United States Department of the Interior

FISH AND WILDLIFE SERVICE

Western Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

In Reply Refer To:
13410-2007-F-0298

FEB 11 2008

Mike Gearheard, Director
Office of Water and Watersheds
U.S. Environmental Protection Agency, Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Dear Mr. Gearheard:

This document transmits the U.S. Fish and Wildlife Service's (FWS) Biological Opinion (BO) on the effects of the Environmental Protection Agency's (EPA) proposed approval of the 2006 revised water quality standards (WQS) for the State of Washington. This BO addresses the effects of the proposed action on the bull trout (*Salvelinus confluentus*) and designated critical habitat for the bull trout in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

The proposed action is EPA's approval of 1) the designated uses, 2) numeric temperature criterion to protect the aquatic life uses, 3) spatial and temporal application of seasonal temperature criteria to protect bull trout, salmon, and steelhead reproduction that occurs during the summer months, 4) dissolved oxygen criteria in stream reaches that were changed to a higher use designation, 5) allowable warming provisions, 6) spill provisions on the Snake and Columbia River, 7) natural and irreversible human conditions, and 8) procedures for applying WQ criteria. The WQS revisions apply to all freshwater surface waters in the State and will remain in effect in perpetuity, unless the standards are revised again in the future.

The EPA determined that the proposed action "may affect, but is not likely to adversely affect" the bald eagle (*Haliaeetus leucocephalus*) and marbled murrelet (*Brachyramphus marmoratus*) and would have "no effect" on all other listed species under the jurisdiction of the FWS that occur in the state of Washington. The bald eagle was removed from the Federal List of Threatened and Endangered Wildlife on August 8, 2007, and consultation is no longer required for this species. The FWS concurs with your determination for the marbled murrelet. Your determination that the action will have no effect on other listed species rests with the action agency.

Based on the information provided in the BE, meetings, and written and verbal correspondence since the project started, the FWS has determined that approval and implementation of the 2006 Washington WQS will have adverse effects to bull trout and designated habitat for the bull trout in areas and/or situations where the standards do not provide adequate protection for essential habitat elements or the life history stage(s) that occur or may be present in the reach. The proposed action is expected to result in improvements of water quality over the long term, especially in areas where the standards became more stringent. The BO addresses the adverse effects associated with the proposed action on bull trout and designated critical habitat for the bull trout in these instances.

If you have any comments or questions regarding the BO, please contact Martha Jensen at (360) 753-9000 or John Grettenberger at (360) 753-6044.

Sincerely,

Ken S. Berg

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

cc:
USFWS, Spokane (S. Martin)
EPA Region 10 (J. Palmer)
NOAA Fisheries, Lacey (S. Landino)
WDOE, Lacey (J. Manning)

U.S. FISH AND WILDLIFE SERVICE
BIOLOGICAL OPINION
for
Environmental Protection Agency's Proposed Approval of the Revised Washington Water Quality Standards for Designated Uses, Temperature, Dissolved Oxygen, and Other Revisions

USFWS Reference: 13410-2007-F-0298

Action Agency:
U.S. Environmental Protection Agency

Conducted by:
Western Washington Fish and Wildlife Office

Date Issued: FEB 11 2008

Issued by: Ken S. Berg

Ken S. Berg, Manager
Western Washington Fish and Wildlife Office

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INTRODUCTION

The Endangered Species Act (ESA) of 1973 (16 USC 1531-1544), as amended, establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS, collectively the Services), as appropriate, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitats. This biological opinion (BO) is the product of an interagency consultation pursuant to section 7(a)(2) of the ESA and implementing regulations found at 50 Code of Federal Regulations (CFR) Part 402.

CONSULTATION HISTORY

The Washington Department of Ecology (WDOE) completed a triennial review of the State's water quality standards in June 2003 and submitted revised standards for water temperature, dissolved oxygen, and policy on antidegradation to the Environmental Protection Agency (EPA), Region 10, for approval under the Clean Water Act (CWA) on July 28, 2003. The new standards also changed from a class-based approach to a use-based system. The use-based system is designed to protect existing aquatic life uses (fish) as well as designated human uses of the water-body, such as fishing, swimming, and consumptive uses of water (potable water, irrigation, etc.).

Upon WDOE's submittal of the new standards to EPA, concerns were immediately expressed by the Tribes, NMFS and the FWS. The Tribes and the Services did not believe that the new temperature standards would adequately protect the designated uses. In particular, concerns were raised about the adequacy of the standards to protect salmon and trout spawning, incubation, and rearing.

The breadth of potential effects of the proposed action to bull trout is extensive. Approval of the 2006 Water Quality Standards (WQS) will affect bull trout in all of the core areas within the Coastal-Puget Sound Interim Recovery Unit (IRU) and 15 percent of core areas in the Columbia River IRU (USDI 2004). Adverse effects are likely to occur in many core areas.

The notable events related to the history of this consultation are summarized below:

- March 13, 2000 – The FWS sent a letter to WDOE commenting on proposed changes to the WQS. Specifically, our comments were related to concerns with inadequate temperature protection for bull trout that "do not meet the conservation and recovery needs of the species."
- January 3, 2003 – WDOE released a draft of the Water Quality Rule for public comment.
- March 3, 2003 – NMFS sent a letter to WDOE commenting on proposed changes to the State's surface WQS. NMFS had concerns with the proposed standards for temperature,

dissolved oxygen, and ammonia. NMFS also had comments and questions related to the proposed antidegradation policy in the standards.

- June 25, 2003 – WDOE adopted the new WQS and submitted the Proposed Final Rule to EPA for approval on July 28, 2003. The EPA received the State of Washington's WQS revisions on August 1, 2003.
- November 12, 2003 – The Services attended a meeting with the Northwest Indian Fish Commission Environmental Policy Group to discuss the Rule with EPA. The Services and Tribal representatives expressed concerns over the adequacy of the proposed standards to protect fish. The new Rule was a simple conversion from the old class-based system to the new use-based system with no refinements to match existing fish distribution and use.
- Between December 2003 and August 2004, the Services attended multiple meetings with EPA and WDOE to discuss approaches and data requirements to make the necessary revisions and correct the Rule to protect existing aquatic life uses.

To better understand fish use and fish life-history information by watershed, and to facilitate Government to Government communication, a number of meetings were organized with the Puget Sound area Tribes. These meetings were attended by the Services, the Washington Department of Fish and Wildlife (WDFW), and the EPA. In addition to obtaining valuable information on salmon run-timing and abundance from Tribal biologists, the meetings provided the Services an opportunity to listen to other Tribal issues regarding the proposed Washington State WQS.

- October 13, 2004 – The Services and EPA met with North Sound Tribes including the Nooksack, Lummi, Stillaguamish, and Tulalip Tribes. The Tribal biologists expressed concerns over the adequacy of temperature standards to protect spawning and incubation that occurs in the mainstem and lower tributaries. For example, in areas where surveys are difficult (e.g. poor visibility in glacial systems or difficult access), the lack of data often resulted in less protection for fish. Issues relating to the marine standards and anti-degredation were brought up at all of the tribal meetings.

- October 14, 2004 – The Services and EPA met with Skagit System Cooperative Tribes and Upper Skagit Tribe. Similar issues were expressed and questions were raised about the marine standards.

- October 27, 2004 – Meeting with the Suquamish and Nisqually Tribes.

- October 28, 2004 – The Services and EPA met with Squaxin, Puyallup and Muckleshoot Tribes. Marine issues were particularly important to these Tribes because the existing standards do not adequately address human consumption levels for fish and shellfish.

- November 2, 2004 – The Services and EPA met with Quileute, Makah and Hoh Tribes. Discussion focused primarily on getting the 16 °C temperature standard for the Dickey River based on juvenile rearing and density only, since there are no listed fish in this watershed. The biologist for the Hoh also provided some temperature and fish distribution information.

- November 8, 2004 – WDOE and EPA met with the Jamestown, Lower Elwha, and Port Gamble Tribes. These Tribes were concerned about the standards for marine waters as well as allowable degradation associated with the removal of dams. Discussions focused on the need for standards to protect fish in areas where restoration projects will provide access to anadromous fish in the future, such as the Elwha River.

- December 7, 2004 – This was the last meeting with west side Tribes. The Services and EPA met with the Chehalis and Quinault Tribes.

- January 22, 2005 – The EPA completed review of portions of the 2003 revisions to the Washington WQS regulations and sent an approval letter to WDOE for many of the revisions. The EPA withheld taking action on the remainder of the provisions in the State's WQS regulations and spent the rest of the year working with the Services, Tribes, and WDFW to revise maps depicting fish distribution and use.

- The EPA worked with eastern Washington Tribes to obtain data on salmon distribution and run timing for eastside watersheds. This information was passed on to the Services in subsequent meetings.

- January 19, 2006 – Letter from WDOE to EPA providing written responses to specific questions that EPA raised on implementation of the revised standards (letter dated July 1, 2003). Specific areas of interest included situations where natural conditions exceed the criteria, methods to estimate natural background temperatures, temperature modeling, protection of cold water (antidegradation), short term modifications, and implementation of the summer spawning criterion (Appendix E and F of the BE).

- March 22, 2006 – The EPA and the Services completed a review of specific aquatic life designated uses and associated temperature criteria. After reviewing the available fish distribution information, the EPA determined that some streams still had incorrect aquatic life use designations, and some streams had temperature criteria that are not protective of the appropriate fish uses in the streams. Based on this review, the EPA disapproved the aquatic life designated use and associated temperature criteria for specific waterbodies in Washington.

- March 2006 – The EPA posted GIS maps on the website for Region 10. The Services spent most of 2005 assisting the EPA in revising the maps to reflect existing fish use and identifying appropriate temperature criteria for each area.

- March 22, 2006 – The EPA presented a partial disapproval letter to the WDOE stating that portions of the revised 2003 WQS do not provide adequate protection for existing aquatic life uses and that the spawning narrative provisions do not identify where and when the spawning temperature criterion will be applied (Appendix D of the BE).

- June 2006 – WDOE proposed revised WQS to address EPA's March 2006 disapproval action. The EPA provided recommendations for changes to the use designations and associated numeric temperature criterion to protect existing uses based on best available scientific data on fish use.

- July 2006 – The Services worked with EPA to resolve proposed temperature standards and steelhead and char issues raised by other Federal agencies (Bureau of Reclamation and Army Corps of Engineers) in the Yakima basin, Walla Walla, and other areas in eastern Washington. Several issues, including the char use designation in the Upper Yakima, remained unresolved.

- August 7-15, 2006 – The Services and EPA assisted WDOE in a series of public workshops and hearings around the State to discuss required changes to the Rule and to solicit public comment. Meetings were held in Mount Vernon, Lacey, Ellensburg, and the Tri Cities.

- Washington revised their WQS in a new Rule that was adopted on November 20, 2006, and adopted the EPA maps. The new standards were submitted to the EPA for approval on December 8, 2006 (Appendix A and B of the BE).

- December 21, 2006 – WDOE finalized the Rule incorporating the required changes and submitted the new package to EPA for approval.

- April 9, 2007 – WDOE letter to EPA outlining the approach to review and revise the DO criteria, if needed (Appendix G of the BE). The WDOE set up a working team to conduct a sampling study to address uncertainties regarding the adequacy of the existing 9.5mg/L to protect egg incubation and fry emergence in the gravel. Based on the results of the review, the DO criterion may need to be revised in all spawning areas.

- A Draft Biological Evaluation (BE) was sent to the Services for review on January 25, 2007. The FWS submitted comments to the draft on February 21, 2007. The final BE and request for section 7 consultation was delivered on April 11, 2007.

- Although the EPA made changes to the designated uses and associated temperature criterion to protect aquatic life uses they did not change the special temperature provisions that apply on many rivers in eastern Washington as part of the proposed action. During a meeting on December 21, 2007, and a conference call on January 9, 2008, WDOE agreed to provide the Services with their proposed strategy for addressing the special temperature provisions.

- On January 28, 2008, WDOE submitted a letter to the EPA indicating that the State will use the TMDL process to model the natural thermal condition of the rivers with special temperature provisions. Based on these calculations, the natural condition becomes the effective criteria for the reach and all point and non-point source allocations are based on attaining these criteria. The TMDLs will be completed by 2012.

Table 1 lists species that occur in Washington State (marine species are not included because revisions to the standards only apply to freshwater) and were included in the request for consultation.

Table 1. EPA's effect determination for federally-listed species in Washington that are under the jurisdiction of the FWS. Shading indicates species that were addressed in the BO.

Common Name	Scientific Name	Status	EPA Effect Determinations
Mammals			
Pygmy rabbit	*Brachylagus idahoensis*	E	NE
Canada lynx	*Felis lynx canadensis*	T	NE
Columbian white-tailed deer	*Odocoileus virginianus leucurus*	CH E	NE
Grizzly bear	*Ursus arctos horribilis*	T	NE
Woodland caribou	*Rangifer tarandus caribou*	E	NE
Gray wolf	*Canis lupus*	T	NE
Birds			
Marbled murrelet	*Brachyramphus marmoratus*	CH T	NLAA
Western snowy plover (coastal populations)	*Charadrius alexandrinus nivosus*	CH T	NE
Bald eagle	*Haliaeetus leucocephalus*	T	NLAA
Northern spotted owl	*Strix occidentalis caurina*	CH T	NE
Fish			
Bull Trout	*Salvelinus confluentus*	CH T	LAA
Invertebrates			
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	CH T	NE
Plants			
Golden paintbrush	*Castilleja levisecta*	T	NE
Showy stickseed	*Hackelia venusta*	E	NE
Water howellia	*Howellia aquatilis*	T	NE
Bradshaw's desert-parsley	*Lomatium bradshawii*	E	NE
Kincaid's lupine	*Lupinus sulphureus kincaidii*	T	NE
Nelson's checker-mallow	*Sidalcea nelsoniana*	T	NE
Wenatchee Mountains checkermallow	*Sidalcea oregano*	E	NE
Spalding's catchfly	*Silene spaldingii*	T	NE
Ute ladies'-tresses	*Spiranthes diluvialis*	T	NE

NE - no effect NLAA - may affect, not likely to adversely affect
LAA – may affect, likely to adversely affect CH - critical habitat
T – threatened E – endangered P - proposed

The EPA made a **"No Effect"** determination for the Canada lynx, northern spotted owl, Columbia white-tailed deer, western snowy plover, grizzly bear, woodland caribou, pygmy rabbit, gray wolf, the Oregon silverspot butterfly, and the nine listed plant species. Your determination that the action will have no effect on these species rests with the action agency.

The EPA determined that revisions to the WQS **"may affect, but are not likely to adversely affect"** the bald eagle and marbled murrelet. These two species are primarily piscivorous and changes to water temperature and dissolved oxygen (DO) criteria could affect prey abundance and distribution. The bald eagle was removed from the Federal List of Threatened and Endangered Wildlife on August 8, 2007 and consultation under section 7(a)2 of the Endangered Species Act is no longer required for this species. We have therefore not provided concurrence on your effect determination for the bald eagle. The FWS concurs with the effect determination for the marbled murrelet. Although approving the new WQS will not result in a measurable effect to murrelets, it should improve the forage base for murrelets over the long-term.

The only species that will be adversely affected by the proposed standards changes is the bull trout. The BO will evaluate effects to the Coastal Puget Sound and Columbia River IRUs as well as designated critical habitat for the bull trout [50 FR 56212 (October 26, 2005)]. The FWS concurs with the EPA determination that approval of WQS that are protective of the existing uses will not have significant effects to the bull trout.

BIOLOGICAL OPINION

This Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.

Overview of the WQS

Part of the Oregon WQS consultation, which was completed in 2004, included a conservation measure that required the EPA to establish and lead a regional effort to review temperature requirements of critical life stages of salmonids native to the Pacific Northwest and develop guidance for the States and Tribes. The project was a collaborative effort between the State agencies, Tribes, EPA, and the Services. The final guidance document, entitled the EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature WQS (USEPA 2003), was completed in March 2003, and will be referred to as the Region 10 Temperature Guidance throughout the context of this document. The temperatures that were developed during this process were used to set the WQS standards to protect aquatic life uses for all water bodies in the State of Washington. The guidance document was also used to determine which water bodies should be designated as "Core" (year-round temperature standard of 16 °C) as well as the spatial and temporal application of temperatures to protect spawning and juvenile rearing.

The CWA provides the statutory basis for the WQS program and defines broad water quality goals. For example, Section 101(a) states, in part, that wherever attainable, waters shall achieve a level of quality that provides for the protection and propagation of fish, shellfish, wildlife, and for human recreation in and on the water. The WQS define goals that a given waterbody should achieve in order to support the existing and designated uses that occur in that waterbody. This is done by setting criteria that are necessary to protect the uses and by preventing or limiting degradation of water quality.

Section 303(c) of the CWA requires that all states adopt WQS and that the EPA review and approve these standards. In addition to adopting WQS, states are required to review and revise the standards every 3 years. This public process, commonly referred to as the Triennial Review, allows for new technical and scientific data to be incorporated into the standards. The regulatory requirements governing WQS are established by 40 Code of Federal Regulations (CFR) Part 131.

Section 303 of the CWA requires states and authorized Indian Tribes to adopt WQS, including antidegradation provisions consistent with the regulations at 40 CFR 131.12. The minimum requirements that must be included in the State standards are 1) designated uses, 2) criteria to protect the uses, and 3) an antidegradation policy to protect existing uses and water bodies with exceptionally high water quality. In addition to these elements, the regulations allow for states to adopt discretionary policies such as allowances for mixing zones and variances from WQS. These policies are also subject to EPA review and approval.

All standards officially adopted by the state are submitted to the EPA for review, and approval or disapproval. The EPA reviews the standards to determine whether the analyses performed are adequate, and evaluates whether the designated uses are appropriate and the criteria are protective of those uses. If the EPA determines that the revised or new WQS are not consistent with the CWA, they will disapprove those portions of the standards that do not meet the requirements. The state is then given an opportunity to make appropriate changes. If the state does not adopt the required changes, EPA must promulgate Federal regulations to replace those disapproved portions.

In addition to requiring states and authorized Indian Tribes to have an antidegradation policy, 40 CFR 131.12 requires that implementation methods be identified. Such methods are not required in the State's regulation, but are subject to EPA review. The EPA's regulations provide a great deal of discretion to states and tribes regarding the amount of specificity required in antidegradation implementation methods. The regulations do not specify minimum elements for such methods, but do require that such methods be consistent with the intent of the antidegradation policy. It should be noted that WDOE only has the authority to regulate point source discharges.

DESCRIPTION OF THE PROPOSED ACTION

The proposed action is the EPA's approval of the revised WQSs for the designated uses, temperature, and dissolved oxygen (only in areas that were changed) for the state of Washington. As mentioned above, section 303(c) of the CWA requires states to adopt WQS to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Once adopted by the state, the standards are submitted to EPA for approval or disapproval. The approval or disapproval of the standards hinges upon EPA's determination that 1) the analyses performed are adequate, 2) the designated uses are appropriate, and 3) the criteria are protective of those uses. State standards are then reviewed and revised, where appropriate, on a triennial basis. This public process allows for new technical and scientific data to be incorporated into the standards.

The specific portions of the Washington Administrative Code (WAC) that EPA proposes to approve include the following (for freshwater aquatic life only):

- definitions (WAC-173-201A-020),

- designated uses (WAC 173-201A-200(1)(a), WAC 173-201A-600(1), and WAC 173-201A-602 (except for the special temperature criteria for portions of the Columbia, Snake, Yakima, Walla Walla, Skagit, Palouse, Pend Orielle, and Spokane Rivers[1]),
- numeric temperature criteria (WAC 173-201A -200(1)(c)),
- narrative spawning temperature criteria (WAC 173-201A -200(1)(c)(i), (ii)(A), (iv), and (v)),
- numeric dissolved oxygen (DO) criteria (WAC 173-201A-200(1)(d))[2],
- special fish passage exemption for the Snake and Columbia Rivers (WAC 173-201A -200(1)(f)(ii)),
- natural and irreversible[3] human conditions (WAC-173-201A-260(1)(a)),
- allowable warming provisions, and
- procedures for applying the standards

A complete copy of Washington's WQS is included in the BE and the administrative record. This consultation is on EPA's approval of the 2006 revised water quality standards. The standards will remain in effect until such time that new information becomes available that warrants a change. Any changes that are made to the standards in the future must go through rule-making and approval by the EPA, which requires consultation with the FWS. The effects of implementing the new standards are indirect and will continue into perpetuity (or until such time as the standards are revised again). The following are descriptions of the Rules that EPA proposes to approve, as taken largely from their BE.

Definitions

The **"7-DADMax**" or "**7-day average of the daily maximum temperatures**" is the arithmetic average of seven consecutive measures of daily maximum temperatures. The 7-DADMax for any individual day is calculated by averaging that day's daily maximum temperature with the daily maximum temperatures of the 3 days prior and the 3 days after that date.

1. **Use Designations (WAC 600(1))**

All surface waters of the state not named in Table 602 of the revised WQS (WDOE 2006a) are to be protected for the designated uses of 1) salmon and trout spawning, 2) salmonid spawning, rearing, and migration, 3) salmon and trout migration, 4) primary contact recreation, 5) domestic, industrial, and agricultural water supply, 6) stock watering, 7) wildlife habitat, 8) harvesting, 9) commerce and navigation, 10) boating, and 11) aesthetic values.

[1] Although EPA is approving the change from Class A to "salmonid migration and rearing" for these rivers, they did not change the existing temperature standard to protect the existing uses.

[2] The WDOE is conducting a study to determine if the 9.5mg/L DO criteria, as measured in the water column, will provide the minimum 8.0 mg/L needed for salmonid egg incubation and early development in the gravel. The state of Oregon adopted 11mg/L as the criterion for DO based on studies conducted by the EPA that indicate an average reduction of 3mg/L between the water column and the gravel where eggs are incubating. Pending results of the study, the DO standards for Washington may need to be increased to 11mg/L to ensure 8mg/L in the gravel.

[3] The EPA is only approving the "natural conditions" portion of this provision. The "irreversible human conditions" aspect of this provision is not part of the proposed action.

(a) Additionally, the following waters are also to be protected for the designated uses of salmon and trout spawning, core rearing, and migration; and extraordinary primary contact recreation:

(i) All surface waters lying within national parks, national forests, and/or wilderness areas;

(ii) All lakes and all feeder streams to lakes (reservoirs with a mean detention time greater than 15 days are to be treated as a lake for use designation);

(iii) All surface waters that are tributaries to waters designated salmon and trout spawning, core rearing, and migration; or extraordinary primary contact recreation; and

(iv) All fresh surface waters that are tributaries to extraordinary quality marine waters (WAC 173-201A-610 through 173-201A-612).

2. **Fresh Water Aquatic Life Uses**

It is required that all indigenous fish and nonfish aquatic species be protected in waters of the state in addition to the key species described below.

(a) The categories for aquatic life uses are:

(i) **Char spawning and rearing**. The key identifying characteristics of this use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden), or use by other aquatic species similarly dependent on such cold water. Other common characteristic aquatic life uses for waters in this category include summer foraging and migration of native char; and spawning, rearing, and migration by other salmonid species. The FWS defines juvenile bull trout as individuals that are smaller than 150 mm (fork length).

(ii) **Core summer salmonid habitat**. The key identifying characteristics of this use are summer (June 15 – September 15) salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and subadult native char. Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids.

(iii) **Salmonid spawning, rearing, and migration**. The key identifying characteristic of this use is salmon or trout spawning and emergence that occurs outside of the summer season (September 16 – June 14). Other common characteristic aquatic life uses for waters in this category include rearing and migration by salmonids.

(iv) **Salmonid rearing and migration only**. For the protection of rearing and migration of salmon and trout, and other associated aquatic life.

The freshwater aquatic life uses are outlined in Table 602 of the WQS. Maps of the designated uses and summer spawning temperatures are listed in Appendix A of the BE and are also available on the web at: http://yosemite.epa.gov/R10/WATER.NSF/1507773cf7ca99a7882569ed007349b5/5a8440cd8b259abd882571390071ef4d!OpenDocument.

3. **Aquatic Life Temperature Criteria**

Except where noted, water temperature is measured by the 7-DADMax temperatures. Table 2 lists the temperature criteria for each of the aquatic life uses categories.

Table 2.

Table 200(1)(c) of the WQS Aquatic Life Temperature Criteria in Fresh Water	
Category	**Highest 7-DADMax**
Char spawning	9 °C (48.2 °F)
Char spawning and rearing	12 °C (53.6 °F)
Salmon and trout spawning	13 °C (55.4 °F)
Core summer salmonid habitat	16 °C (60.8 °F)
Salmonid spawning, rearing, and migration	17.5 °C (63.5 °F)
Salmonid rearing and migration only	17.5 °C (63.5 °F)

Spawning and incubation protection. The WDOE has identified waterbodies, or portions thereof, which require special protection for spawning and incubation in WDOE publication 06-10-038 (WDOE 2006b, also available on the web at www.ecy.gov). This publication indicates where and when the following criteria are to be applied to protect the reproduction of native char, salmon, and trout:

- Maximum 7-DADMax temperatures of 9 °C (48.2 °F) at the initiation of spawning through fry emergence for char; and

- Maximum 7-DADMax temperatures of 13 °C (55.4 °F) at the initiation of spawning for salmon and at fry emergence for salmon and trout.

The two criteria above are protective of incubation as long as human actions do not significantly disrupt the normal patterns of fall cooling and spring warming that maintains significantly colder temperatures over the majority of the incubation period.

- For lakes, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3 °C (0.54 °F) above natural conditions.

4. **Interim Fresh Water Aquatic Life Dissolved Oxygen Criteria**

For water bodies identified as active char and salmonid spawning areas in the places and times indicated on the existing uses and spawning narrative maps (See Appendix A).

Use Category	Lowest 1-day minimum
Char	9.5 mg/L
Core summer salmonid habitat	9.5 mg/L
Salmonid spawning, rearing, and migration	8.0 mg/L

General provisions of the DO standard for Washington that have been revised in the Rule include the following:

> (i) When a waterbody's DO is lower than the criteria listed above (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that waterbody to decrease more than 0.2 mg/L.
>
> (ii) For lakes, human actions considered cumulatively may not decrease the dissolved oxygen concentration more than 0.2 mg/L below natural conditions.

Approval of the 9.5 mg/L DO standard only applies to water bodies that changed from Class A to "Core summer salmonid habitat" or "Char spawning and rearing", and is considered interim, pending the outcome of WDOE's study in 2009. If it is determined that the 9.5 mg/L criterion is inadequate to provide the minimum oxygen levels needed for embryo development and fry emergence (8mg/L in the gravel), WDOE will need to raise the DO standard in all spawning areas. This will be a separate action that requires rule-making, EPA approval, and consultation with the Services.

5. **Total Dissolved Gas and Special Fish Passage Criteria for the Snake and Columbia River**

Aquatic life total dissolved gas (TDG) criteria

> (i) …. The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage:
>
> - TDG must not exceed an average of one hundred fifteen percent (115%) as measured in the forebays of the next downstream dams and must not exceed an average of one hundred twenty percent (120%) as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any one day, relative to atmospheric pressure).
> - A maximum TDG 1-hour average of one hundred twenty-five percent (125%) must not be exceeded during spillage for fish passage.

6. **Natural and Irreversible Human Conditions**

The Washington WQS contains a provision which allows the natural condition of the waterbody to become the criterion when the natural condition of the waterbody is of lower quality than the criterion assigned in the State's WQS (see WAC 173-201A-210A-310(3)). The WAC also includes a provision that allows the standards to be changed due to irreversible human conditions (WAC 173-201A-260). The Rule states that:

(a) It is recognized that portions of many water bodies cannot meet the assigned criteria due to the natural conditions of the waterbody. When a waterbody does not meet its assigned criteria due to natural climatic or landscape attributes, the natural conditions constitute the water quality criteria.

(b) When a waterbody does not meet its assigned criteria due to human structural changes that cannot be effectively remedied (as determined consistent with the federal regulations at 40 CFR 131.10), then alternative estimates of the attainable water quality conditions, plus any further allowances for human effects, may be used to establish an alternative criteria for the waterbody.

Part (b) of this provision was not addressed in the BE and is not part of the action because it requires individual approval by the EPA, and thus must go through a separate consultation with the FWS.

7. **Allowable Warming Provisions**

Washington's WQS include the following provisions:

> (i) When a waterbody's temperature is warmer than the criteria in Table 200(1)(c) (or within 0.3 °C (0.54 °F) of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that waterbody to increase more than 0.3 °C (0.54 °F).
>
> (ii) When the background condition of the water is cooler than the criteria in Table 200(1)(c), the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:
>
> - Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) for freshwater or 12/(T-2) in the marine environment, as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge).

The EPA is approving the thermal provisions that currently apply at the edge of a mixing zone. No changes were made to the size of mixing zones, the allowance of a mixing zone (as opposed to meeting the WQS at the point of discharge), chemical limits that are permitted within the acute and chronic portions of the mixing zones, or other provisions that pertain to point source discharges. These are not considered part of the action, and are not.

8. **Procedures for Applying Water Quality Criteria**

In applying the appropriate water quality criteria for a given waterbody, WDOE will use the following procedure:

(a) Upstream actions must be conducted in manners that meet downstream waterbody criteria. Except where and to the extent described otherwise in this chapter, the criteria associated with the most upstream uses designated for a waterbody are to be applied to headwaters to protect nonfish aquatic species and the designated downstream uses.

(b) Where multiple criteria for the same water quality parameter are assigned to a water-body to protect different uses, the most stringent criterion for each parameter is to be applied.

Aspects of the WQS that are not part of the action

The proposed action does not address WQS that were not revised because the EPA is not taking an action on those provisions. Additionally, the EPA's approval of Washington's antidegradation provision is not addressed in this BE because the EPA has determined it has no discretionary authority, and therefore, the EPA's approval is not an action under ESA section 7(a)(2). These standards are discussed below:

- **Mixing Zone Provision (WAC 173-210A-400) –** A mixing zone is an area where an effluent discharge undergoes dilution. Within a mixing zone, the water quality criteria may be exceeded as long as acutely toxic conditions are prevented. Washington restricts the allowable size of a mixing zone to the more stringent of the following: 1) 300 ft downstream of the discharge and no more than 25 percent of the width of the river, or 2) 25 percent of the river flow. This restriction allows for fish passage. Most discharges to a waterbody include a mixing zone which may allow some adverse impacts to listed and endangered species to occur within the specified mixing zone area.

- **Dissolved Oxygen Criteria (WAC 173-201A200-(1)(d), Table 200– (1)(d))** Table 200(1)(d) lists the dissolved oxygen criteria applicable for each aquatic life use designation. The BE examines the effects to listed species ***only*** for those waterbodies where EPA proposes to approve the DO criteria; specifically where the DO criterion changed from 8.0 mg/L to 9.5 mg/L. The EPA is not acting on or examining the effects associated with the DO criteria that are applied in any other water bodies.
- **Special Temperature Criteria (WAC 173-210A-602, Table 602) –** Table 602 of the WQS lists waterbody segments and the designated uses applicable to these segments. Table 602 also contains special temperature criteria that are applicable to large mainstem rivers, primarily in eastern Washington. These special temperature criteria are 1-day allowable maximums related to human activities on the following rivers:

- Columbia River from the mouth to the Grand Coulee Dam - 20 °C
- Snake River from the mouth to the Washington/Idaho/Oregon border - 20 °C
- Walla Walla and Mill Creek from the mouth to river mile (RM) 6.4 –20 °C
- Yakima River from the mouth to the Cle Elum River - 21 °C
- Skagit River from Gorge Dam to Gorge Powerhouse - 21 °C
- Palouse River from South Fork to the Idaho border - 20 °C
- Pend Oreille from the Canadian border to the Idaho border - 20 °C
- Spokane River from the mouth to Long Lake and from Nine-mile Bridge to the Idaho border - 20 °C

The proposed action is EPA's approval of the Use Designations (WAC 600(1)), Freshwater Aquatic Life Uses, and associated Aquatic Life Temperature Criteria to protect the existing uses. The EPA's approval includes changes to the designated uses and associated temperature criterion to protect the existing aquatic life uses in the freshwater bodies. Because the WDOE did not revise the Special Temperature Provisions that apply to several rivers listed in Table 602, these criteria are not considered part of the action.

- **Temperature Criteria for Marine Waters (WAC 173-201A-210(1)(c), Table 210(1)(c)) –** Table 210(1)(c) provides the temperature criteria for each category of marine aquatic life use. Bull trout and salmon spend many months or years in the marine waters over the course of their lives. The temperature criteria associated with "Good quality" marine water is 19 °C and the temperature criteria associated with "Fair quality" marine water is 22 °C.

- **Antidegradation (WAC 173-210A-300) –** Washington has adopted an antidegradation policy and implementation procedures that are consistent with EPA requirements. Because the EPA has delegated the authority for implementation of the antidegradation policy to the state, there is no approval action.

Approval of the revised WQS will result in modifications to National Pollution Discharge Elimination System permits (NPDES) that are issued in the future and Total Maximum Daily Load (TMDL) calculations to reduce sources of pollution in water bodies that are currently impaired. These actions will occur regardless of the proposed action and are not subject to consultation.

Proposed Conservation Measure

Under section 7(a)(1) of the ESA, Federal agencies shall utilize their authorities in furtherance of the purposes of the ESA, including the conservation of endangered and threatened species. The EPA has determined that the conservation measure described below are in furtherance of the goal of conserving endangered and threatened species and are part of the EPA's action.

1. **Dissolved Oxygen Criteria –** WDOE has committed to review the dissolved oxygen to determine if the 9.5 mg/L criterion, as measured in the water column, will provide the 8 mg/L intergravel levels needed for salmonid egg incubation and embryo development. If the existing DO criterion is found to be inadequate, the standards will be revised to

protect spawning and incubation (e.g. 11 mg/L or percent saturation similar to Oregon). The study was initiated in the fall of 2007 and will be completed by December 2009.

Triennial Review and Updates – As part of the process described in 40CFR § 131.20, WDOE and the EPA will ensure that new information on fish distribution and use (migration and timing and location of spawning and rearing) that would result in a change in the designated or existing use and/or application of the spawning narrative criteria are addressed during the Triennial Review process. In their letter, dated January 28, 2008, WDOE states that the special temperature provisions will be addressed as TMDLs are completed.

Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area of this consultation consists of all surface waters of the State of Washington for which revised standards have been proposed. The revised WQS apply to all freshwater surface waters of the state, which includes all lakes, ponds, impounding reservoirs, springs, rivers, streams, creeks, marshes, and canals within the territorial limits of the State of Washington, and all other bodies of surface water, natural or artificial, public or private (except those private waters which do not combine or affect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction. EPA's approval action does not apply to, and thus the action area does not include, any waters within Native American Country (reservations) or the marine environment[4].

The action area of this consultation consists of all freshwater of the State of Washington for which:

(1) The numeric and narrative temperature criteria have been proposed.

(2) The numeric dissolved oxygen criterion has changed as a result of the aquatic life use designation change (e.g., those waters that Washington is re-designating to address EPA's March 2006 disapproval letter).

(3) The Snake and Columbia River for total dissolved gas.

For water bodies that originate in or flow across state or international boundaries, the action area only includes the portion of the waterbody that lies within the State of Washington.

Approach to the Jeopardy Analysis

To conduct a jeopardy analysis for the bull trout, we evaluate the following: 1) the *Status of the Species*, which evaluates the bull trout's rangewide 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 conservation role of the action area; 3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and any interrelated or interdependent actions on

[4] Except for thermal provisions in mixing zones, which includes mixing zones in the marine environment.

the bull trout; and 4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the bull trout.

Our analysis considers how the likelihood of survival and recovery of the bull trout in its coterminous U.S. range may change with implementation of the proposed Federal action. The analysis involves multiple spatial scales, and is predicated on the concept that the fate of individuals affected by the proposed action may influence the persistence of the affected local population(s), core area(s), IRU(s), and the coterminous U.S. population of the bull trout. Our risk analysis begins by identifying the probable risks posed to individual bull trout by the proposed action, and then integrates those individual risks to identify consequences to the bull trout populations at the higher scales described above. Our jeopardy determination is based on whether bull trout are likely to experience a reduction in viability at the coterminous U.S. scale, and whether any reduction is likely to be appreciable. The term of our analyses is in perpetuity. While WDOE is required to revise their WQS if new information warrants it, there is no assurance that such revisions will occur within a particular timeframe.

In other words, the effects of the proposed Federal action are evaluated with the aggregate effects of everything that has led to the bull trout's current status and, for non-federal activities in the action area, those actions likely to affect the bull trout in the future. We then determine if, given the aggregate of all of these effects, implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of the bull trout in the wild at the scale of the entire listed species.

Approach to the Destruction or Adverse Modification Analysis

In conducting an analysis of effects to critical habitat, we do not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we rely on the statutory provisions of the ESA, using the following analytical framework.

We consider 1) the *Status of Critical Habitat*, which evaluates the range-wide condition of designated critical habitat for the bull trout in terms of its primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat overall; 2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; 3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units; and 4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

STATUS OF THE SPECIES – Bull Trout (Rangewide)

Listing Status

The coterminous United States population of the bull trout (*Salvelinus confluentus*) was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout generally occurs in the Klamath River Basin of south-central Oregon; the Jarbidge River in Nevada; the Willamette River Basin in Oregon; Pacific Coast drainages of Washington, including Puget Sound; major rivers in Idaho, Oregon, Washington, and Montana, within the Columbia River Basin; and the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (Cavender 1978; Bond 1992; Brewin and Brewin 1997; Leary and Allendorf 1997).

Throughout its range, the bull trout are threatened by 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, entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels, and introduced non-native species (64 FR 58910). Poaching and incidental mortality of bull trout during other targeted fisheries are additional threats.

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (63 FR 31647; 64 FR 17110). The preamble to the final listing Rule for the United States coterminous population of the bull trout discusses the consolidation of these DPSs with the Columbia and Klamath population segments into one listed taxon and the application of the jeopardy standard under section 7 of the Act relative to this species (64 FR 58910):

> Although this Rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as IRUs with respect to application of the jeopardy standard until an approved recovery plan is developed. Formal establishment of bull trout recovery units will occur during the recovery planning process.

Current Status and Conservation Needs

In recognition of available scientific information relating to their uniqueness and significance, five segments of the coterminous United States population of the bull trout are considered essential to the survival and recovery of this species and are identified as IRUs: 1) Jarbidge River, 2) Klamath River, 3) Columbia River, 4) Coastal-Puget Sound, and 5) St. Mary-Belly River (USFWS 2002; 2004a, b). Each of these IRUs is necessary to maintain the bull trout's distribution, as well as its genetic and phenotypic diversity, all of which are important to ensure the species' resilience to changing environmental conditions.

A summary of the current status and conservation needs of the bull trout within these IRUs is provided below and a comprehensive discussion is found in the Service's draft recovery plans for the bull trout (USFWS 2002; 2004a,b).

The conservation needs 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 at multiple scales ranging from the coterminous to local populations (a local population is a group of bull trout that spawn within a particular stream or portion of a stream system). The recovery planning process for bull trout (USFWS 2002; 2004a,b) has also identified the following conservation needs: 1) maintenance and restoration of multiple, interconnected populations in diverse habitats across the range of each IRU, 2) preservation of the diversity of life-history strategies, 3) maintenance of genetic and phenotypic diversity across the range of each IRU, and 4) establishment of a positive population trend. Recently, it has also been recognized that bull trout populations need to be protected from catastrophic fires across the range of each IRU (Rieman et al. 2003).

Central to the survival and recovery of bull trout is the maintenance of viable core areas (USFWS 2002; 2004a,b). A core area is defined as a geographic area occupied by one or more local bull trout populations that overlap in their use of rearing, foraging, migratory, and overwintering habitat. Each of the IRUs listed above consists of one or more core areas. There are 121 core areas recognized across the coterminous range of the bull trout (USFWS 2002; 2004a,b).

Jarbidge River IRU

This IRU currently contains a single core area with six local populations. Less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawning adults, are estimated to occur in the core area. The current condition of the bull trout in this IRU is attributed to the effects of livestock grazing, roads, incidental mortalities of released bull trout from recreational angling, historic angler harvest, timber harvest, and the introduction of non-native fishes (USFWS 2004a). The draft bull trout recovery plan (USFWS 2004a) identifies the following conservation needs for this IRU: 1) maintain the current distribution of the bull trout within the core area, 2) maintain stable or increasing trends in abundance of both resident and migratory bull trout in the core area, 3) restore and maintain suitable habitat conditions for all life history stages and forms, and 4) conserve genetic diversity and increase natural opportunities for genetic exchange between resident and migratory forms of the bull trout. An estimated 270 to 1,000 spawning bull trout per year are needed to provide for the persistence and viability of the core area and to support both resident and migratory adult bull trout (USFWS 2004a).

Klamath River IRU

This IRU currently contains three core areas and seven local populations. The current abundance, distribution, and range of the bull trout in the Klamath River Basin are greatly reduced from historical levels due to habitat loss and degradation caused by reduced water quality, timber harvest, livestock grazing, water diversions, roads, and the introduction of non-native fishes (USFWS 2002). Bull trout populations in this IRU face a high risk of extirpation (USFWS 2002). The draft Klamath River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this IRU: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and strategies, 4) conserve genetic diversity and provide the opportunity for genetic exchange among appropriate core area populations. Eight to 15 new local populations and an increase in population size from about 2,400 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002).

Columbia River IRU

The Columbia River IRU includes bull trout residing in portions of Oregon, Washington, Idaho, and Montana. Bull trout are estimated to have occupied about 60 percent of the Columbia River Basin, and presently occur in 45 percent of the estimated historical range (Quigley and Arbelbide 1997). This IRU currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in central Idaho and northwestern Montana. The Columbia River IRU has declined in overall range and numbers of fish (63 FR 31647). Although some strongholds still exist with migratory fish present, bull trout generally occur as isolated local populations in headwater lakes or tributaries where the migratory life history form has been lost. Though still widespread, there have been numerous local extirpations reported throughout the Columbia River basin. In Idaho, for example, bull trout have been extirpated from 119 reaches in 28 streams (Idaho Department of Fish and Game *in litt.* 1995). The draft Columbia River bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this IRU: 1) maintain or expand the current distribution of the bull trout within core areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

This IRU currently contains 97 core areas and 527 local populations. About 65 percent of these core areas and local populations occur in Idaho and northwestern Montana. The condition of the bull trout within these core areas varies from poor to good. All core areas have been subject to the combined effects of habitat degradation and fragmentation caused by the following activities: 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 into diversion channels; and introduced non-native species. The Service completed a core area conservation assessment for the 5-year status review and determined that, of the 97 core areas in this IRU, 38 are at high risk of extirpation, 35 are at risk, 20 are at potential risk, 2 are at low risk, and 2 are at unknown risk (USFWS 2005).

Coastal-Puget Sound IRU

Bull trout in the Coastal-Puget Sound IRU exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this IRU. This IRU currently contains 14 core areas and 67 local populations (USFWS 2004b). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this IRU. Bull trout continue to be present in nearly all major watersheds where they likely occurred historically, although local extirpations have occurred throughout this IRU. Many remaining populations are isolated or fragmented and abundance has declined, especially in the southeastern portion of the IRU. The current condition of the bull trout in this IRU is attributed to the adverse effects of dams, forest management practices (e.g., timber harvest and associated road building activities), agricultural practices (e.g., diking, water control structures, draining of wetlands, channelization, and the removal of riparian vegetation), livestock grazing, roads, mining, urbanization, poaching, incidental mortality from other targeted fisheries, and the introduction of non-native species. The draft Coastal-Puget Sound bull trout recovery plan (USFWS 2004b) identifies the following conservation needs for this IRU: 1) maintain or expand the current distribution of bull trout within existing core areas, 2) increase bull trout abundance to about 16,500 adults across all core areas, and 3) maintain or increase connectivity between local populations within each core area.

St. Mary-Belly River IRU

This IRU currently contains six core areas and nine local populations (USFWS 2002). Currently, bull trout are widely distributed in the St. Mary-Belly River drainage and occur in nearly all of the waters that it inhabited historically. Bull trout are found only in a 1.2-mile reach of the North Fork Belly River within the United States. Redd count surveys of the North Fork Belly River documented an increase from 27 redds in 1995 to 119 redds in 1999. This increase was attributed primarily to protection from angler harvest (USFWS 2002). The current condition of the bull trout in this IRU is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of non-native fishes (USFWS 2002). The draft St. Mary-Belly bull trout recovery plan (USFWS 2002) identifies the following conservation needs for this IRU: 1) maintain the current distribution of the bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in bull trout abundance, 3) restore and maintain suitable habitat conditions for all life history stages and forms, 4) conserve genetic diversity and provide the opportunity for genetic exchange, and 5) establish good working relations with Canadian interests because local bull trout populations in this IRU are comprised mostly of migratory fish, whose habitat is mostly in Canada.

Life History

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 (Fraley and Shepard 1989; 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 (Cavender 1978; 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 (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 (Leathe and Graham 1982; Fraley and Shepard 1989; Pratt 1992; Rieman and McIntyre 1996).

The iteroparous reproductive strategy 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 (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 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 (Pratt 1985; Goetz 1989). The largest verified bull trout is a 32-pound specimen caught in Lake Pend Oreille, Idaho, in 1949 (Simpson and Wallace 1982).

Habitat Characteristics

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; Sedell and Everest 1991; Howell and Buchanan 1992; Pratt 1992; Rieman and McIntyre 1993, 1995; Rich 1996; 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 (Rieman et al. 1997).

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; Gilpin, *in litt.* 1997; Rieman et al. 1997). 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 (Spruell et al. 1999; Rieman and McIntyre 1993). 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 (below 15 °C or 59 °F), and spawning habitats are generally characterized by temperatures that drop below 9 °C (48 °F) 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; Baxter et al. 1997; Rieman et al. 1997). Optimum incubation temperatures for bull trout eggs range from 2 °C to 6 °C (35 °F to 39 °F) whereas optimum water temperatures for rearing range from about 6 °C to 10 °C (46 °F to 50 °F) (McPhail and Murray 1979; Goetz 1989; Buchanan and Gregory 1997). 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 (46 °F to 48 °F), within a temperature gradient of 8 °C to 15 °C (4 °F to 60 °F). 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 (52 °F to 54 °F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River basin (Fraley and Shepard 1989; Rieman and McIntyre 1993, 1995; Buchanan and Gregory 1997; Rieman et al. 1997). Availability and proximity of cold water patches and food productivity can influence bull trout ability to survive in warmer rivers (Myrick et al. 2002). For example, in a study in the Little Lost River of Idaho where bull trout were found at temperatures ranging from 8 °C to 20 °C (46 °F to 68 °F), most sites that had high densities of bull trout were in areas where primary productivity in streams had increased following a fire (Bart Gamett, U.S. Forest Service, pers. comm. 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; Sedell and Everest 1991; Pratt 1992; Thomas 1992; Rich 1996; Sexauer and James 1997; Watson and Hillman 1997). Maintaining bull trout habitat requires 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.

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 200 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 intertgravel 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 WDOE (2002) indicates that adverse effects of lower oxygen concentrations on embryo survival are magnified as temperatures increase above optimal (for incubation). In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep1996 *cited in* Stewart et al. 2007). 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.

Migratory forms of bull trout may develop when habitat conditions allow movement between spawning and rearing streams and larger rivers, lakes or nearshore marine habitat where foraging opportunities may be enhanced (Frissell 1993; Goetz et al. 2004; Brenkman and Corbett 2005). 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 (Rieman and McIntyre 1993; MBTSG 1998; Frissell 1999). 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).

Diet

Bull trout are opportunistic feeders, with food habits primarily a function of size and life-history strategy. A single optimal foraging strategy is not necessarily a consistent feature in the life of a fish, because this strategy can change as the fish progresses from one life stage to another (i.e., juvenile to subadult). Fish growth depends on the quantity and quality of food that is eaten (Gerking 1994), and as fish grow, their foraging strategy changes as their food changes, in quantity, size, or other characteristics. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish (Boag 1987; Goetz 1989; Donald and Alger 1993). Subadult and adult migratory bull trout feed on various fish species (Leathe and Graham 1982; Fraley and Shepard 1989; Brown 1994; Donald and Alger 1993). Bull trout of all sizes other than fry have been found to eat fish half their length (Beauchamp and Van Tassell 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*) (WDFW et al. 1997; Goetz et al. 2004).

Bull trout migration and life history strategies are closely related to their feeding and foraging strategies. Migration allows bull trout to access optimal foraging areas and exploit a wider variety of prey resources. Optimal foraging theory can be used to describe strategies fish use to choose between alternative sources of food by weighing the benefits and costs of capturing one source of food over another. For example, prey often occur in concentrated patches of abundance ("patch model;" Gerking 1994). As the predator feeds in one patch, the prey population is reduced, and it becomes more profitable for the predator to seek a new patch rather than continue feeding on the original one. This can be explained in terms of balancing energy acquired versus energy expended. 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).

<u>Changes in Status of the Coastal-Puget Sound IRU</u>

Although the status of bull trout in Coastal-Puget Sound IRU has been improved by certain actions, it continues to be degraded by other actions, and it is likely that the overall status of the bull trout in this population segment has not improved since its listing on November 1, 1999. Improvement has occurred largely through changes in fishing regulations and habitat-restoration projects. Fishing regulations enacted in 1994 either eliminated harvest of bull trout or restricted the amount of harvest allowed, and this likely has had a positive influence on the abundance of bull trout. Improvement in habitat has occurred following restoration projects intended to benefit either bull trout or salmon, although monitoring the effectiveness of these projects seldom occurs. On the other hand, the status of this population segment has been adversely affected by a number of Federal and non-Federal actions, some of which were addressed under section 7 of the Act. Most of these actions degraded the environmental baseline; all of those addressed through formal consultation under section 7 of the Act permitted the incidental take of bull trout.

Section 10(a)(1)(B) permits have been issued for Habitat Conservation Plans (HCP) completed in the Coastal-Puget Sound population segment. These include: 1) the City of Seattle's Cedar River Watershed HCP, 2) Simpson Timber HCP, 3) Tacoma Public Utilities Green River HCP, 4) Plum Creek Cascades HCP, 5) Washington State Department of Natural Resources HCP, 6) West Fork Timber HCP (Nisqually River), and 7) Forest Practices HCP. These HCPs provide landscape-scale conservation for fish, including bull trout. Many of the covered activities associated with these HCPs will contribute to conserving bull trout over the long-term; however, some covered activities will result in short-term degradation of the baseline. All HCPs permit the incidental take of bull trout.

Changes in Status of the Columbia River IRU

The overall status of the Columbia River IRU has not changed appreciably since its listing on June 10, 1998. Populations of bull trout and their habitat in this area have been affected by a number of actions addressed under section 7 of the Act. Most of these actions resulted in degradation of the environmental baseline of bull trout habitat, and all permitted or analyzed the potential for incidental take of bull trout. The Plum Creek Cascades HCP, Plum Creek Native Fish HCP, and Forest Practices HCP addressed portions of the Columbia River population segment of bull trout.

Changes in Status of the Klamath River IRU

Improvements in the Threemile, Sun, and Long Creek local populations have occurred through efforts to remove or reduce competition and hybridization with non-native salmonids, changes in fishing regulations, and habitat-restoration projects. Population status in the remaining local populations (Boulder-Dixon, Deming, Brownsworth, and Leonard Creeks) remains relatively unchanged. Grazing within bull trout watersheds throughout the recovery unit has been curtailed. Efforts at removal of non-native species of salmonids appear to have stabilized the Threemile and positively influenced the Sun Creek local populations. The results of similar efforts in Long Creek are inconclusive. Mark and recapture studies of bull trout in Long Creek indicate a larger migratory component than previously expected.

Although the status of specific local populations has been slightly improved by recovery actions, the overall status of Klamath River bull trout continues to be depressed. Factors considered threats to bull trout in the Klamath Basin at the time of listing – habitat loss and degradation caused by reduced water quality, past and present land use management practices, water diversions, roads, and non-native fishes – continue to be threats today.

Changes in Status of the Saint Mary-Belly River IRU

The overall status of bull trout in the Saint Mary-Belly River IRU has not changed appreciably since its listing on November 1, 1999. Extensive research efforts have been conducted since listing, to better quantify populations of bull trout and their movement patterns. Limited efforts in the way of active recovery actions have occurred. Habitat occurs mostly on Federal and Tribal lands (Glacier National Park and the Blackfeet Nation). Known problems due to instream flow depletion, entrainment, and fish passage barriers resulting from operations of the U.S. Bureau of Reclamation's Milk River Irrigation Project (which transfers Saint Mary-Belly River water to the Missouri River Basin) and similar projects downstream in Canada constitute the primary threats to bull trout and to date they have not been adequately addressed under section 7 of the Act. Plans to upgrade the aging irrigation delivery system are being pursued, which has potential to mitigate some of these concerns but also the potential to intensify dewatering. A major fire in August 2006 severely burned the forested habitat in Red Eagle and Divide Creeks, potentially affecting three of nine local populations and degrading the baseline.

STATUS OF BULL TROUT CRITICAL HABITAT (Rangewide)

This Biological Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in Gifford Pinchot Task Force v. U.S. Fish and Wildlife Service (No. 03-35279) to complete the following analysis with respect to critical habitat.

Legal Status

The Service published a final critical habitat designation for the coterminous United States population of the bull trout on September 26, 2005 (70 FR 56212); the Rule became effective on October 26, 2005. The scope of the designation involved the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments (also considered as IRUs). Rangewide, the Service designated 143,218 acres of reservoirs or lakes and 4,813 stream or shoreline miles as bull trout critical habitat (Table 3).

Table 3. Stream/shoreline distance and acres of reservoir or lakes designated as bull trout critical habitat by state.

	Stream/shoreline Miles	Stream/shoreline Kilometers	Acres	Hectares
Idaho	294	474	50,627	20,488
Montana	1,058	1,703	31,916	12,916
Oregon	939	1,511	27,322	11,057
Oregon/Idaho	17	27		
Washington	1,519	2,445	33,353	13,497
Washington (marine)	985	1,585		

Although critical habitat has been designated across a wide area, some critical habitat segments were excluded in the final designation based on a careful balancing of the benefits of inclusion versus the benefits of exclusion (see Section 3(5)(A) and Exclusions under Section 4(b)(2) in the final Rule). This balancing process resulted in all proposed critical habitat being excluded in 9 proposed critical habitat units: Unit 7 (Odell Lake), Unit 8 (John Day River Basin), Unit 15 (Clearwater River Basin), Unit 16 (Salmon River Basin), Unit 17 (Southwest Idaho River Basins), Unit 18 (Little Lost River), Unit 21 (Upper Columbia River), Unit 24 (Columbia River), and Unit 26 (Jarbidge River Basin). The remaining 20 proposed critical habitat units were designated in the final Rule. It is important to note that the exclusion of waterbodies from designated critical habitat does not negate or diminish their importance for bull trout conservation.

Conservation Role and Description of Critical Habitat

The conservation role of bull trout critical habitat is to support viable core area populations (70 FR 56212). 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. Critical habitat units generally encompass one or more core areas and may include foraging, migration, and overwintering (FMO) areas, outside of core areas, that are important to the survival and recovery of bull trout.

Because there are numerous exclusions that reflect land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments. These individual critical habitat segments are expected to contribute to the ability of the stream to support bull trout within local populations and core areas in each critical habitat unit.

The primary function of individual critical habitat units 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 local populations, in part, by providing habitat conditions that encourage movement of migratory fish (Rieman and McIntyre 1993, MBTSG 1998); 3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (Rieman and McIntyre 1993, Hard 1995, Healey and Prince 1995, MBTSG 1998); and 4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (Rieman and McIntyre 1993, Hard 1995, MBTSG 1998, Rieman and Allendorf 2001).

The Olympic Peninsula and Puget Sound critical habitat units are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound bull trout population. These critical habitat units contain nearshore and freshwater habitats, outside of core areas, that are used by bull trout from one or more core areas. These habitats, outside of core areas, contain Primary Constituent Elements (PCEs) that are critical to adult and subadult foraging, overwintering, and migration.

Within the designated critical habitat areas, the PCEs for bull trout are those habitat components that are essential for the primary biological needs of foraging, reproducing, rearing of young, dispersal, genetic exchange, or sheltering. Note that only PCEs 1, 6, 7, and 8 apply to marine nearshore waters identified as critical habitat; and all except PCE 3 apply to FMO habitat identified as critical habitat.

The PCEs are as follows:

> (1) Water temperatures that support bull trout use. Bull trout have been documented in streams with temperatures from 32º to 72 ºF (0º to 22 ºC) but are found more frequently in temperatures ranging from 36º to 59 ºF (2º to 15 ºC). These temperature ranges may vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude bull trout use are specifically excluded from designation.
>
> (2) Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.

(3) Substrates 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. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter) in diameter.

(4) A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variation.

(5) Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.

(6) Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

(7) An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

(8) Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

Critical habitat includes the stream channels within the designated stream reaches, the shoreline of designated lakes, and the inshore extent of marine nearshore areas, including tidally influenced freshwater heads of estuaries.

In freshwater habitat, critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line. In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series. For designated lakes, the lateral extent of critical habitat is defined by the perimeter of the waterbody as mapped on standard 1:24,000 scale topographic maps.

In marine habitat, critical habitat includes the inshore extent of marine nearshore areas between mean lower low-water (MLLW) and minus 10 meters (m) mean higher high-water (MHHW), including tidally influenced freshwater heads of estuaries. This refers to the area between the average of all lower low-water heights and all the higher high-water heights of the two daily tidal levels. The offshore extent of critical habitat for marine nearshore areas is based on the extent of the photic zone, which is the layer of water in which organisms are exposed to light. Critical habitat extends offshore to the depth of 33 ft (10 m) relative to the MLLW.

Adjacent stream, lake, and shoreline riparian areas, bluffs, and uplands are not designated as critical habitat. However, it should be recognized that the quality of marine and freshwater habitat along streams, lakes, and shorelines is intrinsically related to the character of these adjacent features, and that human activities that occur outside of the designated critical habitat can have major effects on physical and biological features of the aquatic environment.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to “destroy or adversely modify” critical habitat by altering the PCEs to such an extent that critical habitat would not remain functional to serve the intended conservation role for the species (70 FR 56212, FWS 2004). The Service’s evaluation must be conducted at the scale of the entire critical habitat area designated, unless otherwise stated in the final critical habitat rule (USFWS and NMFS 1998). Therefore, adverse modification of bull trout critical habitat is evaluated at the scale of the final designation, which includes the critical habitat designated for the Klamath River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments.

Current Condition Rangewide

The condition of bull trout critical habitat varies across its range from poor to good. Although still relatively widely distributed across its historic range, the bull trout occurs in low numbers in many areas, and populations are considered depressed or declining across much of its range (67 FR 71240). This condition reflects the condition of bull trout habitat.

There is widespread agreement in the scientific literature that many factors related to human activities have impacted bull trout and their habitat, and continue to do so. Among the many factors that contribute to degraded PCEs, those which appear to be particularly significant and have resulted in a legacy of degraded habitat conditions are as follows: 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 (Rieman and McIntyre 1993, Dunham and Rieman 1999); 2) degradation of spawning and rearing habitat and upper watershed areas, particularly alterations in sedimentation rates and water temperature, resulting from forest and rangeland practices and intensive development of roads (Fraley and Shepard 1989, MBTSG 1998); 3) the introduction and spread of nonnative fish species, particularly brook trout and lake trout, as a result of fish stocking and degraded habitat conditions, which 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; and 5) degradation of FMO habitat resulting from reduced prey base, roads, agriculture, development, and dams.

ENVIRONMENTAL BASELINE (Bull Trout and Bull Trout Critical Habitat)

Regulations implementing the ESA (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the action area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress.

The EPAs proposed approval of the WQS affects all freshwater within the state of Washington that are or could be used by bull trout. Because approval of the revised WQS will only affect temperature (DO is related to temperature), this is the only habitat parameter that will be addressed in the baseline condition section. In general, endangered and threatened species are listed because their habitat has been significantly degraded by human activities. The quality and quantity of freshwater habitat in much of Washington has been adversely impacted by water management activities and declines in water quality. The currently available water supplies are fully or often over-allocated during the low flow months of summer and fall. In the Columbia Plateau ecoregion, less than 20 percent of instream water rights can expect to receive their full allocation 9 months of the year. Consumptive use of freshwater in the upper watersheds has reduced freshwater inflow to estuaries by as much as 60 to 80 percent, thus reducing the natural dilution and flushing of pollutants. Reduced flows may cause mortality of juvenile and adult salmonids by delaying or blocking their migration, loss of sufficient habitat due to dewatering, stranding of fish resulting from rapid flow fluctuations, entrainment of juveniles into poorly screened or unscreened diversions, increased water temperatures, deposition of fine sediments in spawning gravels, and decreased recruitment of new spawning gravels (Spence et al. 1996).

Status of Bull Trout in the Action Area

The action area is comprised of the entire Coastal-Puget Sound IRU and that portion of the Columbia River IRU encompassed by the state of Washington. We conducted a risk analysis to determine those core areas and FMO habitats that would likely be subjected to effects of the action (Appendix C). Within the risk analysis, we ranked the baseline population conditions. For further review of population condition within these core areas, see Appendix B. The risk assessment revealed a number of core areas at highest risk of effects in the action area.

Bull trout within 14 core areas and 3 FMO areas outside of core areas will be affected by the proposed action. The following core areas are expected to be affected because of inadequate application of the WQS in some portion of spawning and rearing and/or FMO habitat: Asotin Creek, Methow, Wenatchee, Entiat, Yakima, Pend Orielle, Grand Ronde, Walla Walla, Tucannon, Lewis, Puyallup, Stillaguamish, Snohomish/Skykomish, and the Nooksack Rivers. The following FMO areas outside of core areas will also be affected because of inadequate temperature provisions: Chehalis, Samish, and Wishkah Rivers.

The following core areas and FMO areas outside of core areas will be adequately protected by the proposed action: Chilliwack, Lower Skagit, Upper Skagit, Snohomish, Chester Morse, Skokomish, Dungeness, Elwha, Hoh, Queets, Quinault, Klickitat, Priest Lake, Lower Green, Humptulips, and Satsop Rivers.

FMO and spawning and rearing habitats for bull trout on Tribal or reservation lands are not set or regulated by the state and are therefore not included in the proposed action. In most cases, the

WQS on Tribal lands are more stringent than the state standards. River segments that run through Tribal lands and are used by bull trout include the lower Queets, Raft River, Moclips, lower Quinault, lower Skokomish, lower Puyallup and portions of the White, portions of the lower Snohomish and Nooksack Rivers, upper Klickitat, Ahtanum Creek, and portions of the Pend Oreille River.

The following recovery objectives are similar for all core areas: maintaining current bull trout distributions and restoring distribution in previously occupied areas, maintaining stable or increasing trends in abundance, restoring and maintaining suitable habitat for all life-history stages, conserving genetic diversity, and providing opportunity for genetic exchange. This can be achieved by correcting prevailing threats in each core area. In addition, the establishment of fisheries management goals and objectives, research and monitoring programs, adaptive-management approaches, and use of available conservation programs and regulations are recommended to achieve recovery objectives, and monitor progress in reaching recovery goals.

The status of each core area is summarized in Appendix B. Most of the information was developed in our draft recovery plan, listing packages, the science information gathered for the bull trout 5-year review, and other recent documents that depict the baselines such as county and watershed or subbasin plans.

Habitat degradation (removal of riparian vegetation, water withdrawals, development, livestock grazing, agriculture, and hydro-modifications) has affected stream temperature in all core areas and is listed as a primary threat to the recovery of bull trout. Many core areas currently support fewer than 1,000 adult spawners and are at increased risk of genetic drift and loss of populations from stochastic events. The draft recovery plan indicates that many of the core areas have less than five local populations, each with fewer than 100 adults. For example, there is only a single small population of bull trout in the entire Pend Oreille core area.

Due to the geographic features of the watersheds (short rivers that drain directly to marine waters), the core areas on the Olympic Peninsula are smaller than core areas in Puget Sound and the Columbia River Basin. Bull trout populations are generally stable or increasing in the Olympic Peninsula management unit. In the Puget Sound management unit, populations are low and generally declining in the Snohomish-Skykomish, Puyallup, Stillaguamish, and Chester Morse core areas (3 to 5 local populations each, most with fewer than 100 individuals). This is largely attributed to habitat modifications related to their proximity to the urban areas of Puget Sound. The populations of bull trout are much stronger in the Skagit (lower and upper), Nooksack, and Chilliwack (transboundary with British Columbia) core areas, with most local populations having more than 1,000 adult spawners each.

In the Columbia IRU, core areas with both low numbers of local populations and adult bull trout include the Pend Oreille, Entiat, Lewis, Touchet, and Asotin Creek core areas. Although larger core areas such as the Yakima, Wenatchee, and Methow have more local populations and overall numbers of bull trout (due to the size of the core areas), there are many local populations within these core areas that have fewer than 100 spawners, are isolated from other populations, and are at increased risk of genetic drift or extirpation from stochastic events. For a detailed status of bull trout in each core area, please refer to Appendix B of this BO.

Factors Affecting the Baseline

Human changes to the landscape have generally increased river warming, which adversely affects salmonids and reduces the number of river segments that are thermally suitable to the developmental needs of bull trout. Human activities can increase water temperatures by increasing the heat load into the river, by reducing a river's capacity to absorb heat, and by eliminating or reducing the amount of groundwater flow which moderates temperatures and provides cold water refugia. Examples in which human development has caused excess warming of rivers include:

1) Removal of streamside vegetation reduces the amount of shade that blocks solar radiation and allows solar heating of streams. Examples of human activities that have reduced shade include past forest harvesting, agricultural land clearing, livestock grazing, and on-going urban development (Murphy et al. 1981; NRC 2002; Spence et al. 1996; May et al. 1997; Karr and Chu 1999).

2) Removal of streamside vegetation also reduces bank stability, thereby causing bank erosion and increased sediment loading into the stream. Bank erosion and increased sedimentation results in wider and shallower streams, which increases the stream's heat load by increasing the surface area subject to solar radiation and heat exchange with the air (Spence et al. 1996; Miller et al. *in press;* May et al. 1997).

3) Water withdrawals from rivers for purposes such as agricultural irrigation and urban/municipal and industrial use result in less river volume. The temperatures of rivers with smaller volumes equilibrate faster to surrounding air temperature, which leads to higher maximum water temperatures in the summer, compared to conditions without water withdrawals (Spence et al. 1996; Karr and Chu 1999).

4) Water discharges from industrial facilities, wastewater treatment facilities and irrigation return flows can add heat to rivers (WDOE, various NPDES permits issued).

5) Channeling, straightening, or diking rivers for flood control and urban and agricultural land development; or other activities that eliminates channel sinuosity, can substantially reduce cool groundwater flow into a river that moderates summertime river temperatures. These human actions can affect hyporheic flow, the water that is exchanged between the river and the riverbed (Coutant 1999; Poole and Berman 2000).

6) Removal of upland vegetation and the creation of impervious surfaces associated with urban development increases storm runoff and can reduce the amount of groundwater that is stored in the watershed and slowly filters back to the stream in the summer to cool water temperatures (May et al. 1997; Karr and Chu 1999; Hartley et al. 2001; Hartley and Funke 2001).

7) Dams and their reservoirs can affect thermal patterns in a number of ways (Coutant 1999). They can increase maximum temperatures by holding waters in reservoirs to

warm, especially in shallow areas near shore. Reservoirs, due to their increased volume of water, are more resistant to temperature change which results in reduced diurnal temperature variation and prolonged periods of warm water. For example, dams can delay the natural cooling that takes place in the late summer-early fall, thereby harming late summer-fall migration runs. Reservoirs also inundate alluvial river segments, thereby diminishing the groundwater exchange between the river and the riverbed (i.e., hyporheic flow) that cools the river and provides cold water refugia during the summer (Poole and Berman 2000). Further, dams can significantly reduce the river flow rate, thereby causing juvenile migrants to be exposed to high temperatures for a much longer time than they would under a natural flow regime. It should also be noted that when cold water is released from the bottom of a thermally stratified reservoir behind a dam downstream water temperature can be cooled depending on season and relative amounts of released flows.

The amount of dissolved oxygen that water can carry is directly affected by temperature, gradient, flows, biological oxygen demand (used by aquatic organisms), and, to some extent, elevation. Oxygen is absorbed during rainfall and enters the water column in cool, steep gradient streams with good mixing (turbulent). It is gradually lost as the water temperature and biological oxygen demand increases and stream gradient decreases (lower turbulence and mixing means less oxygen enters water column). The amount of dissolved oxygen that is present in the stream substrates is lower than levels in the water column and is influenced by the substrate size, amount of fines in the interstitial spaces (embeddedness), and flows through the gravels. Activities such as road maintenance and use, timber harvest, bank armoring, and maintenance and construction of facilities in the floodplain can alter stream flows and substrates and consequently affect the levels of dissolved oxygen in the gravel.

The Federal CWA establishes a process for states in developing information on the quality of its surface waters. Section 305(b) of the CWA requires that each state periodically prepare a water quality assessment report. To conduct a comprehensive statewide assessment, the EPA recommends using a “sample survey” approach. A sample survey approach allows for the estimation of the conditions of waters statewide by making inferences from a defined set of monitoring locations. Sample surveys are intended to produce assessments of the condition of the entire resource when that resource cannot be subject to a complete census.

Selected stream stations were stratified according to size and ecoregion to represent subpopulations of the target resource. Ecoregions denote areas of general similarity in the type, quality, and quantity of environmental resources. The following ecoregions were used:

- Coast Range (SW Washington)
- Puget Lowlands
- SW Washington (Clark County area)
- West Cascades and Olympic Mountains
- East Cascades and Foothills
- Columbia Basin
- Northern Rockies (Pend Oreille Area
- Blue Mountains (Asotin County Area)

Streams stations were also stratified by size into two groupings. "Large Streams" were defined as those reaches that are shown with double-banked cartographic features in the Washington Rivers Information System GIS coverage. "Small Streams" were defined as those reaches that are in the coverage as a single line.

The WDOE conducted a statewide water quality assessment on over 70,000 miles of streams, representing 98 percent of the total streams in Washington. The remaining 2 percent were from areas where samples were not collected. Results of the 305(b) report are outlined in Tables 4-5 through 4-27 of the BE. According to the assessment, 47 percent of the streams in the state supported the overall uses and approximately 86 percent of the streams support the aquatic life uses. However, because WDOE did not use the most current fish distribution data in this assessment, the -results for aquatic life uses and fish spawning and migration may not be accurate for all areas.

The assessment indicates that 30 percent of the stream impairments statewide are related to temperature and 15 percent of impairments are due to low levels of dissolved oxygen. The Columbia Basin Ecoregion, Clark County area, and large rivers in the Puget lowlands have the highest levels of temperature-related impairments, while the percent of impaired streams is much lower for smaller streams and the Cascades, Olympics, and Blue Mountain Ecoregions.

Over 50 percent of the streams in the Puget lowlands, east Cascades, Columbia Basin and Northern Rockies Ecoregions are impaired by metals, with nearly 60 percent of all streams statewide being affected by this pollution parameter. Fecal coliform is another pollutant that is affecting water quality in most of the rivers in Washington. According to the assessment results, between 35 and 50 percent of the streams in all of the geographic areas (except the Blue Mountains) have use impairments caused by fecal coliform.

Water pollution of almost every category is increasing. Sedimentation and increased water temperature related to logging, mining, urban development, and agriculture is a primary cause of salmon habitat degradation. Although the state regulates most activities that affect water quality, the baseline condition includes a legacy of these past actions. While there are regulatory mechanisms in place to control pollution related to point sources, most of the causes of elevated stream temperatures are related to unregulated non-point sources. However, even regulated entities are not always able to meet their permit limits, can receive variances or extensions based on implementation schedules, or can request an exemption based on a use attainability analysis (UAA). The FWS assumes that actions that are permitted or occur in areas with management plans (Federal lands, commercial forest lands, habitat conservation plans, etc.) will meet the WQS. However, with the growth that is occurring in the state, industrial timber lands in many areas are logged and sold for development. It is unlikely that water quality will be maintained in areas where permanent site conversion is taking place.

Current Water Quality in Washington

Washington has collected 7-DADMax temperature data for a number of major rivers since 2001. Table 4 summarizes the existing temperatures for major water bodies in the state. These data are based on daily or hourly readings and are more accurate than the monthly samples that are taken at the stream monitoring stations. It is important to remember that these data are for the lower rivers and show the high degree of variability in temperatures. The EPA classified waterbodies for temperature based on the following criteria:

(1) **High** – A waterbody is included in this category if the aquatic life use is "core summer salmonid habitat" and the waterbody has had at least one 7-DADMax temperature greater than 20 °C; or the aquatic life use is "Salmonid spawning, rearing, and migration" and the waterbody has had at least one 7-DADMax temperature above 21.5 °C; or the aquatic life use is "Salmonid rearing, and migration only" and the waterbody has had at least one 7-DADMax temperature above 21.5 °C.

(2) **Moderately High** – A waterbody is included in this category if the aquatic life use is "core summer salmonid habitat" and the waterbody has had at least one 7-DADMax temperature in the range of 17 °C – 19.9 °C; or the aquatic life use is "Salmonid spawning, rearing, and migration" and the waterbody has had at least one 7-DADMax temperature in the range of 18.5 °C – 21.4 °C; or the aquatic life use is "Salmonid rearing, and migration only" and the waterbody has had at least one 7-DADMax temperature in the range of 18.5 °C – 21.4 °C.

(3) **At or below Criterion** – A waterbody is included in this category if the aquatic life use is "Core summer salmonid habitat" and the 7-DADMax temperature is at or below 16 °C; or the aquatic life use is "Salmonid spawning, rearing, and migration" and the 7-DADMax temperature is at or below 17.5 °C; or the aquatic life use is "Salmonid rearing, and migration only" and the 7-DADMax temperature is at or below 17.5 °C.

It should be noted that monitoring for 7-DADMax temperatures has only been conducted on some of the larger rivers since 2001. The FWS also reviewed temperature data from all of the long-term monitoring stations (up to 20 years) across the range of bull trout. These data show a clear increasing trend for summer maximum temperatures in streams across the state.

Table 4. 7-DADMax Temperature Data.

Category	WRIA	River	Aquatic Life Use	7-DADMax temperature range (°C)	Number of years with 7-DADMax
High	5	S.F. Stillaguamish	Core summer salmonid habitat	19.9 – 22.1	N=5; 2001-2005
	5	Mid - Stillaguamish	Core summer salmonid habitat	20.9 – 23.4	N=5; 2001-2005
	5	N.F. Stillaguamish	Core summer salmonid habitat	19.9 – 22.3	N=5; 2001-2005
	7	Lower Skykomish	Core summer salmonid habitat	18.3 – 21.3	N=3; 2001-2003
	7	Mid - Snoqualmie	Core summer salmonid habitat	18.4 – 20.5	N=5; 2001-2005
	8	Near mouth of Cedar	Core summer salmonid habitat	18.3 – 20.7	N=5; 2001-2005
	13	Lower Deschutes	Salmonid spawning, rearing, migration	19.1-20.5	N=5; 2001-2005
	22	Mid - Humptulips	Core summer salmonid habitat	20.6 – 21.9	N=4; 2002-2005
	23	Chehalis near Porter Creek	Salmonid spawning,rearing,migration	22.3 – 24.1	N=5; 2001-2005
	23	Chehalis at Dryad	Core summer salmonid habitat	21.7 – 24.3	N=5; 2001-2005
	24	Mid Willapa	Salmonid spawning,rearing,migration	22 – 22.7	N=2; 2000-2002

Category	WRIA	River	Aquatic Life Use	7-DADMax temperature range (°C)	Number of years with 7-DADMax
	24	Upper Naselle	Core summer salmonid habitat	18.7 – 21.7	N=4; 2001-2004
	27	Mid E.F. Lewis	Core summer salmonid habitat	23.2 – 25.9	N=5; 2001-2005
	27	Kalama River, near mouth	Core summer salmonid habitat	18.5 – 20.3	N=5; 2001-2005
	32	Walla Walla, near mouth	Salmonid rearing, migration	27.8 - 30	N=5; 2001-2005
	34	S.F. Palouse, near Idaho border	Salmonid spawning,rearing,migration	20.4 – 23.8	N=5; 2001-2005
	34	Palouse, near Idaho border	Salmonid spawning,rearing,migration	26.6 – 29.1	N=5, 2001-2005
	35	Tucannon, near Snake	Salmonid spawning,rearing,migration	25.3 – 26.5	N=5; 2001-2005
	37	Yakima, near Ahtanum Creek	Salmonid spawning,rearing,migration	15.1 – 22.9	N=3; 2001-2003
	38	Cowiche Creek, near Naches river	Salmonid spawning,rearing,migration	22.4	N=1; 2005
	39	Yakima River, near Cle Elum	Core summer salmonid habitat	20.2 – 21.9	N=5; 2000 - 2005
	41	Crab Creek, near Columbia River	Salmonid rearing,migration	28 – 28.8	N=5; 2001-2005
	45	Wenatchee River, near Leavenworth	Core summer salmonid habitat	18.8 – 23.5	N=5; 2001, 2002, 2005
	45	Wenatchee River, near Columbia River	Salmonid spawning, rearing, migration	22.4	N=1; 2001
	46	Entiat River, near Columbia River	Salmonid spawning, rearing, migration	20.9-24.3	N=5; 2001 - 2005
	48	Methow River near Columbia River	Salmonid spawning, rearing, migration	23.4 -4.6	N=5; 2001, 2003-2005
Moderate	1	Lower Nooksack	Core summer salmonid habitat	17.4-19.2	N=5; 2001-2005
	3	Skagit near Mount Vernon	Core summer salmonid habitat	17.6-18.3	N=2; 2004-2005
	9	Green River, mid river	Core summer salmonid habitat	17.9 -20	N=4; 2001, 2003-2005
	10	Lower Puyallup, on Tribal reservation land	On Tribal land, no state designation	17.5-18.4	N=2; 2002- 2003
	11	Nisqually, near mouth of river	Core summer salmonid habitat	16.1 -17.5	N=5; 2001- 2005
	15	Mission Creek	Core summer salmonid habitat	17.2	N=1; 2003
	18	Dungeness, near mouth	Core summer salmonid habitat	17.2 -18.6	N=4; 2002- 2005
	18	Lower Elwha	Core summer salmonid habitat	16.3 -18.9	N=5; 2001- 2005
	20	Hoh River, DNR campground	Core summer salmonid habitat	16 -17.8	N=4; 2001-2003, 2005
	26	Cowlitz River, near Columbia River	Salmonid spawning, rearing, migration	17.8-19.1	N=4; 2001- 2003, 2005
At or Below Criterion	4	Skagit, near Marblemount	Core summer salmonid habitat	13 -14.9	N=5; 2001- 2005
	15	Union River, near	Core summer salmonid habitat	15.1	N=1; 2003

Category	WRIA	River	Aquatic Life Use	7-DADMax temperature range (°C)	Number of years with 7-DADMax
		mouth			
	15	Little Mission Creek	Core summer salmonid habitat	12.8	N=1; 2003
	15	Stimson Creek	Core summer salmonid habitat	15	N=1; 2003
	15	Olalla Creek	Core summer salmonid habitat	14.9	N=1; 2003
	16	Skokomish River	Core summer salmonid habitat	14.7-15.2	N=5; 2001- 2005
	16	Duckabush	Core summer salmonid habitat	13.2-15	N=5; 2001- 2005

Many of the rivers that drain the Cascade Mountains west of the crest start out cool but then gradually warm up as they enter the open agricultural and rural landscapes of the lower basin. The rivers on the Olympic Peninsula generally have temperatures which are at or below the water quality criterion. Exceptions include the lower Elwha and Dungeness. Elevated water temperatures in the latter two rivers are attributed to warming in the reservoirs and water withdrawals for irrigation, respectively.

Many of the large rivers in eastern Washington have Special Temperature Provisions that allow temperatures of 20 or 21 °C related to human actions.

Special Temperature Provisions

Table 602 of the WQS lists water bodies and the designated uses applicable to these segments. Table 602 also contains special temperature criteria that are applicable to several large mainstem rivers, primarily in eastern Washington. These special temperature criteria are 1-day allowable maximums related to human activities (flood control, water withdrawal or storage, irrigation, etc.). Although the proposed action includes the change in use for these water bodies from the former Class A or Class B to "salmonid spawning, rearing and migration" or "salmonid rearing and migration," the 20 and 21 °C temperature criteria remain in effect on these rivers.

River segments that retain the special temperature standards include the Walla Walla (20 °C) Columbia (20 °C), Snake (20 °C), Grande Ronde (20 °C), Pend Oreille (20 °C) and Yakima (21 °C) Rivers. Each of the special temperature criteria are at levels where adverse effects to bull trout, including blocked migration and mortality, are likely to continue to occur. In areas where the temperature standard is close to the natural conditions, no significant impairment is anticipated. Although bull trout evolved in geographic areas where water temperatures are high during the summer, human alterations such as dams and irrigation diversions delay or block fish passage, effectively preventing individuals from reaching areas of cold water.

Impaired Waters [(303(d) List] in Washington

The CWA establishes as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water, wherever attainable." When a lake, river, stream or other waterbody fails to meet the standards, the CWA requires the state to place the waterbody on a list of "impaired" water bodies called the 303(d) list. States are required to prepare a 303(d) list every 2 years.

The WDOE compiled and assessed available water quality data on a statewide basis in order to get a better picture of the overall status of water quality in Washington's waters. The assessed waters are placed in categories which describe the status of the water quality. For each of the water bodies on the 303(d) list a "water cleanup plan," also known as a total maximum daily load (TMDL), will need to be developed. The TMDL identifies the likely cause(s) of the pollution and outlines steps that need to be taken to reduce or eliminate the pollution. An implementation schedule is then developed that sets the timeline to bring the waterbody into compliance with the standards.

The categories are:

- ***Category 1***: **Meets tested standards**. Placement in this category does not necessarily mean that a waterbody is free of all pollutants. Most water quality monitoring is designed to detect a specific array of pollutants, so placement in this category means that the waterbody met standards for the pollutants for which it was tested.

- ***Category 2***: **Waters of concern** is for waters where there is some evidence of a water quality problem, but not enough to require production of a TMDL calculation and implementation report. There are several reasons why a waterbody might be placed in this category: 1) the waterbody might have pollution levels that are not quite high enough to violate the WQS, 2) there may not be enough violations to categorize it as impaired, or 3) there might be data showing water quality violations, but the data were not collected using proper scientific methods.

- ***Category 3***: **No data** is a category that will be largely empty. Water bodies that have not been tested will not be individually listed, but if they do not appear in one of the other categories, they are assumed to belong here.

- ***Category 4***: **Polluted waters that do not require a TMDL** is for waters that have pollution problems that are being solved in one of three ways.

  - ***Category 4*****a –** water bodies that have an approved TMDL in place and are actively being implemented.
  - ***Category 4*****b –** water bodies that have a pollution control plan in place that is expected to solve the water quality problem. While pollution control plans are not TMDLs, they have many of the same features and there is a legal or financial guarantee that they will be implemented.
  - ***Category 4*****c –** is for water bodies that are impaired by factors that cannot be addressed through a TMDL. These impairments include low flow, stream channelization, and dams. These problems require complex solutions to help restore streams to more natural conditions.

- ***Category 5*****: – Polluted waters that require a TMDL**. This is the traditional list of "impaired" water bodies. A waterbody that is in this category means that WDOE has data showing that the WQS have been violated for one or more pollutants.

The latest comprehensive assessment included 32,165 stream segments. The system used for this assessment defines segments of rivers, streams, and lakes of less than 1,500 acres as that portion of the waterbody lying within a given section of a township and range (about a 1-mile square). Of the total number of stream segments that were assessed, about two thirds appear to be compliant for the pollutant that was monitored. The rest are either showing evidence of problems or will require attention to prevent further degradation. Approximately 13 percent of these are waters of concern (Category 2), 9 percent are impaired by physical factors (Category 4c), and 8 percent are on the 303(d) list (Category 5).

The number of stream segments on the Category 5 list has increased from the 1998 list by about 725 waterbody segments. While over half of the 1998 303(d) listings moved off the list, new listings were added as the result of new monitoring data gathered since 1998 (EPA 2007). In the 1998 assessment, 642 streams and lakes were represented on the 303(d) list, many of them with numerous segments monitored for more than one pollutant parameter. In the 2002/2004 assessment, 800 rivers and lakes were in Category 5 of the 303(d) list. This is an increase of 166 new waters on the 303(d) list (EPA 2007).

The key elements that have affected water quality in Washington are fecal coliform, temperature, dissolved oxygen, pH, and total phosphorus. Of the total list of polluted waters, about 70 percent are for these parameters. The most significant increase in 303(d) listings is related to temperature. The breakout of the key pollutant parameters, based on a total of 2,682 listings in Category 5, is as follows:

- Temperature: 33 percent (876) of the total listings;
- Fecal coliform: 25 percent (672) of the total listings;
- Dissolved oxygen: 10 percent (280) of the total listings;
- Total phosphorus: 2 percent (50) of the total listings; and
- Other pollutants (toxics, metals, other): 30 percent (804) of total listings (EPA 2007).

To date, eleven temperature TMDLs have been completed and include a detailed implementation plan. These are in the Stillaguamish, Upper White, South Prairie, Willapa, Chehalis, Wind, Little Klickatat, Walla Walla, Wenatchee, and Teanaway Rivers and the rivers in the Wenatchee National Forest. Additionally, the WDOE is in the process of developing several other TMDLs including: Lower Skagit, Bear-Evans, Green, Deschutes, Lower Puyallup, tributaries to the upper Yakima, the mainstem of the Yakima, and the Naches Rivers. Many of the rivers also have dissolved oxygen TMDLs that have been completed or are underway.

Table 4-4 in the BE lists all of the streams in the state that are impaired for a variety of pollutants. The following Table provides a summary of the existing condition for temperature, dissolved oxygen, and instream flows (low flows due to water withdrawals) in areas that are identified as key recovery habitat for bull trout. Bull trout use of the waterbody is listed as 1) foraging, migration, and overwintering (FMO), 2) spawning and rearing (SR), 3) potential local population (PLP), or 4) unknown (U).

Table 5: Bull trout key recovery habitat that is currently impaired for temperature, dissolved oxygen, and low flows (included here because it affects temperature and DO).

Stream Name	**Temp**	**Dissolved Oxygen**	**Low Flows**	**Bull Trout Use**
Nooksack River, mainstem	Cat 5			FMO
Lower S Fk Nooksack, Lower M Fk Nooksack,Lower Canyon,	Cat 5			SR
Upper S Fk Nooksack	Cat 2		Cat 4c	SR
Skagit River	Cat 2			FMO
Noname and Indian Slough		Cat 5		FMO
Joe Leary Slough		Cat 2		FMO
Stillaguamish River	Cat 5			FMO
S Fk Stillaguamish R	Cat 2	Cat 4a		SR
N Fk Stillaguamish R	Cat 4a			SR
Canyon Cr and Upper Deer Cr	Cat 5			SR
Portage Cr, Hat Slough		Cat 4a		FMO
Snohomish River, mainstem	Cat 2	Cat 4a		FMO
Cedar R	Cat 2			FMO
Snoqualmie R, mainstem and S Fk Skykomish R, and Pilchuck R	Cat 5			FMO
Several sloughs	Cat 2	4a		FMO
Cedar River	Cat 5			FMO
Sammamish R	Cat 5	Cat 5	Cat 4c	FMO
Tributaries	Cat 5	Cat 2		FMO
Lake Washington			Cat 4c	FMO
Duwamish Waterway	Cat 2			FMO
Green R	Cat 2		Cat 4c	FMO
Puyallup River, mainstem	Cat 2		Cat 4c	FMO
White R	Cat 2		Cat 4c	FMO
Clearwater R	Cat 5			PLP
Greenwater R, South Prairie Cr	Cat 4a		Cat 4c	SR
Straight, Wilkeson, Brush, Greenwater, Pyramid, Straight Cr	Cat 4a			FMO
Fife Ditch, Meeker Ditch		Cat 5,2		FMO
Nisqually River			Cat 4c	FMO
McAllister Cr		Cat 5		FMO
Skokomish River	Cat 4a		Cat 4c	FMO
N Fk Skokomish R	Cat 4a			SR
S Fk Skokomish R	Cat 2			SR
Elwha River	Cat 5			FMO
Morse, Lyre, Bell Cr	Cat 2			FMO
Dungeness River			Cat 4c	FMO/SR
Hoh River	Cat 2			FMO
Kalaloch, Matheney, and Sams R	Cat 5			FMO
Queets River	Cat 2			FMO
Quinault River	Cat 2			FMO
Salmon R, M Fk Salmon, Coal, Matheney, Ziegler, and Kahkwa Cr	Cat 2			FMO

Stream Name	**Temp**	**Dissolved Oxygen**	**Low Flows**	**Bull Trout Use**
Joe Creek		Cat 2		U
Chehalis R	Cat 2			FMO
Wishkah and Johns River	Cat 2			FMO
Columbia River, Lower	Cat 5	Cat 2	Cat 4c	FMO
Lewis River	Cat 5			FMO
E Fk Lewis, Clear Cr, Muddy R, Clearwater Cr, Copper, Quartz, Kalama, and Siouxon Cr	Cat 5			U
Columbia River, Middle	Cat 5	Cat 2	Cat 4c	FMO
Little Klickitat R	Cat 4a			
Walla Walla	Cat 2	Cat 2	Cat 4c	FMO
Touchet R, Fk and S Fk Touchet, and Wolf Fork	Cat 5	Cat 2		SR
Little Walla Walla and all forks	Cat 5	Cat 2		FMO
Mill Cr	Cat 5	Cat 2	Cat 4c	SR
Blue, Caldwell, Coates, Cold, Coppei, Doan, Dry, Cottonwood, Jim, Lewis, Pine, Garrison, Robinson, Whiskey, Russel, and Yellowjacket Creeks	Cat 5	Many also Cat 2 for DO		FMO, U
Snake River	Cat 5	Cat 2	Cat 4c	FMO
Middle Snake River			Cat 4c	FMO
Charley, N and S Fk Asotin, Cummins, Tucannon, Meadow, Panjab, and Turkey Cr	Cat 5			FMO, SR
Little Tucannon R	Cat 2			SR
Columbia River	Cat 5	Cat 2	Cat 4c	FMO
Yakima River	Cat 5	Cat 5	Cat 4c	FMO
Ahtanum Cr	Cat 2			SR
Naches River	Cat 2		Cat 4c	FMO
American R, Bumping R, Crow, Rattlesnake, Tieton R and S Fk Tieton, and the Little Naches River	Cat 5	Cat 5		FMO, SR
Bear, Blowout, Cowiche (all forks), Gold, Little Rattlesnake, Mathew, Nile, and Reynolds Cr	Cat 5			FMO
Upper Yakima River	Cat 2	Cat 5	Cat 4c	SR/FMO
Cle Elum R	Cat 5			SR
Blue, Caribou, Cascade, Cherry, French Cabin, Naneum, North Branch, Parke, Thorpe, Umtanum	Cat 5			FMO, U
Teanaway R and all forks	Cat 4a		Cat 4c	FMO, SR
Taneum			Cat 4c	PLP
Wenatchee River	Cat 5	Cat 5		FMO
Icicle Cr, Chiwaukum, Chiwawa, Little Wenatchee, Nason, Wenatchee, Peshastin	Cat 5		Cat 4c	SR

Stream Name	Temp	Dissolved Oxygen	Low Flows	Bull Trout Use
Icicle Cr		Cat 5		FMO and SR
Second, Sand, Chumstick, Tronsen, Mission, Fish Lake Run	Cat 5	Cat 2 - Chumstick	Many Cat 4c	FMO or U
Entiat River	Cat 2			SR/FMO
Methow River	Cat 5		Cat 4c	FMO
Chewuch R	Cat 5		Cat 4c	SR/FMO
Early Winters			Cat 4c	SR
Lost R, Wolf, Twisp R	Cat 2		Cat 4c	SR
Pend Oreille River	Cat 5		Cat 4c	FMO
Calispell, Cedar (Ione), Lime, Little Muddy, Ruby, Sullivan, Ruby, Lost	Cat 5			PLP, U
Le Clerc	Cat 5			SR

Although most of the temperature and dissolved oxygen impairments listed in Table 5 are in the migratory corridors or the lower reaches of the bull trout spawning and rearing areas, water quality problems do occur in some of the upper watersheds, such as areas where the riparian vegetation has been removed by logging, grazing, agriculture, or development.

Habitat Conditions and Non-native Species

There are approximately 251,132 miles of streams in the state of Washington. No statewide measurement of the existing riparian vegetation is available, although some estimates have been made for more localized regions. With the exception of fall chinook, which generally spawn and rear in the mainstem, most salmon and steelhead spawning and rearing occurs in tributaries where riparian areas are usually forested. Land use activities over the past 150 to 200 years have reduced the numbers of large trees, the amount of closed-canopy forests, and the proportion of older forests in riparian areas. In Washington, riparian plant communities have been altered along almost all of the major rivers and tributaries.

Beginning in the early 1800s, many of the riparian areas were extensively changed by human activities such as logging, mining, livestock grazing, agriculture, beaver removal, dams and water diversions, and development. Very little of the once-extensive riparian vegetation remains to maintain water quality and provide habitats for threatened salmonids. Dams have affected flow, sedimentation, and gravel patterns, which in turn have diminished regeneration and natural succession of riparian vegetation along downstream rivers. Introduced plant species pose a risk to some riparian habitat by dominating local habitats and reducing the diversity of native species. Improper grazing in riparian areas is another significant threat. Today, riparian areas in the upper watershed (largely on Federal lands) are still largely dominated by mature forests, while riparian areas on commercial timber lands are largely dominated by younger stands, and more than 80 percent of the mature forests have been lost along the lower rivers.

Forty species of freshwater fish have been introduced in Washington and are now self-sustaining, making up nearly half of the state's freshwater fish fauna (Wydoski and Whitney 2003). Most of the introduced species are warm-water game fish that are thriving in reservoirs and other areas where stream temperatures are higher than natural conditions because of human-caused changes to the landscape. Introduced species are frequently predators on native species, compete for food resources, alter freshwater habitats, and are displacing native salmonids from areas that historically had colder water temperatures.

Hydro System Alterations

In the Columbia River Basin, anadromous salmonids have been dramatically affected by the development and operation of the FCRPS as well as dams that are owned and operated by the public utility districts and the Bureau of Reclamation. Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph, decreasing spring and summer flows and increasing fall and winter flows. This has virtually reversed the natural hydrograph on rivers such as the Yakima, Snake, and Columbia Rivers. Water storage causes flow levels and river elevations to fluctuate, affecting fish movement through reservoirs and riparian ecology, and stranding fish in shallow areas. The eight dams in the migration corridor of the Snake and Columbia Rivers alter smolt and adult migrations. Dams also have converted the once-swift river into a series of slow-moving reservoirs. Water velocities throughout the migration corridor now depend far more on volume runoff than before development of the mainstem reservoirs.

Status of Critical Habitat in the Action Area

Descriptions of the core areas that are included as part of the BO in Appendix B assist with the assessment of critical habitat within the Action Area of this BO. By using the Risk Analysis that we conducted for the core areas for the bull trout analysis, we could identify areas of critical habitat most likely to be affected by the action. Critical habitat units and areas that will be exposed to effects of the action are similar to those areas affected for the bull trout. See the Risk Analysis (Appendix C or a summary in the effects section) for further information.

<u>Spawning and Rearing Areas</u>

In general, most of the bull trout spawning and rearing areas are located on Federal lands, reservations, or in areas with existing management plans and were excluded from designation as critical habitat. However, a few of the lower reaches of some spawning areas in the Middle Columbia River Basin (Unit 20), the Snake River Basin (Unit 23), and Puget Sound (Unit 28), are in areas that do not have management plans and were designated as critical habitat. Water quality in some of the spawning and rearing areas is of concern (see Tables 3 and 4), primarily due to high temperatures during the summer. Because habitat conditions in most of the headwaters are good and water temperatures drop naturally in the fall, the baseline condition of designated critical habitat in areas that support reproduction is relatively good. Baseline conditions of critical habitat located within protected Federal reserves (e.g. wilderness areas and lands administered by the National Park Service) are generally near pristine.

<u>Foraging, Migration, and Overwintering Areas</u>

The vast majority of designated critical habitat is in areas that are used by bull trout for foraging, migration, and overwintering. Water quality (temperature) in most of the migratory corridors is degraded (matrix indicator of "at risk" or "not properly functioning") for bull trout (see Tables 3 and 4). Human alterations of the landscape, such as construction and operation of dams, over-allocation of water resources (water withdrawals), removal of riparian vegetation, agricultural practices, and development, have affected many of the primary constituent elements and are compromising the function of critical habitat. Improving water quality and the function of critical habitat in these areas will require restoration efforts and complex negotiations. Most of the migratory corridors that are designated critical habitat for the bull trout are currently temperature-impaired and do not meet the WQS.

Conservation Role of Critical Habitat in the Action Area

The action area includes all of the Coastal-Puget Sound and approximately 15 percent of the Columbia River IRU. The draft recovery plan states that maintaining viable populations of the bull trout is essential to the conservation of species within each of the core areas, IRU, and the coterminous listing (USDI 2004). To maintain or restore the likelihood of long-term persistence of self-sustaining, complex, interacting groups of bull trout within the action area, the FWS has identified the following needs: 1) maintain the current distribution of bull trout and restore distribution in previously occupied areas, 2) maintain stable or increasing trends in abundance of bull trout, 3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and 4) conserve genetic diversity and provide opportunities for genetic exchange.

The core areas are central to the survival and recovery of the bull trout. They are the smallest scale necessary for maintaining a functioning metapopulation of bull trout because they contain the habitat qualities necessary for them to spawn, rear, forage, overwinter, and migrate and the contiguous habitat necessary to survive catastrophic events. A core area is defined as a geographic area that supports one or more local populations of bull trout that overlap in their use of rearing, foraging, migratory, and overwintering habitat, and in some cases in their use of spawning habitat. The draft recovery plan states that bull trout need at least the following habitat conditions:

- Water temperatures ranging from -2 ºC to 22 ºC , depending on life history stage and form, geography, elevation, diurnal and seasonal variation, and local groundwater influence (PCE #1).

- A natural hydrograph including peak, high, low, and base flows within historic ranges or if regulated according to a biological opinion that supports bull trout populations by minimizing daily and day-to-day fluctuations, etc. (PCE #4).

- Migratory corridors with no physical, biological or chemical barriers between spawning, rearing, overwintering, and foraging habitats (PCE #6).

- An abundant food base including prey items such as: macroinvertebrates, crayfish, and forage fish (PCE #7).

- Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival, are not inhibited (PCE #8).

The intended recovery function of critical habitat is to support the core areas and ensure that the habitat requirements of bull trout are met, now and in the future. The primary constituent elements provide a measure of the habitat conditions and are essential components of critical habitat.

Federal Actions that Affect Bull Trout and the Environmental Baseline

The status of bull trout in each IRU has been affected by a number of ongoing activities addressed through previous biological opinions prepared under section 7 of the ESA, including several Habitat Conservation Plans (HCPs) prepared under section 10(a)(1)(B) permits. A large number of biological opinions addressing bull trout have been issued for Federal actions within the Coastal-Puget Sound and Columbia River IRUs since listing. Most of these biological opinions have permitted the incidental take of bull trout. Habitat Conservation Plans are also discussed in the following section because they have the potential to have large-scale influences over a long period of time. In addition, numerous section 10(a)(1)(A) recovery permits have been issued to aid the recovery of bull trout in each IRU. A discussion of baseline impacts can also be found in each of the core area summaries (Appendix B).

<u>Coastal-Puget Sound IRU</u>

Biological Opinions: The FWS has issued numerous biological opinions that exempted incidental take in the Coastal–Puget Sound IRU. These incidental take exemptions exempted harm and harass, primarily from temporary sediment increases during in-water work, loss or alteration of habitat, and the capturing and handling of fish. None of these actions were determined to result in jeopardy to the bull trout. The combined effects of actions evaluated under these biological opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the IRU.

Habitat Conservation Plans (HCP): The West Fork Timber Company (previously Murray Pacific Corporation), Washington Department of Natural Resources (DNR), and Plum Creek Timber Company added the Coastal-Puget Sound IRU to their Incidental Take Permits, consistent with their respective HCPs and Implementation Agreements. The West Fork Timber Company's HCP ensures that sufficient amounts of habitat types will be maintained or enhanced for bull trout on their land for a term of 100 years. The Washington DNR Permit was updated in 1998 to include an exemption for the incidental taking of bull trout associated with their annual road construction and maintenance program and their annual timber management program. The Coastal-Puget Sound IRU was added to the Plum Creek Cascades Permit in 2004 for forest-related activities on their lands. The Permit allows for the incidental take of bull trout associated with habitat degradation/loss due to selective and thinning/restoration-oriented silvicultural harvest, stream restoration, and road construction, maintenance, and removal per year. The term of the Plum Creek HCP and Permit is 50 to 100 years.

Four other HCPs have been completed in the Coastal-Puget Sound IRU. The City of Seattle's Cedar River Watershed HCP, completed in April 2000, covers municipal water supply and includes: 1) Chester Morse reservoir operations and activities associated with restoration planting, 2) restoration thinning, 3) ecological thinning, 4) instream habitat restoration projects, 5) road removal, 6) road maintenance, and 7) road improvement. This HCP completely encompasses a single core area, the Chester Morse Lake core area. The term of the City of Seattle HCP and incidental take permit is 50 years.

The Green Diamond (formerly Simpson Timber) HCP, completed in October 2000, encompasses 261,575 acres with approximately 354 miles of fish-bearing stream habitat in the Chehalis and Skokomish River drainages in western Washington. Bull trout currently reside in the South Fork Skokomish River watershed, but they also may be found in low numbers within the Wynoochee and Satsop River watersheds (Chehalis River basin). The FWS authorized the incidental take of bull trout as a result of timber harvest and experimental thinning associated with stream habitats over the 50-year permit term. In addition, the FWS authorized incidental take of bull trout associated with habitat adjacent to new road construction, and road remediation. By year 15 of the HCP, effects to bull trout habitat resulting from road remediation should be eliminated.

The Tacoma Public Utilities Green River HCP, completed in July 2001, addresses effects to listed species from the management of 15,000 acres of forest in the upper Green River watershed, including approximately 110 stream miles, and Tacoma's municipal water withdrawal from Green River at RM 61.0. Bull trout have not been documented to occur in the upper watershed and only a few individuals have been found in the FMO habitat of the lower Green River and Duwamish Waterway (USFWS 2001). In this HCP, we permitted the incidental take of bull trout resulting from water withdrawal activities affecting the middle and lower Green River, even-aged harvest, uneven-aged harvest, and the construction, maintenance, and decommissioning of forest road. The term of the Tacoma HCP and incidental take permit is 50 years.

The Washington State Forest Practices HCP (USFWS 2006) addresses effects to listed species from the management of approximately 9.3 million acres of non-Federal and non-Tribal forest land in Washington State. In this HCP, we permitted the incidental take of bull trout and other aquatic species resulting from timber harvest and road-related activities within the riparian area. Most of the conservation measures in the HCP are related to riparian management, road construction and maintenance, and unstable slopes. The term of the Washington State Forest Practices HCP and incidental take permit is 50 years.

Dam Relicencing: The FWS has completed consultation on the relicencing of several dams since the listing of the bull trout, including Baker, Mud Mountain (White River), and the dams on the Lewis River. Negotiations for these projects resulted in improved fish passage and adjustments of flows for migration.

Scientific Permits: The FWS has also issued recovery permits for actions within the Coastal-Puget Sound IRU. Pursuant to these permits, bull trout may be injured or killed for research purposes. These permits usually are issued for 5 years and then renewed, if requested. Based upon past experience, we anticipate that the actual number of fish injured or killed is significantly less than authorized. Prior years (2000-2002) indicate there have typically been no adult mortalities in almost all core areas, except one (Skokomish). Juvenile mortality is typically low as well with, for example, only eight individuals lethally sampled across all core areas between 2000 and 2002.

<u>Columbia River IRU</u>

Biological Opinions: Since the bull trout listing, the FWS has issued biological opinions that exempted incidental take in the Columbia River IRU. These incidental take exemptions were for take in the form of harm and harass, primarily from temporary sediment increases during in-water work, loss or alteration of habitat, and the capturing and handling of fish. None of these projects were determined to result in jeopardy to the bull trout. The combined effects of actions evaluated under these biological opinions have resulted in short-term and long-term adverse effects to bull trout and degradation of bull trout habitat within the Columbia River IRU.

HCPs: The Plum Creek Timber Company's Permit amendment (USDI 1998d) added the Columbia River IRU to their Permit consistent with the HCP and Implementation Agreement. The Permit allows for the incidental take of bull trout associated with habitat degradation/loss due to selective and thinning and silvicultural harvest, stream restoration, and road construction, maintenance, and removal per year. The term of the Plum Creek HCP and Permit is 50 to 100 years. The Washington DNR's HCP incidental take Permit was updated (USDI 1998) to allow for incidental take of bull trout in the lower Columbia River downstream from Greenleaf and Hamilton Creeks. This Permit update was connected with the same effort discussed in the Coastal-Puget Sound IRU for the annual habitat degradation/loss due to road construction and maintenance and selective and thinning harvest. The 2006 Washington State Forest Practices HCP also covers incidental take of bull trout in the Columbia River IRU associated with timber harvest and forest management activities on approximately 9.3 million acres of non-Federal and non-Tribal forest land in the state.

Dam Relicencing: The FWS completed consultation on the continued operation of the Federal Columbia River Power System, Priest Rapids, Albany Falls, and a new hydroelectric facility above Hells Canyon Dam. The HCPs for the Chelan and Douglas PUDs allows for the incidental take of bull trout associated with the continued operation and maintenance of Rocky Reach and Wells Dams, respectively.

Scientific Permits: The FWS has also issued recovery permits that would be in effect during the implementation period of this proposed action within the Columbia River IRU. Pursuant to these permits, bull trout may be injured or killed for research purposes. These permits usually are issued for 5 years and then renewed, if necessary. Based upon past experience we anticipate that the actual number of fish injured or killed is significantly less than authorized.

EFFECTS OF THE ACTION (Bull Trout and Bull Trout Critical Habitat)

The "effects of the action" are defined in the section 7 implementing regulations of the ESA as "The direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline. Indirect effects are those that occur later in time but that are reasonably likely to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR 402.02).

Direct Effects (Bull Trout and Bull Trout Critical Habitat)

The EPA's approval of the revised WQS will not have any direct effect on listed species or critical habitat because changing a standard, in and of itself, does not alter the environmental baseline or affect individuals or their habitat.

Indirect Effects (Bull Trout)

The proposed changes to the WQS may have indirect effects to listed species when CWA programs are implemented. These effects are indirect because they will occur later in time and are linked to implementation of regulations in discharge permits, voluntary incentive programs, and restoration activities. CWA programs that may lead to indirect effects include 303(d) listings, TMDL management plans, NPDES permits, CWA 401 certifications of federally licensed projects, and non-point source management plans designed to meet the WQS over time. Each of these programs is intended to control inputs of both point-source and nonpoint-source pollution to waterbodies such that the WQS are met in the receiving waters and aquatic life is protected.

The discussion below is intended to provide context of how EPA's approval of standards relates to real on-the-ground actions that indirectly affect listed species. Washington's surface WQS consist of three primary components: 1) designated uses that are assigned to the waters; 2) numeric and narrative criteria that are designed to protect the specified designated uses; and 3) a water quality antidegradation program that provides special protection for existing uses and high quality waters.

The WQS establish the foundation for the state's water pollution control programs. Under State and Federal laws, human sources of pollution must not cause or contribute to an exceedance of the WQS. As such, regulated activities must be conditioned and designed to achieve the WQS. While the WQS of the state of Washington apply broadly to all categories and sources of pollution, there are jurisdictional and practical limitations that affect how well certain sources of pollution are brought into compliance. The following provides a general overview of the CWA programs that affect water quality in the state of Washington.

1) **Water Quality Assessments and TMDLs –** Consistent with sections 303(d) and 305(b) of the Federal Clean Water Act, every 2 years WDOE conducts an assessment of the health of its waters. Part of that assessment includes identifying any waters that do not meet the State WQS. Any waters where data show that the standards are not being met are placed on an impaired waters list. Waters on this list are then prioritized for water quality management plans that identify the actions that are needed to bring the waters into compliance with the WQS. The water quality management plans are a primary mechanism for determining how much pollutant reduction will be required from each contributing source. The pollutant allocations in these plans are then used in the

NPDES permits for point sources of pollutants, and serve to guide watershed restoration programs for nonpoint sources.

The temperature and dissolved oxygen (DO) standards that EPA proposes to approve will set the benchmarks that will be the basis for listing waters on the 303(d) list of impaired waters in the future, and serve as the temperature and DO targets in future TMDLs. Implementation of TMDLs will generally be beneficial to listed salmonid species because it occurs through programs that are designed to achieve the WQS. Rivers with Special Temperature Provisions have a higher temperature threshold than other waters in the state for placement on the list of impaired waters.

The TMDL's that have been completed to date identify nonpoint sources of pollution as a primary cause of elevated stream temperatures. The primary methods to restore natural conditions and meet the load reduction targets rely largely on existing regulatory mechanisms and voluntary incentive programs. For example, to improve water temperature on forest lands, the Federal Forest Plan is the implementation mechanism for Federal lands, and the State's Forest Practices Act is the implementation mechanism for State lands. For agricultural lands, the primary mechanism is grant/loan incentive programs through the State's Conservation Districts. For urban lands, local ordinances in accordance with the Shorelines Management Act, Growth Management Act, and WDOE's Municipal Stormwater general permit are the primary mechanisms. The NPDES program is the mechanism used to address point sources discharges. Endangered Species Act Habitat Conservation Plans and Federal actions under section 7 (e.g., operations of Federal dams or fish hatcheries) may also be mechanisms to attain WQS. Additionally, TMDLs help prioritize areas for restoration to aid in acquiring special project funding, such as CWA 319 grants and salmon recovery funds.

2) **Point Source Pollution –** Point sources refer to pollutants that enter surface waters from a discrete location such as a discharge pipe. There are two categories of permits: 1) Municipal and Industrial, and 2) General Permits. Municipal wastewater treatment facilities and industrial facilities that discharge wastewater are regulated under NPDES permits. These permits set limits on the amount of pollutants that may be discharged into surface waters. Limitations are established for wastewater wherever 1) the EPA or the state has established minimum technology-based controls for a wastewater pollutant for the type of activity being regulated, or 2) a reasonable potential exists for the wastewater discharge to exceed a water quality criterion. NPDES permits are on a 5-year renewal cycle that allows new WQS to be considered and incorporated in existing permits. Temperature and dissolved oxygen-related effluent limits are common limits included in NPDES permits for municipal and industrial discharges.

In areas where the WQS are becoming more stringent, it is anticipated that the baseline condition will improve because the discharge limits will become more stringent in order to meet the new water quality standard. However, for new NPDES sources, the environmental baseline may be degraded because the permit will allow a new source of pollutants to be discharged into the waterbody. A recent courtcase in Arizona found that new permits cannot be issued in areas that are already impaired (for the same pollutant that would be discharged) without first completing a TMDL and setting compliance schedules to meet WQS.

The General Permit program was established in recognition there are some point sources of pollutants that are minor contributors individually but are very numerous around the state. General permits cover a wide range of potential dischargers (e.g., stormwater, municipal drinking water, dairies, animal feeding operations, boatyards, aquatic pesticides application, fish hatcheries, log sort yards, and sand and gravel operations). General permits generally do not include specific water quality-based effluent limits. Rather, they use a menu of Best Management Practices (BMP), or in some cases discharge benchmarks, to meet standards. The stormwater water general permits regulate run-off rates which can affect the temperature levels in the river. The stormwater permits also control peak flow conditions, which can affect the physical conditions of the river, which in turn affects water temperature.

3) **Dams and Hydrological Modifications –** Modifications to the channels, substrate, or flows of surface waterbodies are not regulated through a single permit program such as exists for point source pollutants. As such, opportunities to bring the wide variety of activities in this category into compliance with the WQS are highly variable.

Most existing and new proposed private and public utility hydropower facilities require a Federal operating license from the Federal Energy Regulatory Commission. As part of obtaining the license, the state must certify (under section 401 of the CWA) that the operation of the dam will not cause or contribute to a violation of the State WQS. As part of the 401 certification, a state may establish conditions for operation and structural improvements to protect water quality. These state requirements become part of the facilities Federal license. Dams can have a significant impact on river temperatures and certifying that the dam meets temperature standards is a challenging aspect of many 401 certifications. Owners of non-hydropower dams are required by State and Federal law to meet State WQS. However, the state has no comprehensive regulatory mechanism to ensure compliance at these dams.

Although Federal agencies are required by law to meet State WQS, meeting the temperature standards is a challenge for many water detention facilities (e.g., Federal dams on the Columbia, Snake, and Yakima Rivers). Because the state has no direct permitting or regulatory authority over Federal projects, they must rely on negotiations and, if necessary, lawsuits against Federal agencies, to bring these projects into compliance with the standards.

Federal irrigation projects are similar to federal dams. The state does not possess formal review or permitting authority over these projects. The state does, however, have the authority to establish discharge permits to condition the application of aquatic pesticides in these waters. This is because the application of pesticides can be considered point source pollution.

Construction activities that occur in streams require a hydraulic permit from the state WDFW. The primary purpose of these permits is to protect fish habitat and to notify WDOE if it appears that WQS may be violated through an approved permit (typically focused on spikes in turbidity, which is an important water quality issue). Temperature and dissolved oxygen are typically not a significant issue with these permits.

4) **Nonpoint Source Controls –** People or entities that contribute to nonpoint source pollution are not allowed to cause or contribute to a violation of the WQS. The WDOE recognizes that nonpoint sources are a primary contributing factor to elevated stream temperatures. However, no formal permit or review program exists to regulate nonpoint sources of pollution. Additionally, some potential solutions to nonpoint source pollution, such as establishing riparian buffers and setbacks in building ordinances and zoning restrictions, are not within the authority and influence of WDOE. With the notable exception of forest practices activities, the state relies on cost sharing and voluntary incentive programs to obtain compliance from nonpoint sources. Due to limited resources, WDOE reserves formal enforcement actions for only the most serious situations.

Forestry

The Washington Forest Practice Regulations, which are enforced by the Washington State Department of Natural Resources, are specifically designed to ensure compliance with the state surface WQS. Through an adaptive management process, BMPs (prescriptions) undergo scientific scrutiny to select and promulgate rules that will meet the state standards. These rules are applied to forest practices throughout the state. Revisions to the WQS are to be followed by further evaluations to determine to what extent current prescriptions will need to be changed in order to comply with the new standards.

Agriculture

No formal program exists to regulate nonpoint pollution from farms. Agricultural return water from nonpoint source runoff is exempt from NPDES permitting, except for agricultural operations which specifically require NPDES permits (e.g. dairies, feed lots, fish farms, etc.). For those agricultural operations that are not regulated under NPDES permits, WDOE primarily relies on education, cost sharing, and voluntary programs to bring them into compliance with the standards. For facilities that create serious problems or threats to water quality, the state pursues formal enforcement actions to bring them rapidly into compliance. The WDOE has entered into a memorandum of agreement with the State’s conservation districts. The districts take a lead role in developing farm plans that will curb nonpoint runoff from problem farms and attain compliance with the State standards. These farm plans are also voluntarily adopted by farmers wanting to improve their operations. Agricultural activity has considerable impact of temperature and dissolved oxygen levels. Therefore, the new standards will serve to guide these agricultural related programs.

Urban Development

There is no formal review or permitting programs for nonpoint source pollution caused by urbanization. However, WDOE does anticipate that the requirements of the municipal stormwater NPDES permits will assist source control efforts. WDOE recently expanded its municipal stormwater permit program to include small and medium cities located within the U.S. Census defined urban areas. The municipal stormwater permit program has not yet expanded to small municipalities outside the Census defined urban areas. Construction stormwater, industrial stormwater, and municipal stormwater NPDES permits are, however, designed to address point sources of pollution in the urban environment. As discussed above, urban stormwater can impact temperature conditions in the river. As more monitoring occurs, if rivers fail to attain standards (including the new temperature standards), stormwater permits may be revised to require more stringent measures to attain standards.

Description of the Approach to the Analysis

The analysis was conducted by evaluating the EPA's approval of the Washington State's 2006 WQS at the following levels:

- Determining if the temperature and dissolved oxygen criteria themselves are adequate to protect the existing use.
- Determining if the standards are being applied in the correct areas and time of year to protect the existing use (spatial and temporal application across the landscape).
- Determining to what extent application of inadequate standards will affect the long-term survival of bull trout.

Although many components of the approval action are expected to have insignificant effects on bull trout, there is a great deal of spatial and temporal overlap with application of various aspects of the standards. Because application of the new standards may have different effects on bull trout within a given core area, we chose to analyze the combined effects of the entire action (i.e. elements that have insignificant effects as well as those that are likely to have adverse effects) below.

<u>Adequacy of the Standards</u>

Numeric Temperature Criteria for Salmonid Use Designations

The scientific rationale and basis for EPA's recommended criteria is described in the Region 10 Temperature Guidance and the supporting six Technical Issue Papers (McCullough et al. 2001). The Temperature Guidance is a product of a 3-year interagency effort involving the Idaho Department of Environmental Quality, Oregon Department of Environmental Quality, WDOE, NMFS, FWS, Nez Perce Tribe, Columbia River Inter-Tribal Fish Commission, and the EPA.

Two independent peer review panels provided comments and scientific issue papers on the development of the temperature standards. The data indicate the following effects to salmonids at various temperatures:

- Gamete viability in holding adults is reduced at temperatures over 13 °C
- Optimal temperatures for spawning and egg incubation are between 2 °C and 6 °C
- Optimal temperatures for juvenile rearing are in the range of 8 °C to 12 °C
- The distribution and abundance of bull trout is limited at temperatures over 15 °C
- Increased risk of disease and reduced fitness occurs during prolonged exposure at temperatures over 18 °C
- Migration is blocked at temperatures over 20 °C
- A 1-week exposure to temperatures between 21 °C and 23 °C is lethal

Based on these thermal requirements, the FWS recommended a 7-DADMax temperature standard of 15 °C in migratory corridors and overwintering areas and 11 °C in bull trout spawning and rearing areas. The EPA's recommended temperature criteria of 12 °C in areas that are designated as "Char spawning and rearing" and 16 °C in areas that are designated as "Core summer salmonid habitat" are above optimal for bull trout.

Due to the uncertainty regarding the adequacy of 16 °C 7-DADM to be protective of migratory bull trout, we recommend that States and Tribes adopt "strong regulatory provisions to protect existing waterbodies that currently have summer maximum temperatures colder than the numeric criteria." In a letter written by the FWS in 2002, the FWS stated that "it is our understanding that wherever bull trout and non-core salmon rearing and salmon/trout migration only areas overlap, the proposed EPA bull trout use criteria (16 °C) would supercede these other salmon criteria."

Dissolved Oxygen (DO)

The amount of oxygen that is dissolved in water is directly related to temperature, barometric pressure, and the turbulence of the water. Dissolved oxygen saturation levels are highest at lower temperatures (< 10 °C) and higher barometric pressure (i.e., lower elevation) and turbulence. Conversely, DO levels drop with rising temperatures and lower stream gradient. At saturation levels of 95 percent and water temperature of 8 °C, DO levels are around 12 mg/L but can drop by more than half as water temperatures approach 20 °C and stream gradient declines.

Early life stages of fish, specifically the developing embryo, are very sensitive to reduced oxygen levels. The scientific literature suggests that embryo survival drops markedly as IGDO concentrations fall below 8 mg/L and is close to zero at 5 mg/L. Depending on the water temperature and permeability of the gravels, the EPA (1986) has determined that there is an average 3 mg/L drop in DO levels between the water column and the gravel where fish eggs are deposited. Given this, the 9.5 mg/L DO criterion (measured in the water column) relates to an IDGO level of 6.5 mg/L. This level would result in significant adverse effects to egg survival and embryo development. In order to ensure the minimum 8 mg/L IDGO needed for egg incubation and embryo development, the state of Oregon has adopted a DO criterion of 11 mg/L (measured in the water column).

The EPA is proposing to approve the 9.5 mg/L DO criteria for the State of Washington for waterbodies that were previously designated Class A or Class AA and are designated as “Char spawning and rearing” or “Core summer salmonid habitat” under the 2006 rule revisions. The EPA has concluded that approval of the DO criteria is likely to cause adverse effects to salmonids because the new standard, although it is better than the old criterion, may still not be protective enough for incubation and fry emergence. The WDOE is currently conducting a study to determine if the 9.5 mg/L standard will need to be revised to provide adequate protection for salmonids.

Spatial and Temporal Application of the Standards

Although the FWS generally supports the Region 10 Temperature Guidance, implementation of the guidance is left up to the states. The Region 10 Temperature Guidance (p. 27) states that the spatial application of the salmon and trout “Core rearing” temperature criteria (16 °C) should be based on the following:

1. Waters with degraded habitat where high (and low) density juvenile salmon and trout rearing is known or suspected to occur during the summer months.
2. Waters with minimally degraded habitat where moderate to high density juvenile salmon and trout rearing is known or suspected to occur during the summer months.
3. Waters where trout egg incubation and fry emergence and salmon spawning occurs during the summer months (mid-June through mid-September).
4. Waters where juvenile rearing occurs and the 7-DADM temperature is at or below 16 °C (existing cold water).
5. Waters where adult and sub-adult bull trout foraging and migration occurs during the summer months.
6. Waters where other information indicates the potential for moderate to high density salmon and trout rearing use during the summer (e.g. recovery plans, critical habitat designation, historical distribution, suitable habitat that is currently blocked by fish passage barriers that can be modified or removed).

Several of the criteria listed above (e.g., high density juvenile rearing, bull trout migration, and key recovery habitat) were not fully applied because of a lack of data, disagreement on whether it is more important to protect areas with high densities or low populations (areas with ESA listed fish), natural conditions, defining “degraded” habitats, or extensive human modifications.

The WQS for Washington generally follow the recommendations outlined in the Region 10 Temperature Guidance. However, the EPA required “multiple lines of evidence” in determining appropriate temperature criteria for a given area. This resulted in the application of temperature standards that, in our opinion, do not adequately protect bull trout in many areas and did not fully follow the Region 10 Temperature Guidance criteria listed above.

Of the six criteria that are outlined in the Temperature Guidance for "Core rearing," the EPA focused primarily on areas with documented Chinook spawning during the summer months. The areas of concern for application of the adequate temperature standards include bull trout migratory corridors where the 16 °C criterion was not applied (areas where no Chinook spawning occurs during the summer) and bull trout spawning and rearing areas where the 12 °C char use criteria was not applied.

Metric – Changing from a 1-Day Maximum to the 7-DADM

The temperature metric is an integral aspect of the temperature numeric criteria. The metric is not independently assessed, but rather considered part of the effect assessment of the actual criteria. The discussion below provides some context when comparing a 7-DADM temperature value to a 1-day maximum or weekly average value.

Washington's proposed metric for expressing water temperature will affect the application of all freshwater aquatic life temperature criteria. Prior to the 2003 Rule change, an instantaneous maximum temperature was used as the water temperature metric. The new metric, the 7-DADM, is the measure of the maximum temperatures in a stream, averaged over a 7-day period. The EPA considers this metric to be better because it is not overly influenced by the maximum temperature of any single day and reflects an average temperature that fish are exposed to over a week-long period. This metric can also be protective of aquatic life from chronic effects (e.g. reduced growth) because the metric describes the thermal exposure over 7 days. The Region 10 Temperature Guidance considered both acute and chronic effects to fish when developing its recommended temperature criteria.

The EPA states that studies have shown the 7-DADM temperature in Pacific Northwest salmon and trout streams to be about 3 °C higher than the weekly mean temperature. For example, a stream with a 7-DADM of 18 °C will generally have a weekly mean value of 15 °C. Additionally, based on studies of fluctuating temperatures, the EPA concluded that when the mean temperature is above the optimal growth temperature for salmon, the mid-point between the mean and maximum temperatures is the "equivalent" constant temperature. The "equivalent" constant temperature is the value that can be compared to the "constant" value temperature in the salmon studies. Therefore, in Pacific Northwest streams, which generally have a 3 °C temperature differential between the 7-DADM and the weekly mean, the 7-DADM temperature can be translated to an "equivalent" constant temperature by subtracting 1.5 °C (i.e., the mid-point between the 7-DADMax and the weekly mean). Conversely, a 7-DADM temperature can be derived from a "constant" value temperature by adding 1.5 °C to the "constant" value temperature. For example, the highest "constant" temperature that is considered protective of salmon and trout juvenile rearing, under limited food conditions, is 16 °C. This translates to a 7-DADM temperature of 17.5 °C, which is the temperature standard that was applied to many of the migratory corridors and lower rivers. For bull trout streams, where the difference between the 7-DADM and the weekly mean is smaller because there is less diurnal variation, the EPA subtracted 0.5 °C from the 7-DADM criterion to make comparisons to juvenile growth studies at constant temperatures in a typical stream (see Temperature Guidance, pages 19-20).

It is important to note that there are confounding variables related to in-stream temperatures that are difficult to account for but are important to recognize. For instance, the amount of diurnal variation in rivers and streams in the Pacific Northwest varies considerably and may be less than 1 °C for rivers with little diurnal variation and as high as 9 °C for streams with high diurnal variation (USEPA 2003). Another variable is food availability. Studies indicate that temperatures for optimal growth are generally lower under conditions where the food supply is limited than in conditions where food is readily available. The EPA believes that laboratory studies where food availability is restricted are most reflective of environmental conditions. In conclusion, the 7-DADM numeric criterion is more protective in situations where there is high diurnal variation and/or abundant food, and will be less protective in situations where there is low diurnal variation (which, unfortunately, includes many areas used by bull trout) and limited food.

Effects on the Temperature Standard Resulting from Changing WQS

The primary factors that affect the temperature standard between the 1997 WQS and the 2006 WQS are the change in metric (1-day max to 7-DADM) and application of more stringent standards in areas with ESA listed fish. For water bodies where the 2006 standards are more stringent than the 1997 standards, the assumption is that the environmental baseline will improve over time. There are, however, two situations where the environmental baseline may worsen as a result of implementing the new standards: 1) a waterbody that is designated as "Core Summer Salmonid Habitat" use in the 2006 standards that was previously designated as "Class AA" in the 1997 standards <u>and</u> which is in attainment with the 1997 criteria. Changing the metric from a 1-day maximum to the 7-DADM would effectively allow an increase of 1 °C in these water bodies and, 2) a river segment designated as "Salmon Spawning, Rearing, and Migration" use in the 2006 standards that was previously designated as "Class A" in the 1997 standards <u>and</u> which is in attainment with the 1997 criteria. In this case, the temperature of the river segment could be increased by 0.5 °C.

However, the EPA has determined that it is very unlikely that the environmental baseline will be degraded as a result of approving the 2006 WQS for the following reasons:

1. Many of the lower rivers are currently not meeting the 1997 temperature standards and efforts are under way to address the factors that are contributing to warming.
2. Many of the water bodies that were previously designated as "Class AA" support ESA listed fish. In areas where salmon spawn during the summer or steelhead are emerging from the gravel in late spring, the more stringent 13 °C spawning criterion will be applied. This will effectively keep the stream temperatures below the summer maximum criterion of 16 °C.
3. Many of the rivers that are currently at or below the standards are in areas with established management programs in place that serve to minimize future degradation of water quality (e.g. Federal lands).
4. The State's antidegradation requirements are applicable in situations where the existing stream temperatures are colder than the revised 2006 standards, which will serve to minimize degradation to these streams.

The discussion below summarizes the relative difference between 1997 and 2006 temperature standards. The effects analysis will focus on the effects to listed species from the standards themselves, not the incremental change between the 1997 and 2006 standards. The discussion below provides context on the incremental change in the standards.

Washington's 1997 WQS (1997 WQS) used a "Class-based" system which assigned each waterbody to a particular "Class." For example, fresh waters were assigned to either Class AA, Class A, Class B, or Lake Class. Each "Class" contained a suite of beneficial uses (i.e., water supply uses, recreational uses, fish and shellfish use, etc.). In the 1997 WQS temperature criteria are specified for each Class.

Table 6. 1997 Water Quality Criteria for Temperature.

Class	Use	Temperature Criteria[1]
Class AA (extraordinary)	Salmonid and other fish migration, rearing, spawning, and harvesting	16 °C
Class A (excellent)	Salmonid and other fish migration, rearing, spawning, and harvesting	18 °C
Class B (good)	Salmonid and other fish migration, rearing, and harvesting. Other fish spawning	21 °C
Special Temperature Provisions	Allowable 1-day maximum related to human actions	20 or 21°C
Lake Class	Salmonid and other fish migration, rearing, spawning, and harvesting	No measurable change from natural

[1] Represents daily maximum temperature.

The 2003 WQS revisions removed the "Class" system and instead applied the beneficial uses directly to specific waterbodies. The general "fish and shellfish" use that was contained in each of the 1997 Classes was divided into specific aquatic life use categories in the 2003 WQS, and a new temperature criterion was adopted for each of these new aquatic life uses. The 2006 WQS revisions refined the "name" of the aquatic life use designations (as well as re-designated some waterbodies). The table below summarizes the new aquatic life designated uses and associated temperatures in the 2006 WQS revisions:

Table 7. 2006 WQS Aquatic Life Uses and Temperature.

Designated Use	Description	Highest 7-DADMax
Char Spawning and Rearing	The key identifying characteristics of this use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden), or use by other aquatic species similarly dependent on such cold water. Other common characteristic aquatic life uses for waters in this category include summer foraging and migration of native char; and spawning, rearing, and migration by other salmonid species. Note: Where WDOE determined the Char spawning and rearing temperature criterion of 12 °C would likely not result in protection of spawning and incubation, the 9 °C criterion was applied.	12 °C 9 °C
Core Summer	The key identifying characteristics of this use are summer (June 15 –	

Designated Use	Description	Highest 7-DADMax
Salmonid Habitat	September 15) salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and subadult native char. Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids. Note: Where WDOE determined the Core summer salmonid habitat criterion of 16 °C would likely not result in protection of spawning and incubation the 13 °C criterion was applied.	16 °C 13 °C
Salmonid Spawning, Rearing, and Migration	The key identifying characteristic of this use is salmon or trout spawning and emergence that only occurs outside of the summer season (September 16 -June 14). Other common characteristic aquatic life uses for waters in this category include rearing and migration by salmonids. Note: Where WDOE determined the Salmonid spawning, rearing, and migration criterion of 17.5 °C would likely not result in protection of spawning and incubation the 13 °C criterion was applied.	17.5 °C 13 °C
Salmonid Rearing and Migration only	The key identifying characteristic of this use is use only for rearing or migration by salmonids (not used for spawning).	17.5 °C

The following describes the temperature changes that will occur when changing from the 1997 Class-based system to the proposed use-based system and applying the 7-DADM metric rather than a 1-day maximum threshold.

Table 8. Temperature changes resulting from the new use designations and associated temperature criteria.

1997 WQS		2006 WQS		
Class	Temperature criterion[1] (1-day Max)	Use designation	Temperature criterion (7DADMax)	Temperature change as a result of revised WQS
AA	15 °C	Char spawning and juvenile rearing (approx. 20% of the water bodies in the State)	12 °C 9 °C (part of year)	- 3.0 °C - 6.0 °C (part of year)
AA	15 °C	Core summer salmonid habitat (approx. 30% of State)	16 °C 13 °C (part of year)	+1 °C - 2 °C (part of year)
A	17 °C	Salmonid spawning, rearing and migration (approx. 30% of State)	17.5 °C 13 °C (part of year)	+ 0.5 °C - 4.0 °C (part of year)
A	17 °C	Core summer salmonid habitat (approx. 15% of State)	16 °C 13 °C (part of year)	- 1.0 °C - 4.0 °C (part of year)
A	17 °C	Char spawning and rearing (<1% of State)	12 °C	- 5 °C
B	20 °C	Salmonid rearing and	17.5 °C[4]	No change on rivers

1997 WQS		2006 WQS		
Class	**Temperature criterion[1] (1-day Max)**	**Use designation**	**Temperature criterion (7DADMax)**	**Temperature change as a result of revised WQS**
B	20 °C	migration only (<2% of State) Salmonid spawning, rearing and migration (<1% of State)	17.5 °C[4]	with Special Temp. Provisions - 2.5 °C in some areas No change on rivers with Special Temp. Provisions - 2.5 °C in some areas
Lake Class	No measurable change from natural condition	Core summer salmonid habitat	Temperature increase can't exceed 0.3 °C above natural conditions	No change from how WDOE implemented their 1997 standard
Notes 1. The temperature standards in the 1997 WQS were expressed as a 1-day maximum temperature. Class AA had a temperature criterion of 16 °C which is approximately equal to a 7-DADMax of 15 °C ; Class A had a temperature criterion of 18 °C which is approximately equal to a 7-DADMax of 17 °C ; Class B had a temperature criterion of 21 °C which is approximately equal to a 7-DADMax of 20 °C.				

1) **Former Class AA Waters**

Waters designated as Class AA in the 1997 WQS are designated as either "Char spawning and rearing" or "Core Summer Salmonid Habitat" in Washington's 2006 WQS. For waters that were formerly Class AA and are now designated as "Char," the temperature criterion will change from a daily maximum of 16 °C to a 7-DADMax of 12 °C. A daily max of 16 °C is approximately equivalent to a 7-DADMax of 15 °C. Therefore, the Class AA streams that are now "Char" will have approximately 3 °C reduction in the allowable temperature. The EPA states that approximately 20 percent of the State's streams fall into this category.

Waters that were formerly Class AA and are now designated "Core Summer Salmonid Habitat," will change from a daily maximum of 16 °C to a 7-DADMax of 16 °C. A daily maximum of 16 °C is approximately equivalent to a 7-DADMax of 15 °C. Therefore, the Class AA streams that are now designated as "Core" will have a 1 °C allowable increase in temperature. The EPA states that approximately 30 percent of the State's streams fall into this category. In general, these waterbodies are located in the foothills of the Cascade Mountains, the Olympic Peninsula, and the Colville, Okanogan, and the Blue Mountains. The "Core Summer Salmonid" use designation is typically downstream of the "Char spawning and rearing" waters. In rivers where the 13 °C criterion is applied during the late summer, the effective stream temperature will effectively be below the 16 °C 7-DADMax criterion. In order to attain the 13 °C criterion, the seasonal temperature pattern necessitates that the summer maximum temperature be below 16 °C. Examples where the 13 °C criterion applies during the summer include most of the rivers on the Olympic Peninsula, the middle reaches of rivers that drain into Puget Sound, a few rivers in the east Cascades (Methow, Entiat, Naches, Wenatchee), and the Klickitat and Tucannon Rivers.

2) **Former Class A Waters**

Waters that were formerly Class A in the 1997 WQS are now either designated as "Salmonid Spawning, Rearing and Migration" or "Core Summer Salmonid Habitat" in Washington's 2006 WQS. For those waters designated as "Salmonid Spawning, Rearing and Migration," the temperature criterion will change from a daily maximum of 18 °C to a 7-DADMax of 17.5 °C. A daily max of 18 °C would be approximately equivalent to a 7-DADMax of 17 °C. Therefore, the Class A streams that are designated as "Salmonid spawning rearing and migration" will have approximately 0.5 °C increase in the allowable temperature. The 13 °C spawning criteria does not apply in most of these areas. Approximately 30 percent of the State's streams fall into this category. The vast majority of these streams are in eastern Washington. The lower mainstem portions of several large rivers in western Washington also fall into this category (e.g., Stillaguamish, Snohomish, Duwamish, and Chehalis Rivers). In areas where the 13 °C temperature criteria applies in the spring to protect steelhead spawning and incubation, the 2006 standards would be 2 °C more stringent than the 1997 criteria (e.g., Lower Stillaguamish, Chehalis, and Wenatchee Rivers). However, because most of the rivers are naturally cool in the winter and spring, applying the 13 °C temperature criteria early in the year probably reflects the natural condition.

For water bodies that were formerly Class A and are now designated "Core summer salmonid habitat," the temperature criterion will change from a daily maximum of 18 °C (approximately 17 °C 7-DADMax) to a 7-DADMax of 16 °C. This will result in a 1 °C decrease in the allowable temperature. Approximately 15 percent of the streams fall into this category. This is the category of river segments that were designated as "Core summer salmonid habitat" as a result of EPA's 2006 disapproval action. Most of the river segments in this category are in lower elevation regions in western Washington and the Columbia Plateau.

In a few cases, water bodies that were formerly Class A are now designated as "Char spawning and rearing" in the 2006 WQS. In these cases, the temperature criterion changed from a daily maximum of 18 °C (approximately 17 °C 7-DADMax) to a 7-DADMax of 12 °C. These water bodies will have approximately 5 °C decrease in the allowable temperature.

3) **Former Class B Waters**

Most former Class B waters will be designated as "Salmonid rearing and migration only," but there are a few that were designated as "Salmonid spawning, rearing, and migration." In some cases, the temperature criterion will change from a daily maximum of 20 °C to a 7-DADMax of 17.5 °C. A daily maximum of 21 °C is approximately equivalent to a 7-DADMax of 20 °C. Therefore, the former Class B streams will have an approximately 2.5 °C decrease in the allowable temperature. Approximately 5 percent of the State's streams are designated as "Salmonid rearing and migration only." Most of these streams are in eastern Washington, but a few are in western Washington (e.g., lower Duwamish

River, Lower Puyallup River, and Lower Hoquiam River). Many of these rivers are used by ESA listed salmonids for migration.

In eastern Washington, most of the former Class B waters have Special Temperature Provisions that were not changed by the WDOE or the EPA as part of this action. These rivers will retain the 20 and 21 °C temperature criteria, even though they are designated as “Salmonid spawning, rearing, and migration” or “Salmonid rearing and migration.” Rivers in eastern Washington that have temperature standards over 17.5 °C include: the Columbia River from the mouth to the Grand Coulee Dam (20 °C), the Snake River from the mouth to the Washington/Idaho/Oregon border (20 °C), the Walla Walla River from mouth to Oregon border (20 °C), the Yakima River from the mouth to the Cle Elum River (21 °C), the Skagit River from Gorge Dam to Gorge Powerhouse (21 °C), the Palouse River from South Fork to the Idaho border (20 °C), the Grande Ronde River from Oregon to Idaho border (20 °C), the Pend Oreille River from the Canadian border to the Idaho border (20 °C), and the Spokane River from the mouth to Long Lake and from Nine-mile bridge to the Idaho border (20 °C).

4) **Lake Class Waters**
Lake Class waters will be designated as “Core summer salmonid habitat.” The temperature criterion for Lake Class was “no measurable change from natural.” In the new WQS, the temperature criterion is: “For lakes, human actions considered cumulatively may not increase the 7-DADM temperature more than 0.3 °C above natural conditions.”

The analysis of effects to bull trout associated with EPA’s approval and subsequent implementation of various aspects of the WQS will be addressed in the following order:

- Freshwater aquatic life uses
- Numeric temperature criteria to protect existing uses, including spawning temperature criteria
- Interim DO criteria in areas that changed from Class A or B to “Core summer salmonid habitat”
- Special fish passage exemptions for spill on the Snake and Columbia Rivers
- Natural (and irreversible human) conditions
- Allowable incremental increases in mixing zones
- Procedures for applying the standards

Freshwater Aquatic Life Use Designations

Beneficial use designations are an integral part of a State’s WQS. Without designating where and when the use being protected occurs, the standards developed to protect those uses are ineffective. With respect to this action, Washington has submitted use designations for salmonids throughout the State. Washington’s standards for temperature and DO, which are specifically designed to protect salmonids, would apply wherever salmonid uses are designated. The EPA has provided maps and tables to display where and when salmonid uses occur in each of the water resource inventory areas (WRIAs) in the State (Appendix A in the BE).

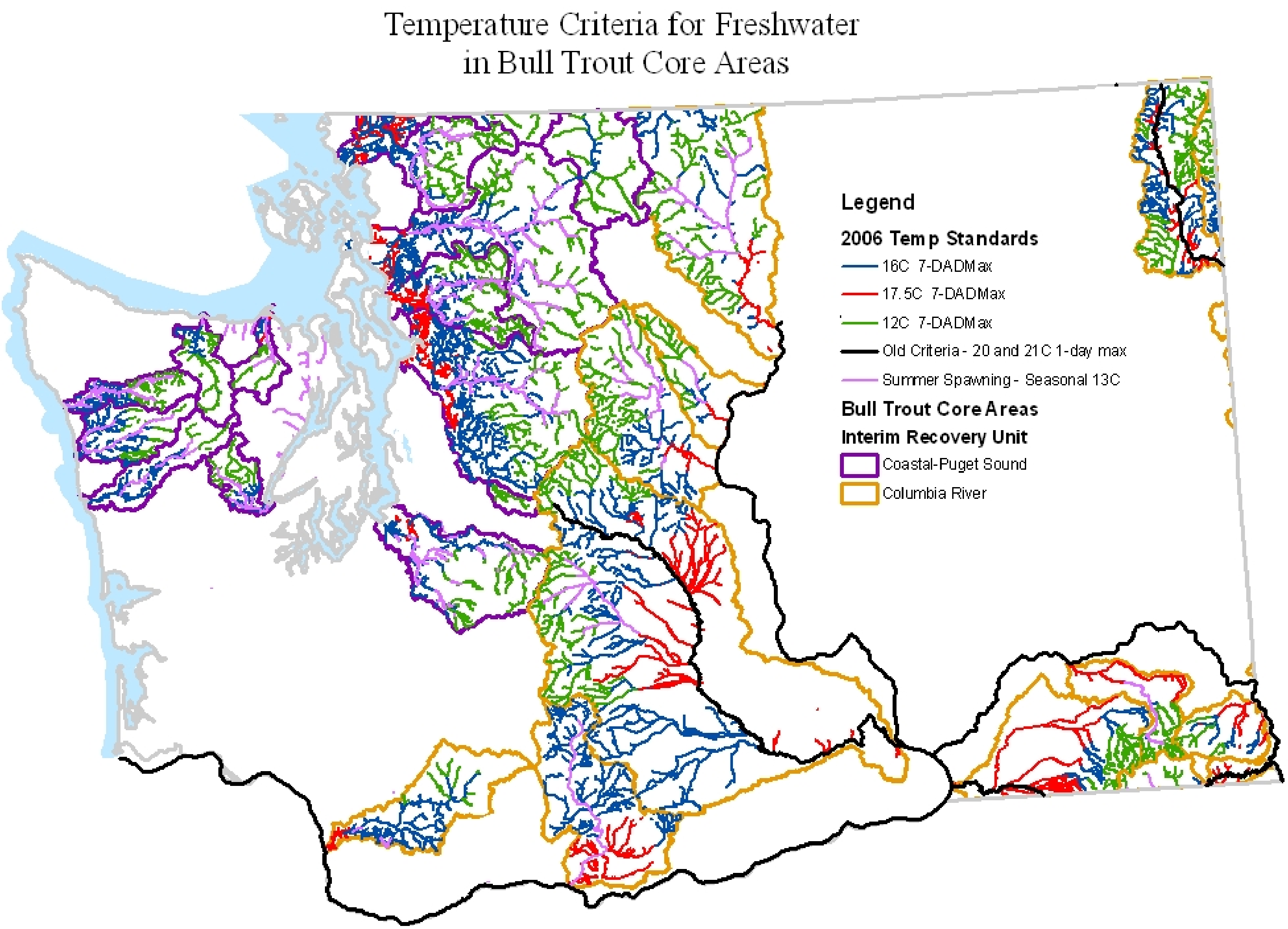
Washington's numeric criteria specified in Table 2 are intended to generally be protective of the fresh water aquatic life uses. However, in some instances, early spawning salmonids may not be protected by these criteria. In these cases, more stringent spawning and incubation criteria are applied to protect these uses. The aquatic life uses and associated 7-DADMax numeric temperature criteria outlined in Table 2 are summarized again below:

- Early (summer) Char Spawning 9 °C (48.2 °F)
- Char Use Designation 12 °C (53.6 °F)
- Early (summer) Salmon and trout spawning 13 °C (55.4 °F)
- Core Summer Salmonid Habitat designated use 16 °C (60.8 °F)
- Salmonid Rearing and Migration 17.5 °C (63.5 °F)

The WDFW maintains several databases that have survey information on fish distribution, populations, and productivity in spawning index reaches. The most complete databases are the Washington Lakes and Rivers Information System and Salmonid Stock Inventory System (SaSI), which are the two databases that WDOE used to apply the aquatic life use designations. Although these databases contain the best available information on salmon, steelhead, and bull trout distribution, they were never intended to be used to delineate spawning and early tributary rearing areas or determine the spatial and temporal application of spawning temperature criterion.

Given the limitations of the databases, the EPA also used information in the draft recovery plan for the bull trout and held numerous meetings in 2005 with Tribes to solicit additional or updated information. The WDFW also held several meetings in November/December 2005 with their state biologists to add updates or make corrections. The EPA acknowledges that, even with these efforts to ensure that the most current information on salmonid distribution and spawning timing were included in the analysis, some areas may not have been delineated correctly.

Figure 1: 2006 temperature criterion that will be applied in areas that are used by bull trout. For detailed maps, please refer to Appendix A of the BE



The three elements of the standards, “designated use,” the associated “numeric criteria,” and “location” of the designated use (i.e., the use designation that is assigned to a particular waterbody), are interrelated in their effect to bull trout and other salmonids as they dictate 1) the species and life history phase that is affected, 2) the temperature that a particular species and life history is exposed to, and 3) the location of that effect based on species distribution. The temporal and spatial application of the standards is illustrated on the maps in Appendix A of the BE.

Areas in green on the map are the “Char spawning and rearing” use designations (12 °C), areas in purple are areas where the 13 °C temperature criterion is applied to protect Chinook spawning during the summer, areas in blue are the water bodies that are designated “Core summer salmonid habitat” (16 °C), areas in red are streams where the 17.5 °C temperature criterion (and special temperature provisions) will be applied, and rivers in black retain the old temperature standards.

Temperature Provisions to Protect the Existing Use

This section assesses 1) the adequacy of the 12 °C temperature to protect bull trout spawning and juvenile rearing, 2) the spatial application of the 12 °C and 9 °C early spawning char criterion, 3) adequacy of the 16 °C temperature criterion to protect foraging and migrating adult and subadult bull trout, 4) spatial application of the 16 °C standard, and 5) effects of applying the 17.5 °C temperature criterion in areas that are used by bull trout. The EPA made effects determinations on each of these criteria individually and we have reflected these “effects determinations” in our discussion. The only appropriate effect determination under Section 7 of the ESA is that for the entire action. Although each criterion has a separate determination, the criteria operate in concert along with the spawning narrative provisions.

Char Use Designation (12°C 7-DADM)

Washington adopted 12 °C (54 °F) 7-DADM to protect waters designated for char spawning and early juvenile rearing. This new use designation resulted in many headwater areas that were previously Class A, which had a temperature criterion of 16 °C, now having a 7-DADM temperature criterion of 12 °C. The key identifying characteristics of this designated use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden) and use by other aquatic species that are dependent on cold water (trout, whitefish, amphibians, macro-invertebrates etc.).

The WDOE converted streams that were Class AA and A under the old 1997 WQS to the “Char spawning and rearing” use designation if the WDOE knew or had reason to believe that char spawning and rearing occurred in those waters. They studied the locations of known spawning areas in the WDFW database and found that their occurrence is largely related to elevation and stream order. Using this information, the WDOE developed a formula to delineate water bodies where this use designation would be applied. This resulted in approximately 90 percent of the areas that are currently known to be used by bull trout for spawning and rearing being included in the char use designation. However, there were approximately 92 stream reaches covering an estimated 600 miles that the FWS identified as current or potential spawning and juvenile rearing habitat that were not designated as char using the physical/landscape process developed by the WDOE.

The EPA reviewed the information contained in the draft bull trout recovery plan and current information on bull trout use in each of these 92 stream reaches and determined that streams warranted the “Char spawning and rearing” use designation if 1) bull trout spawning has been documented, 2) bull trout spawning and early juvenile rearing is presumed based on indicators such as presence of adults during the spawning season, and/or multiple age classes of juveniles, or 3) bull trout spawning and rearing is likely to occur in the near future because the stream reach was used historically for spawning, has suitable habitat, provides a connection between local populations, and/or is necessary for recovery. Following most, but not all of these procedures, the EPA concluded that approximately 69 of the 92 stream reaches should receive the char use designation and associated 12 °C temperature criterion. The EPA determined that there was not enough information to designate the remaining 23 stream reaches as char spawning and rearing, even though the draft bull trout recovery plan and proposed rule for bull trout critical habitat identified these areas as essential for recovery. The potential consequences of this decision are addressed below.

Effects of Applying the 12 °C and 9 °C Numeric Temperature Criteria in Bull Trout Spawning and Rearing Areas

Protectiveness of the 12 °C Temperature Criterion

The 12 °C 7-DADM criterion roughly translates to a maximum weekly average temperature of 11 °C , and an equivalent constant temperature of 11.5 °C (53 °F) for comparison to juvenile growth studies at constant temperatures (McCullough et al. 2001).

Little information was found on the preferred temperature range for core rearing in bull trout. In a laboratory study conducted by McMahon et al. (1999, as cited in McCullough et al. 2001), optimal growth was observed at lower temperatures when rations were limited. For satiation-fed and 66 percent of satiation-fed juvenile bull trout, optimum growth occurred at a temperature range of 12 to 16 °C. When energy availability was low (one-third satiation-fed fish), maximum growth occurred at temperatures ranging from 8 to 12 °C. In Arctic char, a related species, the upper thermal limits to both feeding and growth was between 21.5 and 21.8 °C (Thyrel et al. 1999, as cited in McCullough et al. 2001).

Selong et al. (2001) assessed the upper thermal limits and optimal temperatures for growth of age-0 bull trout fed daily to satiation at temperatures ranging from 8 to 28 °C during 60-day trials. Survival of bull trout was at least 98 percent at a temperature range of 8 to 18 °C, but was 0 percent at a temperature of 22 °C and above. Peak growth occurred at 13.2 °C, but feed consumption declined significantly at temperatures over 16 °C.

In another study analyzing the temperature effects on bull trout distribution in 581 sites, Rieman and Chandler (1999, as cited in McCullough et al. 2001) found that juvenile/small bull trout were most likely to occur in areas where summer-mean temperatures ranged from 6 to 9 °C or single maximum temperatures were between 11 °C and 14 °C. When given a choice of temperatures from 8 to 15 °C in a large plunge pool, juvenile bull trout showed a clear preference for the coldest water available (8 to 9 °C) (Bonneau and Scarnecchia 1996).

Numerous authors have addressed temperature in relation to successful bull trout spawning. In studies conducted in Montana, spawning was initiated at temperatures less than 9 to 10 °C (Fraley and Shepard 1989) and less than 9 °C in British Columbia (Spence et al. 1996, Pratt 1992). Peak spawning occurred at temperatures between 5 and 6.5 °C. In the Metolius River in Oregon, spawning is initiated at a temperature of 4.5 °C (Spence et al. 1996).

McPhail and Murray (1979) found that bull trout egg survival also varies with water temperature. They reported egg survival to hatching in eggs from British Columbia at 0 to 20 percent, 60 to 90 percent, and 80 to 95 percent at water temperatures of 8 to 10 °C, 6 °C, and 2 to 4 °C, respectively. The authors also reported that 4 °C was the optimum temperature for growth of bull trout fry. In a Montana study, Weaver and White (1985) reported that 4 to 6 °C was needed for bull trout egg development.

The proposed 12 °C 7-DADM temperature criterion is well above the temperature range reported in the literature to initiate spawning in bull trout but is within the optimal temperature range for juvenile rearing. Bull trout generally spawn in the late summer and fall in the same waters where young and resident juvenile bull trout rear. The EPA decided that a single numeric temperature criterion (12 °C 7-DADM) that limits summer maximum temperatures would be protective for bull trout spawning, egg incubation, fry emergence, and juvenile rearing. The EPA assumes that applying a temperature criterion of 12 °C during the hottest time of the year is protective because the natural thermal patterns indicate that temperatures will gradually drop to levels that are protective of bull trout spawning (9 °C) in the fall and will further decrease over the winter to levels that will protect egg incubation (2 to 6 °C). This assumption is validated in areas where spawning and juvenile use is documented during annual surveys for bull trout and salmon.

Salmonids not only respond to maximum temperatures, but also to maximum diel fluctuations. In anthropogenically altered systems, the magnitude of fluctuation and the duration of elevated temperatures are greater than in unaltered systems (ODEQ 1995, Berman 1990). Although bull trout may be present throughout large river basins, most of the spawning and rearing areas are at higher elevations and in the least disturbed portions of the watershed. Bull trout spawning areas are often associated with cold water springs and upwellings (Rieman and McIntyre 1993). Because most of the areas that are designated as char spawning and rearing are in areas that are relatively undisturbed, eggs would not be expected to experience the extreme temperature fluctuations or extended durations of elevated temperatures that occur in the lower, more disturbed reaches.

Delineating the char use designation resulted in many water bodies that were previously Class AA or A (with associated temperature criterion of 16 °C and 18 °C) now having a temperature criterion of 12 °C. The EPA has determined that approval of the char spawning and rearing use designation and associated 12 °C 7-DADM temperature criterion, **is not likely to adversely affect** the bull trout (Coastal-Puget Sound and Columbia River IRUs). Based on the assumption that streams will cool naturally to < 9 °C in time for spawning and continue to cool down during the incubation period (2 to 8 °C), the FWS has determined that application of the 12 °C temperature standard in areas that are used for spawning, incubation, and juvenile rearing is not expected to have a significant effect on bull trout.

Protectiveness of 9 °C Criterion

In areas with naturally cold water, bull trout may begin to spawn in late summer (August/September). The EPA compiled information on distribution of early bull trout spawning from numerous sources including WDFW's Bull Trout SaSI Report (WDFW 1998), the U.S. Forest Service, and more recent data collected by the FWS. Areas where bull trout spawning occurs during the late summer include: local populations in the upper Lewis River; local populations in the Touchet, Tucannon, and Asotin Core Areas; bull trout populations that spawn in tributaries to the Naches and Tieton Rivers (Naches Core Area); Panther Creek in the Wenatchee Core Area; and local populations in the Methow, Twisp River, and Wolf Creek (Methow Core Area). In waterbodies inhabited by these early spawners, the EPA has determined that the 12 °C temperature criterion may not provide adequate protection and application of the 9 °C char spawning and incubation criterion will be applied.

Based on the data found on char spawning timing in each of these reaches, the EPA applied the following convention for temporal application of the 9 °C criterion to protect early char spawning: If bull trout spawning timing is "mid-August," "late August," or "the last week of August," then application of 9 °C starts August 21. If spawn timing is "early September," then application of 9 °C starts September 1st. Finally, EPA determined from discussions with local biologists (FWS, WDFW, Tribes, etc.) that an end-date of May 15 for the 9 °C criterion was appropriate as bull trout incubation is completed by this date across all areas.

As mentioned above, spawning areas are often associated with cold-water springs, groundwater-infiltration sites, and streams with the coldest summer temperatures (Pratt 1992; Rieman and McIntyre 1993; Rieman 1997; Baxter and Hauer 2000). It is well-documented that spawning is initiated as temperatures drop to 9 °C or lower, and that increases in temperature during that period can interrupt or postpone spawning activity (Ratliffe and Howell 1992; Sexauer and James 1997; Brenkman 1998; Kraemer 1994). In areas where streams freeze in winter, spawning in groundwater-infiltration areas may actually ensure that the incubating eggs in the gravel remain in relatively constant cold water with little diel fluctuation and are not affected by anchor ice. As mentioned above, survival of bull trout eggs is highest at 2 °C and 4 °C with mortality sharply increasing above 6 °C (McPhail and Murray 1979).

The EPA believes that application of the 9 °C temperature criterion will provide adequate protection for early bull trout spawning and incubation (2-6 °C) because temperatures will continue to drop naturally during the fall and winter. The vast majority of local populations are in areas with relatively good habitat conditions and adequate regulatory mechanisms to ensure that the standards are achievable and will be met. The Service agrees that stream temperatures will drop below 9 °C in areas that are used by bull trout for early spawning. Therefore, we have determined that application of the 9 °C temperature standard in these areas will provide adequate protection for early spawning (August to September) and incubation.

Effects of Not Applying the 12 °C Numeric Temperature Criterion in Areas that are used by Bull Trout for Spawning and Rearing (including Potential Local Populations)

There are approximately 23 stream reaches where the char spawning and rearing use designation (and associated 12 °C 7-DADM temperature criterion) was not applied in areas where bull trout may be spawning but the EPA considered the data to be inadequate to designate the use as char. There are instances where conditions make it difficult to document bull trout spawning or juvenile rearing (e.g. low populations, difficult access, poor visibility, or limited survey effort) and the FWS had to rely on best professional judgment to determine if the area could be used by bull trout, was important for juvenile rearing, or is essential for recovery.

Because there is a potential that these areas are currently being used by bull trout for spawning and rearing and/or could be inhabited in the near future, the EPA has determined that lack of application of the 12 °C criterion to these stream reaches is **likely to adversely affect** the Coastal/Puget Sound bull trout and Columbia River bull trout. The FWS concurs that there would be adverse effects to bull trout.

There were also two reaches in the Naches River Basin (Bumping River and Upper North Fork of the Tieton River) where the FWS provided input that these areas are currently being used by early-spawning bull trout, but the 9 °C criterion was not applied. Because ongoing data collection likely will result in a change of status of these reaches and the fact that other reaches in these areas have documented early spawning bull trout, the EPA has determined that the lack of application of the 9 °C temperature criterion in these reaches is **likely to adversely effect** the bull trout (Columbia River Basin). Not applying temperature criteria that are cold enough for initiation of spawning will result in a significant impairment of breeding and may reduce the extent of habitat necessary for reproduction. Therefore, the FWS concurs with this determination.

There area several instances where the 9 °C early spawning criterion is applied to individual spawning areas along the same stream reach, resulting in short segments where the char use designation and associated 12 °C temperature criterion are interspersed with the 9 °C spawning temperature criterion (e.g. Panther Cr. in the Wenatchee, the American River in the Naches, Spangler Cr. in the North Fork Touchet). From an ecological and implementation standpoint, it would be difficult to apply and regulate these interspersed numeric temperature standards along the entire stream reach.

The following table lists bull trout spawning and juvenile rearing areas where the 12 °C temperature criterion was not applied. All of these areas also include reaches that are designated critical habitat:

Table 9. Local populations (LP) and potential local populations (PLP) where the revised temperature standards may not provide adequate protection for bull trout. Areas where spawning and/or juvenile rearing has been documented (WDFW databases, USFWS, or other surveys) are indicated in the reach miles column.

Core Area Local Population	**% not covered by Char (12 °C)**	**Temp. criteria that is applied**	**WRIA**	**Reach Miles**
Nooksack Core Area			1	
Lower S Fk Nooksack LP (RM 10.0 to RM 19.0)	26	16 °C, 13 °C 9/1	1	9.0
Snohomish/Skykomish Core Area			7	
S Fk Skykomish LP (Money Creek – mouth to forks and above)	36	16 °C, 13 °C 9/15	7	4.2
Puyallup Core Area			10	
Clearwater PLP (mouth to Milkey Cr)	17	16 °C, 13 °C 9/1	10	7.0
Asotin Creek Core Area			35	
N Fk Asotin Cr	5	16 °C	35	0.8
Wormell Gulch PLP	54	16 °C	35	5.2
Charley LP (mouth to RM 2.3)	24	16 °C	35	2.3
Tucannon	5	16 °C, 13 °C 9/1	35	1.0
Yakima Core Area Naches, Tieton, Ahtanum			37, 38, 39, 45	
Ahtanum LP (mouth to confluence M Fk Ahtanum)	23	16 °C	37	10.7
Rattlesnake LP (mouth to NFk)	21	16 °C, 13 °C 9/15	38	7.0
Taneum Cr PLP	100	**17.5 °C**	39	Entire PLP
Upper Yakima LP (Lk Easton to RM 208)	60	16 °C , 13 °C 9/15	39	6.0 **Documented**
Cle Elum[2] LP (Cle Elum Lk to Yakima River - formerly FMO)	5	16 °C	39	8.0
N Fk Teanaway LP (lower 9 miles)	18	16 °C, 13 °C 9/15	39	9.2 **Documented**
Wenatchee Core Area			45	
Icicle[2] LP (mouth to Jack Cr)	32	16 °C, 13 °C 8/15	45	15.0 **Documented**
Chiwawa[2] LP (mouth to RM 9.5)	28	16 °C, 13 °C 9/1	45	9.5 **Documented**
Chiwaukum LP (1 mi)	5	16 °C	45	1.0
Entiat Core Area[5]	60		46	
Entiat[2] River (lower 5 mi)	60	16 °C, 13 °C 8/15 17.5 °C	46	5.0 - CH **Documented**
Mad LP[2] (lower 4 mi)	64	16 °C, 13 °C 8/1	46	4.0
Methow Core Area			48	
Goat Cr[2] LP	54	16 °C, 13 °C 8/15	48	6.5

[5] In early 2006, the FWS made revisions to the local populations in some core areas in eastern Washington for the Forest and Fish Analysis. Although the spawning and rearing areas were covered by the char use designation early on in the process, portions of the lower reaches were left out when the maps were revised.

Core Area Local Population	% not covered by Char (12 °C)	Temp. criteria that is applied	WRIA	Reach Miles
(mouth to Roundup Creek)				**Documented**
Wolf Cr[2] LP (mouth to diversion dam)	43	16 °C, 13 °C 8/15	48	4.5
Chewack[2] LP (RM 11 to RM 23/ conf. Lake Creek)	40	16 °C, 13 °C 8/15	48	12.0
Lost[2] LP (mouth to Drake Cr)	23	16 °C, 13 °C 8/15	48	11.2
Twisp[2] LP (Little Bridge Cr to War Cr)	14	16 °C, 13 °C 8/15	48	7.0 **Documented**
W Fk Methow[2] LP (Lost R. to Robinson Cr)	4	16 °C, 13 °C 8/15	48	1.4 **Documented**
Pend Oreille Core Area			62	
Le Clerc LP (mouth to W Branch)	5	16 °C	62	0.8
Cedar PLP (mouth to RM 1.3)	13	16 °C	62	1.3
Harvey PLP (Sullivan Lk to Paupac Cr)	14	16 °C	62	1.6
Mill PLP	100	16 °C	62	1.3
Ruby PLP	100	16 °C	62	12.5
Tacoma PLP	100	16 °C	62	8.5
S Fk Tacoma PLP	30	16 °C	62	0.3

In most cases, the char use designation stops at the lower end of the documented spawning area but may not include all of the area that is or could be used for juvenile rearing. The draft recovery plan for the bull trout (USDI 2004) emphasizes the importance of maintaining genetic connectivity between local populations. Applying the 12 °C temperature criterion only to the upper portion of the reach likely will reduce juvenile rearing habitat and may contribute to further isolation of local populations.

Of particular concern are areas where there is no summer salmon spawning. The 16 °C temperature criterion is not cold enough to initiate spawning and will not provide adequate protection for egg incubation and juvenile rearing that may occur in these areas. Application of numeric temperature criterion that exceeds 12 °C in areas that support local populations, or potentially could be used by bull trout in the future (potential local populations), will cause a significant impairment of spawning and juvenile rearing. Not applying the char use designation over the entire area that is used by bull trout for reproduction and juvenile rearing may preclude use of some areas and reduce connectivity between local populations. The 13 °C temperature criterion may provide some protection for juvenile bull trout and adults that are staging downstream of the spawning areas but does not replace the char use designation because it is not cold enough to initiate spawning.

Many of the reach segments listed in Table 9 are on private property that is within or just downstream of Federal or commercial timber lands. Activities that are occurring in these riparian areas that affect stream temperature include livestock grazing, farming, and construction of residential housing. The WDOE has limited regulatory authority over activities that are conducted on private property. Most of the programs that deal with non-point sources of pollution are incentive-based or voluntary programs that encourage landowners to protect riparian vegetation. The FWS assumes that temperatures in areas that are currently used by bull trout for spawning and rearing are sufficiently cold to support the existing use. Not designating these areas as “Char spawning and rearing” is likely to result in an increase in water temperatures in the future. Any increase in temperatures over 12 °C will reduce reproductive success of bull trout in these areas.

Effects of Applying the 16 °C and the 13 °C Salmon Spawning Temperature Standards in Areas that are Used by Bull Trout for Foraging, Migration, and Overwintering

Core Summer Salmonid Habitat (16 °C 7-DADM)

The WDOE converted waters that were classified as Lake Class and Class AA waters under the old 1997 rule, and that were not designated as “Char spawning and rearing,” as “Core Summer Salmonid Habitat.” Although most of the streams were correctly assigned using this simple conversion, some areas were not correctly designated using this method. The EPA conducted an analysis of fish distribution data to identify other waterbodies where application of 16 °C criterion was warranted based on the existing aquatic uses. The primary sources of information that EPA used were the WDFW databases and survey information provided by the tribes. The EPA used the following rationale for including streams in the “Core Summer Salmonid Habitat” use designation:

1. Areas where Chinook, pink, sockeye, and chum salmon begin spawning in the summer (i.e., mid-September or earlier). In these areas, adults are present at the spawning grounds days to weeks, or sometimes months (e.g., spring Chinook) prior to the onset of spawning. These holding adult salmon need temperatures at or below 16 °C with declining temperature prior to spawning to them from disease and maintain the viability of developed gametes (McCullough et al. 2001).

2. Steelhead stocks that spawn in late spring will likely have significant number of eggs in the final stages of incubation and fry emerging in late June. Salmon fry also emerge from the gravel in the spring. These juveniles begin rearing near where they emerged from the spawning grounds and many will spend the first year of life in their natal rivers.

The “Core Summer Salmonid Habitat” use designation is designed to 1) protect juvenile salmon and steelhead from lethal temperatures (23 to 26 °C), 2) provide conditions during the summer that are in the optimal range for juvenile growth for salmon and trout (10 to 16 °C), 3) protect salmonids against temperature-induced diseases, 4) provide temperatures that juvenile salmon and trout prefer (10 to 17 °C), 5) protect salmon and steelhead from competitive disadvantage with warm water species which can occur when average temperatures exceed 15 °C and maximum temperatures exceed 17-18 °C, 6) provide conditions during the period of summer maximum temperatures that protect adult and sub-adult bull trout foraging and migration (less than 15 °C), and 7) provide conditions that protect Chinook salmon that are holding over the summer (USEPA 2003).

Current knowledge indicates that bull trout prefer temperatures less than 15 °C and are seldom found in streams with summer temperatures exceeding 18 °C (Allan 1980 and Shepard et al. 1984, as cited in Brown 1994). In the Flathead drainage, bull trout juveniles were rarely observed in streams with summer maximum temperatures exceeding 15 °C (Fraley and Shepard 1989, as cited in Brown 1994). Fry and age+1 individuals in the Metolius drainage occupy only groundwater-fed tributaries that seldom exceed 10 °C (Ratliff 1987, as cited in Brown 1994). Basic rearing habitat for juvenile bull trout includes cold summer water temperature (<15 °C) with sufficient surface and ground water flows (Carnefix 2003). Habitat characteristics that are important for juvenile bull trout of migratory populations are also important for stream-resident subadults and adults (Carnefix 2003).

Bull trout can tolerate warmer temperatures for short periods of time. For example, mature adult anadromous char have been observed in Puget Sound tributaries when stream temperatures were 20 to 24 °C (C. Kraemer, WDFW, pers. comm., as cited in Brown 1994). Since 2003, a total of 119 bull trout that were captured in the lower rivers and nearshore marine waters of northern Puget Sound have been outfitted with acoustic radio transmitters. Over 95 percent of these fish migrated through or resided for short periods of time in the lower rivers during the spring and early summer (Goetz et al. 2005 *in litt.*).

Upstream spring migration of adult bull trout may be related to water temperatures and flows. In Rapid River, Idaho, a review of trap counts and temperatures for 1985 through 1992 reported a general trend of increasing upstream bull trout counts as water temperatures reached 10 °C (Elle et al. 1994, as cited in McCullough et al. 2001). McPhail and Murray (1979, as cited in McCullough et al. 2001) found that peak upstream movement coincided with water temperatures of 10 to 12 °C. Swanberg (1997) studied the seasonal movements and habitat use by fluvial bull trout in the Blackfoot River drainage of western Montana in 1994 and 1995. Twenty-four radio-tagged bull trout made upriver migrations, 33 percent of which were related to spawning. In June of both years fish began migrations that appeared to be cued by an increase in maximum daily water temperature to 17.7 °C.

No information was found regarding temperature effects on disease in bull trout, but according to the Water Temperature Criteria Technical Workgroup (2001) disease rates in anadromous salmon are minimized at temperatures below 12 °C, but are elevated at temperatures of 14 to 17 °C. On the basis of laboratory and field studies on Chinook, coho, and sockeye salmon, and rainbow and steelhead trout, infection and mortality by columnaris disease were negligible at temperatures at or below 12.8 °C, but temperatures above 15 °C produced significantly increased mortalities (Materna 2001).

The 16 °C numeric temperature criterion applies during the warmest times of the summer, the warmest years, and throughout the waterbody, including the lowest downstream extent of the waterbody designated for this use, which means that the 7-DADM temperatures will be cooler than 16 °C most of the time where this use occurs. Because of the conservative nature of how this criterion is applied, the EPA believes that it is appropriate to propose numeric criteria near the warmer end of the optimal temperature range for the aquatic life uses that it is intended to protect. The EPA also determined that tributaries that drain into waterbodies that EPA identified as needing the "Core Summer Salmonid Habitat" use and 16 °C criterion should also have the

“Core” use designation. The reason for the extension of the use upstream is to assure that the downstream reaches attain the 16 °C criterion necessary to support their “Core” use designation. This is consistent with Washington’s approach for tributaries (see WAC 173-201A-600(1)).

The EPA considers the 16 °C temperature to be protective of the “Core Summer Salmonid Habitat” because it is within the range of temperatures that are used by salmonid life histories specified under the designated uses listed by WDOE including, emergence, adult holding; summer rearing, and foraging by adult and sub-adult salmonids. Where this water quality standard is applied in areas that are used by bull trout for foraging and migration, the EPA has determined that the application of the “Core Summer Salmonid Habitat” designated use and the associated 16 °C criterion **is not likely to adversely affect** the bull trout.

The proposed salmon and steelhead core juvenile rearing criterion of 16 °C is at the high end of the temperature range reported in the literature to support migrating and foraging subadult and adult bull trout. It should also be noted that converting from a single day maximum of 16 °C to a 7-DADM may result in an allowable increase of approximately 1 °C in waters that are currently colder than the standards and are now designated as “Core summer salmonid habitat” (see Table 8).

The EPA estimates that approximately 30 percent of the water bodies in the state fall under this use designation. The 16 °C 7-DADM temperature criterion roughly translates to 13 °C maximum weekly mean, and an equivalent constant temperature of 14.5 °C for comparison to juvenile growth studies at constant temperatures. Based on a review of the temperature patterns in Washington, streams with a 16 °C summer maximum temperature generally cool to 13 °C maximum temperatures by mid-September (WDOE, March 2005, Unpublished Data). Moreover, WDOE’s stream data indicates that many rivers that meet this criterion will only experience water temperatures above 15 °C for short durations over the summer. Application of the “Core summer salmonid use” designation and associated 16 °C 7-DADM temperature criterion will ensure that temperatures are generally below 15 °C. Based on these data, the FWS believes that application of this temperature criterion in areas that are used by bull trout for foraging and migration (including lakes) will not result in adverse effects to bull trout, especially if there are areas of cooler waters that can provide thermal refugia. Based on the assumption that average temperatures over the course of the summer will remain below 16 °C and the assurance that streams that are currently colder than the standard would not be allowed to be degraded, the FWS has determined that designating areas that are used by bull trout for migration, subadult rearing, and overwintering as “Core summer salmonid habitat” is not expected to have a significant effect on bull trout.

Most of the areas that were designated as “Core summer salmonid habitat” are on Federal or commercial forest lands and transition to open agricultural or rural areas. Federal lands and facilities (e.g. dams and hatcheries), Indian reservations, and areas with completed habitat conservation plans have regulatory requirements that protect water quality. Although current temperatures in the upper and middle portions of the watersheds are generally good, many of the lower rivers are temperature-impaired (see Table 4). Because most of the water bodies that are designated as “Core summer salmonid habitat” are located on lands where there are legal requirements to meet the standards, the FWS anticipates that water quality will be protected and baseline conditions will improve in the future.

Application of 13 °C *Summer Spawning Temperature Criterion*

The 16 °C is not protective of the reproductive life history phases of fertilization, embryo development, and hatching unless spawning occurs late enough that the natural temperature decline results in sufficiently cool temperatures. Washington elected to include summer salmon spawning or incubation as part of the "Core summer salmonid habitat" use. The 13 °C temperature criterion is applied in areas where adult salmon are holding in the rivers during the summer months and spawn in August or September and areas where steelhead egg incubation and fry emergence occurs in the spring.

Temperature requirements for the salmon and trout reproductive life history phases (i.e. holding of adults with mature gametes, spawning/fertilization, and embryo development to emergence) are generally <16 °C , based on available literature (EPA 2003). Mature gametes within adult salmonids exposed to excessive temperatures can reduce fertilization success or embryo survival to emergence. Salmonid gamete viability is reduced at adult holding temperatures of >13-16 °C according to the EPA (McCullough et al. 2001). A literature review of Chinook and other salmonids found that 16 °C is excessive (McCullough 1999) for the protection of gametes in holding Chinook salmon (EPA Temperature Guidance Issue Paper 5 – Summary of Technical Literature Examining the Physiological Effects of Temperature on Salmons pages 30-38).

Of the various reproduction related life history phases of salmon/trout (maturation of gametes, spawning/fertilization, embryo development, hatching), the gamete maturation process in holding adults occurs earliest in time. As previously stated, temperatures below ≤13 to16 °C are considered protective of holding adults with mature gametes (McCullough et.al. 2001). The Temperature Guidance recommends 16 °C for adults holding over the summer and 13 °C for spawning. These two temperatures effectively bracket the period where some adults may hold with mature gametes. The 13 °C criterion is also applied into the spring in areas used by steelhead. Application of the 13 °C temperature criterion will provide additional protection in many areas that are used by adult and subadult bull trout for foraging, migration, and overwintering. The FWS considers application of the salmon spawning narrative temperature criterion to be entirely beneficial to bull trout.

Effects of Not Applying the 16 °C Numeric Temperature Criterion in Areas that are Used by Bull Trout During the Summer

Application of 17.5 °C 7-DADM Temperature Criterion

Washington adopted 17.5 °C (64 °F) to protect waters designated for "Salmonid rearing and migration." This use designation is applied in areas that were formerly Class A or B (18 °C and 20 °C temperature criterion respectively) and water bodies that are not designated as "Char spawning and rearing" or "Core Summer Salmonid Habitat." The key identifying characteristics of the "Salmonid Spawning, Rearing, and Migration" designated use is salmon or trout spawning and rearing that occurs outside of the summer season (September 16 - June 14) and salmonid migration. Generally, waterbodies where the 17.5 °C temperature criterion applies are found in the mid and lower part of a basin, typically downstream of the areas that are designated as "Core Summer Salmonid Habitat."

The EPA used information from the Technical Synthesis (McCullough et al. 2001) to determine if the 17.5 °C temperature criterion is protective of salmonid species. In this synthesis of temperature literature, thermal temperature ranges that are important to juvenile salmon and trout include: 1) lethal temperatures of 23 °C-26 °C, 2) optimum growth under conditions with limited food (10 °C-16 °C), and 3) preferred rearing temperatures of 10 °C-17 °C. Studies indicate adult salmonid migration is blocked at temperatures ranging from 18 °C to 23.9 °C and reduced fitness due to cumulative stress occurs at prolonged exposure to temperatures over 17 °C-18 °C (McCullough et al. 2001). Impairment of smoltification occurs at temperatures of 12 °C-15 °C for salmon and >12 °C for steelhead. Elevated disease risk for both rearing juveniles and migrating adults occur at temperatures ranging from 14 °C-17 °C.

On page 144 of the BE it states that there are several situations where the EPA made exceptions to the general approach of relying on WDFW databases for determining where "Core" use is the appropriate use. In many situations, particularly in eastern Washington, the data describes summer salmon/steelhead spawning or incubation and/or documented bull trout use during the summer months, but the EPA did not make a "Core" use determination. The EPA also determined that it is not necessary for all tributaries that drain into "Core" waters to have a 16 °C criterion, unless summer salmon/steelhead spawning or incubation occurs in the tributary. The EPA made this exception on several tributaries in the lower portions of the Nooksack, Skagit, Snohomish, Nisqually, and Klickitat Rivers and the lower portion of several small tributaries in the upper Yakima River.

The EPA determined that "…a few relatively low flow tributaries with a 17.5 °C criterion in the lower downstream portion of these rivers will have a negligible impact" on the receiving waters that are designated as "Core summer salmonid use." This statement should be verified, because several of the tributaries that were exempted are fairly large and most are currently temperature-impaired. For example, there are several instances where numerous tributaries with the 17.5 °C temperature criterion drain into the same waterbody that is designated as "Core" and two situations where the temperature standards on the mainstem and/or large tributary alternate back and forth between 16 °C and 17.5 °C (Snohomish and Puyallup Rivers). The FWS believes that applying a higher temperature standard on tributaries or mainstem rivers that lead to areas that are designated as "Core summer salmonid habitat" could degrade water quality in the receiving waterbody.

The Special Temperature Provisions that apply to most of the large rivers in eastern Washington were not changed to match the existing use, even though the EPA approved the change from Class B to "Salmonid Spawning, Rearing, and Migration" or "Salmonid Rearing and Migration." This means that the 20 °C and 21 °C temperature criteria that were applied in the mid 1970's will remain in effect on these rivers. Rivers where the special temperature provisions apply are not included in the proposed action and are addressed in the environmental baseline. These include: the Columbia, Yakima, Pend Oreille, Walla Walla, Grande Ronde, Snake, and a small segment of the Skagit River. The WDOE is using the TMDL process to determine natural conditions of these water bodies. Results of the model calculations will be used to regulate point and non-point pollution sources to achieve the target natural thermal potential of the reach. Based on the model calculations and estimates outlined in TMDLs that have been completed to date, it will take decades for restoration activities and pollution control measures that are outlined in the implementation plan to reduce temperatures in these large rivers.

The 17.5 °C 7-DADM temperature criterion roughly translates to a 14.5 °C maximum weekly mean and an equivalent constant temperature of 16 °C (62 °F) for comparison to juvenile growth studies at constant temperatures. This following assesses the effects of applying the 17.5 °C temperature standard in migratory areas that may be used year-round by bull trout.

The proposed 17.5 °C temperature criterion is at the upper end of the temperature range reported in the scientific literature to protect migrating bull trout, and above the temperature range reported to support optimal growth during conditions of limited food availability. The potential effects of temperature on salmonids must be considered in terms of duration of exposure, life stage, whether the exposure is constant or intermittent, population density, and the availability of thermal refugia. This temperature criterion is intended to ensure that salmon and trout will not be exposed to long-term constant summer temperatures above 17.5 °C.

Based on the available data, adult bull trout begin their upstream migration during the late spring and early summer and generally reach their spawning areas by August or September (or earlier in areas where spawning begins in August). Sub-adults (2 and 3-year olds) mature in larger tributaries and may be present in the rivers all year long if foraging opportunities and conditions are good. Although there is a distinct seasonal use pattern, especially in areas where stream temperatures are high during the summer, human alterations of the landscape have influenced migratory patterns, resulting in fish being exposed to summer temperatures that they historically would have been able to avoid. The EPA states that the 17.5 °C criterion is not intended to protect bull trout use that occurs during the summer and has determined that application of the 17.5 °C criterion in areas where bull trout are present **is likely to adversely affect** bull trout.

In western Washington, most of the rivers were designated as “Core summer salmonid habitat” (with the associated 16 °C temperature criterion) because salmon spawn during the late summer and fall in the mainstem rivers and larger tributaries. However, east of the Cascade Crest, the distribution of salmon use during the summer is largely restricted to the upper watersheds, resulting in 75 percent of the lower rivers being designated as migratory corridors. It is unknown how many of the rivers and streams in the Columbia Plateau were historically cool (i.e. could meet 16 °C during the summer months). We suspect that the 17.5 °C temperature criterion probably approximates the natural condition in many areas that are used by bull trout and salmon seasonally for migration.

As is the case on the west side, current summer maximum temperatures already exceed the standard in many of the lower rivers in eastern Washington. The higher stream temperatures seen in rivers on the east side are due to a combination of factors, including warmer summers, different geology, and human-caused hydro modifications (dams, water withdrawals, diversion canals, etc.). Approving the 17.5 °C temperature criterion in water bodies that were previously Class A (18 °C 1-day maximum temperature criterion) is not going to result in a measureable change in the baseline. However, approving a temperature standard that is higher than the natural condition will prolong restoration and maintain degraded conditions that are attributed to human actions. Without completed TMDLs, we do not have adequate information to determine where this situation applies. We suspect that stream temperatures in the upper and middle portions of the watersheds would have historically been cooler than they are today.

Table 10: Bull trout migratory corridors where the 16 °C temperature criterion was not applied.

Core Area	% not covered by 16 °C Temp criterion	Temp. criteria that is applied	Stream miles	Comments
Lower Skagit Core Area				
Samish River (mouth to Friday Cr)	40	17.5 °C	9.0	Foraging and overwintering
Stillaguamish Core Area	25			
Stillaguamish River (mouth to Forks/RM 17.8)		17.5 °C	17.8	Adult and subadult bull trout use documented
Snohomish/Skykomish Core Area	19			
Snohomish River (mouth to RM 8)		17.5 °C	8.0	Adult and subadult presence/migration
Snoqualmie River (mouth to Harris Cr)		17.5 °C	21.0	Foraging and migration only
Duwamish/Green (mouth to Mill Cr/Kent)	20	17.5 °C	17.8	Foraging and overwintering
Puyallup Core Area	3	17.5 °C		
Puyallup River (mouth to RM 1.0)		17.5 °C Standard may be higher than historic	1.0	Adult and subadult presence/migration. Current temp 17-18.4°C, conditions are degraded.
White River (mouth to RM 4.0)		17.5 °C Standard may be higher than historic	4.0	Low populations and poor visibility make surveys difficult. Temps are naturally cool in this glacial system
Wishkah River (approx. 15 miles)	30	17.5 °C	15.0	Foraging and overwintering
Humptulips	5	17.5 °C	4.0	Foraging and overwintering
Satsop River	5	17.5 °C	1.0	Research needs area. Historically supported bull trout
Chehalis River	100	17.5 °C		Seasonal use. Temps exceed standards. Conditions are degraded
Lewis Core Area (mouth to Houghton Cr)	9	17.5 °C	13.5	Passage to Columbia is blocked by dams

Core Area	% not covered by 16 °C Temp criterion	Temp. criteria that is applied	Stream miles	Comments
Walla Walla River	100	***20 °C[6] 1-day max***	Approx. 123 mi.	Migration is limited by low flows and thermal barriers. TMDL indicates natural thermal potential is 6 °C cooler than current
Lower Touchet R, Mud, Mill Cr, and Yellowhawk Cr	68	17.5 °C		Documented bull trout use in spring and summer
Tucannon Core Area (mouth to RM 10)	46	17.5 °C	10.0	Bull trout use the Snake for foraging and wintering. Current temps exceed the standard.
Grande Ronde Core Area	100	17.5 °C	37.0	Thermal barriers impede migration in this river
Lower Snake	100	***20 °C[6] 1-day max***		Foraging and migration only. Current temps exceed the standard.
Asotin Creek Core Area	95	17.5 °C		Adult and subadult presence/migration
(Asotin, Pintler, and George Cr)		17.5 °C	13.0	Low population with declining trends
Columbia River	100	***20 °C[6] 1-day max***	Pacific Ocean to Methow River RM 526	Documented year-round use by bull trout for migration and foraging in Middle Columbia (above Priest Rapids Dam).
Yakima Core Area	90			Lack of passage and thermal barriers threaten migratory populations in this core area.
Ahtanum Cr (mouth to forks)		17.5 °C	20.0	Adult and subadult presence/migration
Naches River (mouth to RM 19)		17.5 °C	19.0	Documented bull trout use in spring and summer
Yakima River (mouth to Cle Elum River, RM 187)		***21 °C[6] 1-day max***	187.0	Documented bull trout use in spring and summer
Taneum Cr[3]		16/17.5 °C		Potential recovery area
Wenatchee Core Area	40	17.5 °C		FMO
Wenatchee River (mouth to Peshastin Cr)		17.5 °C	17.3	Documented year-round use by bull trout. TMDL emphasizes restoring riparian vegetation
Peshastin Cr (mouth to Mill Cr)		17.5 °C	8.7	Adult and subadult presence/migration
Entiat Core Area[7]	60	17.5 °C		SR no FMO

[6] Rivers with Special Temperature Provisions are not part of the action being consulted on.

Core Area	% not covered by 16 °C Temp criterion	Temp. criteria that is applied	Stream miles	Comments
Entiat River (mouth to Mad River)			10.6	Documented year-round use by bull trout. 7DADM temps 21-24°C, degraded condition
Methow Core Area	36	17.5 °C		Documented year-round use by bull trout. Temps similar to Entiat
Methow River (mouth to Twisp River)			42.0	Documented year-round use by bull trout
Beaver Cr			7.5	Adult and subadult presence/migration
Pend Oreille River	100	***20 °C[6] 1-day max***	105	Passage is restricted by dam. Very low population

The EPA emphasizes that waters will be cooler than 17.5 °C most times of the year when bull trout actually use these waters because this numeric criterion applies during the warmest times of the summer, during the warmest years, and extends to the lowest downstream section of the waterbody designated for this use. However, the 17.5 °C is a 7-DADM standard, which means that the allowable temperatures could be approximately +0.5 °C warmer than the measure using the single day maximum. Application of this temperature criterion in areas that are used by adult and subadult bull trout during the summer months will result in a significant alteration of behavior, including impairment of feeding, breeding (gamete production), and sheltering.

Application of temperature standards above 16 °C in areas that are used by bull trout for migration and foraging could result in the significant impairment or disruption of behavioral patterns such as feeding or sheltering and likely will have adverse effects on individuals, including reduced fecundity (gamete viability in adults), increased stress and competition and/or predation, blocked migration (temperatures over 20 °C), and death (1 week exposure to temperatures over 21 °C). Therefore, the FWS concurs with EPA's "**likely to adversely affect**" determination.

Many of the tributaries listed in Table 10 are in non-forested areas where activities such as livestock grazing, water storage or withdrawal, farming, and rural development are common activities that affect stream temperature. Because programs that deal with non-point sources of pollution are incentive-based and largely voluntary, it will take some time for many of these streams to meet the standards. Temperature in the larger rivers, especially in eastern Washington, is largely influenced by modifications associated with water storage and/or withdrawal that often result in low flows and reversed hydrographs. Although facilities like dams are regulated and must meet the standards, they have up to 10 years to evaluate what operational changes need to be made to meet the standards. If a facility is economically or structurally unable to make the necessary changes to achieve the standards, they may request an exemption after conducting a UAA.

Under 40 CFR 131.10(g) of the CWA, states may remove a designated use which is not an existing use, as defined in § 131.3, or establish sub-categories of a use if the state can demonstrate that attaining the designated use is not feasible because:

1. Naturally occurring pollutant concentrations prevent the attainment of the use; or
2. Natural, ephemeral, intermittent or low flow conditions or water levels prevent the attainment of the use …; or
3. Human caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place; or
4. Dams, diversions or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the waterbody to its original condition or to operate such modification in a way that would result in the attainment of the use; or
5. Physical conditions related to the natural features of the waterbody, such as the lack of a proper substrate, cover, flow, depth, pools, riffles, and the like, unrelated to water quality, preclude attainment of aquatic life protection uses; or
6. Controls more stringent than those required by sections 301(b) and 306 of the ESA would result in substantial and widespread economic and social impact.

If WDOE intends to remove a designated or existing use based on a UAA, the process must go through public review and rule making. This requires approval by the EPA and will undergo separate consultation with the Services.

Effects of Elevated Temperatures on Bull Trout

The thermal environment within a stream is a fundamental element that influences the availability of suitable habitat for bull trout and other native salmonids. Stream temperatures directly influence the distribution, health, and survival of bull trout and may also influence biotic relationships such as competition and predation (Rieman and Chandler 1999; McMahon et al. 2007; Rieman et al. 2006). Thermal stress occurs when a change in temperature produces a significant change to biological functions leading to decreased likelihood of survival. From the onset of elevated temperatures, thermal stress can lead to lethal effects either immediately or in a period of days, weeks, or months. Thermal stress can also result in "sublethal" or indirect effects resulting in death or reduced fitness that can impair essential life proccesses such as growth, spawning, or swimming speed. Metabolic processes are also directly related to temperature, and the metabolic rate increases as a function of temperature (McCullough et al. 2001).

A well-documented facet of bull trout biology is the species' requirement for cold water (Rieman and McIntyre 1993). Bull trout require a narrow range of cold temperature conditions to reproduce and survive and are regarded as having one of the lowest temperature tolerances among North American salmonids (Selong et al. 2001; Bonneau and Scarnecchia 1996; Goetz 1989). Species, such as bull trout, that have a narrow thermal "niche," are likely to be affected by even small increases in stream temperatures, particularly summer maximum temperatures (McPhail and Baxter 1996; Dunham et al. 2003; Rieman et al. *in press*). As temperatures increase, the following effects to bull trout may occur: 1) an increased rate of physiological damage, including sublethal impacts, 2) changes in the relative abundance of bull trout in relation to other salmonids, 3) reduction in overall abundance, 4) changes in the distribution of bull trout, and 5) behavioral adjustments (Saffel and Scarnecchia 1995; Myrick, *in litt.* 2002).

Temperature Effects to Individuals

The temperature requirements of bull trout vary by life-cycle stage, with the young generally being most sensitive to increases in the temperature of their environment (Buchanan and Gregory 1997; Johnson and Jones 2000), while adults are more sensitive to changes in the amount and distribution of thermal refugia as a result of changes in stream temperatures. Thermal refugia are primarily found at the confluence of small or moderate tributaries with larger, more-productive streams, in deep pools, or in areas of hyporheic or groundwater upwelling.

Temperature can influence the abundance and well-being of fish by controlling their metabolic processes. Fish and other aquatic species have optimal metabolic ranges. Increasing stream temperatures result in changes in metabolism because higher temperatures require more energy to sustain increased rates and processes (Johnson and Jones 2000). When stream temperatures are warmed over optimal, the increase in energy required for basic life processes can deplete the energy reserves of individual fish. Conversely, as food availability decreases, optimal temperature for bull trout decreases (lower temperatures require less energy to sustain metabolic rates and processes) (McMahon et al. 2001).

Bull trout are fall spawners and water temperature appears to be an important cue for initiation of redd building and spawning behavior (McPhail and Baxter 1996). As temperature in the fall drops to about 9 °C or lower, spawning is initiated (Ratliffe and Howell 1992; Sexauer and James 1997; Rieman 1997; Brenkman 1998). In some streams, when the temperature rises above 8 °C or 9 °C, spawning activity has been observed to stop or slow (Kraemer 1994). Spawning sites are often associated with cold-water springs, groundwater infiltration areas, and cold, high elevation streams (Pratt 1992; Rieman and McIntyre 1993; Rieman 1997; Baxter and Hauer 2000). In areas with harsh winter conditions, groundwater infiltration areas tend to remain open and prevent the accumulation of anchor ice, which can scour redds and destroy eggs.
As with other char, successful incubation of eggs requires very cold temperatures. In a laboratory study by McPhail and Murray (1979), survival of eggs at 2,4,6, 8, and 10 °C was highest at 2 °C and 4°C. Under natural conditions in the Flathead drainage, interstitial temperatures ranged from 1.2 °C to 5.4°C during the incubation period (Weaver and White 1985 in MBTSG 1998).

Juvenile bull trout appear to have low upper thermal limits both for growth and distribution. This life stage is often most vulnerable to summer warming from anthropogenic sources (Buchanan and Gregory 1997; McCullough 1999). In a study analyzing the temperature effects on bull trout distribution in 581 sites, Rieman and Chandler (1999) found that juvenile/small bull trout were most likely to occur in areas where summer-mean temperatures ranged from 6 °C to 9 °C or single maximum temperatures were between 11 °C and 14 °C. In another study of the influence of temperature on distribution of bull trout, the probability of occurrence did not become high (e.g., >75 percent) until the maximum daily temperature declined to approximately 11 °C-12 °C (Dunham et al.2003). When given a choice of temperatures from 8 °C to 15 °C in a large plunge pool, juvenile bull trout showed a clear preference for the coldest water available (8 °C to 9 °C) (Bonneau and Scarnecchia 1996). The patterns found in the results of these studies could reflect sub-lethal influences of temperature (Dunham et al., 2003).

If rations are limited, the temperature at which maximum growth occurs can be shifted downward (Dunham et al. 2003). In a laboratory study conducted by McMahon et al. (1999), for "satiation-fed" and "66 percent of satiation-fed" juvenile bull trout, optimum growth occurred at a temperature range of 12 °C to 16 °C. When energy availability was low ("33 percent satiation-fed" fish), maximum growth occurred at temperatures ranging from 8 °C to 12 °C.

The importance of understanding the relationship of food availability and the metabolic requirements for growth and reproduction is related to evidence that bull trout tend to spawn and rear in cold headwater streams and that these streams in the Pacific Northwest are characterized by naturally low levels of primary and secondary productivity (Gregory et al. 1987). In addition, throughout the entire stream network of the Pacific Northwest salmon fry, eggs, and decomposing carcasses historically were an important source of food and nutrients in streams. With the recent decline of Pacific salmon, productivity of Northwest streams has been further diminished (Cederholm et al. 2000).

Although currently there is little information on temperature requirements of subadult and adult bull trout, in general, adult fish are physiologically less tolerant of elevated temperatures than smaller fish of the same species (Myrick et al. 2002). As bull trout mature, they move to larger rivers, lakes, or marine waters in order to exploit the availability of larger or more abundant prey items. Although temperatures in these habitats may be elevated during periods of low flow or during the warmest months, these fish are able to exploit the spatial variation of temperatures within a stream and can behaviorally thermoregulate by periodically moving to more-suitable, cooler thermal environments. For example, when water temperatures in the Blackfoot River were unfavorably warm during the summer, non-spawning migratory bull trout used confluences with cold water tributaries, which provided thermal refugia (Swanberg 1997). Loss of coldwater habitat can reduce spatial variation within a stream. This loss of spatial variation can reduce the ability of bull trout and other salmonids to escape high temperatures or avoid other detrimental physiological and ecological conditions (Poole et al. 2001). This reliance upon access to patches of cooler stream temperature tends to make migratory bull trout more sensitive to changes in the amount and distribution of thermal refugia.

Temperature Effects to the Population

As was stated earlier, juvenile bull trout distribution is strongly influenced by water temperature. Numerous studies indicate that juvenile bull trout are associated with cold water and this relationship is most likely a very critical one (McPhail and Baxter 1996). Juvenile fish move far less than subadult or adult fish and tend to reside in the same stream segments or local stream networks for several years. Because juvenile bull trout tend to reside in the same area for a number of years, any increases in temperature could decrease the amount of thermally suitable habitat within their limited home range (McPhail and Baxter 1996; Rieman and Chandler 1999). Juvenile bull trout are rarely found at temperatures exceeding 15 °C (Rieman and McIntyre

1993; Buchanan and Gregory 1997) and a study conducted by Saffel and Scarnecchia (1995) suggest that high water temperatures may be physically constraining to bull trout.

As stream temperatures warm, there is less suitable habitat available for bull trout, which can result in populations becoming more become fragmented as connectivity is disrupted (Dunham et al. 2003; Myrick, *in litt.* 2002). When fish experience temperatures outside their physiological optimum range, sublethal and indirect effects may occur, e.g., reduction in swimming speed. Species may become more susceptible to disease and predation, as well as competition. For example, a long-term change in temperatures can result in changes in the species composition in a waterbody. These changes in composition can result in sublethal effects such as increased competition, predation, and disease, and reduced access to coldwater refugia (McCullough et al. 2001; Ebersole et al. 2001). Applying temperature standards >12 °C in areas that the FWS has identified as important for recovery (potential local populations) likely will preclude use of these areas by bull trout for spawning and rearing in the future.

Within the range of bull trout, brook trout are an exotic species that is more thermally tolerant than bull trout. A recent study by McMahon et al. (2007) demonstrated that the presence of brook trout has a measurable negative effect on bull trout that is magnified at higher water temperatures. In an earlier report by McMahon et al. (1999), bull trout growth declined significantly when brook trout were present, especially at temperatures over 12 °C. When in sympatry, brook trout appear to have a depressive effect on foraging by bull trout and appear to be more aggressive than bull trout. Hybridization and competition with brook trout has been identified as a threat to bull trout populations and are implicated in depressing bull trout populations throughout their southern range (Dambacher et al. 1992; USFWS 2004).

Furthermore, increased stream temperature or alterations in cold water refugia may reduce the ability of a stream to support bull trout prey species, thus reducing the bull trout's ability and success at finding forage in these streams. This could affect the growth and survival of adult and subadult bull trout depending on the severity of effects to these stream systems over time. Increased temperatures can also lead to expansion of the populations of introduced sport fish, many of which are predatory. This can result in increased competition for limited food resources and increased predation on subadult bull trout.

Based on telemetry studies, snorkel surveys, smolt trap data, and angler captures, we know that adult bull trout begin their upstream migrations to the spawning areas in late spring/early summer and are traveling through the mainstem rivers and larger tributaries during the summer months. Although these fish may move through patches of water that appear to be above the range of optimal, they rarely reside in these areas for more than a short time (hours). If suitable refugia or cold water tributaries are not available, migration may be delayed, disease and predation are more likely to occur, and in-vitro viability of eggs may be reduced (McCullough et al. 2001).

Applying the 17.5 °C temperature standard in areas where the natural thermal potential indicates that a lower temperature could be achieved, will result in further degrading the baseline condition. The state's antidegradation policy alone may not provide adequate protection for water bodies where the degradation is related to non-point sources because there is no regulatory mechanism for compliance. Tables 3 and 4 list streams that are currently meeting the WQS and streams where water quality is a concern. Streams that are not meeting the current temperature criterion will still need TMDLs under the revised standards.

Review of Spatial and Temporal Application of the Use Designations and Associated Temperature Standards on Bull Trout

Based on an analysis of the spatial and temporal application of the temperature criterion, we have determined that the revised WQS will provide adequate protection for most of the areas in Washington that currently support bull trout. Eighty-three percent of the 144 bull trout local populations in Washington are within the char use designation and will be protected by the application of the 12 °C and 9 °C temperature criterion. Of the 25 populations that are not entirely covered by the char use designation, 5 are potential local populations (no current bull trout use) and another five have more than 90 percent of the local populations within the Char use designation.

The FWS has determined that indirect effects of the proposed action on bull trout will be insignificant in the following areas:

Coastal-Puget Sound Interim Recovery Area:

- Olympic Peninsula
  - All core areas and areas that are used for foraging and overwintering will be adequately protected by the revised temperature standards, including the Dungeness, Elwha, Hoh, Queets, Quinault, and Skokomish core areas.
  - The revised WQS will provide adequate protection of FMO habitat in the Wynoochee, Satsop, Wishkah, Humptulips, and tributaries to the Pacific Ocean and Straits of Juan deFuca because bull trout use these areas primarily during the winter and spring.
- Puget Sound
  - All local populations and migratory corridors in the Nooksack core area except for a small portion of the lower South Fork Nooksack.
  - All local populations and migratory corridors in the Skagit River and Chilliwack Core Areas.
  - Most of the Stillaguamish, Snohomish/Skykomish, and Puyallup – all local populations are protected but some inadequate temperature standards in portions of the migratory corridors.
  - The revised WQS will provide adequate protection in the following FMO only areas: Nisqually, Duwamish/Green, Lake Washington.

Columbia River Interim Recovery Area

- Tributaries to the lower Columbia – Lewis, Klickitat, and White Salmon Rivers
- Local populations in the Pend Oreille core area

- Snake River Basin - All local populations in the Tucannon and Asotin Core Areas will be adequately protected by the new temperature standards
- Transboundary Areas
  - Coeur d'Alene Lake, lower Grand Ronde River, Priest Lake, and Clark Fork core areas are all adequately protected

The "Core summer salmonid habitat" use designation and associated 16 °C and 13 °C temperature criteria will provide adequate cold water protection in most of the foraging areas and migratory corridors in western Washington. However, less than 25 percent of the bull trout migratory corridors in eastern Washington are designated as "Core summer salmonid" use areas. Temperature standards that are above 16 °C may not provide adequate thermal protection for bull trout that utilize the waterbody year round. It is acknowledged that temperatures during the summer months are generally higher in eastern Washington than on the west side of the Cascade Mountains. However, applying a temperature standard that is higher than the natural condition will result in continued degradation of the baseline.

The 13 °C summer salmon spawning temperature criterion will provide additional cold water protection in many of the migratory corridors. For example, application of the 13 °C spawning criterion in the spring and early summer will ensure almost year-round cold water protection in the Methow and Nooksack core areas and will contribute to reducing stream temperatures in the upper reaches of migratory corridors that were not designated as "Core summer salmonid habitat" in the Snohomish, Puyallup, Wenatchee, Entiat, Naches, and Tucannon Rivers. However, in areas where the 13 °C temperature criterion is only applied in the spring to protect steelhead, the temperature standard will not have a significant cooling effect because temperatures in most rivers are naturally cool in the spring. Although it is uncertain how much or how far downstream the salmon spawning temperatures will affect stream temperatures, we do expect some beneficial effects to bull trout in areas where the 13 °C summer spawning temperature criterion is applied.

Effects of Approving the 9.5 mg/L Dissolved Oxygen (DO) Criterion

The purpose of the DO criterion is to protect salmonid egg incubation through fry emergence from low DO concentrations. Washington's WQS includes the following provision at WAC 173-201A-200(1)(d) – Table 200(1)(d) Aquatic Life Dissolved Oxygen Criteria in Fresh Water:

Category	Lowest 1-Day Minimum
Char	9.5 mg/L
Core summer salmonid habitat	9.5 mg/L
Salmonid spawning, rearing and migration	8.0 mg/L

The EPA is proposing to approve the 9.5 mg/L DO criteria for waterbodies that were previously designated Class A or Class B and are now designated as "Core summer salmonid habitat" or "Char spawning and rearing." The DO criteria changed from 8.0 mg/L to 9.5 mg/L on approximately 16 percent of the streams across the state.

The standard is intended to ensure that 9.5 mg/L is an absolute minimum during the time of year when DO is lowest (late summer). This would provide adequate protection for salmonids during the non-incubation (rearing/migration) and will meet 11 mg/L (or 8 mg/L in the gravel) at 95 percent saturation. Data indicate that the lowest values are in the late summer and higher concentration throughout the rest of the year (see WDOE's website at: ecy.wa.gov/biblio). However, there are situations where the 9.5 mg/L criterion could result in DO levels below 11 mg/L during part of the incubation period. Although the revised DO criteria for water bodies in Washington that changed from "Class A" to "Core" or "Char" will be more stringent (changing from 8.0 mg/L to 9.5 mg/L), levels lower than 95 percent saturation during incubation will not provide the minimum 8 mg/L needed for egg incubation in the gravels and is likely to have adverse effects on developing embryos.

Early life stages of fish, specifically the developing embryo, require the highest DO concentrations and are the most sensitive life stage to reduced oxygen levels. The oxygen demand of embryos depend on temperature and on the stage of development, with the greatest DO required just prior to hatching. At approximately 15 °C (59 °F), oxygen requirements for steelhead exceed 10 mg/L (ODEQ 1995). Researchers have reported that the required DO concentration increases with temperature and with the stage of fish development (ODEQ 1995). At 15 °C, the critical level of DO (where ambient levels meet metabolic needs) for steelhead increases from 1.0 mg/L shortly after fertilization to greater than 9.7 mg/L prior to hatching. The Oregon Department of Environmental Quality (ODEQ 1995) observed that embryo survival in field studies is negligible when oxygen levels in the gravel falls below 5 mg/L. ODEQ (1995) reported no embryo survival in a field study where oxygen levels in redds fell below 8.0 mg/L. They suggest that survival of embryos exposed to moderately reduced oxygen concentrations may be compromised under natural conditions.

In a literature summary conducted by the WDOE to evaluate the DO criteria (WDOE 2002), a review of the data indicates that the adverse effects of lower oxygen concentrations on embryo survival is magnified as temperatures increase above optimal (for incubation). For instance, at temperatures of 13.5 °C, a decrease of DO levels from 11 to 10 mg/L resulted in a 4 percent reduction in embryo survival to hatching for salmon and steelhead and was reduced by 20 percent at 7 mg/L at this temperature. At optimal temperatures of 10 °C, survival was close to 100 percent. Even under conditions that are not lethal for embryos, the research indicates that a delay of hatching or reduction in fry size may result in mortality because the fry may be too weak to emerge from the gravel or their subsequent success in the natural environment may be compromised.

In field testing of brown trout spawning habit impacted by non-point source pollution (agricultural pollutants) in Idaho, Maret et al. (1993) found a significant relationship between IGDO and survival. Percent survival was less than 10 percent when mean IGDO fell below 8.0 mg/L. Maret et al. (1993) suggest that growth and survival were positively correlated to IGDO concentrations above 8.0 mg/L when seepage velocities exceeded 100 cm/hr. Survival was also inversely related to the amount of fine-grained sediments (fines) present. The research suggests that sediments consisting of more than 15 percent fines may reduce IGDO to unacceptable concentrations for successful incubation and survival. In another study, Hollender (1981) measured the IGDO in natural brook trout redds in two Pennsylvania streams. The overall mean

DO levels in natural redds was 8.2 mg/L, with a range of means between 3.7 and 11.6 mg/L. Only about 25 percent of the redds had mean DO concentrations below 6 mg/L. Hollander (1981) also observed that embryo survival was related to the mean particle size of the redds; lower particle size corresponded to reduced IGDO making it difficult to independently evaluate the effects of these two parameters. The EPA (1986) recommends that IGDO concentration can be estimated as having a value at least 3 mg/L less than the water column DO concentration. This recommendation does not specifically address the relationship between IGDO concentration and sediment grain size and organic content. ODEQ (1995) et al. report that IGDO concentration is inversely related to the percent organic fines in the sediments, thus, the recommended assumption that IGDO is 3 mg/L less than water column DO concentrations, may overestimate IGDO concentrations in degraded systems that have a high percentage of fine-grained, organic-rich, sediments.

In a laboratory study conducted in Canada, researchers found that low oxygen levels retarded embryonic development in bull trout (Giles and Van der Zweep 1996, *in* Stewart et al. 2007). 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). Results of field studies in Oregon were similar to those reported by Maret et al. (1993) in Idaho. Survival was negligible for juvenile salmonids when IGDO concentrations fell below 6 mg/L, especially at relatively low intergravel velocities (ODEQ 1995). ODEQ (1995), studying wild brook trout, observed that survival of embryos in natural redds exposed to IGDO concentrations usually above 6.0 mg/L were positively correlated with the mean IGDO concentration up to 8.0 to 9.0 mg/L in natural redds. Artificial redds used in this study produced much lower survival, but also indicated negligible survival below about 8.0 mg/L. ODEQ (1995) studied steelhead in streambed gravels and recovered few or no sac fry from containers placed where mean oxygen concentrations were below 8 mg/L. ODEQ (1995), studying juvenile trout, found approximately 35 percent survival at IGDO concentrations of 6 mg/L and approximately 95 percent survival when the IGDO concentration was 8 mg/L. Results from ODEQ (1995) suggest that IGDO concentrations less than 5 mg/L are lethal.

Several studies have documented that low IGDO concentration appears to reduce the likelihood of survival to emergence or post-emergent survival for embryos (ODEQ 1995). ODEQ (1995) observed that alevin size was positively correlated with IGDO concentrations. Maret et al. (1993) reported reduced growth (length) in brown trout alevins at moderate IGDO concentrations of 6 to 7 mg/L, as compared with that of alevins incubated at IGDO concentrations of 9 to 10 mg/L. ODEQ (1995) found that alevins raised at low DO concentrations were smaller; however, the fish eventually reached nearly the same weight as fish incubated at higher DO concentrations. ODEQ (1995) similarly reported compensatory growth in Chinook salmon and steelhead trout after about 2 months. The ability of fry to survive in their natural environment may be related to the size of fry at hatch (ODEQ 1995). Results from researchers (ODEQ 1995; Chapman and McLeod 1987) studying coho salmon demonstrate that late-emerging alevins and small-sized fry are poor competitors and face almost certain death from predation, disease, starvation, or a combination of these factors.

There are complicating factors which arise when trying to interpret the effects of IGDO concentration. IGDO concentrations, water velocities in the water column, and especially the intergravel flow rate, are often interrelated variables that affect the survival of incubating embryos (ODEQ 1995). ODEQ (1995), from fieldwork with rainbow trout embryos, reported 50 percent embryo survival with a IGDO concentration of 8 mg/L and seepage velocities exceeding 100 cm/hour. These authors also reported that survival was negligible at intergravel water velocities below 20 cm/hour.

The studies cited above did not use standardized methodologies and their results must be considered in light of certain methodological problems. Spatial variability of IGDO in redds is high, due to variable biological oxygen demand, dilution with ground water, periphyton on and near the gravel surface, and gravel permeability (Vaux 1962). Also, productive streams exhibit diurnal cycles in DO concentrations due to photosynthesis and respiration. Average measures of DO concentration do not reflect the damage to aquatic life that can occur during diurnal minima. Many of the studies described in this section, such as Maret et al. (1993), did not account for such confounding variables. Samples taken during mid-day could be biased towards higher IGDO values that would not be representative of the average conditions experienced by embryos and alevins in the gravel.

The EPA determined that its approval of the revised DO criteria would have **no effect** on Columbia River Basin bull trout and Coastal/Puget Sound bull trout. However, in subsequent discussions with the EPA, it became apparent that there was an oversight on the extent of the water bodies where the DO criterion was changed (summary table 5-22 in the BE). The FWS believes that approval of the DO criteria will have adverse effects on bull trout as described below.

Bull trout have a very long incubation period (220 days). The 9.5mg/L DO standard is a 90-day average with a 7.0 mg/L 1-day minimum (in the water column). By definition, this means that oxygen levels in the gravels can drop below 8.0 mg/L during half of the 90 days and is allowed to drop to 4 mg/L for 1 day. The scientific literature reviewed above suggests that adverse effects increase markedly at IGDO concentrations less than 8 mg/L and embryo survival was close to zero at 5 mg/L. Embryo survival to hatching and emergence is also adversely affected by minor decreases in oxygen at temperatures above 10 °C. Due to the long incubation period of bull trout and cold temperatures required for embryo development (2 to 8 °C), the FWS has determined approval of a DO criterion that does not ensure a minimum of 8 mg/L in the gravels is likely to result in mortality of eggs, embryos, and fry and could have a significant effect on the reproductive success of several local populations (see Table 11).

As stated above, oxygen levels seen in rivers used by bull trout during spawning ranged from 8 to 12 mg/L in the gravel, indicating that bull trout spawning and rearing areas are characterized by good mixing and low water temperatures (i.e., oxygen saturation levels that are close to 100 percent). The extent of adverse effects from application of the 9.5 mg/L criterion would be dependent upon the duration of exposure and the actual concentration of DO. Because DO levels are directly affected by environmental and physical parameters, the primary WQS driver that will influence the amount of oxygen that is dissolved in the water column is temperature.

The FWS anticipates that, in areas that are designated as char and where environmental conditions are optimal for spawning, the DO criterion itself is not expected to affect the actual levels of DO. Because dissolved oxygen levels are directly influenced by temperature and atmospheric pressure, applying a single standard has spatial and temporal limitations. For example, the 9.5 mg/L DO standard, in conjunction with an adequate temperature standard (16 °C or less), will provide better protection for aquatic organisms during the summer and at mid- to low elevations. However, the 9.5 mg/L DO standard will be less protective at higher elevations and at lower temperatures. Based on the physical factors that affect oxygen levels, the cross-over or threshold temperature where the DO standard will become limiting and result in adverse effects to bull trout is at around 10 °C. The FWS estimates that, at temperatures below 10 °C, the 9.5 mg/L DO standard will provide less protection than the natural condition. Actions that reduce DO levels to the standard in areas where bull trout spawn will result in increased mortality of developing embryos and fry. Examples of activities that occur in the areas listed in Table 11 and could affect DO, include timber harvest (removal of streamside vegetation), development, farming and livestock grazing (increased fecal coliform), water withdrawals, and small business operations.

The following table shows the bull trout spawning and juvenile rearing areas where the EPA intends to approve the 9.5 mg/L DO standard.

Table 11.

Core Area **Local Population**	**Former Class A waters that are now Core or Char (DO 8mg/L to 9.5mg/L)**	**WRIA**
Nooksack Core Area		1
S Fk Nooksack River Hutchinson Cr to RM 20	10 miles	
Hutchinson Cr	All	
Stillaguamish Core Area		5
N Fk Stillaguamish – Confluence of Boulder River to Squire Cr	Approx 10 mi with tribs	
Deer Cr and Little Deer Cr	Lower 2.5 mi	
Puyallup R Core Area		10
Carbon River LP	Fairfax Bridge to park boundary -9mi	
Walla Walla Core Area		32
S Fk Touchet River	Griffin and Burnt Forks	
Tucannon Core Area		33
Cummings Cr	Lower 4 miles	
Asotin Core Area		35
George Cr	Entire stream	
N Fk Asotin Cr	Lower 4 miles	
Charley Cr	Lower 6.5 miles	
Upper Yakima		37,38,39
N Fk, M Fk, and S Fk Ahtanum Cr	All	37
Rattlesnake Cr LP	Lower 4 miles	38
Taneum Cr PLP	Lower 3.5 miles	39
N Fk Teanaway LP	Most of stream Approx. 9 miles	39
Wenatchee Core Area		45
Icicle Cr LP	Lower 3 miles	
Entiat Core Area		46

Entiat River LP	Lower 3 miles	
Mad River LP	Lower mile	
Methow Core Area		48
Gold Cr	Lower 1.5 miles	
Pend Oreille Core Area		62
Indian Cr PLP	Lower 2 miles	
Small/E Fk Small Cr	All	
Le Clerc Cr LP Ea and W Branch	Lower 4 miles	
S Fk Tacoma Cr PLP	To confluence of N Fk	
Cedar Cr PLP	Lower 2.5 mi	

The reaches listed in Table 11 where bull trout spawning occurs and adverse effects to developing bull trout embryos are anticipated are Hutchinson Creek, the Carbon River, Ahtanum Creek, and the Teanaway. The remaining areas are juvenile rearing areas that were designated as char by WDOE using their elevation model.

The WDOE is currently in the process of determining if the 9.5 mg/L DO standard is adequate to ensure IGDO levels of 8.0 mg/L in all spawning areas across the state. Based on the results of the study, the DO standard may be increased to 11 mg/L or a saturation level of at least 95 percent in all areas that support spawning.

Dissolved Oxygen Narrative Provisions—Allowable Decreases

Washington's WQS includes the following provision at WAC 173-201A-200(1)(d)(i) and (ii):

> "(i)When a waterbody's DO is lower than the criteria in Table 200(1)(d) (or within 0.2 mg/L of the criteria) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that waterbody to decrease more than 0.2 mg/L."
>
> "(ii) For lakes, human actions considered cumulatively may not decrease the dissolved oxygen concentration more than 0.2 mg/L below natural conditions."

These provisions allow a decrease in the DO level from human activities when the natural condition criterion is the applicable criterion. Dissolved oxygen is a characteristic of a waterbody that can be affected by several different parameters such as temperature, physical characteristics (stream velocities, percent sediments, etc.), nutrients, sunlight, ammonia, etc. Because any oxygen demanding material or nutrient will negatively affect dissolved oxygen, meeting the "natural condition criterion" without allowing some insignificant decrease in dissolved oxygen would require disallowing any discharge of any pollutant that would affect dissolved oxygen. Absent such a provision as proposed by Washington, no oxygen demanding material would be allowed from human activities when the natural condition criteria are the applicable criterion. The EPA believes that this is unnecessarily restrictive for the protection of designated uses, and would lead to unnecessary and costly expenditures. Additionally, 0.2 mg/L is within the monitoring measurement error for recording instruments typically used to monitor dissolved oxygen. Since this level of dissolved oxygen decrease is considered within the error band associated with typical dissolved oxygen monitors, the EPA considers it insignificant.

The EPA has determined that its approval of this provision **is not likely to adversely affect** the bull trout. Although the FWS agrees that the allowable decrease is insignificant, we do not have any reasonable assurance that the existing DO standard will provide adequate protection for bull trout. Therefore, we are unable to make a determination on the overall effect of approving this provision. If it is determined that the current DO standards are not providing adequate protection for native fish (i.e., adverse effects are occurring), the DO criterion may need to be increased to 11 mg/L for all water bodies that are used by native fish for spawning and rearing.

Natural and Irreversible Human Conditions

As described in EPA's Temperature Guidance (USEPA 2003), in order to assert that a State's natural condition criteria fully supports salmonids, the criteria must truly reflect conditions absent human impacts and the criteria cannot allow temperature changes due to past human activities to be considered as part of the natural condition.

The EPA's Temperature Guidance (USEPA 2003) also recommends that when estimating natural conditions (i.e., natural thermal potential) on a case-by-case basis in the context of a TMDL, a 303(d) listing, NPDES permit, or a 401 certification, the best available scientific information and techniques should be utilized. The EPA (2003) provides guidance on the best available methods to estimate the natural conditions for temperature. The methods that are used by WDOE to determine natural conditions are consistent with the recommendations in the Region 10 Temperature Guidance (USEPA 2003).

It is anticipated that Washington will use its natural condition criteria almost exclusively in the context of a TMDL or 303(d) listings. For waterbodies where elevated temperatures are a result of both human activities and natural conditions, the TMDL is typically the forum where the natural thermal potential is determined. For waterbodies where existing conditions are believed to be at natural conditions, the WDOE may make a natural condition determination for those waterbodies to avoid listing them as impaired. Because of the complexities of estimating natural conditions in waterbodies where temperatures are elevated due to both natural conditions and human sources, the EPA does not anticipate the state making natural condition determinations in individual NPDES or 401 certification actions.

Under the CWA, EPA is required to approve Washington's TMDLs and 303(d) listings of impaired waters. For TMDLs where the applicable water quality standard is the natural condition criteria, the TMDL must document the methodology and resultant estimates of natural thermal potential. If the methodology and the resultant natural thermal potential in the TMDL are inconsistent with Washington's natural condition criteria, the EPA must disapprove the TMDL because the implementation plan would not result in attainment of the WQS. If Washington relies on its natural condition criteria to avoid a 303(d) listing for a waterbody that exceeds the biologically-based criteria, it must document its basis for making such a determination, and its basis must be consistent with the natural conditions criteria in order for EPA to approve the 303(d) list. It is important to recognize that use of the natural background criteria in a TMDL context will result in temperatures that are beneficial to the listed species, relative to current baseline conditions, because the natural thermal potential is almost always colder than the current temperature conditions in waterbodies that are currently impacted by human activities.

In areas where the WQS cannot be met due to natural conditions, the EPA's approval of the natural conditions criteria is likely to result in temperatures in some waters that lead to adverse effects on listed species. Because any adverse effects associated with this provision are due to natural causes and not attributable to the provision itself, the EPA has concluded that their approval of the natural conditions criteria **may affect, but is not likely to adversely affect** bull trout. The FWS agrees that effects would be insignificant.

WAC 173-201A-260 includes a provision that would allow the standard to be changed due to irreversible human actions. WAC 173-201A-440 describes WDOE's method for conducting a UAA. This is a process for removing a designated use assigned to a waterbody. According to the WAC, it is a structured scientific assessment of the factors affecting the attainment of the use which may include physical, chemical, biological, and economic factors. A "use" can only be removed through a UAA if it is not existing or attainable.

Anyone can submit a proposal to WDOE to conduct a UAA to remove a designated use (e.g., summer core spawning and rearing). The written proposal must include sufficient information to demonstrate that the use is neither existing nor attainable. The decision to approve a UAA is subject to a public process including intergovernmental coordination and Tribal consultation. The EPA must approve or disapprove WDOE's decision, based on the UAA process, to remove a designated use.

It is impossible to predict at this point what affect, if any, this chapter of the 2006 standards will have on listed species. Approval of the UAA process itself will have no effect on listed species; however, the results from a specific UAA may. Because each UAA is subject to an EPA approval action, the FWS's consideration of this part of the EPA action will be taken up on a case by case basis when future UAA approval actions are proposed by EPA, which require independent consultations.

NPDES Implementation

Under the NPDES program, all facilities that discharge pollutants from any point source into waters of the United States are required to obtain an NPDES permit. NPDES permits contain conditions that limit the amount of a pollutant that may be discharged to surface waters. After analyzing the effect of a discharge on the receiving water, a permit writer may find that effluent limits are needed to ensure that the discharge does not cause or contribute to an exceedance of the State's WQS.

The State's WQS are composed of three components: 1) use classifications, 2) numeric or narrative water quality criteria deemed necessary to support the use classification, and 3) an antidegradation policy. Federal regulations at 40 CFR 122.44(d) require permits to contain conditions necessary to achieve the WQS. To evaluate the effect that the discharger has on a receiving water, a permit writer must use the State's WQS, the allowable mixing zone, and a method for predicting impacts to surface waters, and defining effluent limits for numeric criteria.

By definition, the mixing zone is an area near the discharge outfall where the WQS can be exceeded. However, the mixing zone should be small enough so that it does not interfere with the beneficial uses of the water and the temperature criterion for that waterbody must be met at the edge of the mixing zone. In Washington, mixing zones for rivers and streams must comply with the following conditions:

1. Not extend in a downstream direction more than 300 ft plus the depth of the water over the discharge port, or extend upstream for a distance of over 100 ft upstream from the diffuser.
2. Not use more than 25 percent of the flow (note: this dilution is determined by taking 25 percent of the 7-day average low flow with a return period of 10 years (7Q10).
3. Not occupy more than 25 percent of the width of the waterbody.

Any facility whose discharge temperature would increase the temperature at the edge of the mixing zone by more than the specified amount allowed in the permit likely would exceed the WQS. Therefore, an effluent limit for temperature would need to be incorporated into the permit to ensure that the temperature standard was met at the edge of the mixing zone. Facilities whose discharge temperature would increase the temperature at the edge of the mixing zone by an amount equal to or greater than 0.3 °C are required to complete a Tier II antidegradation analysis, as described under the cold water protection provisions.

In a waterbody that is already temperature-impaired, an individual point source may increase the temperature by 0.3 °C above the applicable criteria within the mixing zone (25 percent of the river). Theoretically, if five or more point sources were all discharging into a river at or near the same location, it is possible for the cumulative temperature increase to be more than 0.3 °C. Although possible, the EPA is not aware of such a situation and believes that NPDES discharges are spaced far enough apart that this cumulative impact would be discountable. For purposes of calculating an NPDES effluent limit, the permit writer generally assumes that the upstream temperature is exactly at the numeric criterion (e.g., assumed to be at the 17.5 °C numeric criterion even if the current river temperature is 19 °C). Assuming this, it is then possible to calculate, using a mass-balance equation and the river and point source discharge flow rates, the effluent discharge temperature that would result in the river temperature increasing by 0.075 °C. The result of this approach is that the NPDES limit is established in such a way that the point source meets the water quality standard even if the river itself exceeds the standard due to other sources. Eventually, as non-point sources are reduced and other NPDES sources are limited in a similar way, the river should attain standards.

The EPA believes that a 0.3 °C or less temperature increase is insignificant for two reasons. First, monitoring measurement error for recording instruments typically used in field studies is about 0.2 °C to 0.3 °C. In other words, this level of a temperature increase is considered undetectable with typical temperature monitors. Second, a 0.3 °C temperature difference is well within the range of uncertainty of our understanding of the thermal requirements of salmonids, which are more in the range of ±0.5 °C. However, the FWS has determined that, in areas where temperatures are already above optimal levels for bull trout, the additional allowable increases at point sources contributes to the cumulative warming of the waterbody and maintains the degraded baseline condition.

Allowable Warming in Mixing Zones

Washington's WQS include the following provisions for mixing zones:

> "When the natural condition of the water is cooler than the criteria in Tables 200, 210 (1)(c), the allowable rate of warming up to, but not exceeding, the numeric criteria from human actions is restricted as follows:
>
>> (A) Incremental temperature increases resulting from individual point source activities must not, at any time, exceed 28/(T+7) for freshwater or 12/(T-2) in the marine environment, as measured at the edge of a mixing zone boundary (where "T" represents the background temperature as measured at a point or points unaffected by the discharge and representative of the highest ambient water temperature in the vicinity of the discharge)."

The EPA proposes to approve the allowable temperature increase at the edge of a mixing zone, for point source dischargers when the natural condition of a waterbody is cooler than the numeric temperature criteria. However, the permitted increase cannot exceed the criteria established to protect the existing aquatic life use for that waterbody.

Washington's antidegradation policy requires that a Tier II analysis be completed for any State regulated new or expanded action, such as point source discharges, that would warm temperatures by 0.3 °C or more at the edge of the mixing zone. Therefore, a Tier II analysis would have to be completed if the incremental temperature increase resulted in an increase of 0.3 °C or more at the edge of the mixing zone for point sources.

The EPA recognizes that temperatures within the mixing zone of some NPDES discharges could result in temperatures near the vicinity of the discharge that may adversely affect bull trout. Because this provision would authorize thermal discharges that could be harmful to listed salmonids, the EPA has concluded that its approval of this provision **is likely to adversely affect** bull trout. The Region 10 Temperature Guidance outlines Thermal Plume Provisions for mixing zones that reduce the likelihood of instantaneous mortality of salmonids associated with exposure to temperatures over 32 °C within the mixing zone.

Acute thermal shock leading to death can be induced by rapid shifts in temperature (McCullough 1999). For example, exposure to temperatures over 32 °C for less than 10 seconds leads to instant lethality for many salmonids (WDOE 2002). The effect of the shock depends on acclimation temperature, the magnitude of the temperature shift, and exposure time (Tang et al. 1987, as cited in McCullough 1999). Thermal shock can also indirectly increase mortality. Juvenile Chinook salmon and rainbow trout acclimated to 15 °C to 16 °C and transferred to temperature baths in the range of 26 °C to 30 °C suffered significantly greater predation than controls (Coutant 1973). Coho salmon and steelhead trout acclimated to 10 °C and transferred to 20 °C water suffered sublethal physiological changes, including hyperglycemia, hypocholestorolemia, increased blood hemoglobin, and decreased blood sugar regulatory precision (Wedemeyer 1973). Based on this information, sublethal adverse effects from shifts of

10 °C shock are possible for bull trout that enter the thermal plume of a mixing zone. The mixing zone provision limits thermal shock to that which occurs in 5 percent (acute area of the mixing zone) of the cross section of the 7Q10 low flow of the waterbody. Although this is consistent with the Temperature Guidance, it does not completely avoid adverse effects.

The size restrictions for mixing zones limit potential migration blockage conditions to less than 25 percent of the cross-sectional area of the 7Q10 low flow of the waterbody. Although fish can go around or move through the mixing zone without any impairment of migration, any fish that enter the acute mixing zone (5 percent of the cross-sectional area of the 7Q10 low flow, or approximately 33 ft, at the end of the pipe) could be exposed to temperatures that cause acute impairment or instantaneous lethality. Based on a review of numerous NPDES permits and load limitations for point source discharges in TMDLs that have been completed to date, the effluent discharges are regularly permitted at temperatures up to 33 °C, which can lead to instant mortality.

Although the FWS agrees that the large scale and cumulative effects from point source discharges may be insignificant, there is a potential that bull trout that linger near the discharge or spend a significant amount of time in or near mixing zones may be subjected to temperatures that could result in thermal stress (sublethal harm), alterations of normal feeding and migratory behavior (avoiding the mixing zone), acute impairment of function, or instantaneous mortality. Potential adverse effects in the form of harm through significant impairment of behavioral patterns could occur within the mixing zone from direct exposure to elevated temperatures.

Allowable Temperature Increases for Lakes

Washington's WQS includes the following criteria for lakes:

> "(v) For lakes, human actions considered cumulatively may not increase the 7-DADMax temperature more than 0.3 °C (0.54 °F) above natural conditions."

The above provision is consistent with the recommendations in EPA's Temperature Guidance which discusses allowing the temperature in a waterbody to be insignificantly higher than the applicable criteria. The purpose of such a provision is to allow an insignificant level of heat into the waterbody related to human activities when the natural conditions criteria is the applicable criteria or where waters are currently exceeding the biologically-based numeric criteria. Absent such a provision, no heat would be allowed from human activities when the natural condition criteria is the applicable criteria. The EPA believes, for the reason described above, that this provision does not undermine the protection of uses provided by the natural conditions criteria.

Exemptions on Total Dissolved Gas (TDG) for the Snake and Columbia Rivers

Washington's water quality standards includes the following provision at WAC 173-201A-200(1)(f)(ii):

> "(ii) …. The following special fish passage exemptions for the Snake and Columbia Rivers apply when spilling water at dams is necessary to aid fish passage:

1. TDG must not exceed an average of one hundred fifteen percent (115%) as measured in the forebays of the next downstream dams and must not exceed an average of one hundred twenty percent (120%) as measured in the tailraces of each dam (these averages are measured as an average of the 12 highest consecutive hourly readings in any 1 day, relative to atmospheric pressure); and
2. A maximum TDG 1 hour average of one hundred twenty-five percent (125%) must not be exceeded during spillage for fish passage."

The EPA made a **"likely to adversely affect"** determination for bull trout and requested consultation on their approval of these special fish passage exemptions for the Snake and Columbia River. However, the spill operations are causing adverse effects to bull trout, not approval of the WQS. The Army Corps of Engineers (Corps) is authorized under Federal statutes to operate eight mainstem projects on the lower Columbia and lower Snake Rivers to provide passage for migratory fish species. Since 1992, NOAA Fisheries has prepared several Biological Opinions on operation of the Columbia/Snake hydro system which require project spill in the spring and summer to aid juvenile fish passage. On December 20, 2000, the FWS issued a BO on the operation of the Federal dams on the Columbia and lower Snake River. The Corps is currently operating in accordance with the 2004 NOAA Fisheries BO on Operation of the FCRPS and an updated proposed action prepared by the Corps, Bonneville Power Administration, and the Bureau of Reclamation.

Because the FWS already issued a BO on the FCRPS, effects of approving the special fish passage provision will not be addressed again in this BO. There are five major non-Federal dams on the Columbia River (Rock Island, Priest Rapids, Rocky Reach, Wells, and Wanapum Dams) that were not addressed in the 2000 FCRPS BO. Although these Public Utiltiy District dams follow spill patterns that are similar to the Federal facilities, WDOE has no regulatory authority over their operations. HCPs have been completed for the continued operations of Rocky Reach and Wells dams. Effects related to the operation of other non-Federal dams will be evaluated during the Federal Energy Regulatory Commission's relicensing process or individual section 10 permits.

Procedures for Applying Water Quality Standards

Washington's water quality standards include the following provisions at WAC 173-201A-260(3):

> "(3) Procedures for applying water quality criteria**.** In applying the appropriate water quality criteria for a water, the department will use the following procedure:
>
> > (b) Upstream actions must be conducted in manners that meet downstream waterbody criteria. Except where and to the extent described otherwise in this chapter, the criteria associated with the most upstream uses designated for a waterbody are to be applied to headwaters to protect nonfish aquatic species and the designated downstream uses.

> (c) Where multiple criteria for the same water quality parameter are assigned to a waterbody to protect different uses, the most stringent criterion for each parameter will apply."

These provisions will ensure that Washington's water quality standards are applied in a way that will be most protective of aquatic life. Part (b) of this section ensures that when a criterion is being applied in a specific action (e.g., in an NPDES permit or a TMDL) the effects of the action must be analyzed in downstream waters to ensure that the downstream criteria will be met.

Provisions of the WQS that Protect Cold Water

Washington's regulatory process, in combination with natural physical processes can be used to ensure that many of the State's waters will be maintained at temperatures well below the established criteria. The state has three antidegradation tiers that can be used to protect waters that are currently colder than the designated temperature criteria. Each tier has different applications and strengths.

Tier I requires the maintenance and protection of existing instream water uses and the level of water quality necessary to protect those existing uses. Existing uses are "...those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the WQS" (40 CFR 131.3(e)). Tier I regulations include a provision directing that protecting existing uses takes precedence over just applying numeric criteria. WAC 173-201A-310(1) reads:

> "Existing and designated uses must be maintained and protected. No degradation may be allowed that would interfere with, or become injurious to, existing or designated uses, except as provided for in this chapter".

This basic tenant of Tier I is further strengthened by language directing that:

> " The department will establish water quality requirements for water bodies in addition to those specifically listed in this chapter on a case-specific basis where determined necessary to provide full support for designated and existing uses" (WAC 173-201 A-260(3)(a)).

These two regulatory provisions for protecting existing uses can be applied to protect areas within waterbodies that have aquatic life uses that are unique to the overall waterbody. For example, where cold water tributaries or ground water emergence zones exist, these areas may support uses that are generally unique in that waterbody. Once documented, the narrative provisions for protecting the uses that rely on these cold water areas can be invoked on a site-specific basis without having to go through rulemaking, but can also serve to provide interim protection while formal designation of the cold water area occurs during a rulemaking process.

The second level of protection, **Tier II**, is designed to protect high quality waters. The regulatory requirements for Washington's Tier II are among the most stringent in the nation when it comes to protecting temperature criteria. All actions that WDOE has regulatory authority over (e.g., NPDES permits, forest practices permits, 401 certifications) must go through a Tier II evaluation. For example, any action that could raise temperatures by more than 0.3 °C at the edge of a mixing zone would need to go through a comprehensive examination of non-degrading or less degrading alternatives and the applicant would be required to adopt those alternatives that are technically and economically feasible. Prior to being approved, the entity must also conduct an analysis that shows the economic and social benefits are larger than the economic, social, and environmental costs of allowing any necessary degradation. In many cases, the Tier II evaluation is expected to identify alternatives that will lessen or even eliminate the thermal warming of waters during the summer months. This high quality is to be maintained and protected unless, through a public process, some lowering of water quality is deemed to be necessary to accommodate important economic or social development to occur in the area of the lowering.

However, the standards elsewhere allow for a 2.8 °C increase in water temperature from non-point sources per 173-201A-200(1)(c)(ii)(B). Theoretically, under this provision waters that are currently colder than the standards could be warmed by up to 2.8 °C or the standard (whichever is lower).

Tier III provides the third and highest level of protection and is restricted to waters that have "Outstanding National Resource Values." Tier III protection is available for waters in national and state parks, monuments, preserves, wildlife refuges, wilderness areas, marine sanctuaries, wild and scenic rivers, and can be used to protect waters that provide important cold water refugia. Washington's regulations limits the criteria for consideration under Tier III to just temperature and dissolved oxygen. This approach removes some of the political and administrative opposition that would be associated with requiring prohibitions on all forms of pollutants in waters whose special value was its use as thermal refugia. There are currently no streams in Washington that are protected under Tier III. Crater Lake, is an example of a waterbody that is protected under Tier III in the state of Oregon.

Because it is unclear how much regulatory authority and assurance the antidegradation policy affords, the FWS considers this provision to have limited benefits to listed species. For example, it is unclear what documentation or process would be required to invoke Tier I protection for species that are "unique" to a given watershed.

Natural Physical Processes

- **Cooler upstream waters needed to meet downstream criteria.** Temperatures naturally increase as water moves downstream. While this general pattern can be altered by very cold and large tributaries or large springs, it is a dependable physical process with the water moving towards equilibrium with air temperature. Since temperature criteria apply to all portions of a waterbody, the application of these criterion to the lower reaches of a waterbody means that more stringent thermal protection is needed upstream than just meeting the assigned criteria. Thermal controls in upstream reaches must be sufficient such that even when taking into account the natural process of warming as water moves downstream those downstream reaches will also remain in compliance. Thus, upstream areas must be maintained in reality at temperatures below the maximum state water quality criteria in order for the waterbody as a whole to comply with the state WQS.

While not every mechanism for protecting existing cold waters applies to each and every waterbody in the state, most of these mechanisms are uniformly applied, and most of the others were developed specifically to target protection of cold waters. Thus, taken in total, WDOE indicates that the implementation programs will help ensure that water temperatures throughout the state will be maintained at or below the standards.

Risk Assessment Summary

To assess the potential effects of the Washington State WQS on bull trout, we conducted a risk analysis that integrated both spatial and non-spatial information. In this way we could evaluate where the effects could occur in relation to bull trout core areas and local populations within Washington, and what level of risk those potential effects present to bull trout and their habitat given their life history needs and baseline conditions. Please refer to Appendix C for the full analysis and methodology used in the risk assessment.

Integrating the results of the core area and local population overall potential effects risk rankings would indicate that the Yakima, Methow, Entiat, and Wenatchee core areas are at greatest risk from the proposed action. The Yakima is of particular concern because of the degraded baseline condition (impassable dams, reversed hydrograph, and temperature standards that restrict migration). Although the Wenatchee and Methow core areas rated out as high risk, the risk is reduced by the early onset of the salmon spawning criterion (the 13 °C effectively applies year-round in the Methow) and the fact that most of the riparian areas are protected under the Northwest Forest Plan. The Asotin rated out as a Moderate-High risk in both the spawning and rearing areas and degraded condition of the FMO habitats. The Nooksack is at Moderate risk because of the exposure to local populations and spawning and rearing habitat, but there is no FMO exposure. Overall, the effects are similar in both areas because of poor population baseline conditions. The following table summarizes the exposure risk and effects of the action by core area (Table 7 in Appendix C).

Table 12. Summary of Overall effects risk rankings for local population and core areas.

	Overall Population Effects Risk		**Overall Core area Effects Risk**
Core Area	**Local Population**	**Rating**	
Yakima			H
	Ahtanum	H	
	Rattlesnake	H	
	Upper Yakima	MH	
	NF Teanaway	MH	
Pend Oreille*			H
Methow			H
	Goat	H	
	Wolf	H	
	Chewack	H	
	Lost	M	
	Twisp	M	
Entiat	Entiat	H	H
	Mad	H	

Wenatchee	Icicle	H	MH
	Chiwawa	M	
Walla-Walla*			MH
Asotin	Charley	MH	MH
Nooksack			M
	Lower SF Nooksack	MH	
Stillaguamish*			M
Snohomish/ Skykomish	SF Skykomish	M	M
Tucannon*			M
Grande Ronde*			M

* Indicates core areas where effects are limited to the FMO habitat. Most of the risk ratings are related to degraded baseline conditions and existing temperature standards that do not protect aquatic life uses.

Indirect Effects (Bull Trout Critical Habitat)

The FWS designated critical habitat based on physical and biological features that are essential to the survival and recovery of bull trout. Essential features or primary constituent elements (PCEs) of designated critical habitat include: 1) water temperatures that support bull trout use; 2) complex stream channels; 3) substrates of sufficient amount, size, and composition to ensure egg and embryo survival and fry emergence; 4) a natural hydrograph; 5) springs, seeps, and groundwater sources to provide cold water; 6) migratory corridors with minimal physical, biological, or water quality impediments; 7) and abundant food base; and 8) permanent water of sufficient quality and quantity such that normal reproduction, growth and survival are ensured. Figure 1 shows bull trout critical habitat that will be affected by the proposed action.

Critical habitat for the bull trout was designated on October 26, 2005 (50 FR 56212). Areas with existing management plans in place that provide adequate protection of water quality were excluded. Examples of areas that were excluded include some Federal lands (areas managed by the National Park Service were not excluded), state and commercial forest lands, areas with approved habitat conservation plans, and Indian reservations.

The FWS has determined that approval of the revised WQS will have insignificant effects on designated bull trout critical habitat in the following units:

Coastal Puget Sound IRU

- Olympic Peninsula (Unit 27)
- Puget Sound (Unit 28)
    - All areas except for portions of the lower South Fork Nooksack, Stillaguamish, Snohomish, Skykomish, and White River.

Columbia River IRU

- Tributaries to the lower Columbia (Unit 19)

- River basins in northeast Washington (Unit 22) – not including the Pend Oreille River
- Local populations in the Snake River Basin (Unit 23) – does not include mainstem
- Transboundary Areas
    - Coeur d'Alene Lake, lower Grand Ronde River, Priest Lake, and Clark Fork.

Application of temperature criteria that do not adequately protect or restore water quality may adversely affect critical habitat in the following areas (see Tables 8 and 9 for exact locations):

- Stream reaches that are designated critical habitat within the middle and upper Columbia River Basin (Unit 20)
- South Fork Nooksack, Snohomish, Skykomish, and White Rivers in Puget Sound (Unit 28).
- All rivers with temperature standards that exceed natural conditions

The proposed action is relevant to the four PCEs that address water quality (PCEs 1, 5, 6, 7 and 8). Within these PCEs, substrate, water quality, water quantity, food, riparian vegetation, natural cover, floodplain connectivity and access, water velocity, space and safe passage are essential physical and biological features. These essential features are necessary to support viable bull trout populations. The proposed action will only affect water quality.

In 2005, the FWS designated approximately 1,519 miles of streams and shorelines in the State of Washington as critical habitat for bull trout. Water quality, particularly temperature, is listed as one of the primary factors limiting bull trout recovery. The WDOE 2006 standards will help to maintain good water quality in areas that are currently functioning properly. In areas where the temperature standards are becoming more stringent (new Char use designation, application of the 13 °C summer spawning and fry emergence standard, and assignment of 16 °C summer core in place of old Class A designation), the condition of critical habitat is expected to improve. However, in areas where the temperature standards did not change, degraded conditions may prevent attainment of the natural thermal potential of the reach in the future. This will result in adverse effects to PCEs 1, 5, 6, and 8. The following summary of effects on critical habitat PCE's, parallels the preceding analysis for effects to individuals and populations of bull trout.

The proposed action has the potential to affect all of these primary constituent elements, both in a positive and potentially negative way (no change to baseline). In areas where the standards will become more stringent, water quality will improve. However, in areas where the standards did not change and baseline conditions are degraded, the proposed action will exacerbate conditions and prolong recovery. Available information is not sufficiently detailed to allow individual analyses of critical habitat for each population of bull trout.

PCE 1 – *Water temperatures that support bull trout use*

Bull trout have been documented in streams with temperatures from 32 °F to 72 °F (0 °C to 22 °C) but are found more frequently in temperatures ranging from 36 °F to 59 °F (2 to 15 °C). These temperatures may vary depending on bull trout life history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence. Stream reaches with temperatures that preclude any bull trout use are specifically excluded from designation.

Although juvenile, subadult, and adult bull trout are periodically documented in water with temperatures that are higher than the optimal range for a particular life stage, unless there is a very abundant prey base (see discussion on metabolism and prey base) it is likely that these warmer temperatures have sublethal effects on the fish. Thus, any action that results in temperatures above optimal levels is considered to have **adverse effects** on critical habitat.

Spawning and Juvenile Rearing Areas

Most spawning occurs at temperatures between 2 °C and 9 °C, with optimal incubation temperatures between 4 °C and 8 °C, and optimal juvenile rearing temperatures between 8 °C and 13 °C. The abundance of juvenile bull trout in a given reach is directly influenced by the size of the population, success of that years' embryo survival, food availability, interactions with other species – including predators, and the quantity and quality of suitable habitat. Water quality is an essential element that defines suitable habitat.

The proposed action will maintain functional PCEs and protect critical habitat in all areas that were designated as "Char spawning and rearing" (with the 9 °C or 12 °C spawning criterion) and temperatures naturally cool prior to the onset of spawning. However, applying temperature standards over 12 °C in areas that are, or may be, used by bull trout for spawning or juvenile rearing, may preclude use by bull trout now and in the future (PCE 1) and affect normal growth and survival (PCE 8) in these areas. All of the 23 streams where the revised standards will not provide adequate protection for reproduction (see Table 9) have segments that are designated as critical habitat. The current data indicates that application of the 9.5 mg/L DO standard likely is inadequate to ensure that oxygen levels within the gravels will be maintained at 8 mg/L in all of the bull trout spawning areas. Applying a DO standard that will not provide adequate oxygen levels for embryo development and survival will have adverse effects on reproduction, growth and survival (PCE 8) of bull trout and will adversely affect critical habitat.

The EPA has determined that not applying the char spawning and rearing and core summer salmonid designated uses, not applying the 9 °C spawning temperature criterion in areas where the existing use should be protected, and approving the warming allowance provision is **likely to adversely affect** designated critical habitat for the bull trout. The FWS concurs with this determination. The FWS has also determined that approving the 9.5 mg/L DO criteria in bull trout spawning and rearing areas is **likely to adversely affect** designated critical habitat for the bull trout.

PCE 6 and 8 – *Freshwater migratory corridors*

In addition to the long period of adult maturation, bull trout have unusually long periods of embryonic development compared to other salmonids. Also, the spawning grounds may be many miles distant from the mouth of the river. Thus the two ends of the reproductive process – the initiation of gamete maturation to spawning – may be greatly separated in time and in space. As a consequence of this temporal and spatial separation, water quality conditions experienced by adults from freshwater entry through migration to the spawning grounds may be directly connected to the developmental success of their offspring many months later. Natural selection favors individuals who time their migration and reproductive cycles when water quality conditions are suitable for each river. These conditions, given the river's natural thermal and flow regime, will allow them to reach the spawning grounds with enough energy to spawn and allow their offspring to develop and emerge in time to feed, grow, and mature.

The proposed action will have varying effects on the function of migratory corridors. The extent of effects will depend on the use designation and the time of year that the summer salmonid spawning temperature criterion will be applied. Migratory corridors are not only used by adult bull trout, but are also used by subadults for growth and maturation. The temperature sensitivities for these two life-history phases can be different depending on the behavioral need of the individual at any given time.

Temperature affects migration timing, growth, disease, and degree of predation on bull trout. Upriver migration to distant spawning grounds is energetically demanding and effects related to prolonged exposure to high temperatures may result in adult mortalities or reproductive failure.

The WDOE 2006 revised standards generally protects water quality and will maintain the function of migratory corridors that are used seasonally by bull trout, especially in western Washington. However, application of temperature standards over 16 °C in areas that are used by bull trout during the summer will have adverse effects on critical habitat and will not provide adequate protection of cold water refugia (PCE 5). In reaches where allowable temperatures are above optimal, bull trout use may be decreased or precluded (PCE 1) and normal growth and survival may be affected (PCE 6 and 8). This could lead to the eventual isolation of local populations and overall reduction in the amount of area that is thermally suitable for bull trout.

Baseline conditions in many of the migratory corridors currently present physical or thermal barriers that impede or preclude bull trout movement and connectivity between local populations during the summer months. For example, high stream temperatures (thermal barriers) and/or low flows/seasonal dewatering of the channel, are listed as primary threats to survival and recovery of bull trout in the Touchet and Asotin River (Walla Walla core area), Entiat, Yakima, and Grande Ronde core areas. Significant progress has been made in Mill Creek and other areas of the Walla Walla core area to restore instream flows and provide fish passage over dams. It is recognized that applying the 17.5 °C temperature criterion in areas where summer temperatures currently exceed the standard should result in a gradual improvement of baseline conditions as TMDL's are implemented. However, applying a temperature standard that is higher than the natural thermal potential of the waterbody, **is likely to adversely affect** bull trout migratory corridors (PCE 6).

PCE 7 – *Effects on bull trout prey resources*

The proposed action is expected to result in **beneficial** effects to the prey base (PCE 7) of bull trout through the application of more stringent temperature criteria in areas that are used by salmon and steelhead for spawning and juvenile rearing. Approval of the new standards should result in a gradual increase in the populations of prey resources as actions that improve water quality are implemented.

In summary, WDOE's 2006 revised standards provide sufficient protection of the freshwater PCEs by setting standards that meet the overall needs of bull trout at the scale of the IRU. Although we do not have sufficient information to determine the extent or location, it is likely that many of the larger rivers in eastern Washington had summer temperatures that were historically warmer than 16 °C. The following table summarizes the overall effects of the action on the function of critical habitat at the unit level.

Table 13: Effects on designated critical habitat from approval of 2006 WQS

Designated critical habitat outside of exclusions* CH Unit	**BT Use**	**2006 Temp. criteria**	**Is the intended recovery function of the CH unit likely to occur and why?**
Coastal Puget Sound Interim Recovery Unit			
Olympic Peninsula Unit 27			
Chehalis, Wynootchee, Wishkah, Satsop, Humptullips River Outer coast, Straits of Juan de Fuca and Hood Canal	FMO outside of core area BT use is seasonal	17.5 °C only on lower rivers 16 °C upstream, 13 °C in many areas	Action will not preclude overall function of CH in this unit. Bull trout use of these areas is seasonal (primarily winter). WQS are adequate to protect intended recovery function of CH that is used seasonally (FMO)
Hoh, Quinault, Queets, Elwha, Dungeness, Skokomish River core areas	CH that supports core populations	16 °C and 13 °C	WQS are adequate to protect core populations and intended recovery function of **CH Unit 27**
Puget Sound Unit 28			
Samish River Nisqually River Green/Duwamish	FMO outside of core area BT use is seasonal	17.5 °C on lower Samish then 16 °C 13 °C on most of Nisqually	Action will not preclude overall function of CH that is used seasonally by bull trout
Chilliwack, Nooksack, lower and upper Skagit, Stillaguamish, Snohomish/ Skykomish, Chester Morse, and Puyallup core areas	CH that supports core populations	17.5 °C in small areas, 16 °C and 13 °C on most	WQS are adequate to protect core populations and intended recovery function of **CH Unit 28**
Columbia River Interim Recovery Unit			
Trans-boundary Units Portions of Units 2, 14, 10			
Clark Fork and Coeur d'Alene Lake	CH that supports core	Char in headwaters	Action is not expected to affect intended recovery function of

	populations		CH in adjacent states (Idaho and Oregon)
Umatilla/Walla Walla Unit 9			
Tributaries to the Walla Walla River	CH that supports core populations	12 °C in headwaters	WQS are adequate to protect local populations
Lewis River Unit 19			
Lower Lewis, White Salmon and Klickitat River	CH that supports core populations	17.5 °C in lower reach, 16 °C and 13 °C on most	WQS are adequate to protect core populations and intended recovery function of **CH Unit 19**
Middle Columbia River Unit 20			
Upper Yakima, Teanaway and Ahtanum Cr populations	Spawning and rearing	16 °C and 17.5 °C in lower reaches	Temp is too high for intended recovery function of CH and may result in reduction of population(s)
Tieton and Naches River	Migration, wintering, and foraging	17.5 °C in lower reach, 16 °C, 13 °C in some areas	WQS are adequate to protect core populations and intended recovery function in this portion of the unit
Northeast Washington Unit 22			
Small, Tacoma, Ruby, Harvey, Cedar and LeClerc	All but LeClerc are PLPs	16 °C and 12 °C	WQS are adequate to protect existing local population in LeClearc Creek and most, but not all, PLPs. Proposed action will not preclude overall function of CH in **Unit 22**
Snake River Basin Unit 23			
Tucannon, Cummins Creek Asotin and George Creek	CH that supports core populations	17.5 °C in lower reach, 16 °C, 13 °C and 12 °C	WQS are adequate to protect core populations and intended recovery function of **Unit 23**

Effects of Interrelated/Interdependent Actions

Interdependent actions are defined as actions with no independent use apart from the proposed action. Interrelated actions include those that are part of a larger action and depend on the larger action for justification. The EPA's approval of NPDES permits and TMDLs based upon these WQS is an interdependent action, but the specifics of such approvals are not known at this time, and will have to be consulted on individually in the future.

The BE states that there are 146 dams within a 500-ft buffer of affected waters, 14 of which are federally-owned. Sufficient monitoring data are not available to assess the impact that each of these dams may have on downstream stream temperatures or DO concentrations. To achieve the temperature criteria on spawning waters and the DO criteria on newly designated core summer salmonid habitat, char habitat, and salmonid spawning, rearing, and migration waters, dam modifications may be necessary. For hydropower dams, any potential actions will be addressed during Federal relicensing and 401 certifications. It is likely that controls necessary to meet the 2003 WQS revisions (i.e., baseline standards) will result in compliance with the 2006 proposed standards.

The BO assumes that riparian buffer requirements and BMPs for timber harvest, road construction, recreational activities, fire management, silvicultural treatments, and research that is conducted on Federal lands and state or private lands with approved HCPs will be in compliance with the 2006 WQS. Actions on Federal lands must meet the criteria outlined in the Northwest Forest Plan and specific National Forest, Bureau of Land Management, or Park management plans. All Federal actions and ongoing operations at Federal facilities must comply with the CWA and ESA. Land management activities that are conducted on Federal lands are not considered interrelated or interdependent to the proposed action.

CUMULATIVE EFFECTS (Bull Trout and Bull Trout Critical Habitat)

Cumulative effects include the 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 ESA.

The human population in the state is projected to increase 41 percent by the year 2030, resulting in higher demands for water in the future (WDOT 2007). The largest increases in population have occurred in the counties along Puget Sound and adjacent to metro areas like Seattle and Spokane. Future anticipated non-Federal actions that may occur in or near surface waters in Washington include timber harvest, grazing, mining, agriculture, urban development, municipal and industrial wastewater discharges, road building, sand and gravel operations, off-road vehicle use, fishing, hiking and camping, water withdrawals and other activities. These non-Federal actions are likely to continue having unquantifiable, but significant adverse effects on bull trout, their habitat, and designated bull trout critical habitat.

There are also non-Federal actions likely to occur in or near surface waters in the State of Washington that are likely to have beneficial effects on the endangered and threatened species. These include implementation of riparian improvement measures, BMPs associated with timber harvest, grazing, agricultural activities, urban development, road building and abandonment, recreational activities, and other nonpoint source pollution controls.

The primary factor that affects stream temperature is non-point sources of pollution. Nonpoint sources that affect instream temperatures and DO concentrations include agricultural and forest practices, water uses, and urban development. Several TMDLs have been completed or are currently being conducted to address existing water quality impairments. TMDLs that address temperature have been completed for the Wenatchee, Stillaguamish, Upper White, Humptulips, Chehalis, Willapa, Wind, Little Kickitat, Walla Walla, and the Teanaway. Others are currently under development, including the Naches, Methow, Palouse, upper Yakima, Columbia, Tucannon, Pend Oreille, Skagit, Stillaguamish, Green, Chehalis, and Lewis Rivers.

For areas that have completed implementation plans, the common theme is for non-federal actions to reduce high stream temperatures with 1) riparian planting, 2) increasing instream flows, 3) improving bank stability, and 4) reducing width:depth ratios. Most of the restoration activities, such as riparian planting and working with farmers and irrigation districts to improve instream flows, rely on voluntary actions that are funded by grants or special programs. Considerable improvements to instream flows have been achieved with farmers shifting from rill irrigation to the more efficient pressurized sprinkler systems, and millions of trees have been planted along rivers and streams to improve shade and bank stability.

Most of the temperature exceedances that are attributable to human alterations of the landscape will take decades to reverse. According to the Wenatchee TMDL, shade targets and temperature standards could be met by 2068 (WDOE 2007). The implementation schedule for the Teanaway indicates that the river may come into compliance with the standards by 2080 (WDOE 2003). The TMDL for the Walla Walla states that once mature riparian vegetation has been established (in about 50 years) and instream flows have been restored, the average maximum temperature during July and August could be 5.9 °C lower than current conditions (WDOE 2007). All of these TMDLs indicate that development of a 100-ft buffer on both sides of the stream should provide maximum effective shading, thus restoring the natural thermal potential and ultimately bringing the water into compliance with the standards. However, addressing non-point sources that affect stream temperatures in several watersheds will require coordination across state lines and dedicated participation from private landowners.

Approved TMDLs for DO in Washington indicate that the DO criteria can be achieved through reductions in stream temperatures, biological oxygen demand, and nutrient (e.g., nitrogen and phosphorus) loads. Riparian buffers not only provide shade and microclimate benefits, reducing stream temperatures, but also provide filtration and serve other functions that reduce nutrient loadings to water. Reduced loadings of nutrients and sediment (including organic matter) will result in reduced biological oxygen demand, which will in turn lead to higher instream DO concentrations. Lower stream temperatures also contribute to higher DO levels, since oxygen is more soluble at lower water temperatures.

Riparian buffers are already required in many instances. The Washington Forest Practices Act and associated rules contain an array of BMPs, including riparian buffer requirements, to protect water quality and achieve other environmental goals. It is anticipated that the revised WQS standards likely will result in stricter buffer requirements for the forestry sector, especially in headwater streams and areas where salmon spawn during the late summer.

As for point sources, compliance with the 2003 WQS revision represents the baseline control scenario for nonpoint sources; only incremental controls and costs needed to achieve further reductions represent the impact of the proposed Rule. However, water quality modeling would likely be needed to determine baseline temperatures after implementation of controls (including riparian buffers) needed to attain the 2003 revision. An upper-bound scenario of the extent of riparian buffers that may be needed is all potentially plantable land adjacent to affected waters; this scenario likely overstates acreage needed and costs for compliance with the proposed Rule.

Based on GIS analysis of USGS land cover data, there are 39,300 acres of agricultural, urban, or other potentially plantable (not including forest lands) land within 100 ft of waters affected by the proposed Rule. The WDOE estimates that it would cost approximately $5.2 million annually to plant riparian buffers along the newly designated core summer salmonid habitat and char waters. Although progress is slow and costly, approving the revised temperature standards should ultimately result in reduced stream temperatures in the future.

State laws that protect instream water flows do not affect existing rights for water use (WDOE 2004d). The ongoing removal of water associated with irrigation withdrawals and water rights will continue to affect instream flows and stream temperatures in many areas. To enhance instream flows, the State can purchase existing water rights from willing owners. In these instances, the State bears the cost voluntarily (which implies that the benefits exceed the costs).

Global Climate Change

One of the most significant cumulative effects to bull trout and their associated aquatic habitat throughout the state of Washington is climate change. Climate change, and the related warming of global climate, has been well documented in the scientific literature (IPCC 2007; ISAB 2007; WWF 2003). Evidence includes increases in average air and ocean temperatures, widespread melting of snow and 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. Further, some climate models predict 10 to 25 percent reductions in late spring, summer, and early fall runoff amounts in the coming decades.

Climate change has the potential to profoundly alter the aquatic habitat through both direct and indirect effects (Bisson et al. in press). Direct effects are evident in alterations of water yield, peak flows, and stream temperature. Indirect effects, such as increased vulnerability to catastrophic wildfires, occur as climate change alters the structure and distribution of forest and aquatic systems. Observations of the direct and indirect effects of global climate change include changes in species ranges and a wide array of environmental trends (ISAB 2007; Hari et al. 2006; Rieman et al. 2007). In the northern hemisphere, ice cover durations over lakes and rivers have decreased by almost 20 days since the mid-1800s (WWF 2003). For many species, their ranges have shifted towards the poles and higher in elevation. For cold-water associated salmonids in mountainous regions, where upper distribution is often limited by impassable barriers, an upward thermal shift in suitable habitat can result in a reduction in range, which in turn can lead to a population decline (Hari et al. 2006).

In the Pacific Northwest, most models project warmer air temperatures and increases in winter precipitation and decreases in summer precipitation. Warmer temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, stream flow timing will change, and peak flows will likely increase. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Data taken from long-term stream monitoring stations in western Washington indicate a marked increasing trend in temperatures in most major rivers over the past 25 years (WDOE 2007).

Bull trout rely on cold water throughout their various life stages and increasing air temperatures likely will cause a reduction in the availability of suitable cold water habitat. For example, ground water temperature is generally correlated with mean annual air temperature and has been shown to strongly influence the distribution of char species. Groundwater temperature can also be linked to bull trout selection of spawning sites and has been shown to influence the survival of embryos and early juvenile rearing of bull trout (Rieman et al. *in press*). Increases in air temperature are likely to be reflected in increases in both surface and groundwater temperatures.

Climate change is already affecting the frequency and magnitude of fires, especially in the warmer, drier regions of the west. To further complicate our understanding of these effects, the forest that naturally occurred in a particular region may or may not be the forest that will be responding to the fire regimes of an altered climate (Bisson et al. *in press*). In several studies related to the effect of large fires on bull trout populations, bull trout appear to have adapted to past fire disturbances through mechanisms such as dispersal and plasticity. However, as stated earlier, the future may well be different than the past and extreme fire events may have a dramatic effect on bull trout and other aquatic species, especially in the context of continued habitat loss, simplification and fragmentation of aquatic systems, and the introduction and expansion of exotic species (Bisson et al. *in press*).

Migratory bull trout can be found in lakes, large rivers and marine waters. Effects of climate change on lakes are likely to impact migratory adfluvial bull trout that seasonally rely upon lakes for their greater availability of prey and access to tributaries. Climate-related warming of lakes will likely lead to longer periods of thermal stratification, forcing coldwater fish such as bull trout to be restricted to the bottom layers for greater periods of time. Deeper thermoclines resulting from climate change may further reduce the area of suitable temperatures in the bottom layers and intensify competition for food (WWF 2003).

Bull trout require very cold water for spawning and incubation. Suitable spawning habitat is often found in accessible higher elevation tributaries and headwaters of rivers. However, impacts on hydrology associated with climate change will cause shifts in timing, magnitude, and distribution of peak flows that are also likely to be most pronounced in these high elevation stream basins (Battin et al. 2007). The increased magnitude of winter peak flows in high elevation areas is likely to affect spawning and incubation habitat for bull trout and Pacific salmon. Although lower elevation rivers are not expected to experience as severe an impact from alterations in stream hydrology, they are generally not cold enough for bull trout spawning, incubation, and juvenile rearing.

As climate change progresses and stream temperatures warm, thermal refugia will be critical to ensure the persistence of bull trout and other cold water dependent species. Thermal refugia are important for providing bull trout with patches of suitable habitat while allowing them to migrate through, or to make foraging forays into, areas with greater than optimal temperatures. Juvenile rearing may also occur in waters that are at or above optimal temperature, but these rearing areas are usually in close proximity to colder tributaries or other areas of cold water refugia (EPA 2003).

There is still a great deal of uncertainty associated with predictions of timing, location, and magnitude of climate change. It is also likely that the intensity of effects will vary by region (ISAB 2007). However, the long term water quality monitoring data and several studies have revealed that climate change does have the potential to impact ecosystems throughout the state of Washington (ISAB 2007, Battin et al. 2007; Rieman et al. 2007). In water bodies where temperatures are already at or above the WQS, there is little if any likelihood that bull trout will be able to adapt to or avoid the potential adverse effects of climate change. There is little doubt that climate change is and will be an important factor affecting bull trout distribution. As distribution contracts, patch size decreases and connectivity is truncated; populations that are currently connected may become thermally isolated, which could accelerate the rate of local extinction beyond that resulting from changes in stream temperature alone (Rieman et al. 2007). In areas with already degraded water temperatures or where bull trout are at the southern edge of their range, they may already be at risk of impacts from current as well as future climate change.

The research indicates that temperatures in many areas will continue to increase due to the effects of global climate change. According to model predictions, average temperatures in Washington State are likely to increase between 1.7 °C and 2.9 °C (3.1 °F and 5.3 °F) by 2040 (Casola et al. 2005). The FWS believes that it is vital to maintain or restore stream temperatures as close to natural conditions as possible if bull trout and other cold-water dependent species are to persist.

INTEGRATION AND SYNTHESIS

The preceding analysis of bull trout and its critical habitat at the range-wide and action area scales, and the effects of the action and cumulative effects on the bull trout and its critical habitat, form the foundation for determining if the proposed action is reasonably expected to appreciably reduce the bull trout's likelihood of survival and recovery in the wild due to a reduction in its reproduction, numbers, or distribution (i.e., jeopardy), and/or reduce the capability of the primary constituent elements of critical habitat to function in a manner that will support the recovery of the bull trout (i.e., destruction or adverse modification). This section describes the key findings of these analyses and discusses them at the local population, core area, IRU, and critical habitat unit scales.

Key Findings Relative to Bull Trout and the Primary Constituent Elements of Designated Critical Habitat

- The conservation role of each IRU is to maintain or expand the current distribution of the bull trout within core areas; maintain stable or increasing trends in bull trout abundance; maintain/restore suitable habitat conditions for all bull trout life history stages and strategies; and conserve genetic diversity and provide opportunities for genetic exchange. Collectively, these criteria constitute the intended survival and recovery function of the IRUs.

- Bull trout are threatened by the combined effects of habitat degradation and fragmentation associated with dewatering, road construction and maintenance, mining, grazing, the blockage of migratory corridors by dams or other diversion structures, poor water quality, entrainment (a process by which aquatic organisms are pulled through a diversion or other water control structure), introduced non-native species, poaching and incidental mortality during other targeted fisheries.

- Maintaining viable populations of the bull trout is essential to conserving the bull trout at the core area, IRU, and range-wide scales (USFWS 2004). Core areas are the smallest scale for restoring/maintaining a functioning metapopulation of bull trout because they contain the habitat qualities necessary for bull trout to spawn, rear, forage, overwinter, and migrate and the contiguous habitat necessary to minimize local extirpations of the bull trout due to catastrophic events.

- Human alteration of the landscape has generally increased river temperatures and lowered dissolved oxygen levels, particularly in bull trout migratory corridors. These effects have reduced the number of river segments suitable to meet the bull trout's life history needs.

- According to WDOE's most recent Clean Water Act section 305(b) analysis, water quality in approximately 86 percent of streams in the state of Washington is generally adequate to support the existing aquatic life uses. Of the water bodies that are impaired, 30 percent are due to high water temperature and 15 percent are due to low levels of dissolved oxygen.

- The Columbia River Basin and large rivers in the Puget Sound lowlands have the highest levels of temperature-related impairments, while the percent of impaired streams is much lower for streams in the Cascade, Olympic, and Blue Mountains. Most temperature and dissolved oxygen impairments are in bull trout migratory corridors or the lower reaches of bull trout spawning and rearing areas. However, water quality problems do occur in some of the upper watersheds, such as areas where the riparian vegetation has been removed by logging, grazing, agriculture, or development.

- The proposed action is expected to result in long-term improvements of water quality in areas where the WQS became more stringent than the old standards and/or adequately protect the most sensitive existing aquatic life uses. Additional beneficial effects to bull trout are anticipated in areas where the seasonal summer spawning temperature criteria will be applied.

- The proposed action is likely to cause adverse effects to individual bull trout and to the primary constituent elements associated with water quality of some segments of bull trout critical habitat by allowing for higher than natural water temperatures in some stream reaches; these effects are expected to continue in perpetuity unless new temperature standards are established for these stream reaches via the triennial review process.

- The effects of the proposed action relative to the DO standard, which was changed in four bull trout spawning reaches where the temperature standards were also changed, will only occur through 2009. The magnitude and consequences of those effects on the bull trout and its critical habitat are summarized below.

- The bull trout and its critical habitat will continue to be threatened by factors identified in the final listing rule related to the effects of ongoing actions, future actions, and impacts caused by global climate change.

- The effects of the proposed action are expected to be beneficial to individual bull trout and to the primary constituent elements of its critical habitat that address water quality in all areas where the standards are adequate to protect the life history stages of the bull trout. The proposed action will adversely affect sub-adult and adult bull trout and the primary constituent elements of critical habitat that address water quality during the summer in migratory corridors that were not designated as "core summer salmonid habitat" (Table 10). Juvenile bull trout and the primary constituent elements associated with water quality are likely to be adversely affected in areas that were not designated as "char spawning and juvenile rearing" (Table 9). Although most of these effects are likely to be sub-lethal, some affected bull trout may be killed or injured as a result of the action.

- Overall, implementation of and compliance with, the revised standards are likely to improve water quality (i.e., provide cooler temperatures) in more than half of the streams statewide that currently support bull trout, especially in areas that are used by bull trout and other salmonids for reproduction and juvenile-rearing. For example, compliance with the revised WQS will result in a 4 °C decrease in temperature in water bodies that are now designated as "char spawning and rearing." Although the new char use designation applies to approximately 20 percent of the water bodies in Washington, we are unable to quantify or measure the extent of beneficial effects that the new use designation will provide because many of these streams are in areas where temperatures are already naturally cool.

- The proposed action will also result in a reduction of stream temperatures by several degrees in all areas that were formerly Class A or AA and are now designated as "core summer salmonid habitat" (approximately 30 percent of the water bodies in the State) with seasonal application of the salmon spawning temperature criterion (13 °C late summer through late spring). The temperature standards were also lowered by several degrees in some areas that were formerly Class B and are now designated as "salmonid migration and rearing."

- The baseline condition will remain unchanged in areas where the current temperature standards are retained. The Yakima, Columbia, Walla Walla, Pend Oreille, Grande Ronde, and Snake Rivers have special provisions that allow temperatures of 20 °C and 21 °C related to human actions. These temperatures were not addressed in the proposed action.

- Prolonged exposure to temperatures at or above 18 °C is expected to increase the risk of disease, predation, and thermal stress to bull trout, resulting in a significant impairment of behavior, a reduction in the amount of suitable habitat, and likely mortality. Because the EPA did not disapprove the Special Temperature Provisions, these provisions are not considered part of the proposed action.

- The only stream reaches where the DO standard was changed are listed in Table 11. Although the DO criterion was increased from 8 mg/L to 9.5 mg/L in these areas, the higher standard is not adequate to ensure successful embryo development and fry emergence in bull trout spawning areas. Based on the physical factors that affect oxygen levels, the cross-over or threshold temperature where the DO standard will become limiting and result in adverse effects to bull trout is around 10 °C. The FWS estimates that, at temperatures below 10 °C, the 9.5 mg/L DO standard will provide less protection than the natural condition, resulting in increased mortality of developing embryos and fry.

- Because the DO criterion was only changed in a few areas, we limited our analysis and extent of adverse effects associated with approval of this standard only to the bull trout spawning reaches in Hutchinson Creek, the Carbon River, Teanaway Creek, and Ahtanum Creek. The Teanaway Creek and Ahtanum Creek local populations are already at high risk with respect to the baseline population (annual spawner abundance is between 50 and 100 and is declining, and the migratory form is nearly absent (see Table 5 in Appendix C). Applying a DO criterion that would allow oxygen levels to drop below 8 mg/L in the gravels will not provide adequate protection for bull trout reproduction and could result in the extirpation of local populations. Based on a review of WDOE's permitted facilities, it does not appear that there are any current point sources or permitted facilities that will affect oxygen levels in the spawning areas listed in Table 11. Therefore, we expect the risk to bull trout in spawning and rearing areas from point source permits to be very low.

- Due to the fact that naturally cold temperatures will ensure adequate DO levels in the areas and at the time of year when bull trout are spawning, as well as the limited scope and duration of the action (2007 to 2009), approval of the interim DO standard in some bull trout spawning areas is not expected to cause a measurable decline in populations in the affected areas. The WDOE will revise the DO standard in all salmonid spawning areas if it is determined that the 9.5 mg/L criterion is inadequate to ensure the 8 mg/L minimum needed in the gravel for successful embryo development and fry emergence. Consultation on this matter will be reinitiated when EPA approves the final DO criterion for the entire state.

Key Findings Relative to Bull Trout Critical Habitat at the Unit Scale

- The recovery role of bull trout critical habitat units is to support viable core area populations of the bull trout (USFWS 2004b). The proposed action will adversely affect PCE 1 (water temperature), PCE 5 (cold water sources), PCE 6 (migratory corridors), PCE 7 (abundant prey base), and PCE 8 (water quality) in areas where inadequate WQS will be applied (see Tables 8-10) and will have neutral or beneficial effects in areas where the revised standards protect the existing aquatic life uses.

- Similar to the effects of the action on individual bull trout, the indirect effects to critical habitat are expected to continue in perpetuity, unless WDOE revises the standards through the triennial review process. While the effects of approving temperature standards that are above optimal for bull trout may prolong the time needed to restore bull trout populations in a few small areas, we anticipate that critical habitat Units 2, 9, 10, 14, 19, 22, 23, 25, 27 and 28, will retain their ability to serve their intended conservation role (see Table 13) because the standards generally reflect natural seasonal thermal patterns and will not preclude bull trout use of critical habitat during the most important times of the year relative to their biological/life cycle needs. Application of the summer salmon spawning criterion will ensure that critical habitat will meet the intended conservation role in many areas where the designated uses are not adequate for the bull trout because it provides additional cold water protection, which will support bull trout life cycle needs.

- Approving temperature criteria that are inadequate for bull trout will allow adverse effects to continue in the migratory corridors and several spawning and rearing areas in Unit 20 (Yakima). The proposed action will also impair the function of some spawning and rearing areas and preclude restoration of bull trout populations in areas that are currently unoccupied.

- The existing temperature standard which was not changed as part of the action on the Yakima River from the confluence of Ahtanum Creek (RM 108) to the mouth of the Cle Elum River (RM 186) constitutes an 80-mile thermal barrier for bull trout migration. The Yakima River is currently temperature-impaired and TMDLs are being conducted to determine what actions are needed to bring the tributaries into compliance with the WQS. If it is determined that the existing temperature standard on the mainstem exceeds the natural condition, the 21 °C criterion will need to be revised (see WDOE letter, dated January 28, 2008).

- The ongoing adverse effects that are occurring to bull trout critical habitat in Unit 20 are largely related to past actions that are currently contributing to the degradation of water quality. Bull trout use of most migratory corridors is seasonal and they have evolved to avoid areas where water temperatures are high during the summer months. However, past actions have significantly altered the natural flow and seasonal temperature patterns in many areas, resulting in the isolation of bull trout populations and a reduction in the amount of suitable habitat that is available for bull trout use. Given the degraded condition of the baseline, the proposed action will prolong recovery of the three fluvial populations of bull trout and will prevent critical habitat in Unit 20 from providing fully functional habitat in some areas.

- The proposed action will not result in a change in baseline conditions or affect critical habitat in areas that are currently on the 303(d) list of impaired waters for temperature and/or DO. However, approving a temperature standard that is higher than the natural condition will impair the function of the unit in the future by preventing the waterbody from being added to the 303(d) list, thus reducing the likelihood for restoration of that function. Information on the natural thermal potential of a given waterbody is generally not available until a watershed assessment or TMDL is conducted. Implementation of actions to address non-point sources of pollution that are outlined in TMDLs are voluntary and incentive-based. Where water quality is impaired, primarily due to non-point sources of pollution, improvements in water quality and the eventual achievement of the standards in the future will depend on the successful implementation of these voluntary actions.

Key Findings Relative to Effects of the Action on Local and Core Populations of the Bull Trout

- Eighty-three percent of bull trout spawning and rearing areas in Washington will be adequately protected by the "char spawning and rearing" use designation. Most of the bull trout spawning and rearing areas that will not be protected by the 12 °C temperature criterion are either unoccupied or are located in the lower sections of rearing areas that are used primarily by older juveniles. Cold water in many areas like the Nooksack, Skykomish, Puyallup, Klickitat, Methow, Entiat, Chiwawa, Wenatchee, Tucannon Rivers and Icicle Creek will be protected with nearly year-round application of the 13 °C salmon spawning criterion. While the 13 °C temperature standard is not as protective as the char use designation, the prolonged application of the 13 °C salmon spawning temperature criterion in these areas is compatible with the life history requirements of the bull trout in the Nooksack, Snohomish, Puyallup, Tucannon, Wenatchee, Entiat, and Methow core areas.

- The salmon spawning criterion will also provide seasonal protection for juvenile bull trout in the upper Naches River. However, the revised temperature standards do not provide adequate protection for several local populations of bull trout in the Yakima core area. Although the Yakima is the largest core area in the action area, bull trout populations there are unstable and decreasing. The proposed action will adversely affect three (Ahtanum Creek, upper Yakima River, and Teanaway Creek) of the 16 local populations that are not protected by the salmon spawning criterion, and will maintain degraded habitat conditions in Taneum Creek, which is needed for recovery of bull trout in the future (potential local population).

- Because of the lack of fish passage at several dams, the Ahtanum, upper Yakima, and Teanaway local populations are the only migratory forms remaining in the Yakima core area. Ahtanum Creek has fewer than 20 adult spawners, making this local population extremely vulnerable to stochastic events and genetic drift. Applying the 16 °C temperature criterion on the lower 20 percent of the spawning and rearing areas of the Ahtanum Creek and Teanaway Creek local populations will reduce the area that is suitable for juvenile rearing and potential spawning in the future.

- Not applying the 12 °C temperature criterion in 60 percent of the area currently used by bull trout for spawning and juvenile rearing in the upper Yakima River is anticipated to measurably reduce the likelihood of persistence of this local population, but is not expected to measurably reduce the likelihood of persistence of the remaining local populations and the core area as a whole for the following reasons: 13 of 16 local populations will be adequately protected, and compliance with the new char use designation is likely to result in long-term improvements in the temperature baseline condition in Ahtanum Creek and Teanaway Creek.

- The temperature standards in the Yakima River, Walla Walla, Grande Ronde, Snake, Columbia, and Pend Oreille Rivers were not changed and are therefore not part of the action. The numeric temperature criteria in these rivers will be evaluated as TMDLs are completed in these areas. Although these temperature standards are well above the 15 °C threshold that is known to limit the distribution and abundance of bull trout, the connectivity of bull trout populations is likely to be reduced only in areas where, and at the time of year when, the standards exceed the natural condition.

Effects of the Action on the Coastal-Puget Sound IRU

- Implementation of the proposed action is not expected to result in significant, long-term, impacts to the survival and recovery needs of bull trout in this IRU because it will provide better thermal protection than existing temperature standards for over 90 percent of the bull trout local populations and migratory corridors within the unit to the extent that water temperatures that meet the proposed standards will contribute to maintaining and restoring bull trout populations in that unit. Application of the 17.5 °C temperature criterion in some portions of the lower rivers (Snohomish, Stillaguamish, Samish, Wishkah, White, Puyallup, Chehalis, and Humptulips) is not likely to preclude the passage function of these migratory corridors. Current summer maximum temperatures already exceed 17.5 °C in most areas and the proposed standard generally reflects the natural thermal potential of rivers on the west side. Application of the 13 °C and 16 °C temperature criteria is likely to provide additional cooling upstream of agricultural and urban areas and implementation of the antidegredation policy will protect water bodies with temperatures that are colder than the standard. Although individual bull trout may be present year-round in the lower reaches of rivers, most of the use of the lower rivers occurs in the winter and spring when water temperatures are lowest and when adult and subadult bull trout are moving into or out of the marine environment.

- Because DO is driven by temperature and the two affected spawning streams (Carbon River and Hutchinson Creek) are located in areas with management plans that will protect cold water, the effects to bull trout related to the approval of the DO standard will not result in a measurable decline of populations or impacts to the conservation needs of bull trout in the Coastal Puget Sound IRU.

Effect of the Action on the Columbia River IRU

- The Columbia River IRU includes all of Washington, Oregon, Idaho, and Montana. Approximately 15 percent of this IRU is within the action area. The proposed action will improve thermal protection within approximately 80 percent of the occupied spawning and rearing areas and 25 percent of the migratory corridors in the action area to the extent that the water temperatures are likely to support successful completion of bull trout spawning, rearing, and migration activities. Adverse effects associated with the proposed action are anticipated in 20 percent of the bull trout spawning and rearing areas and will continue to occur in areas where the WQS were not revised and baseline conditions are degraded.

- Approximately one third of the spawning and rearing areas with inadequate temperature standards are currently unoccupied. The remaining areas are within the lower reaches of streams that are largely used by juvenile bull trout. Most of these areas are also used by other salmonids. Seasonal application of the 13 °C temperature criterion will provide additional cold water protection in areas used by juvenile bull trout.

- Adverse effects to bull trout associated with retaining current WQS are anticipated in the migratory corridors that were not designated as "core summer salmonid habitat." Bull trout (and other salmonids) evolved seasonal movement patterns that allowed them to pass through the lower rivers before temperatures got too hot, and reach their spawning areas in time for temperatures to naturally drop in the fall. Human alterations to the landscape have created barriers to migration and have significantly impacted stream flows and temperatures in many of the areas that support bull trout in the Columbia River IRU. Dams and diversions delay migration and reduce or reverse instream flows, resulting in bull trout being exposed to summer temperatures that they historically would have been able to avoid. Although individuals can find thermal refugia in the stratified layers of large reservoirs or at the base of dams, they are often trapped in these areas until they can find passage or temperatures are suitable to allow movement away from the cool water. Applying temperature standards that exceed the natural thermal potential of the waterbody, or present thermal barriers to migration, will allow ongoing adverse effects to continue in many areas.

- Because areas that support bull trout spawning are generally in protected areas and have good water quality, the effects of the proposed action to bull trout related to the approval of the interim DO standard will not result in a measurable decline of bull trout populations in the Teanaway and Ahtanum Creek. The DO standard will be addressed in 2009 and may need to be revised statewide if it is determined that the 9.5mg/L criterion does not provide adequate protection for egg development and fry emergence.

- Based on a review of all available stream temperature data from WDOE's website (20 years for some long-term monitoring stations), afternoon temperatures in many of the larger rivers in Washington have been increasing and currently exceed 18 °C during the summer. Although these temperatures include effects of human actions, modeling results indicate that water temperatures in eastern Washington were historically warmer than on the west side during the summer. Based on these geographic differences, not designating all of the bull trout migratory corridors in eastern

Washington that are as “core summer salmonid habitat” is probably appropriate because the natural condition of the larger rivers on the east side likely is above 16 °C. Therefore, we anticipate that seasonal use by bull trout will only be affected in a fraction of the migratory corridors with inadequate thermal protection.

- The proposed action is likely to result in improved water quality in most areas that are used by bull trout for reproduction and juvenile rearing. This will ensure long-term viable populations of bull trout in the most critical areas. Bull trout use of the larger rivers is seasonal, application of inadequate temperature standards will only affect a fraction of the migratory corridors, and the proposed action will not prevent genetic exchange or preclude the various life history stages of bull trout from using suitable habitat when they need to. Consequently, we have determined that the proposed action will not appreciably reduce the likelihood of survival and recovery of bull trout in the Columbia River IRU.

CONCLUSION

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of EPA’s proposed approval of revised Washington WQS for temperature and DO, and the cumulative effects, it is the FWS's biological opinion that the proposed approval of the revised Washington WQS is not likely to jeopardize the continued existence of the bull trout and is not likely to destroy or adversely modify designated bull trout critical habitat for the following seven reasons.

1. The various temperature criterion and provisions that EPA is proposing to approve, in combination, are likely to provide better thermal protection than existing temperature standards for over 90 percent of the bull trout local populations and migratory corridors within the Coastal-Puget Sound IRU and for about 80 percent of occupied spawning and rearing areas and 25 percent of the migratory corridors in the action area within the Columbia River IRU. Water temperatures that meet the proposed standards will contribute to maintaining and restoring bull trout populations in both of these units.
2. Approval of the proposed WQS should result in long-term improvements in baseline conditions in areas where temperature standards became more stringent (> 50 percent of the action area). In areas where the standards were not changed, baseline conditions will remain the same. In stream reaches that are currently temperature-impaired (exceeding the standards), the effects of the action will not be measurable until baseline conditions improve to the level of the standards.
3. Approval of temperature standards that exceed natural conditions is likely to impair or delay recovery of some bull trout populations and may prevent some areas of designated critical habitat from fully meeting its recovery function. These effects will continue into perpetuity.
4. Approval of the DO criteria in specific areas will not result in a measurable change in the baseline condition. The WDOE is currently conducting a study to determine if the 9.5

mg/L DO criteria provide adequate protection to ensure the 8 mg/L needed for bull trout egg incubation and embryo development in gravels. Based on the results of the study, the DO standard may need to be revised in all water bodies that support spawning and rearing.

5. Application of the “Char spawning and rearing” use designation (12 °C temperature criterion) is not likely to result in an appreciable reduction of spawning and rearing habitat in 83 percent of the Coastal-Puget Sound and Columbia River IRUs for the following reasons:

    a. The new char use designation is likely to provide better thermal protection in areas used by bull trout for spawning and rearing than was provided under the old standards because it is within the range of temperature that the bull trout requires to successfully complete its life cycle.

    b. The 12 °C temperature criterion applies during the hottest time of year and the furthest downstream extent of the use designation. It is anticipated that temperatures are likely to drop naturally below 9 °C in time for spawning and provide adequate protection for egg incubation and embryo development over the winter. This assumption has been validated in areas where bull trout spawning and juvenile use is documented.

    c. The 13 °C summer salmon spawning temperature provision is likely to provide some protection for juvenile bull trout in areas that were not designated as “Char spawning and rearing.”

6. Application of the “Core summer salmonid habitat” designation (and 13 °C summer spawning criterion in many areas) will ensure cold water protection in most of the migratory corridors of the Coastal-Puget Sound IRU and some of the migratory corridors in the Columbia River IRU.

7. Application of the 17.5 °C temperature criterion is not expected to preclude bull trout use of the migratory corridors for the following reasons:

    a. The criterion applies during the hottest time of year and must be met at the furthest downstream extent of the use, which significantly reduces bull trout exposure to this temperature. Bull trout use of the lower rivers is largely seasonal and most individuals will have passed through the area or found areas of cooler water during the hottest time of year.

    b. This temperature criterion applies during the time of year and in areas where it generally reflects the natural thermal pattern.

    c. Approval of this temperature criterion will not result in a measurable degradation of the baseline conditions.

    d. Since temperatures in most of the lower rivers in Washington State exceed the standard, baseline conditions should gradually improve as TMDLs are implemented to meet this standard; this will benefit the bull trout.

    e. The antidegradation policy will provide protection for waters that are currently meeting or are colder than the standard.

f. The summer salmon spawning temperature criterion will provide additional thermal protection in the upper reaches of bull trout migratory corridors that were not designated as "Core summer salmonid" use.

INCIDENTAL TAKE STATEMENT

Sections 4(d) and 9 of the ESA, as amended, prohibit taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or attempt to engage in any such conduct) of listed species of fish or wildlife without a special exemption. Harm is further defined by the FWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by the FWS as intentional or negligent actions that create the likelihood of injury to listed species 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(a)(2) of the ESA, taking that is incidental to and not intended as part of the agency action is not considered a prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the EPA, as appropriate, in order for the exemption in section 7(a)(2) to apply. The EPA has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the EPA 1) fails to require WDOE to adhere to the terms and conditions of this Incidental Take Statement, and/or 2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) of the ESA may lapse.

The EPA will utilize its CWA authorities as necessary to ensure that the below terms and conditions are met. Generally, it is expected that the EPA will ensure that WDOE implements the measures below through EPA's general coordination and oversight of the WDOE water program.

Form and Amount or Extent of Take

Based on the biological effects described above under the "Effects of the Action" section, implementation of the proposed action is likely to cause the incidental take of the bull trout in the form of harm and harass.

Quantifying and detecting that take in terms of individual bull trout is not possible for specific locations because of the variable distribution and abundance of the bull trout in the action area during the course of its annual life cycle, especially in response to year-to-year variation in the timing and magnitude of stream flows within occupied bull trout habitat. Detecting the take will be very difficult for those reasons as well as 1) the primarily nocturnal activity patterns of the bull trout, 2) their tendency to hide in or near the substrate, 3) their relatively small body size, 4) the cryptic coloration and behavior of juvenile and sub-adult bull trout, 5) a high rate of removal of injured individuals by predators or scavengers, 6) the uncertainty of volitional movement by migratory-size bull trout, and 7) the need to use snorkeling techniques to detect bull trout.

For the above reasons, a spatial/temporal habitat surrogate has been developed to express the extent of take associated with implementation of the proposed action because it is the effects of the action on bull trout habitat that are likely to cause the take. On that basis, the following levels of take are anticipated:

1. Approving water temperature criteria and beneficial use designations that, at certain times and in certain areas, are likely to injure or kill bull trout by significantly impairing their feeding, breeding, and sheltering behavior.

Spawning and Rearing Areas

Optimal temperatures for bull trout egg incubation and embryo development are between 2 and 6 °C; temperatures < 9 °C are required for initiation of spawning, optimal temperatures for juvenile rearing are in the range of 8 to 12°C, and gamete viability is reduced at temperatures > 13 °C. In areas where it is demonstrated that the natural thermal condition exceeds 12 °C or stream temperatures exceed the standard (i.e. impaired), take is not attributable to the proposed action. Based on these biological requirements, the following take of bull trout is anticipated in areas that are used for spawning and juvenile rearing:

- All juvenile bull trout in spawning and rearing areas listed in Table 9, where approval of the WQS will allow summer maximum temperatures to exceed 12 °C, will be taken in the form of harm. Most of this take is likely to involve sublethal effects to affected bull trout that result in their suboptimal growth and development. However, some mortality may occur to individuals due to an increased risk of predation and disease. The duration of this take is estimated to be from June to September of each year and will continue into perpetuity or until the standards are revised to protect bull trout in these areas.
- In situations listed in Table 9 where temperatures in the gravel exceed 6 °C, eggs and developing embryos may be harmed. Most of this take is likely to involve sublethal effects to eggs and embryos that result in their suboptimal development. The duration of this take is estimated to occur from April through mid-May of each year.
- All juvenile and holding, pre-spawning adult bull trout that are displaced in response to rising temperatures that are allowed to exceed 12 °C, are likely to be taken in the form of harassment. Reproductive success will also be affected by reduced gamete viability in adults that are holding in areas where temperatures exceed 13 °C. The extent of take involves the lower reaches of the spawning and rearing areas listed in Table 9 where the natural thermal condition is at or below 12 °C. These stream reaches are used year roung by juvenile bull trout and seasonally by pre-spawning adults. The duration of this take is estimated to be from June to September of each year and will continue into perpetuity, unless the standards are revised to protect bull trout in these areas.

Foraging, Migration, and Overwintering Areas

Bull trout distribution and abundance is limited at temperatures over 15 °C, increased risk of disease and reduced fitness occurs at temperatures over 18 °C, migration is blocked and prolonged exposure to temperatures over 20 °C results in mortality. In areas where stream temperatures exceed the standard (i.e. impaired water bodies), take is not attributable to the proposed action. Based on these biological requirements, the following take of bull trout is anticipated in areas that are used by bull trout during the summer for migration and foraging:

- All adult and subadult bull trout that are foraging, rearing, or migrating in areas where approval of the WQS will allow summer (between June and September) maximum temperatures to exceed 16 °C are likely to be taken in the form of harm. Individuals that are unable to access cold water refugia and are exposed to temperatures above 18 °C for extended periods of time will experience thermal stress, impaired growth, and increased risk of disease. Most of the take of adult and subadult bull trout in migratory corridors is likely to involve sublethal effects. However, some individuals may be killed resulting from competition with, or predation by, other fish species that prefer warmer temperatures. Migration is blocked and mortality can occur during prolonged exposure to temperatures exceeding 20 °C. The extent of this take includes the portions of the rivers and tributaries listed in Table 10 where the natural thermal condition is colder than the proposed standard.

- All bull trout that use the migratory corridors listed in Table 10 between June and September are likely to be taken (when temperatures exceed 16 °C) in the form of harass due to excessive water temperatures allowed under the WQS, in perpetuity. For those areas listed in Table 10 where it is demonstrated though a TMDL or UAA that the applicable criteria cannot be attained due to natural conditions, take of bull trout will not be attributed to the proposed action.

2. Approval of a DO criterion that may not provide adequate oxygen levels to protect bull trout eggs and embryos that are developing in the gravel:

    - Mortality of eggs and embryos is likely to occur in some of the spawning areas where the EPA is proposing to approve the 9.5mg/L DO criterion. That DO criterion will not provide adequate protection for embryo development and fry emergence in the following bull trout spawning areas listed in Table 11: Hutchinson Creek, the Carbon River, Teanaway River (including its tributaries), and Ahtanum Creek.

    - Data indicate that embryo survival is less than 40 percent at oxygen levels of 6.5 mg/L (3 mg/L difference between water column and intergravel) and drops to zero at 5 mg/L. Approval of a DO criterion that does not ensure a minimum of 8 mg/L in the gravels is likely to result in mortality of eggs, embryos, and fry and will have a significant effect on the reproductive success of the four local populations listed above. The duration of incidental take resulting from approval of the interim DO criterion is for the duration of incubation (starting as early as

August and generally extending to mid- May) and is expected to continue annually until 2009, or when the DO standards are revised, whichever is sooner.

3. Approval of provisions that are likely to cause sublethal physiological effects that result in injury or mortality of affected bull trout, and cause significant disruptions of bull trout movement and foraging behavior in and around mixing zones:
   - All juvenile, subadult, and adult bull trout that are exposed to mixing zones are likely to be taken in the form of harm. Exposure to temperatures over 30 °C for just a few seconds can lead to instantaneous death in salmonids. NPDES permits allow point source facilities to discharge at temperature up to 33 °C for a short distance within the acute mixing zone. Individual bull trout that are exposed to high temperatures at the end of the pipe for more than a few seconds will be injured or killed. However, it is extremely unlikely that bull trout would be exposed to lethal conditions because they are able to detect and avoid high temperatures in mixing zones. Therefore, most of the harm associated with exposure to the temperature provisions in mixing zones established under the proposed action is likely to involve sublethal effects that will cause injury to affected bull trout.
   - Incidental take in the form of harass is anticipated in areas where bull trout avoid mixing zones with high temperatures. The size of mixing zones is restricted to 300 ft (up and downstream from the end of the pipe) and less than 25 percent of the width of the channel during extreme low flows. The duration of effects is anticipated to continue for as long as the facility is operating and will increase where new facilities are constructed.

Incidental take related to EPA's approval of provisions that allow temperature mixing zones to be established is authorized only for discharges that are in full compliance with the NPDES permit. Incidental take caused by the discharger or by the WDOE and EPA's authorization of mixing zones generally, including other water quality variables beyond the scope of EPA's action, is beyond the scope of this Incidental Take Statement.

REASONABLE AND PRUDENT MEASURES (RPM)

In the accompanying BO, the FWS determined that the level of effects caused by the proposed action, including those that conform to the regulatory definition of take, is not likely to result in jeopardy to the bull trout. However, the FWS believes the following reasonable and prudent measures are necessary and appropriate to minimize take:

RPM #1 – Minimize harm of bull trout.

RPM #2 – Assure effectiveness of the conservation measures included as part of the proposed action.

TERMS AND CONDITIONS

To be exempt from the prohibitions of section 9 of the ESA, the EPA and WDOE must comply with the following Terms and Conditions which implement the Reasonable and Prudent Measures described above. These Terms and Conditions are non-discretionary.

The following Terms and Conditions apply to implementing RPM #1:

1. To protect existing and newly documented aquatic life uses, the EPA shall ensure that WDOE makes timely updates to the standards, as needed in order to protect those aquatic life uses. The EPA shall ensure that WDOE establishes, within a year from the date of this BO, a process to review new fish use data to evaluate if changes to the aquatic life designations or application of the spawning criteria are needed. The process shall include establishing a protocol with WDFW, the Services, and the Tribes to obtain current data on salmonid spawning, rearing, and migration. The process shall include an annual WDOE review of any new fish use information (e.g., changes in WDFW's fish distribution databases). To protect existing and newly documented aquatic life uses, the EPA shall ensure that necessary revisions to the WQS at issue in this consultation are adopted as part of the triennial review process, which means that changes in the standards would occur approximately 3 years of when information on fish use becomes available. The following will be applied in the review process:
    a. The "Char spawning and rearing" aquatic life use designation and associated 12 °C temperature criterion shall be applied in all areas where bull trout spawning and juvenile rearing have been documented or are suspected to occur unless there are data to indicate that the temperature standard does not reflect the natural condition of the waterbody.
    b. The 9 °C temperature criterion shall be applied in all areas where bull trout are known or suspected to spawn early (August or September).
    c. Due to the low populations of bull trout in most areas, any one of the following criteria are considered adequate documentation for the "Char spawning and rearing" aquatic life use:
        i. Observations of one or more bull trout redds;
        ii. Observations of one or more adult bull trout in suitable habitat during the spawning season;
        iii. Documentation of juvenile bull trout (<150 mm in size) in or near areas of known bull trout spawning reaches or suitable spawning habitat.
    d. Additional bull trout observations indicate that the following areas warrant inclusion in the "Char spawning and rearing" use designation based on documented use, unless there is information to indicate that the temperature standard does not reflect the natural condition of the waterbody:
        i. Upper Yakima River – Lake Easton to char use designation (Keechelus Lake);
        ii. North Fork Teanaway River – mouth to char use designation;

iii. Icicle Creek – confluence of Ida Creek to char use designation;

iv. Chiwawa River – mouth to char use designation;

v. Entiat River – RM 15 to char use designation (RM 27);

vi. West Fork Methow and Lost River – confluence of both to char use designation;

vii. Twisp River – confluence of Little Bridge Creek to char use designation (War Creek Campground);

viii. Other areas where ongoing research on bull trout is resulting in more frequent documentation or confirmation of existing uses, affirming the need for regular updates.

e. Where information from a TMDL, temperature monitoring data, or watershed analysis indicates that the current condition or natural thermal potential of the waterbody is at or below 17.5 °C, the EPA shall ensure that water bodies that are designated as "Salmonid spawning, rearing, and migration" or "Salmonid rearing and migration" are changed to "Core summer salmonid habitat."

2. WAC 173-201A-310(1) reads as follows:

   "Existing and designated uses must be maintained and protected. No degradation may be allowed that would interfere with, or become injurious to, existing or designated uses, except as provided for in this chapter."

   In areas where information indicates that existing aquatic life uses are not correctly designated or protected by the standards (discussed in Term and Condition #1 (above), the EPA shall ensure WDOE applies its applicable antidegradation policy (e.g., using Tier I or Tier II) in any regulatory actions (e.g., NPDES permit, 401 certification, review of state non-point regulations) that may adversely affect these existing uses. This will provide interim protection until the standards are revised after formal rulemaking.

3. The EPA shall ensure that WDOE fully implements its water quality policies and procedures described in the BE and in this Biological Opinion to maximally protect areas with existing cold water.

   a. Rivers that are currently at or below their designated temperature criteria (e.g., those listed near the bottom of Table 4 or by long-term water quality monitoring stations) shall be protected using WDOE's Tier II antidegradation policy.

   b. Rivers currently at or above their designated temperature criteria, but which have pockets of cooler water that meet or only slightly exceed the criteria shall be protected using WDOE's Tier I antidegradation policy.

4. When the WDOE issues NPDES permits for sources with heat discharges, EPA shall ensure that aquatic life designated uses are protected. The EPA shall ensure that the

WDOE considers and implements the following measures to reduce impacts from thermal plumes where applicable.

a. Prevent or minimize the potential exposure to bull trout from temperatures exceeding the 10° C spawning criterion in spawning, incubation and rearing areas;

b. Minimize the risk of acute impairment or instant mortality by ensuring that bull trout are not exposed to temperatures above 30 °C for more than 2 seconds within the acute mixing zone.

c. Prevent or minimize the risk of thermal shock to salmonids by restricting the area of the mixing zone, where temperatures could reach or exceed 25 °C, to less than 5 percent of the 7Q10 flow of the waterbody; and

d. Prevent or minimize the potential for temperatures that could block or delay bull trout migration by restricting the area of the mixing zone, where temperatures reach 21.0 °C (or more), to less than 25 percent of the cross section of the 7Q10 low flow of the waterbody.

5. Monitoring and Reporting Requirements

a. The EPA or the WDOE shall notify the FWS when WDOE intends to conduct their annual review of fish use data or proposes to make any changes to the use designations or temperature criteria that could affect bull trout.

b. The EPA or the WDOE shall provide information on areas of cold water or stream reaches that may warrant protection under the antidegradation policy or a potential change in use designation. Examples of data that are of interest to the FWS include results of flights using forward-looking infrared technology, temperature data for stream reaches listed in Tables 9 and 10, and any information on natural thermal condition or historic stream temperatures for areas listed in Table 10 of this BO.

c. Section 305(b) of the CWA requires that each state periodically prepare a water quality assessment report. The EPA or the WDOE shall provide a copy of the Integrated Report to the FWS when it becomes available.

As information on the effectiveness of actions to implement temperature TMDLs becomes available, the EPA or the WDOE shall provide a summary of this information to the FWS.

The following Terms and Conditions apply to implementing reasonable and prudent measure 2:

1. The EPA shall review the results from the WDOE DO/IGDO study in collaboration with the FWS to determine whether changes to the DO standards to protect designated uses are warranted. The water column DO criterion must ensure a minimum of 8 mg/L in the gravel for the duration of bull trout spawning, incubation and fry emergence periods unless the natural saturation potential prevents attainment of this level.

2. If the WDOE study warrants changes to the DO standard to provide sufficient IGDO levels, the EPA shall work closely with WDOE to make necessary changes to the standards upon completion of the WDOE study.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The FWS recommends the following additional actions to promote the recovery of federally listed species and their habitats:

1. The WDOE did not revise the special temperature criteria for several rivers in eastern Washington, resulting in water bodies that were designated as "salmon spawning, rearing, and migration use" or "salmon rearing and migration" under the proposed action retaining temperature standards that are well above 17.5 °C. Based on the letter from WDOE to the EPA (dated January 28, 2008), the State has agreed to address the special temperature provisions in the TMDL process. The FWS recommends that, if model calculations indicate that the temperature criteria exceed the natural conditions, the standards be revised to ensure that aquatic life uses are protected.
2. Several sections of the WDOE water quality standards were not changed, and therefore not considered in this consultation. The EPA should recommend to WDOE that they make necessary changes to the remaining standards in a timely manner to improve baseline conditions for listed fish and their designated critical habitat. The FWS is willing to work with the EPA to identify those sections of the standards and help with their revision. Examples of aspects of the WQS that should be addressed include:

    a. Designated uses, dissolved oxygen, and temperature criteria in the marine environment;
    b. Criteria for toxins in fresh water and the marine environment. It is anticipated that Washington will review this aspect of the WQS pending completion of the review in Oregon;

3. The EPA should encourage WDOE to begin the process to designate high quality water as an outstanding resource water, and designate as either Tier III(A) which prohibits any and all future degradation, or Tier III(B) which allows for de minimis (below measurable amounts) degradation from well controlled activities. To begin with, Tier III designations should apply to those water bodies with temperatures that are at or below the numeric criteria. Alternatively, WDOE should consider setting the existing temperatures in these cold water streams as the standard.

4. Coordinate and partner with the Bureau of Reclamation to reduce stream temperatures to protect bull trout in the Yakima River. In particular, develop a partnership to manage instream flows to meet the water quality criteria.

REINITIATION NOTICE

This concludes formal consultation on the on EPA's proposed approval of the WQS for the State of Washington. 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. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

The FWS anticipates that reinitiation may be required in the following situations if:

- The WDOE does not change the use designation and associated temperature criterion to protect the aquatic life uses in areas with newly documented uses (new spawning information, new juvenile rearing information, etc.).
- The WDOE does not apply its antidegradation policy on an interim basis and change the use designation and associated temperature criterion to protect the aquatic life uses in areas with newly documented uses (new spawning information, new juvenile rearing information, etc.) in accordance with the terms and conditions described above.
- The WDOE issues NPDES permits exceeding the thermal plume limitation described in the above terms and conditions in waters used by bull trout.
- The EPA authorizes or approves new NPDES permits that will contribute to stream warming on water bodies that are already temperature-impaired.

If you have any questions regarding this Biological Opinion, please contact Martha Jensen of this office at (360-753-9000).

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Appendices:

Appendix A: **Maps - Designated Uses and Spawning Temperature Criteria**

Appendix B: **Status of the Species and Core Area Summaries**

Appendix C: **Risk Assessment**