moving support facilities outside of RMZs or further from water bodies where feasible.

I. Roads and Trails Guidelines (FW-RT-GDL)

01 Newly constructed or reconstructed roads, temporary roads, skid trails, and trails should be hydrologically disconnected from delivering water, sediment, and pollutants to water bodies (except at designated stream crossings) to maintain the hydrologic integrity of watersheds.

02 When placing physical barriers such as berms on travel routes such as roads, skid trails, temporary roads, and trails, drainage features should be sufficient to avoid future risks to aquatic resources (for example, remove culverts from stream crossings).

03 To maintain channel stability and reduce sediment delivery to watercourses, trails, fords, and other stream crossings should be hardened to protect stream beds, banks, and approaches during construction or reconstruction.

04 To reduce the risk to aquatic resources when decommissioning roads, making roads impassable, or putting roads into intermittent stored service (i.e. storing roads for longer than 1 year), roads should be left in a hydrologically stable condition (for example, drainage off roads should route away from water resources and landslide prone areas and towards stable areas of the forest floor to provide filtering and infiltration).

05 To maintain and/or improve watershed ecosystem integrity and reduce road-related mass wasting and sediment delivery to watercourses, new and relocated roads, trails (including skid trails and temporary roads), and other linear features should not be constructed on lands with high mass wasting potential.

06 For maintenance activities such as road blading and snow plowing on existing roads, sidecasting should be minimized, particularly into or adjacent to water bodies. Care should be taken when plowing snow so as not to include road soil. Breaks should be designed in the snow berms to direct water off the road.

07 Wetlands and unstable areas should be avoided when reconstructing existing roads or constructing new roads and landings. Impacts should be minimized where avoidance is not practical.

08 When constructing, reconstructing, or maintaining roads, sediment delivery to streams should be minimized. Road drainage should be routed away from potentially unstable channels, fills, and hillslopes.

09 Transportation infrastructure should be designed to maintain natural hydrologic flow paths to the extent practical (for example, streams should have crossing structures and not be routed down ditches).

10 In fish-bearing streams, construction, reconstruction, or replacement of stream crossings should provide and maintain passage for all life stages of native aquatic organisms unless barriers should be created or maintained to prevent spread or invasion of non-native species in alignment with fish

management agencies. These crossings should also allow for passage for other riparian dependent species through the establishment of banks inside/beneath the crossing structure.

11 To maintain free-flowing streams, new, replacement, and reconstructed stream crossing sites (culverts, bridges and other stream crossings) should be constructed to prevent diversion of stream flow out of the channels in the event the crossing is plugged or has a flow greater than the crossing was designed.

12 Roads not needed in the long term should be decommissioned to benefit fish and wildlife habitat (prioritizing native fish habitat), enhance the desired recreation opportunity spectrum settings and opportunities, and/or create a more cost-efficient transportation system.

J. Livestock Grazing Guidelines (FW-GRAZ-GDL)

01 To maintain or improve riparian and aquatic conditions and achieve riparian desired conditions over time through adaptive management, new grazing authorizations and reauthorizations that contain low-gradient, alluvial channels should require that end-of-season stubble height be 10 to 15 cm (4 to 6 inches) along the greenline. However, application of the stubble height numeric value range should only be applied where it is appropriate to reflect existing and natural conditions for the specific geo- climactic, hydrologic, and vegetative conditions where it is being applied. Alternative use and disturbance indicators and values, including those in current ESA consultation documents, may be used if they are based on current science and monitoring data and meet the purpose of this guideline. Long-term monitoring and evaluation should be used to adapt this numeric range and/or the use of other indicators.

02 To ensure grazing is sustainable and contributes to other resource desired conditions, forage use by livestock should maintain or enhance the desired structure and diversity of plant communities on grasslands, shrub lands, and forests and should maintain or restore healthy riparian conditions as defined in the allotment management plan.

03 New or revised allotment management plans should design grazing practices (such as stocking rate, duration, timing), and/or physical structures to reduce negative effects to riparian areas or riparian dependent at risk species.

04 Allotment management plans should incorporate adaptive management to move towards desired conditions for vegetation and riparian resources, considering both the needs and impacts of domestic livestock and wildlife.

05 When updating or managing existing facilities that are located within RMZs, facilities should be minimized or relocated to other areas. Livestock management activities (trailing, bedding, watering, salting, loading, and other handling or management efforts) should be avoided in RMZs to reduce effects to riparian resources and aquatic biota. Also see FW-RMZ section for additional information.

06 Livestock watering facilities should be constructed or maintained to provide for forage use that will maintain or enhance structure and diversity of plant communities on suitable rangelands, but avoid impacts to soil and water resources.

07 To attract livestock out of riparian areas, salt and/or supplements should be placed at least one-quarter (1/4) mile away.

K. Geology, Energy and Minerals Guidelines (FW-EMIN-GDL)

01 To minimize adverse effects to aquatic and riparian resources, new authorizations and reauthorizations for mineral development and operations should avoid RMZs to the extent practicable. If the RMZ cannot be avoided, then ensure operators take all practicable measures to maintain, protect, and rehabilitate fish and wildlife habitat that may be affected by the operations. Required bonding should consider (in the estimation of bond amount) the cost of stabilizing, rehabilitating, and reclaiming the area of operations.

02 To minimize adverse effects to aquatic and riparian resources, new authorizations and reauthorizations for mineral development and operations should avoid adverse effects to aquatic and riparian resources. This should include requirements that operators take all practicable measures to maintain, protect, and rehabilitate water quality, and habitat for fish and wildlife and other riparian associated resources which may be affected by the operations.

VII. Forestwide Suitability of Lands

Specific lands within the Forest will be identified as suitable (SUIT) for various multiple uses or activities based on the desired conditions applicable to those lands. The plan will also identify lands within the Forest as not suitable for uses that are not compatible with desired conditions for those lands. The suitability of lands need not be identified for every use or activity (36 Code of Federal Regulations 219.7

(e)(1)(v)). Suitability identifications may be made after consideration of historic uses and of issues that have arisen in the planning process.

Identifying suitability of lands for a use in the forest plan indicates that the use may be appropriate, but does not make a specific commitment to authorize that use. Final suitability determinations for specific authorizations occur at the project or activity level decision making process. Generally, the lands on the Forest are suitable for all uses and management activities appropriate for national forests, such as outdoor recreation, range, or timber, unless identified as not suitable. Every plan must identify those lands that are not suitable for timber production (§ 219.11). (36 Code of Federal Regulations 219.7(e)(1)(v)). For forestwide suitability determinations, please see chapter 2 and for GA specific suitability determinations, see chapter 3 of the Forest Plan.

A. Riparian Management Zone Suitability (FW-RMZ-SUIT)

01 RMZs are not suitable for timber production, but harvest for other multiple use values is allowed as appropriate under the RMZ plan components.

Table A2. Monitoring elements for watershed (WTR), fisheries and aquatic habitat (FAH), riparian management zones (RMZs, and conservation watershed networks (CWNs).

Selected plan components	Monitoring question	Indicator(s) and measure(s)
FW-WTR-DC-03; FW-WTR-DC-04; FW-WTR-DC-08; FW-WTR-DC-10; FW-FAH-DC-02; FW-FAH-DC-03; FW-RMZ-DC-01	MON-WTR-01 What is the trend in instream physical characteristics for managed watersheds as compared to unmanaged?	Instream physical habitat • Woody debris, bank angle, pooltail fines, percent pool and residual pool depth, pebble count data (D50)
FW-WTR-DC-05; FW-WTR-DC-11; FW-WTR-STD-02; FW-WTR-STD-03	MON-WTR-02 What BMPs are implemented in wetlands in order to not impede the sustainability of wetland characteristics and diversity?	BMP implementation for projects with wetlands • Number and types of BMPs implemented • Quality at which the BMP are implemented
FW-WTR-DC-06; FW-WTR-DC-07; FW-WTR-DC-08	MON-WTR-03 What is the status of 303 and 305 State listed streams?	State listed stream segments forestwide and by conservation watershed network • Number and locations stream reaches on 303 and 305 list • Acres, miles, and types of actions that improve the reasons for which the stream reach was listed • MT State assessment of Beneficial Uses status (fully supporting, not fully supporting, threatened) for each listed stream segment
FW-CWN-GDL-02; FW-CWN-GDL-03 FW-WTR-OBJ-01; FW-WTR-OBJ-02	MON-WTR-04 Are watershed restoration projects occurring in priority watersheds?	Watershed restoration projects • Number, type, and location of projects in priority watersheds (Conservation Watershed Framework and priority watersheds as identified in the Watershed Condition Framework) • Number, type, and location of projects NOT in priority watersheds (Conservation Watershed Framework and priority watersheds as identified in the Watershed Condition Framework)
FW-CWN-DC-01; FW-FAH-OBJ-01; FW-FAH-OBJ-02	MON-WTR-05 What stream habitat improvement actions have occurred?	Stream habitat improvements • Miles, types, and locations of stream habitat improvements
FW-CWN-GDL-01; FW-CWN-GDL-02 FW-CWN-OBJ-01: FW-CWN-OBJ-02	MON-WTR-06 What road and access improvements have been completed in Conservation Watershed Network areas?	Road management in conservation watershed networks • Number, types, miles or road management actions/decisions in watershed conservation network
FW-FAH-GDL-04; FW-CWN-GDL-03	MON-WTR-07	Water quality maintained or improved forestwide and by conservation watershed network

Selected plan components	Monitoring question	Indicator(s) and measure(s)
	Are new and revised livestock management plans designed to maintain water quality?	• Miles of intermittent and perennial streams moving towards desired condition • Number of improved management strategies expected to move RMZs towards desired conditions
FW-FAH-DC-01; FW-FAH-DC-04 FW-FAH-DC-05; FW-FAH-DC-08	MON-FAH-01 What is the status of westslope cutthroat trout?	Presence and abundance of genetically pure westslope cutthroat trout populations • Number of fish per mile, or miles of occupied stream reaches • Locations of populations
FW-RT-STD-02; FW-RT-STD-03; FW-RT-STD-04; FW-BRDG-DC-01	MON-FAH-02 Are culverts and bridges on fish-bearing streams being constructed/upgraded/removed to allow aquatic organism passage?	Infrastructure for aquatics systems • Number of culverts and bridges on fish-bearing streams that comply with standards • Number of culverts and bridges on fish-bearing streams that DO NOT comply with standards.
FW-RMZ-DC-01; FW-RMZ-DC-02; FW-RMZ-OBJ-01	MON-RMZ-01 How many acres of riparian management zones have been improved?	Acres of riparian management areas improved through activities including but not limited to: • Road obliteration • Riparian planting • Reconstruction of flood plains through removal of roads or berms

Appendix B. Life History and Population Dynamics of Bull Trout

A. Distribution

The historical range of bull trout includes major river basins in the Pacific Northwest at about 41 to 60 degrees North latitude, from the southern limits in the McCloud River in northern California and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, Bond 1992). To the west, the bull trout's range includes Puget Sound, various coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992). Bull trout occur in portions of the Columbia River and tributaries within the basin, including its headwaters in Montana and Canada. Bull trout also occur in the Klamath River basin of south-central Oregon. East of the Continental Divide, bull trout are found in the headwaters of the Saskatchewan River in Alberta and Montana and in the MacKenzie River system in Alberta and British Columbia, Canada (Cavender 1978, Brewin and Brewin 1997).

B. Reproductive Biology

The iteroparous reproductive strategy (i.e., fishes that spawn multiple times, and therefore require safe two-way passage upstream and downstream) of bull trout has important repercussions for the management of this species. Bull trout require passage both upstream and downstream, not only for repeat spawning but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous salmonids (i.e., fishes that spawn once and then die, and require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a safe downstream passage route. Additionally, in some core areas, bull trout that migrate to marine waters must pass both upstream and downstream through areas with net fisheries at river mouths. This can increase the likelihood of mortality to bull trout during these spawning and foraging migrations.

Growth varies depending upon life-history strategy. Resident adults range from 6 to 12 inches total length, and migratory adults commonly reach 24 inches or more (Goetz 1989, Pratt 1985). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Bull trout typically spawn from August through November during periods of increasing flows and decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel (Fraley and Shepard 1989). Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater (Goetz 1989, Pratt 1992, Rieman and McIntyre 1996). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992). After hatching, fry remain in the substrate, and time from egg deposition to emergence may surpass 220 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows (Pratt 1992, Ratliff and Howell 1992).

Early life stages of fish, specifically the developing embryo, require the highest inter-gravel dissolved oxygen (IGDO) levels, and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depends on temperature and on stage of development, with the greatest IGDO required just prior to hatching.

A literature review conducted by the Washington Department of Ecology (WDOE 2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). Normal oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L (in the gravel), with corresponding instream levels of 10 to 11.5 mg/L (Stewart et al. 2007). In addition, IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are interrelated variables that affect the survival of incubating embryos (ODEQ 1995). Due to a long incubation period of 220+ days, bull trout are particularly sensitive to adequate IGDO levels. An IGDO level below 8 mg/L is likely to result in mortality of eggs, embryos, and fry.

C. Population Structure

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior (Rieman and McIntyre 1993). Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs (Goetz 1989). Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), river (fluvial form) (Fraley and Shepard 1989, Goetz 1989), or saltwater (anadromous form) to rear as subadults and to live as adults (Brenkman and Corbett 2005, McPhail and Baxter 1996, WDFW et al. 1997). Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. They are iteroparous (i.e., they spawn more than once in a lifetime). Repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Fraley and Shepard 1989, Leathe and Graham 1982, Pratt 1992, Rieman and McIntyre 1996).

Bull trout are naturally migratory, which allows them to capitalize on temporally abundant food resources and larger downstream habitats. Resident forms may develop where barriers (either natural or manmade) occur or where foraging, migrating, or overwintering habitats for migratory fish are minimized (Brenkman and Corbett 2005, Goetz et al. 2004). For example, multiple life history forms (e.g., resident and fluvial) and multiple migration patterns have been noted in the Grande Ronde River (Baxter 2002). Parts of this river system have retained habitat conditions that allow free movement between spawning and rearing areas and the mainstem Snake River. Such multiple life history strategies help to maintain the stability and persistence of bull trout populations to environmental changes.

Benefits to migratory bull trout include greater growth in the more productive waters of larger streams, lakes, and marine waters; greater fecundity resulting in increased reproductive potential; and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss (Frissell 1999, MBTSG 1998, Rieman and McIntyre 1993). In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbances make local habitats temporarily unsuitable. Therefore, the range of the species is diminished, and the potential for a greater reproductive contribution from larger size fish with higher fecundity is lost (Rieman and McIntyre 1993).

Whitesel et al. (2004) noted that although there are multiple resources that contribute to the subject, Spruell et al. (2003) best summarized genetic information on bull trout population structure. Spruell et al. (2003) analyzed 1,847 bull trout from 65 sampling locations, four located in three coastal drainages (Klamath, Queets, and Skagit Rivers), one in the Saskatchewan River drainage (Belly River), and 60 scattered throughout the Columbia River Basin. They concluded that there is a consistent pattern among genetic studies of bull trout, regardless of whether examining allozymes, mitochondrial DNA, or most recently microsatellite loci. Typically, the genetic pattern shows relatively little genetic variation within populations, but substantial divergence among populations. Microsatellite loci analysis supports the existence of at least three major genetically differentiated groups (or evolutionary lineages) of bull trout (Spruell et al. 2003). They were characterized as:

1. “Coastal”, including the Deschutes River and all of the Columbia River drainage downstream, as well as most coastal streams in Washington, Oregon, and British Columbia. A compelling case also exists that the Klamath Basin represents a unique evolutionary lineage within the coastal group.
2. “Snake River”, which also included the John Day, Umatilla, and Walla Walla rivers. Despite close proximity of the John Day and Deschutes Rivers, a striking level of divergence between bull trout in these two systems was observed.
3. “Upper Columbia River” which includes the entire basin in Montana and northern Idaho. A tentative assignment was made by Spruell et al. (2003) of the Saskatchewan River drainage populations (east of the continental divide), grouping them with the upper Columbia River group.

Spruell et al. (2003) noted that within the major assemblages, populations were further subdivided, primarily at the level of major river basins. Taylor et al. (1999) surveyed bull trout populations, primarily from Canada, and found a major divergence between inland and coastal populations. Costello et al. (2003) suggested the patterns reflected the existence of two glacial refugia, consistent with the conclusions of Spruell et al. (2003) and the biogeographic analysis of Haas and McPhail (2001). Both Taylor et al. (1999) and Spruell et al. (2003) concluded that the Deschutes River represented the most upstream limit of the coastal lineage in the Columbia River Basin.

More recently, the U.S. Fish and Wildlife Service identified additional genetic units within the coastal and interior lineages (Ardren et al. 2011). Based on a recommendation in the U.S. Fish and Wildlife Service’s 5-year review of the species’ status (U.S. Fish and Wildlife Service 2008), the U.S. Fish and Wildlife Service reanalyzed the 27 recovery units identified in the 2002 draft bull trout recovery plan (U.S. Fish and Wildlife Service 2002) by in part utilizing information from previous genetic studies and new information from additional analysis (Ardren et al. 2011). In this examination, the U.S. Fish and Wildlife Service applied relevant factors from the joint U.S. Fish and Wildlife Service and NMFS DPS policy (U.S. Fish and Wildlife Service 1996) and subsequently identified six draft recovery units that contain assemblages of core areas that retain genetic and ecological integrity across the range of bull trout in the coterminous United States. These six draft recovery units were used to inform designation of critical habitat for bull trout by providing a context for deciding what habitats are essential for recovery (U.S. Fish and Wildlife Service 2010). The six draft recovery units identified for bull trout in the coterminous United States include: Coastal, Klamath, Mid-Columbia, Columbia Headwaters, Saint Mary, and Upper Snake. These six draft recovery units are described and identified in the final bull trout recovery plan (U.S. Fish and Wildlife Service 2015) and RUIPs (U.S. Fish and Wildlife Service 2015a-f).

D. Population Dynamics

Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991). Burkey (1989) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth for local populations may be low and probability of extinction high (Burkey 1989, Burkey 1995).

Metapopulation concepts of conservation biology theory have been suggested relative to the distribution and characteristics of bull trout, although empirical evidence is relatively scant (Rieman and McIntyre 1993, Dunham and Rieman 1999, Rieman and Dunham 2000). A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meffe and Carroll 1997). For inland bull trout, metapopulation theory is likely most applicable at the watershed scale where habitat consists of discrete patches or collections of habitat capable of supporting local populations; local populations are generally independent and represent discrete reproductive units; and long-term, low-rate dispersal patterns among component populations influences the persistence of at least some of the local populations (Rieman and Dunham 2000). Ideally, multiple local populations distributed throughout a watershed provide a mechanism for spreading risk because the simultaneous loss of all local populations is unlikely. However, habitat alteration, primarily through the construction of impoundments, dams, and water diversions has fragmented habitats, eliminated migratory corridors, and in many cases isolated bull trout in the headwaters of tributaries (Rieman and Clayton 1997, Dunham and Rieman 1999, Spruell et al. 1999, Rieman and Dunham 2000).

Human-induced factors as well as natural factors affecting bull trout distribution have likely limited the expression of the metapopulation concept for bull trout to patches of habitat within the overall distribution of the species (Dunham and Rieman 1999). However, despite the theoretical fit, the relatively recent and brief time period during which bull trout investigations have taken place does not provide certainty as to whether a metapopulation dynamic is occurring (e.g., a balance between local extirpations and recolonizations) across the range of the bull trout or whether the persistence of bull trout in large or closely interconnected habitat patches (Dunham and Rieman 1999) is simply reflective of a general deterministic trend towards extinction of the species where the larger or interconnected patches are relics of historically wider distribution (Rieman and Dunham 2000). Research does, however, provide genetic evidence for the presence of a metapopulation process for bull trout, at least in the Boise River Basin of Idaho (Whiteley et al. 2003), while Whitesel et al. (2004) identifies that bull trout fit the metapopulation theory in several ways.

E. Habitat Characteristics

The habitat requirements of bull trout are often generally expressed as the four “Cs”: cold, clean, complex, and connected habitat. Cold stream temperatures, clean water quality that is relatively free of sediment and contaminants, complex channel characteristics (including abundant large wood and undercut banks), and large patches of such habitat that are well connected by unobstructed migratory pathways are all needed to promote conservation of bull trout throughout all hierarchical levels.

Bull trout have more specific habitat requirements than most other salmonids (Rieman and McIntyre 1993). Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors (Fraley and Shepard 1989, Goetz 1989, Hoelscher and Bjornn 1989, Howell and Buchanan 1992, Pratt 1992, Rich 1996, Rieman and McIntyre 1993, Rieman and McIntyre 1995, Sedell and Everest 1991, Watson and Hillman 1997). Watson and Hillman (1997) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), bull trout should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout (Rieman and McIntyre 1993). Migrations facilitate gene flow among local populations when individuals from different local populations interbreed or stray to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants. However, it is important to note that the genetic structuring of bull trout indicates there is limited gene flow among bull trout populations, which may encourage local adaptation within individual populations, and that reestablishment of extirpated populations may take a long time (Rieman and McIntyre 1993, Spruell et al. 1999). Migration also allows bull trout to access more abundant or larger prey, which facilitates growth and reproduction. Additional benefits of migration and its relationship to foraging are discussed below under “Diet.”

Cold water temperatures play an important role in determining bull trout habitat quality, as these fish are primarily found in colder streams, and spawning habitats are generally characterized by temperatures that drop below 9 °C in the fall (Fraley and Shepard 1989, Pratt 1992, Rieman and McIntyre 1993).

Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, Rieman and McIntyre 1993). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (Buchanan and Gregory 1997, Goetz 1989). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8 °C to 9 °C, within a temperature gradient of 8 °C to 15 °C. In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 0.75) until maximum temperatures decline to 11 °C to 12 °C.

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Buchanan and Gregory 1997, Fraley and Shepard 1989, Rieman and McIntyre 1993, Rieman and McIntyre 1995). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Fraley and Shepard 1989, Goetz 1989, Hoelscher and Bjornn 1989, Pratt 1992, Rich 1996, Sedell and Everest 1991, Sexauer and James 1997, Thomas 1992, Watson and Hillman 1997). Maintaining bull trout habitat requires natural stability of stream channels and maintenance of natural flow patterns (Rieman and McIntyre 1993). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997). These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and young juveniles in the gravel from winter through spring (Fraley and Shepard 1989, Pratt 1992, Pratt and Huston 1993). Pratt (1992) indicated that increases in fine sediment reduce egg survival and emergence.

F. Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow their foraging strategy changes as their food changes, in quantity, size, or other characteristics (Quinn 2005). Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987, Donald and Alger 1993, Goetz 1989). Subadult and adult migratory bull trout generally feed on various fish species (Donald and Alger 1993, Fraley and Shepard 1989, Leathe and Graham 1982). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and VanTassell 2001). In nearshore marine areas of western Washington, bull trout feed on Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus*), and surf smelt (*Hypomesus pretiosus*) (Goetz et al. 2004, WDFW et al. 1997).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies and their environment. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. For example, in the Skagit River system, anadromous bull trout make migrations as long as 121 miles between marine foraging areas in Puget Sound and headwater spawning grounds, foraging on salmon eggs and juvenile salmon along their migration route (WDFW et al. 1997). Anadromous bull trout also use marine waters as migration corridors to reach seasonal habitats in non-natal watersheds to forage and possibly overwinter (Brenkman and Corbett 2005, Goetz et al. 2004).

Literature Cited in Life History and Population Dynamics

Ardren, W.R., P.W. DeHaan , C.T. Smith , E.B. Taylor , R. Leary , C.C. Kozfkay , L. Godfrey , M. Diggs , W. Fredenberg , J. Chan, C.W. Kilpatrick , M.P. Small, and D.K. Hawkins. 2011. Genetic Structure, Evolutionary History, and Conservation Units of Bull Trout in the Coterminous United States, Transactions of the American Fisheries Society, 140:2, 506-525.

Baxter, C.V. 2002. Fish movement and assemblage dynamics in a Pacific Northwest riverscape. Doctor of Philosophy in Fisheries Science. Oregon State University, Corvallis, Oregon. 174 pp.

Beauchamp, D.A., and J.J. VanTassell. 2001. Modeling seasonal trophic interactions of adfluvial bull trout in Lake Billy Chinook, Oregon. Transactions of the American Fisheries Society 130:204-216.

Boag, T.D. 1987. Food habits of bull char (*Salvelinus confluentus*), and rainbow trout (*Salmo gairdneri*), coexisting in a foothills stream in northern Alberta. Canadian Field-Naturalist 101(1):56-62.

Bond, C.E. 1992. Notes on the nomenclature and distribution of the bull trout and the effects of human activity on the species. Pages 1-4 in Howell, P.J. and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Bonneau, J.L., and D.L. Scarnecchia. 1996. Distribution of juvenile bull trout in a thermal gradient of a plunge pool in Granite Creek, Idaho. Transactions of the American Fisheries Society 125(4):628-630. Can. J. Fish. Aquat. Sci. 71: 1059–1071

Brenkman, S.J., and S.C. Corbett. 2005. Extent of anadromy in bull trout and implications for conservation of a threatened species. North American Journal of Fisheries Management 25:1073-1081.

Brewin, P.A., and M.K. Brewin. 1997. Distribution maps for bull trout in Alberta. Pages 209-216 In Mackay, W.C., M.K. Brewin and M. Monita eds. Friends of the Bull Trout, Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary, Alberta T2P 2C8, Canada. 8 pp.

Buchanan, D.V., and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. Pages 119-126 In Mackay, W.C., M.K. Brewing and M. Monita eds. Friends of the Bull Trout, Alberta, Canada.

Burkey, T.V. 1989. Extinction in nature reserves: the effect of fragmentation and the importance of migration between reserve fragments. Oikos 55:75-81.

Burkey, T.V. 1995. Extinction rates in archipelagoes: Implications for populations in fragmented habitats. Conservation Biology 9: 527-541

Cavender, T.M. 1978. Taxonomy and distribution of the bull trout, *Salvelinus confluentus* (Suckley), from the American Northwest. California Fish and Game 64(3):139-174.

Costello, A.B., T.E. Down, S.M. Pollard, C.J. Pacas, and E.B. Taylor. 2003. The influence of history and contemporary stream hydrology on the evolution of genetic diversity within species: an examination of microsatellite DNA variation in bull trout, *Salvelinus confluentus* (Pisces: Salmonidae). Evolution. 57(2): 328-344.

Donald, D.B., and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71:238-247.

Dunham, J.B. and B.E. Rieman. 1999. Metapopulation structure of bull trout: influences of physical, biotic, and geometrical landscape characteristics. Ecological Applications. 9: 642-655.

Dunham, J., B. Rieman, and G. Chandler. 2003. Influences of temperature and environmental variables on the distribution of bull trout within streams at the southern margin of its range. North American Journal of Fisheries Management 23:894-905.

Fraley, J.J., and B.B. Shepard. 1989. Life history, ecology and population status of migratory bull trout (*Salvelinus confluentus*) in the Flathead Lake and River system, Montana. Northwest Science 63(4):133-143.

Frissell, C.A. 1999. An ecosystem approach to habitat conservation for bull trout: groundwater and surface water protection. Flathead Lake Biological Station, University of Montana, Open File Report Number 156-99, Polson, MT, January 07, 1999. 46 pp.

Goetz, F. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. Willamette National Forest, Eugene, Oregon, February 1989. 53 pp.

Goetz, F., E.D. Jeanes, and E.M. Beamer. 2004. Bull trout in the nearshore. U.S. Army Corps of Engineers, Preliminary draft, Seattle, Washington, June 2004. 396 pp.

Haas, G.R., and J.D. McPhail. 2001. The post-Wisconsin glacial biogeography of bull trout (Salvelinus confluentus): a multivariate morphometric approach for conservation biology and management. Canadian Journal of Fisheries and Aquatic Sciences 58:2189-2203.

Hoelscher, B., and T.C. Bjornn. 1989. Habitat, density, and potential production of trout and char in Pend Oreille Lake tributaries. Idaho Department of Fish and Game, Project F-710R-10, Subproject III, Job No. 8., Boise, Idaho, January 1989. 60 pp.

Howell, P.J., and D.V. Buchanan. 1992. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. 67 pp.

Leathe, S.A., and P.J. Graham. 1982. Flathead Lake fish food habits study. US EPA, Region VIII, Water Division, Contract R008224-01-4, Denver, Colorado, October, 1982. 209 pp.

MBTSG (Montana Bull Trout Scientific Group). 1998. The relationship between land management activities and habitat requirements of bull trout prepared for: The Montana Bull Trout Restoration Team, Montana Fish, Wildlife and Parks, Helena, MT

McPhail, J.D., and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Department of Zoology, University of British Columbia, Vancouver, British Columbia. Fisheries Management Report No. 104.

Meffe, G.K., and C.R. Carroll. 1997. Principles of conservation biology, 2nd edition. Sinauer Associates, Sunderland, MA, 673p.

Myrick, C.A., F.T. Barrow, J.B. Dunham, B.L. Gamett, G.R. Haas, J.T. Peterson, B. Rieman, L.A. Weber, and A.V. Zale. 2002. Bull trout temperature thresholds: peer review summary. USFWS, Lacey, Washington, September 19, 2002. 14 pp.

ODEQ (Oregon Department of Environmental Quality). 1995. 1992-1994 water quality standards review: dissolved oxygen - final issue paper. Oregon Department of Environmental Quality, Portland, OR.

Pratt, K. L. 1985. Pend Oreille trout and char life history study. Idaho Department of Fish and Game, Boise.

Pratt, K.L. 1992. A review of bull trout life history. Pages 5-9 In Howell, P.J. and D.V. Buchanan eds. Proceedings of the Gearhart Mountain bull trout workshop, Oregon Chapter of the American Fisheries Society, Corvallis, Oregon. 5 pp.

Pratt, K.L., and J.E. Huston. 1993. Status of bull trout (*Salvelinus confluentus*) in Lake Pend Oreille and the lower Clark Fork River: draft. The Washington Power Company, Spokane.

Quinn, T. P. 2005. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle.

Ratliff, D.E., and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in Howell, P.J. and D.V. Buchanan, editors. Proceedings of the Gearhart Mountain bull trout workshop. Oregon Chapter of the American Fisheries Society, Corvallis.

Rich, C. F. 1996. Influence of abiotic and biotic factors on occurrence of resident bull trout in fragmented habitats, western Montana. M. S. thesis Montana State University, Bozeman.

Rieman, B., and J. Clayton. 1997. Wildfire and native fish: Issues of forest health and conservation of sensitive species. Fisheries 22:6-14.

Rieman, B.E., and J.B. Dunham. 2000. Metapopulations and salmonids: a synthesis of life history patterns and empirical observations. Ecology of Freshwater Fish 9:51-64.

Rieman, B. E. and J. D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. GTR-INT-302. U.S. Forest Service, Boise, Idaho.

Rieman, B. E. and J. D. McIntyre. 1995. Occurrence of bull trout in naturally fragmented habitat patches of varied size. Transactions of the American Fisheries Society 124:285-296.

Rieman, B.E., and J. D. McIntyre. 1996. Spatial and temporal variability in bull trout redd counts. North American Journal of Fisheries Management 16:132-141.

Saunders, D.A., R.J. Hobbs, and C.R. Margules. 1991. Biological consequences of ecosystem fragmentalion: A review. Conservation Biology 5:18-32.

Sedell, J.R., and F.H. Everest. 1991. Historic changes in pool habitat for Columbia River Basin salmon under study for TES listing. Pacific Northwest Research Station, Draft U.S. Department of Agriculture Report, Corvallis, Oregon. 6 pp.

Sexauer, H.M., and P.W. James. 1997. Microhabitat use by juvenile bull trout in four streams located in the eastern Cascades, Washington. Pages 361-370 *In* W.C. McKay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings, Bull Trout Task Force (Alberta), c/o Trout Unlimited, Calgary, Alberta, Canada.

Simpson, J.C., and R.L. Wallace. 1982. Fishes of Idaho. University of Idaho Press, Moscow, ID. 93 pp.

Spruell, P., B.E. Rieman, K.L. Knudsen, F.M. Utter, and F.W. Allendorf. 1999. Genetic population structure within streams: microsatellite analysis of bull trout populations. Ecology of Freshwater Fish (8):114-121.

Spruell, P., A.R. Hemmingsen, P.J. Howell, N. Kanda, and F. Allendorf. 2003. Conservation genetics of bull trout: Geographic distribution of variation at microsatellite loci. Conservation Genetics 4: 17-29.

Stewart, D.B., N.J. Mochnacz, C.D. Sawatzky, T.J. Carmichael, and J.D. Reist. 2007. Fish life history and habitat use in the Northwest territories: Bull trout (*Salvelinus confluentus*). Department of Fisheries and Oceans, Canadian Manuscript Report of Fisheries and Aquatic Sciences 2801, Winnipeg, MB, Canada, 2007. 54 pp.

Taylor, E.B., S. Pollard, and D. Louie. 1999. Mitochondrial DNA variation in bull trout (*Salvelinus confluentus*) from northwestern North America: implications for zoogeography and conservation. Molecluar Ecology. 8:1155-1170.

Thomas, G. 1992. Status report: bull trout in Montana. Montana Department of Fish, Wildlife and Parks, Helena.

U.S. Fish and Wildlife Service. 1996. Policy regarding the recognition of distinct vertebrate population segments under the Endangered Species Act. February 7, 1996. Federal Register 61:4722-4725

U.S. Fish and Wildlife Service. 2002. Chapter 1, Introduction, Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon (www.fws.gov/pacific/bulltrout/colkla/recovery/).

U.S. Fish and Wildlife Service. 2008. Bull trout (*Salvelinus confluentus*) 5-year review: Summary and evaluation. U.S. Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service. 2010. Endangered and threatened wildlife and plants; revised designation of critical habitat for bull trout in the coterminous United States; final rule. October 18, 2010. Federal Register 75:63898-64070.

U.S. Fish and Wildlife Service. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. xii + 179 pp.

U.S. Fish and Wildlife Service. 2015a. Coastal recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Lacey, Washington, and Portland, Oregon. 155 pp.

U.S. Fish and Wildlife Service. 2015b. Columbia headwaters recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana, and Spokane, Washington. 179 pp.

U.S. Fish and Wildlife Service. 2015c. Klamath recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Klamath Falls, Oregon. 35 pp.

U.S. Fish and Wildlife Service. 2015d.Mid-Columbia recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Portland, Oregon. 345 pp.

U.S. Fish and Wildlife Service. 2015e. St. Mary recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Kalispell, Montana. 30 pp.

U.S. Fish and Wildlife Service. 2015f. Upper Snake recovery unit implementation plan for bull trout (*Salvelinus confluentus*). U.S. Fish and Wildlife Service, Boise, Idaho. 113 pp.

WDFW, FishPro Inc., and Beak Consultants. 1997. Grandy Creek trout hatchery biological assessment. Washington Department of Fish and Wildlife, Olympia, WA, March 1997. 47 pp.

WDOE. 2002. Evaluating criteria for the protection of freshwater aquatic life in Washington's surface water quality standards - dissolved oyxgen: Draft discussion paper and literature summary. Washington Department of Ecology, Publication Number 00-10-071, Olympia, WA, December 2002.
90 pp.

Watson, G., and T.W. Hillman. 1997. Factors affecting the distribution and abundance of bull trout: an investigation at hierarchical scales. North American Journal of Fisheries Management 17(2):237-252.

Whiteley, A., P. Spruell and F.W. Allendorf. 2003. Population genetics of Boise Basin bull trout (*Salvelinus confluentus*). Final Report to Bruce Rieman, Rocky Mountain Research Station. University of Montana Wild Trout and Salmon Genetics Lab, Missoula, Montana.

Whitesel, T.A. and 7 coauthors. 2004. Bull trout recovery planning: A review of the science associated with population structure and size. Science Team Report #2004-01, U.S. Fish and Wildlife Service, Region 1, Portland, Oregon.

Appendix C. Tables of PCEs of Critical Habitat, Effects Codes, HUC6 Ratings, and Generalized Crosswalk of Changes Between the Aquatic Conservation Strategy under INFISH and the 2021 HLC Forest Plan**.**

Table C1. Descriptive relationships between indicators from the Matrix of Indicators and PCEs of bull trout critical habitat.

PCE 1 - Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia. The analysis of *floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. Floodplain and riparian areas provide hydrologic connectivity for springs, seeps, groundwater upwelling and wetlands and contribute to the maintenance of the water table. The *sediment* and *substrate embeddedness* indicators describe the level of fine sediment in the gravel which affects hyporheic flow. Fine sediment fills interstitial spaces making the movement of water through the substrate less efficient. The *chemical contamination/nutrients* and *temperature* indicators evaluate the water quality of groundwater. The *off-channel habitat* indicator suggests how much off-channel habitat is available, and generally off-channels are connected to adjacent channels via subsurface water. The *change in peak/base flows* indicator considers whether or not peak flow, base flow, and flow timing are comparable to an undisturbed watershed of similar size, geology, and geography. Peak flows, base flows, and flow timing are directly related to subsurface water connectivity and the degree to which soil compaction has decreased infiltration and increased surface runoff. The *drainage network increase* and *road density and location* indicators assess the influence of the road and trail networks on subsurface water connectivity. If there is an increase in drainage network and roads are located in riparian areas, it is likely that subsurface water is being intercepted before it reaches a stream. If groundwater is being intercepted then it is likely that water quality is being degraded through increased temperatures, fine sediment, and possibly chemical contamination. *Streambank condition* addresses groundwater influence through an assessment of stability. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology. The *riparian conservation areas* indicator determines whether riparian areas are intact and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.
PCE 2 - Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers. The *physical barriers* indicator provides the most direct assessment of this PCE. Analysis of this indicator includes consideration of whether man-made barriers within the watershed allow upstream and downstream passage of all life stages at all flows. However, some indicators further evaluate physical impediments and others evaluate the biological or water quality impediments that may be present. The *temperature*, *sediment, substrate embeddedness,* and *chemical contamination/nutrients* indicators assess whether other barriers may be created, at least seasonally, by conditions such as high temperatures, high concentrations of sediment, or contaminants. The *average wetted width/maximum depth ratio* indicator can help identify situations in which water depth for adult passage may be a problem. A very high average wetted width/maximum depth value may indicate a situation where low flows, when adults migrate, are so spread out that water depth is insufficient to pass adults. The *change in peak/base flows* indicator can help determine if change in base flows have been sufficient to prevent adult passage during the spawning migration. The *persistence and genetic integrity* indicator addresses biological impediments by evaluating negative interactions (e.g., predation, hybridization, and competition) with other species.

PCE 3 - An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

None of the indicators directly address this PCE, but a number of them address it indirectly. The *sediment* and *substrate embeddedness* indicators document the extent to which substrate interstitial spaces are filled with fine sediment. Interstitial spaces provide important habitat for aquatic macroinvertebrates, sculpin, and other substrate-oriented prey which are important food sources for bull trout. The *chemical contamination/nutrients* indicator evaluates the level to which a stream is contaminated by chemicals or has a high level of nutrients. Chemicals and nutrients greatly affect the type and diversity of aquatic invertebrate communities present in a water body. The *large woody debris* and *pool frequency and quality* indicators assess habitat complexity. High stream habitat complexity is associated with diverse and abundant macroinvertebrate and fish prey. The *off-channel habitat* and *floodplain connectivity* indicators document the presence of off-channels which are generally more productive than main channels. Off channel areas are important sources of forage, particularly for juveniles. The *streambank condition* and *riparian conservation areas* indicators both shed light on the very basis of the food base of a stream. Vegetation along streambanks and in riparian areas provide important habitat for terrestrial macroinvertebrates that can fall into the water as well as sources of nutrient inputs that support aquatic invertebrate production.

PCE 4 - Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.

Several indicators address this PCE directly. The *sediment* and *substrate embeddedness* indicators provide insight into how complex substrates are within a stream by documenting percent fines and embeddedness. As percent fines and embeddedness increase, substrate complexity decreases. The *large woody debris* indicator provides an excellent picture of habitat complexity. The indicator rates the stream based on the amount of in-channel large woody debris. Habitat complexity increases as large wood increases. The *pool frequency and quality* and *large pools* indicators address habitat complexity by rating the stream based on the frequency of pools and their quality. Habitat complexity increases as the number of pools and their quality increase. The *off-channel habitat* indicator directly addresses complexity associated with side channels. The indicator is rated based on the amount of off-channel habitat, cover associated with off-channels, and flow energy levels. *Average wetted width/maximum depth ratio* is an indicator of channel shape and pool quality. Low ratios suggest deeper, higher quality pools. The *streambank condition* and *riparian conservation areas* indicators both shed light on the complexity of river and stream shorelines. Vegetation along streambanks and in riparian areas provides important habitat complexity and channel roughness. The *streambank condition* indicator also provides information about the capacity of an area to produce undercut banks, which can be a very important habitat feature for bull trout. The *floodplain connectivity* indicator addresses complexity added by side channels and the ability of floodwaters to spread across the floodplain to dissipate energy and provide access to high-flow refugia for fish. The *road density and location* indicator addresses complexity by identifying if roads are located in valley bottoms. Roads located in valley bottoms reduce complexity by eliminating vegetation and replacing complex habitats with riprap or fill, and often confine the floodplain. The *disturbance regime* indicator documents the frequency, duration, and size of environmental disturbance within the watershed. If scour events, debris torrents, or catastrophic fires are frequent, long in duration, and large, then habitat complexity will be greatly reduced.

PCE 5 - Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.

The *temperature* indicator addresses this PCE directly. The indicator rates streams according to how well temperatures meet bull trout requirements. Other matrix indicators address temperature indirectly. The *off-channel habitat* and *floodplain connectivity* indicators address how well stream channels are hydrologically connected to off-channel areas. Floodplains and off-channels are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute cool water to channels. The *average wetted width/maximum depth ratio* indicator also corresponds to temperature. Low width to depth ratios indicate that channels are narrow and deep with little surface area to absorb heat. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the vegetation provides shade which helps prevent increases in temperature. The *change in peak/base flows* indicator evaluates flows and flow timing characteristics relative to what would be expected in an undisturbed watershed. If base flow has been reduced, it is likely that water temperature during base flow has increased since the amount of water to heat has decreased. The *road density and location* and *drainage network increase* indicators documents where roads are located. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance history* indicator describes how much of the watershed has been altered by vegetation management and therefore indicates how much shade has been removed. The *riparian conservation areas* indicator addresses stream shade which keeps stream temperatures cool. The presence of *large pools* may provide thermal refugia when temperatures are high.

PCE 6 - In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.

The *sediment* and *substrate embeddedness* indicators directly address this PCE. These indicators evaluate the percent fines within spawning areas and the percent embeddedness within rearing areas. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that in-channel fine sediment levels will be elevated above natural levels. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that fine sediment levels will be elevated above background levels. A consideration for all indicators directly or indirectly influencing this PCE is that it is desirable to achieve an appropriate balance of stable areas to provide undercut banks and eroding areas that are sources for recruiting new spawning gravels. Too little sediment in a stream can also be detrimental.

PCE 7 - A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.

The *change in peak/base flows* indicator addresses this PCE directly by documenting the condition of the watershed hydrograph relative to an undisturbed watershed of similar size, geology, and geography. There are several indicators that address this PCE indirectly. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the streambank can store water during moist periods and releases that water during dry periods which contributes to water quality and quantity. The *floodplain connectivity* indicator is relevant to water storage within the floodplain which directly affects base flow. Floodplains are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute to water quality and quantity. The *increase in drainage network* and *road density and location* indicators assess the influence of the road and trail networks on hydrology. If there is an increase in drainage network and roads are located in riparian areas, it is likely is being intercepted and quickly routed to a stream which can increase peak flow. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology; for example, it may suggest the degree to which soil compaction has decreased infiltration and increased surface runoff. The *riparian conservation areas* indicator determines whether riparian areas are intact, functioning, and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

PCE 8 - Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.

This PCE is closely related to PCE 7, with PCE 8 adding a water quality component (i.e., there is a high level of overlap in indicators that apply to both PCEs 7 and 8). The *temperature* and *chemical contamination/nutrients* indicators directly address water quality by comparing water temperatures to bull trout water temperature requirements, and documenting 303(d) designated stream reaches. Several other indicators indirectly address this PCE by evaluating the risk of fine sediment being introduced that would result in decreased water quality through increased turbidity. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. *Average wetted width/maximum depth ratio* is an indication of water volume, which indirectly indicates water temperature, (i.e., low ratios indicate deeper water, which in turn indicates possible high-flow refugia). This indicator in conjunction with *change in peak/base flows* is an indicator of potential water quality and quantity deficiencies, particularly during low flow periods. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that suspended fine sediment levels will be elevated above natural levels. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that turbidity levels will be elevated above background levels.

PCE 9 - Sufficiently low levels of occurrence of non-native predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

The only indicator that directly addresses this PCE is the *persistence and genetic integrity* indicator. This indicator addresses the likelihood of predation, hybridization, or displacement of bull trout by competitive species. The *temperature* indicator can provide indirect insights about whether conditions are conducive to supporting "warm water" species.

Table C2. Effects Codes for Adverse Effects to Bull Trout.

Effects Code	Effects to Habitat and Species
UN	Unable to determine effects (either positive or negative)
A1	Negative effects to habitat that may not be predictable individually*; no predictable biological or behavioral effects
A2	Negative effects to habitat that are predictable individually* but will not result in biological or behavioral effects
A3	Effects to habitat or individuals that will result in short-term behavioral effects but no ongoing disruption of normal behavior (including but not limited to spawning, incubation, rearing, foraging, sheltering, migration etc.)
A4	Effects to habitat or individuals that will result in ongoing disruption of normal behavior (including but not limited to spawning, incubation, rearing, foraging, sheltering, migration, etc.) but not physical impairment or death
A5	Effects to habitat or individuals that will result in physical impairment (but not death) of individuals
A6	Effects to habitat or individuals that will result in death of individual bull trout but not expected to impair or limit local population reproduction/productivity or distribution (e.g., lost individuals likely to be replaced within 1-2 generations)
A7	Effects to habitat or individuals that will result in death of individual bull trout and impair or limit local population reproduction/productivity (e.g., lost individuals will not be replaced within 1-2 generations); however, not likely to impair or limit local population distribution
A8	Effects to habitat or individuals that will impair or limit reproduction/productivity <u>and</u> distribution of a local population
A9	Likely to result in the extirpation of one local population
A10	Likely to result in the extirpation of two or more local populations

* Individually means that an effect can be predicted for one activity or effect category; however, effects may be predictable collectively, i.e., across multiple Action/Work Types or effects categories

Table C3. Effects Codes for Beneficial Effects to Bull Trout.

Effects Code	Effects to Habitat and Species
B1	Effects to habitat or individuals that maintain* conditions necessary for normal behavior and expression of life history, including but not limited to spawning, incubation, rearing, foraging, sheltering, migration etc…
B2	Effects to habitat or individuals that improves conditions necessary for normal behavior and expression of life history at the stream reach level, including but not limited to spawning, incubation, rearing, foraging, sheltering, migration etc…
B3	Effects to habitat or individuals that improves conditions necessary for normal behavior and expression of life history at the multiple stream reach level, including but not limited to spawning, incubation, rearing, foraging, sheltering, migration etc…
B4	Effects to habitat or individuals that improves or restores conditions necessary for survival and reproduction at the stream reach level, but may not increase local population density or distribution
B5	Likely to improve reproduction/productivity of a local population (resulting in an increase in pop. density or size); however, not likely to positively affect local population distribution
B6	Likely to greatly improve reproduction/productivity and distribution of a local population
B7	Likely to result in the founding or refounding of a local population
B8	Likely to result in the founding or refounding of more than one local population

* "Maintain" means that the conditions described are not really restored, but some amount of degradation that would otherwise occur (e.g., via natural events, or past legacy of management) is prevented.

Table C4. Effects Codes for Adverse Effects to PCEs of Bull Trout Critical Habitat.

Effects Code	Effects to PCEs of Critical Habitat
UN	Unable to determine effects to the PCE (either positive or negative)
A1	Negative effects to PCE may not be predictable individually*
A2	Negative effects to PCE are predictable individually* but will have only a very minor and temporary negative effect on the PCE's function
A3	Effects to PCE that will result in a predictable, negative change in the PCE's function that will not be minor, but will be temporary. The change will have little effect on the actual or potential use of the area by bull trout.
A4	Effects to PCE that will result in alteration of the function of the PCE that may negatively affect actual or potential use of the area by bull trout; however the alteration is temporary and the function will likely recover.
A5	Effects to PCE will result in serious modification of the function described by that PCE, at least locally (stream reach level PCE effect); the function may improve in time but the full function of the PCE likely will not recover. Actual or potential use of the area by bull trout will be reduced.
A6	Effects to PCE that will result in the permanent alteration or elimination of the function described by that PCE at least locally (permanent stream reach level PCE effect). Actual or potential use of the area by bull trout will be reduced or changed but use of the area by individual bull trout may not be completely eliminated.
A7	Effects to PCE that will result in the permanent alteration or elimination of the function described by that PCE at the local population segment level (local population level PCE effect). Actual or potential use of the area formerly or potentially occupied by a local population will be reduced significantly.
A8	Effects to PCE that will result in the permanent alteration or elimination of the function described by that PCE at the local population segment level (extreme local population level PCE effect). Actual or potential use of the area formerly or potentially occupied by a local population will be completely eliminated or precluded.
A9	Effects to PCE that will result in the permanent alteration or elimination of the function described by that PCE at the core area/CH Unit level (core area/CH unit level PCE effect). Significant reduction of bull trout use across the core area is likely.
A10	Effects to PCE that will result in the permanent alteration or elimination of the function described by that PCE at the core area/CH Unit level (severe core area/CH Unit level PCE effect). Elimination of bull trout use across the core area/CH unit is likely.

* Individually means that an effect to the PCE can be predicted for one project element, activity, or category of effect; however effects may be predictable collectively, i.e., across multiple project elements, activities, or effects categories

Table C5. Effects Codes for Beneficial Effects to PCEs of Bull Trout Critical Habitat.

Effects Code	Effects to PCEs of Critical Habitat
B1	Effects that maintain the function of the PCE (e.g., prevents alteration or modification of the PCE's function, or allows for natural expression of conditions described in the PCE).
B2	Effects to PCE that slightly or gradually improve the function of the PCE (e.g., minor benefit for use by bull trout or for normal behavior and expression of life history, including but not limited to spawning, incubation, rearing, foraging, sheltering, migration etc…).
B3	Effects to PCE that significantly improve the function(s) described in the PCE and/or greatly improve conditions necessary for use of the area by individual bull trout or for their normal behavior and expression of life history, including but not limited to spawning, incubation, rearing, foraging, sheltering, migration etc…
B4	Effects to PCE that significantly improve the function(s) described in the PCE across a local population or larger population sub-unit, and/or improves PCE conditions affecting one or more bull trout local populations.
B5	Effects to PCE (e.g., partial elimination of a migration barrier) that will likely result in use by individual bull trout of a local stream reach or small portion of a stream network not currently occupied or useable by bull trout, at certain times or season
B6	Effects to PCE (e.g., complete removal of a migration barrier) that will extend to one or more local populations, i.e., by increasing the availability or use of a larger stream network, thereby increasing the number of bull trout that will likely use the area, across multiple times or seasons
B7	Effects to PCE that will likely result in the founding or refounding of a local population
B8	Effects to PCE (e.g., dam removal) that will likely result in the founding or refounding of more than one local population

Table C6. Matrix of Indicator Rating for the HUC6 watersheds used for analysis of effects.

Habitat Pathway Indicators	Ontario Creek 0501	Little Blackfoot Larabee 0502	Little Blackfoot Hat 0507	Copper Creek 0103	Lower Landers Fork 0104	Poorman Creek 0302
Water Quality						
Temperature	FAR	FAR	FAR	FA	FA	FA
Sediment	FUR	FAR	FUR	FUR	FA	FUR
Chemical Contamination/ Nutrients	FUR	FA	FUR	FA	FA	FUR
Habitat Access						
Physical Barriers	FAR	FA	FAR	FAR	FA	FUR
Habitat Elements						
Substrate Embeddedness	FUR	FAR	FUR	FUR	FA	FUR
Large Woody Debris	FAR	FA	FAR	FAR	FAR	FAR
Pool Frequency & Quality	FAR	FA	FUR	FAR	FAR	FAR
Large Pools	FAR	FA	FUR	FAR	FAR	FAR
Off Channel Habitat	FUR	FAR	FUR	FAR	FAR	FAR
Refugia	FAR	FA	FAR	FAR	FA	FUR
Channel Condition & Dynamics						
Wetted Width/Depth Ratio	FAR	FA	FAR	FAR	FA	FAR
Streambank Condition	FAR	FA	FAR	FAR	FA	FAR
Floodplain Connectivity	FAR	FAR	FAR	FUR	FA	FUR
Flow Hydrology						
Change in Peak/Base Flows	FAR	FAR	FAR	FAR	FA	FAR
Drainage Network Increase	FAR	FAR	FAR	FAR	FA	FAR
Watershed Conditions						
Road Density & Location	FUR	FUR	FUR	FUR	FA	FUR
Disturbance History	FAR	FA	FAR	FAR	FA	FAR
Riparian Conservation Areas	FAR	FAR	FAR	FAR	FA	FAR
Disturbance Regime	FAR	FAR	FAR	FAR	FA	FAR

[1] FA = Functioning Appropriately, FAR = Functioning at Risk, FUR = Functioning at Unacceptable Risk.

Table C6. (continued)

Habitat Pathway Indicators	Arrastra Creek 0309	Blackfoot-Little Moose 0310	Hogum Creek 0205	Lower Alice Creek 0204	Blackfoot-Hardscrabble 0206	Blackfoot-Anaconda 0202
Water Quality						
Temperature	FAR	FAR	FA	FAR	FAR	FAR
Sediment	FAR	FUR	FUR	FUR	FUR	FUR
Chemical Contamination/ Nutrients	FA	FA	FAR	FA	FAR	FAR
Habitat Access						
Physical Barriers	FAR	FA	FAR	FA	FA	FA
Habitat Elements						
Substrate Embeddedness	FAR	FUR	FUR	FUR	FUR	FUR
Large Woody Debris	FAR	FUR	FUR	FUR	FUR	FUR
Pool Frequency & Quality	FA	FUR	FUR	FUR	FUR	FUR
Large Pools	FA	FUR	FUR	FUR	FUR	FUR
Off Channel Habitat	FAR	FUR	FUR	FUR	FUR	FUR
Refugia	FAR	FUR	FUR	FUR	FUR	FUR
Channel Condition & Dynamics				FUR		
Wetted Width/Depth Ratio	FAR	FUR	FUR	FUR	FAR	FUR
Streambank Condition	FAR	FUR	FUR	FUR	FAR	FUR
Floodplain Connectivity	FAR	FUR	FUR	FUR	FUR	FUR
Flow Hydrology				FUR		
Change in Peak/Base Flows	FAR	FUR	FAR	FUR	FA	FUR
Drainage Network Increase	FAR	FUR	FAR	FUR	FA	FUR
Watershed Conditions				FUR		
Road Density & Location	FAR	FUR	FUR	FUR	FUR	FUR
Disturbance History	FAR	FAR	FAR	FAR	FA	FAR
Riparian Conservation Areas	FAR	FUR	FUR	FUR	FUR	FUR
Disturbance Regime	FAR	FUR	FAR	FUR	FAR	FAR

[1] FA=Functioning Appropriately, FA =Functioning at Risk, FUR=Functioning at Unacceptable Risk.

Table C6. (continued)

Habitat Pathway Indicators	Nevada Creek Headwaters 0401	East Frk North Frk Blackfoot 0603	Meadow Creek 0601	Mineral Creek 0602	Humbug Creek 0301	Beaver Creek 0303
Water Quality						
Temperature	FA	FA	FA	FA	FA	FA
Sediment	FUR	FA	FA	FA	FUR	FUR
Chemical Contamination/ Nutrients	FUR	FA	FA	FA	FA	FA
Habitat Access						
Physical Barriers	FA	FA	FA	FA	FA	FAR
Habitat Elements						
Substrate Embeddedness	FUR	FA	FA	FA	FUR	FUR
Large Woody Debris	FAR	FUR	FAR	FA	FAR	FAR
Pool Frequency & Quality	FAR	FAR	FAR	FA	FAR	FAR
Large Pools	FAR	FAR	FAR	FA	FAR	FAR
Off Channel Habitat	FUR	FUR	FAR	FA	FAR	FUR
Refugia	FUR	FA	FA	FA	FUR	FUR
Channel Condition & Dynamics						
Wetted Width/Depth Ratio	FAR	FA	FA	FA	FAR	FUR
Streambank Condition	FAR	FA	FA	FA	FAR	FUR
Floodplain Connectivity	FUR	FA	FA	FA	FA	FUR
Flow Hydrology						
Change in Peak/Base Flows	FA	FA	FA	FA	FAR	FAR
Drainage Network Increase	FA	FA	FA	FA	FAR	FAR
Watershed Conditions						
Road Density & Location	FUR	FA	FA	FA	FUR	FUR
Disturbance History	FA	FA	FA	FA	FA	FAR
Riparian Conservation Areas	FUR	FAR	FA	FA	FAR	FUR
Disturbance Regime	FAR	FA	FA	FA	FAR	FUR

[1] FA=Functioning Appropriately, FAR=Functioning at Risk, FUR=Functioning at Unacceptable Risk.

Table C6. (continued)

Habitat Pathway Indicators	Keep Cool Creek 0304	Sauerkraut Creek 0307	Middle Nevada Creek 0407	Lower Nevada Creek 0415	Rock Creek 0703
Water Quality					
Temperature	FA	FA	FAR	FA	FAR
Sediment	FUR	FUR	FUR	FUR	FAR
Chemical Contamination/ Nutrients	FA	FAR	FAR	FUR	FAR
Habitat Access					
Physical Barriers	FA	FA	FA	FA	FA
Habitat Elements					
Substrate Embeddedness	FUR	FAR	FUR	FUR	FAR
Large Woody Debris	FAR	FUR	FUR	FUR	FUR
Pool Frequency & Quality	FAR	FUR	FUR	FUR	FUR
Large Pools	FAR	FUR	FUR	FUR	FUR
Off Channel Habitat	FUR	FUR	FUR	FUR	FUR
Refugia	FAR	FUR	FUR	FUR	FA
Channel Condition & Dynamics					
Wetted Width/Depth Ratio	FUR	FUR	FUR	FUR	FAR
Streambank Condition	FUR	FUR	FUR	FUR	FAR
Floodplain Connectivity	FUR	FUR	FUR	FUR	FAR
Flow Hydrology					
Change in Peak/Base Flows	FAR	FUR	FUR	FUR	FAR
Drainage Network Increase	FAR	FUR	FUR	FUR	FAR
Watershed Conditions					
Road Density & Location	FUR	FUR	FUR	FUR	FAR
Disturbance History	FAR	FAR	FAR	FAR	FAR
Riparian Conservation Areas	FUR	FUR	FUR	FAR	FAR
Disturbance Regime	FUR	FAR	FAR	FAR	FAR

[1] FA=Functioning Appropriately, FAR=Functioning at Risk, FUR=Functioning at Unacceptable Risk.

Table C7. Watershed Condition Framework (WCF) Indicator Ratings used to Determine Watershed Condition Class.

HUC6 Name (last 4 digits of HUC6 code)	Aquatic Biota	Riparian Vegetation	Water Quality	Water Quantity	Aquatic Habitat	Roads Trails	Soil Condition	Fire Condition	Forest Cover	Forest Health	Terrestrial Invasives	Range Vegetation
Divide Geographic Area												
Little Blackfoot-Larabee Gulch (0502)	Fair	Fair	Poor	Good	Good	Fair	Fair	Poor	Good	Fair	Good	Fair
Ontario Creek (0501)	Poor	Poor	Poor	Good	Poor	Poor	Poor	Poor	Good	Fair	Good	Good
Little Blackfoot-Hat Creek (0507)	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Poor	Good	Fair	Fair	Fair
Upper Blackfoot Geographic Area												
Copper Creek (0103)	Good	Fair	Good	Fair	Fair	Poor	Fair	Fair	Poor	Good	Fair	Fair
Lower Landers Fork (0104)	Fair	Fair	Good	Good	Good	Poor	Good	Fair	Poor	Good	Poor	Poor
Poorman Creek (0302)	Poor	Fair	Poor	Poor	Poor	Poor	Poor	Good	Good	Fair	Fair	Fair
Arrastra Creek (0309)	Good	Fair	Poor	Good	Fair	Poor	Good	Poor	Good	Fair	Good	Fair
Blackfoot-Little Moose Creek (0310)	Good	Fair	Poor	Good	Fair	Poor	Fair	Poor	Good	Fair	Poor	Poor
Hogum Creek (0205)	Fair	Fair	Fair	Good	Fair	Poor	Good	Fair	Good	Fair	Fair	Fair
Lower Alice Creek (0204)	Fair	Fair	Good	Good	Fair	Poor	Good	Fair	Good	Fair	Poor	Poor
Blackfoot-Hardscrabble Creek (0206)	Fair	Fair	Good	Good	Good	Fair	Good	Fair	Good	Fair	Good	Fair
Blackfoot-Anaconda Creek (0202)	Poor	Fair	Poor	Poor	Poor	Poor	Good	Fair	Good	Fair	Fair	Fair
Nevada Creek Headwaters (0401)	Fair	Fair	Poor	Poor	Fair	Poor	Fair	Poor	Good	Fair	Fair	Fair
East Fork North Fork Blackfoot (0603)	Fair	Fair	Good	Good	Fair	Fair	Good	Good	Good	Good	Good	Good

Table C7 (continued)

Meadow Creek (0601)	Fair	Fair	Good	Good	Good	Fair	Good	Good	Good	Good	Good	Good
Mineral Creek (0602)	Fair	Fair	Good	Good	Fair	Fair	Good	Good	Good	Good	Good	Good
Humbug Creek (0301)	Poor	Fair	Poor	Good	Good	Poor	Poor	Good	Good	Fair	Good	Good
Beaver Creek (0303)	Fair	Fair	Good	Poor	Fair	Poor	Fair	Poor	Good	Fair	Fair	Fair
Keep Cool Creek (0304)	Fair	Fair	Good	Poor	Poor	Poor	Fair	Poor	Good	Fair	Fair	Fair
Sauerkraut Creek (0307)	Fair	Fair	Fair	Poor	Fair	Poor	Fair	Poor	Good	Fair	Good	Fair
Middle Nevada Creek (0407)	Poor	Fair	Poor	Fair	Fair	Poor	Fair	Poor	Good	Fair	Poor	Poor
Lower Nevada Creek (0415)	Fair	Fair	Poor	Fair	Poor	Poor	Fair	Poor	Good	Fair	Fair	Fair
Rock Creek (0703)	Good	Fair	Fair	Good	Fair	Fair	Good	Fair	Good	Good	Fair	----

Table C8. Generalized crosswalk of changes between the aquatic conservation strategy under INFISH and the 2021 HLC Forest Plan.

1995 INFISH component	Comparable INFISH component/strategy in 2021 HLC Forest Plan	Differences between 1995 INFISH and 2021 HLC Forest Plan	Rationale for changes
Riparian goals	The 2021 HLC Forest Plan uses desired conditions rather than goals.	More description listed in plan revision for desired conditions, focused on ecological conditions that sustain riparian and aquatic habitat. The intent is similar.	Goals are optional components in 2012 Planning Rule that according to rule are "other than desired conditions, usually related to process or interaction with the public".
Riparian management objectives (RMOs)	Not carried forward as written in 1995 as best available scientific information (BASI) no longer supports a site-by-site approach without placing in context with conditions and drivers beyond the stream reach. Some interim RMOs did not apply to all stream channel forms.	The 2021 HLC Forest Plan relies on DCs, which focus on retaining process function in combination with PIBO monitoring data and analysis, which compares habitat attributes of managed against unmanaged or reference sub watersheds.	BASI since 1995 has moved away from the expectation that numerical values found in high value habitat could occur everywhere at the same time. Also, objectives in 2012 Planning Rule require a completion date, which would be difficult to predict for dynamic riparian instream conditions.
Riparian habitat conservation areas (RHCAs)	Component carried forward with name change to riparian management zone (RMZ), to be consistent with 2012 Planning Rule.	Some adjustments to widths for wetlands and intermittent streams (increase), otherwise plan components do require minimum widths same as 1995 INFISH. Widths are broken down into inner and outer zones.	Review of BASI show that the most important area for protecting water resources is the inner zone where only activities that benefit the RMZ are allowed. Activities in outer zone must maintain and not retard function of inner zone.
Standards and guidelines (for activities in or affecting RHCAs)	Component carried forward with few exceptions; now distinguish between standards and guidelines.	No longer just standards and guidelines, split into either standard or a guideline. Also, some text changes in individual standards and guidelines	Concept was retained for standards and guidelines, but language was sometimes changed to ensure a standard or guideline was achievable, and/or to clarify intent. Split aligns with 2012 Planning Rule.
Priority watersheds	Carried forward in two ways: 1. priority watersheds as other plan content identified for WCF as required by 2012 rule and 2. Identification of a conservation watershed network with objectives for storm-proofing. 2nd way builds on the intent of priority watersheds in	Four sub-watersheds under this revision will be identified as priorities for restoration activities via WCF on forest to be compatible with 2012 Planning Rule. Identification of Conservation Watershed Network, a new term, is actually what originally occurred in INFISH as priority watersheds. and corresponding	WCF recognizes the agency moving towards attaining desired outcomes from project, versus the standard outputs typically associated with target accomplishment. CWN favors selection of watersheds with aquatic biota needs and prioritizes them for treatment.

	INFISH	objectives for storm proofing prioritizes the most important watersheds to treat during the span of the new plan	
Watershed analysis	Not carried forward as described in 1995 INFISH. Instead, multi-scale analysis is included in other plan content as a strategy of the revised HLC Forest plan, mostly consistent with ICEBMP 2014 framework.	Multi-scale analysis strategy provides guidance on integration commensurate with issues being addressed.	Watershed analysis as originally practiced became cumbersome and struggled to integrate resources. Existing tools provide much greater capabilities for data analysis than in 1995. Multi scale sharpens focus on the need to integrate information commensurate with issues.
Watershed restoration	See priority watersheds	See priority watersheds	See priority watersheds
Monitoring	2021 HLC Forest Plan will use PIBO monitoring data at the HLC Forest scale (or BASI replacement) to show if conditions are trending towards improving conditions.	PIBO generated from INFISH and PACFISH requirements	With 19 years of data collection across the Interior Columbia Basin and numerous peer reviewed publications, this program is uniquely positioned and funded to effectively monitor aquatic trends on the HLC Forest.