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U.S. Fish and Wildlife Service
Idaho Fish and Wildlife Office
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NOV 0 2 2012

Memorandum

To: State Director, Idaho State Office, Bureau of Land Management, Boise, Idaho

From: State Supervisor, Idaho Fish and Wildlife Office, Fish and Wildlife Service, Boise, Idaho

Russ Holder for Brian Kelly

Subject: Bureau of Land Management Ongoing Actions and Livestock Trailing—Bull Trout and Critical Habitat— Benewah, Bonner, Boundary, Kootenai, Owyhee, and Shoshone Counties, Idaho and Elko County, Nevada—Biological Opinion
In Reply Refer to: 01EIFW00-2012-F-0092 Internal Use: CONS-100b

Enclosed are the U.S. Fish and Wildlife Service's (Service) Biological Opinion (Opinion) and concurrence with the U.S. Bureau of Land Management's (Bureau) determinations of effect on species listed under the Endangered Species Act (Act) of 1973, as amended, for eight Bureau ongoing actions in Benewah, Bonner, Boundary, Kootenai, Owyhee, and Shoshone Counties, Idaho and in Elko County, Nevada. In a letter dated January 13, 2012, and received by the Service on January 18, the Bureau requested reinitiation of formal consultation on the determinations under section 7 of the Act that the six of the eight ongoing actions are likely to adversely affect designated critical habitat for the bull trout (*Salvelinus confluentus*). This request for formal consultation was updated August 15, 2012 with new information addressing the effects of ongoing livestock trailing associated with the Wilkins Island and the 71 Desert Allotment areas on bull trout and its critical habitat. The Bureau determined that livestock trailing associated with the 71 Desert Allotment area is not likely to adversely affect bull trout; we concur with the Bureau's determination.

In 2006, 2004, and 1998, we provided biological opinions on six of the eight actions (refer to Service Tracking Numbers 1-9-06-F-0092, 1-5-03-F-114, and 1-5-99-F-003) regarding effects on the bull trout. As of the date of your letter, the Bureau has not completed these six actions. Other than the completion of some project components, the projects as described in your original Biological Assessments remain unchanged and our no-jeopardy Opinions for bull trout and Incidental Take Statements remain valid. However, the Service designated critical habitat for the bull trout, a portion of which was located within the Coeur d'Alene and Jarbidge Field Office areas, on October 18, 2010. In addition, as the effects of spring livestock trailing associated with the Wilkins Island Allotment and the effects of spring and fall trailing associated with the 71 Desert Allotment were not addressed in previous consultations, the Bureau requested these actions also be included within this reinitation. Therefore, we are providing the enclosed

Opinion to address effects of the six ongoing actions on bull trout critical habitat as well as effects of the two livestock trailing actions on bull trout and its critical habitat.

The enclosed Opinion is based primarily on our review of the six ongoing actions, as described in your January 13, 2012 Biological Assessment (Assessment) and the two additional livestock trailing actions as described in your August 15, 2012 email, and the anticipated effects of the actions on designated critical habitat for bull trout, and was prepared in accordance with section 7 of the Act. Our Opinion concludes that the eight ongoing actions will not destroy or adversely modify designated critical habitat for the bull trout. In addition, our Opinion concludes that livestock trailing associated with the Wilkins Island Allotment area will not jeopardize the continued existence of bull trout. A complete record of this consultation is on file at this office.

Thank you for your continued interest in the conservation of threatened and endangered species. Please contact Barbara Chaney at (208) 378-5259 if you have questions concerning this Opinion.

Attachment

cc: BLM, ISO, Boise (Hoefer)
BLM, Twin Falls (Forster)
BLM, Coeur d'Alene (Weston)
FWS, Spokane (Deeds, Holt)
FWS, Reno (Starostka)
Brackett Livestock, Inc., Rogerson (Bert Brackett)
C. E Brackett Cattle Company, Rogerson (Chet Brackett)
JR Simplot Company, Grand View (Chuck Jones)

BIOLOGICAL OPINION
FOR

Effects of Idaho Bureau of Land Management Ongoing Actions on Bull Trout Critical Habitat and Jarbidge Field Office Livestock Trailing on Bull Trout and its Critical Habitat

01EIFW00-2012-F-0092

October 2012

FISH AND WILDLIFE SERVICE
IDAHO FISH AND WILDLIFE OFFICE
BOISE, IDAHO

Supervisor Russell R. Holder for Brian T. Kelly

NOV 0 2 2012
Date

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1. BACKGROUND AND INFORMAL CONSULTATION

1.1 Introduction

The U.S. Fish and Wildlife Service (Service) has prepared this Biological Opinion (Opinion) of the effects of the Coeur d' Alene Resource Management Plan (RMP), ongoing fire suppression actions in the Jarbidge Field Office (FO) area, ongoing livestock grazing in the Diamond A Allotment, ongoing livestock grazing in the Poison Butte Allotment, ongoing livestock grazing in the Wilkins Island Allotment, and implementation of the Jarbidge Resource Area Resource Management Plan (RMP) as amended by the Interim Strategy for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada (INFISH) on designated critical habitat for the bull trout (*Salvelinus confluentus*). In addition, this Opinion addresses the effects of livestock trailing associated with the Wilkins Island and 71 Desert Allotment areas on bull trout and its critical habitat. In a letter dated January 13, 2012 and received on January 18, the U.S. Bureau of Land Management (Bureau) requested formal consultation with the Service under section 7 of the Endangered Species Act (Act) of 1973, as amended, for its proposal to continue to carry out these six ongoing actions. This consultation was put on hold in April 2012 in order for the Bureau to amend their original Biological Assessment (Assessment, USBLM 2012a, entire) to include two livestock trailing actions in the Jarbidge FO area. In an email dated August 15, 2012 (USBLM 2012b, entire), the Bureau provided the Service with information to update the original Assessment to include the effects of livestock trailing in the Wilkins Island and 71 Desert Allotment areas on both bull trout and its critical habitat. The Bureau determined that each of the eight ongoing actions may affect, and is likely to adversely affect bull trout critical habitat, and that livestock trailing in the Wilkins Island Allotment area may affect, and is likely to adversely affect bull trout. In addition, the Bureau determined that livestock trailing in the 71 Desert Allotment area may affect, is not likely to adversely affect bull trout; Service concurrence for the Bureau's "not likely to adversely affect" determination is provided below. As described in this Opinion, and based on the Assessment (USBLM 2012a, entire) developed by the Bureau and other information (USBLM 2012b, entire), the Service has concluded that the eight ongoing actions will not destroy or adversely modify critical habitat for bull trout. In addition, the Service has also concluded that livestock trailing in the Wilkins Island Allotment area will not jeopardize the continued existence of bull trout.

1.2 Consultation History

The Service provided three biological opinions to the Bureau addressing the effects of six of the eight actions on bull trout. These three opinions did not address bull trout critical habitat because at the time none was designated in the action areas. On October 18, 2010, the Service published a revised final critical habitat rule which significantly increased the miles of designated stream reaches in Idaho and northern Nevada. Stream reaches within these six action areas were included in the revised designation. Under 50 CFR §402.16, action agencies are required to reinitiate consultation if newly designated critical habitat may be affected by their projects and if the agency maintains discretionary control of the project. These conditions have been met for these six ongoing actions, and the Bureau properly requested reinitiation of these consultations.

The current Opinion addresses bull trout critical habitat for the three original biological opinions. However, our three original opinions remain valid for the bull trout and we will not repeat those analyses here. Refer to our three original opinions for our bull trout jeopardy analyses and Incidental Take Statements. We will reference sections of the three original opinions in the following sections where it is applicable to the critical habitat analysis. Refer to Bureau's Assessment and the three original opinions for the consultation history prior to reinitiation. The three original opinions are listed below:

- Biological Opinion on the Coeur d'Alene Resource Management Plan (Service Tracking Number 1-9-06-F-0092; USFWS 2006, 128 pp.)
- Biological Opinion on Bureau Ongoing Activities in the Jarbidge River Watershed in Owyhee County, Idaho and Elko County, Nevada (Service Tracking Number 1-5-03-F-114; USFWS 2004a, 97 pp.)
- Biological Opinion on Effects to Bull Trout from Continued Implementation of the Bureau of Land Management Jarbidge Resource Area Resource Management Plan, as Amended by the Interim Strategy for Managing Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada (INFISH), (Service Tracking Number 1-5-99-F-003; USFWS 2001, 121 pp. + appendices).

The current Opinion also addresses the effects of livestock trailing in the Wilkins Island and 71 Desert Allotment areas on bull trout and its critical habitat. This Opinion replaces a previous informal consultation completed for livestock trailing in the Wilkins Island Allotment area dated September 10, 1998 (1-5-98-I-315) that concluded that livestock trailing across the East Fork of the Jarbidge River in September and October is not likely to adversely affect the bull trout (USFWS 1998a, entire). Effects of livestock trailing across the Bruneau River Canyon in the 71 Desert Allotment area had not been previously addressed through section 7 consultation.

The Bureau and the Service have had the following correspondence concerning the effects of the eight ongoing actions on bull trout critical habitat and the effects of livestock trailing in the Wilkins Island and 71 Desert Allotment areas on bull trout.

December 21, 2011	The Bureau provided the Service with a draft biological assessment on the effects of six ongoing actions on bull trout critical habitat for review and comment.
December 23, 2011	The Service provided the Bureau with review comments on the draft biological assessment on the effects of six ongoing actions on bull trout critical habitat.
January 18, 2012	The Service received a request for reinitiation of formal consultation and the final Assessment on the effects of ongoing actions on bull trout critical habitat.
April 4, 2012	The Service and the Bureau discussed revision of the ongoing actions addressed in this consultation to include the effects of livestock trailing in

	the Wilkins Island and 71 Desert Allotment areas on bull trout and its critical habitat in the Opinion.
August 15, 2012	The Bureau provided the Service with updated information on livestock trailing in the Wilkins Island and 71 Desert Allotment areas and the effects of these actions on bull trout and its critical habitat for inclusion in the Opinion.
September 2012	The Bureau and the Service coordinated to clarify the updated information on livestock trailing in the Wilkins Island and 71 Desert Allotment areas.
October 3, 2012	The Service provided a draft Opinion to the Bureau for review and comment. The Draft Opinion addressed the effects of eight individual ongoing actions on bull trout critical habitat as well as the effects of two actions (livestock trailing in the Wilkins Island and 71 Desert Allotment areas) on bull trout.
October 15, 2012	The Service received the Bureau's comments on the draft Opinion. These review comments were incorporated into the Opinion, as appropriate.
October 22, 2012	The Service received comments from the Bureau's applicants on the draft Opinion. These review comments were incorporated into the Opinion, as appropriate.

1.3 Informal Consultation

1.3.1 Effects of Livestock Trailing in the 71 Desert Allotment Area on Bull Trout

A Bureau livestock trailing permit will allow about 1,000 cattle per trailing event to be moved on Bureau-administered lands between the 71 Desert Allotment in the Jarbidge FO area to grazing allotments on the Bruneau FO on the Bureau's Boise District. Livestock cross the Bruneau River on private lands during one spring and one fall livestock trailing event annually. This traditional livestock trailing route may affect bull trout as it bisect about 2.3 acres of the Riparian Conservation Area (RCA) along the Bruneau River located on Bureau-administered lands in the Jarbidge FO area immediately downstream of the private land containing the existing livestock stream crossing site. Livestock trail on a primitive road on Bureau lands near the Bruneau River as the road enters a private inholding, where cattle are herded across the Bruneau River at an existing stream crossing site located on the private land. Because the effects of livestock trailing through the RCA on Bureau-administered lands and the interrelated and interdependent effects of crossing the Bruneau River on private lands on bull trout and its critical habitat were not considered in the original consultation for the 71 Desert Allotment (USBLM 2003, entire; USFWS 2004a, entire), the Bureau submitted a supplemental analysis to the Service for inclusion in this Opinion (USBLM 2012b, entire). Effects of the 71 Desert Allotment area livestock trailing permit on bull trout are addressed here; effects of this livestock trailing action on bull trout critical habitat in the Bruneau River are addressed on pages 61-65 of this Opinion.

Although bull trout have not been documented in the Bruneau River, the Bruneau River is considered foraging, migration, and overwintering (FMO) habitat for bull trout due to the lack of physical barriers to movement with upstream bull trout populations in the Jarbidge River and its tributaries (USFWS 2004c, p. 30). Once in the Bruneau River, fish passage is physically unrestricted for approximately 40 miles downstream to Buckaroo Ditch Dam at Hot Springs, Idaho, inclusive of the 71 Desert Allotment area livestock trailing location. Water temperatures in the Bruneau River during the spring (February/March) and fall (November) when stream crossing events will occur are suitable for supporting bull trout. Therefore, it is possible that individual bull trout could be present in the Bruneau River during spring and fall livestock trailing events.

In addition, thermal outflow from Indian Hot Springs, located less than 1 mile downstream of the mouth of the Jarbidge River and in the vicinity of the existing stream crossing site on private land, might influence bull trout movements in the Jarbidge River. The thermal waters may be a deterrent to bull trout passage during warm seasons, but may also provide additional foraging opportunities for bull trout at other times of the year. The Jarbidge River Recovery Team has identified a research need to determine whether or not fluvial bull trout use FMO habitat in the mainstem Bruneau River.

Although the majority of potential effects to bull trout and its habitat are expected to occur at the existing livestock stream crossing site located on private land, the 2.3 acres of Bureau lands located in the RCA may be affected by livestock trailing, which in turn could affect individual bull trout. Effects to bull trout and its habitat associated with the trailing activities are most likely to occur in the spring and fall when cattle may access the Bruneau River RCA as they are trailed down the Indian Hot Springs Road. Riparian vegetation and streambank trampling may occur on Bureau-administered lands if errant cattle break away from the herd and wander into the riparian area from the main cattle trailing route on the primitive road. In addition, sediment and nutrients generated by trailing 1,000 cattle on the primitive road may wash into the Bruneau River following heavy precipitation events where the trailing route bisects the RCA, resulting in short-term elevated sediment and nutrient levels in the Bruneau River. Increased levels of sediment and nutrients can impact individual bull trout as well as prey availability[1]. However, it is estimated that increased sediment and nutrient levels from annual livestock trailing activities are only expected to affect about a 600 foot reach of the Bruneau River downstream of where trailing-generated sediment and nutrients enter the water, which is less than 1 percent of the 40 miles of the Bruneau River that may contain fluvial bull trout. Therefore, effects from elevated sediment and nutrient levels are expected to be short-term and limited in area. Furthermore, interrelated and interdependent effects associated with livestock crossing the Bruneau River on private lands located upstream and adjacent to the trailing route through the RCA on Bureau lands may include short-term bull trout displacement due to disturbance and habitat related effects associated with streambank trampling and short-term instream elevated sediment and nutrient levels. However, the absence of documented accounts of bull trout in the Bruneau River (which suggests that if bull trout are present, they exist in low numbers) supports the low

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[1]For a more detailed explanation of the effects of increased sediment and nutrient levels on bull trout, see the effects description for the Wilkins Island Allotment area livestock trailing action in this Opinion.

probability of individual bull trout being affected by livestock trailing near the Bruneau River on Bureau lands. Since the potential for individual bull trout to be present in the Bruneau River reach (2.3 RCA acres on Bureau lands) is extremely low, livestock trailing-related effects to bull trout are extremely unlikely to occur (discountable).

Basis for Service Concurrence – Section 7 Consultation

Service concurrence that the activities associated with the livestock trailing in the 71 Desert Allotment area are not likely to adversely affect bull trout is based on the following rationale:

- The absence of documented accounts of bull trout in the Bruneau River makes trampling-related bull trout death or injury, bull trout displacement due to disturbance or elevated instream sediment and nutrient levels, and effects to bull trout due to trailing-related habitat damage (trampled streambanks and vegetation adjacent to the Bruneau River) extremely unlikely to occur (discountable).

2. BIOLOGICAL OPINION

2.1 Description of the Ongoing Actions

This section provides an overview of the eight ongoing Federal actions addressed in this Opinion (Table 1). The term "action" is defined in the implementing regulations for section 7 as "all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies in the United States or upon the high seas." The term "action area" is defined in the regulations as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action."

Table 1. Batched, programmatic, and individual Federal actions that are likely to adversely affect bull trout critical habitat as categorized by Bureau of Land Management District and Field Office.

Bureau District	Bureau Field Office	Federal Action	Biological Opinion or LOC* Completion Date	Service Consultation Tracking No.
Coeur d'Alene	Coeur d'Alene	Coeur d'Alene RMP	Nov 30, 2006	1-9-06-F-0092
Twin Falls	Jarbidge	Ongoing Activities in the Jarbidge Watershed – Wildfire Suppression	Nov 17, 2004	1-5-03-F-114
		Ongoing Activities in the Jarbidge Watershed – Diamond A Grazing Allotment	Nov 17, 2004	1-5-03-F-114
		Ongoing Activities in the Jarbidge Watershed – Poison Butte Grazing Allotment	Nov 17, 2004	1-5-03-F-114
		Ongoing Activities in the Jarbidge Watershed – Wilkins Island Grazing Allotment	Nov 17, 2004	1-5-03-F-114
		Implementation of the Bureau's Jarbidge Resource Area Resource Management Plan, as Amended by INFISH	April 27, 2001	1-5-99-F-003
		Livestock Trailing in the Wilkins Island Allotment in the Jarbidge River Basin	September 10, 1998 (as cited in Opinion dated Nov 17, 2004)	1-5-98-I-315 (as cited in 1-5-03-F-114)
		Livestock Trailing in the 71 Desert Allotment in the Bruneau River Subbasin	NA	NA

* LOC = Letter of Concurrence

2.1.1 Action Areas Overview

Activities addressed in this Opinion occur on Bureau-administered lands within the Bureau's Coeur d'Alene (CdA) and Jarbidge FOs, which are administered by the Bureau's Idaho State Office. Detailed descriptions for six of the eight action areas for each activity are included in the original biological assessments; these biological assessments are incorporated by reference. The two remaining actions, livestock trailing activities in the Wilkins Island and 71 Desert Allotment areas, are located in the Jarbidge Field Office area. The Wilkins Island Allotment area trailing action includes a traditional livestock crossing site on the East Fork Jarbidge River in Owyhee County about 0.3 mile upstream of Murphy Hot Springs, Idaho (Figure 1). The 71 Desert Allotment trailing action includes livestock trailing through a portion of the Riparian Conservation Area (RCA) on Bureau lands along the Bruneau River in Owyhee County near Indian Hot Springs, Idaho (Figure 2). This Allotment trails livestock from the uplands in the Indian Hot Springs Pasture down the Indian Hot Springs Road (approximately 0.2 mile) to a private land inholding where livestock are herded across the Bruneau River at an existing stream crossing site.

2.1.2 Ongoing Actions Overview

Detailed descriptions of six of the eight ongoing actions are included in the three original Assessments. This batched consultation includes analyses of the effects of ongoing implementation of the CdA RMP, the ongoing fire suppression program in the Jarbidge FO, ongoing livestock grazing in three allotments in the Jarbidge FO area, and continued implementation of the Jarbidge RMP as amended to include INFISH on bull trout critical habitat. A summary of each of these six ongoing actions is provided in the Effects of the Ongoing Actions section of this Opinion. Descriptions of livestock trailing activities in the Wilkins Island and the 71 Desert Allotments are as follows.

Information Applicable to the Wilkins Island Allotment and 71 Desert Allotment Areas Livestock Trailing Actions

In 2011, a clarification of Bureau policy created the need to issue livestock trailing permits on Bureau-managed land. The regulations at 43 CFR Sec. 4130.6-3 state that "A crossing permit may be issued by the authorized officer to any applicant showing a need to cross the public land or other land under Bureau of Land Management control, or both, with livestock for proper and lawful purposes. A temporary use authorization for trailing livestock shall contain terms and conditions for the temporary grazing use that will occur as deemed necessary by the authorized officer to achieve the objectives of this part."

In response to this policy clarification, the Bureau established 640 miles of 1.0-mile wide (372,982 acres) livestock trailing corridors across the Jarbidge Field Office. The 1.0 mile wide corridors allow for flexibility to move livestock around areas of high resource value (e.g., sagebrush stands, known sage-grouse leks, known areas of high slickspot density, riparian areas). Beginning in April 2012, the Bureau issued Crossing Permits to qualified applicants authorizing the trailing of livestock across Bureau-administered lands within these established corridors. Grazing permittees or other livestock producers needing to trail livestock across Bureau-administered lands on the Jarbidge FO are required to submit an application prior to trailing.

The National Environmental Policy Act (NEPA) analysis of direct, indirect and cumulative effects of the livestock trailing permits is on file at the Jarbidge FO (DOI-BLM-ID-T010-2012-0004-EA).

The livestock trailing environmental assessment (EA) includes design features to reduce impacts from livestock trailing on natural resources, including riparian areas. Crossing permits include a requirement for permittees to stay on existing roads within trailing corridors, when and where needed, to avoid sensitive resources (such as riparian areas). A completed list of design features can be found in the EA, Chapter 2. Design features to avoid or minimize potential impacts to riparian areas include:

- Bedding or over-night areas will be at least 0.25 mile from riparian areas;
- Temporary water facilities will be placed at least 0.25 mile from riparian areas; and
- Livestock trailing across riparian areas and wetlands will be restricted to pre-determined locations (e.g., road crossing or existing designated crossing areas).

Beginning in October 2011, the Jarbidge FO received several applications to trail livestock across Bureau-administered land. The applications received were for trailing routes where livestock operators have trailed in the past and would like to continue to trail, and routes where they may trail in the future. Two livestock trailing permit applications received by the Bureau that may affect bull trout and its critical habitat are described in detail below. The Bureau's section 7 effects determinations associated with any permits issued for livestock trailing in the Jarbidge FO will be valid for 5 years from the date that this consultation is completed, or until the renewal of the associated livestock grazing permits (which will be completed 3 years after the completion of the Jarbidge Resource Management Plan).

Wilkins Island Allotment Livestock Trailing Permit

The Wilkins Island Allotment area trailing permit will authorize the trailing of livestock across the East Fork Jarbidge River at an existing livestock stream crossing site on Bureau lands (Figure 1). During the preparation of the livestock trailing EA, it was determined there were potential impacts to bull trout that were not considered in the original consultation that considered the effects of livestock trailing in the Wilkins Island Allotment area on bull trout in 1998 and in 2003; the previous consultations only addressed livestock trailing events in fall and did not address critical habitat, which was not designated at the time of the original consultations. Because the impacts of the spring livestock crossing on bull trout were not considered in the original consultation for the Wilkins Island Allotment (USBLM 2003, entire; USFWS 2004a, entire; USFWS 1998a, entire) and the effects of the livestock trailing on recently designated bull trout critical habitat needed to be addressed, the Bureau prepared a supplemental analysis for submission to the Service for inclusion in this Opinion.

In spring, livestock are trailed down the graded Jarbidge Road, which parallels the East Fork Jarbidge River, toward the community of Murphy Hot Springs, Idaho. About 0.3 mile south of the privately-owned parcel that contains Murphy Hot Springs, the cattle are herded along a two-track road to the existing stream crossing on the East Fork Jarbidge River (see Figure 1). Stream substrate at this livestock stream crossing site is predominantly cobble with some gravel and a few large boulders. Streambanks at the crossing site have previously been used by livestock and off-highway vehicles; current slopes are less than 15 percent.

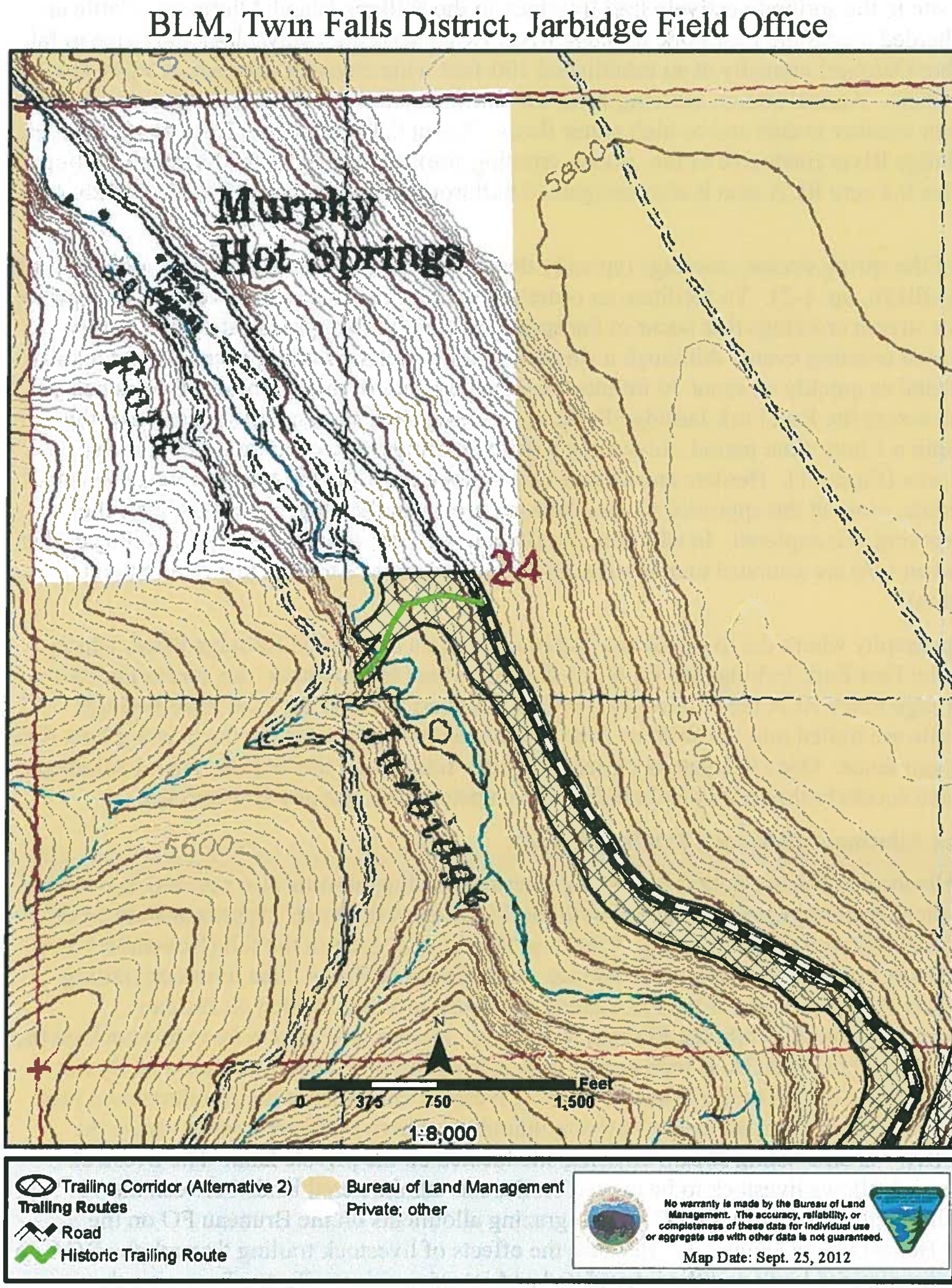

Figure 1. Location of the livestock trailing route across the East Fork Jarbidge River near Murphy Hot Springs in the Wilkins Island Allotment area.

Impacts to bull trout addressed in this Opinion include the use of the existing livestock stream crossing site in the spring to actively trail livestock to the Wilkins Island Allotment. Cattle are actively herded across the East Fork Jarbidge River twice in spring (May/June) and twice in fall (September/October) annually at an established 100-foot wide crossing site near Murphy Hot Springs, Idaho. Annual stream crossing dates for spring and fall livestock trailing events vary based upon weather events and/or high water flows. About 0.3 acres of the RCA along the East Fork Jarbidge River (inclusive of the stream crossing site) is bisected by the livestock trailing route. This 0.3 acre RCA area is also designated bull trout critical habitat (USBLM 2012b, pp. 1-2).

Timing of the spring stream crossings typically depend on water conditions during spring run-off (USBLM 2012b, pp. 1-2). To facilitate an orderly crossing, livestock are moved in two separate groups for stream crossings that occur in the spring and fall, with approximately 400 to 500 cattle in each crossing event. Although a single livestock stream crossing event can potentially be completed as quickly as about 30 minutes, for the purposes of this Opinion, all livestock will be herded across the East Fork Jarbidge River at the designated stream crossing and exit the RCA within a 1 hour time period. Livestock stream crossings only occur at the designated crossing area (Figure 1). Herders ensure that all livestock enter the RCA within the designated trailing route, cross at the approved stream crossing area, and then leave the RCA after the stream crossing is completed. In addition, the Bureau will not authorize livestock trailing during periods when soils are saturated to minimize trailing-related impacts to soils (e.g., rutting and compaction).

Steep topography where the livestock trailing route follows the graded Jarbidge Road, which parallels the East Fork Jarbidge River, limits the area where the livestock can access the East Fork Jarbidge River RCA (see Figure 1). From the western bank of the East Fork Jarbidge River, cattle are trailed into the Wilkins Island Allotment through a gate in the existing East Fork Jarbidge gap fence. Once this gate is closed, livestock trailed into the Wilkins Island Allotment do not have access to the East Fork Jarbidge River upstream of Murphy Hot Springs.

71 Desert Allotment Livestock Trailing Permit

The clarification in Bureau policy for issuing livestock trailing permits also resulted in a request for a livestock trailing permit associated with the 71 Desert Allotment. Approximately 1,000 cattle are actively trailed in the spring (February/March) and again in the fall (November) on a primitive road that leads to Indian Hot Springs on the Bruneau River. The livestock trailing events bisect about 2.3 acres of the RCA along the Bruneau River located on Bureau-administered lands in the Jarbidge FO area (Figure 2). Herders are used to keep livestock on the trailing route within the RCA as topography within this portion of the RCA would likely not preclude livestock access to the Bruneau River. Livestock continue on the primitive road near the Bruneau River as the road enters a private inholding, where cattle are herded across the Bruneau River at an existing stream crossing site located on the private land. The livestock trailing permit allows livestock to be moved on Bureau-administered lands between the 71 Desert Allotment in the Jarbidge FO area to grazing allotments on the Bruneau FO on the Bureau's Boise District (Figure 3). Because the effects of livestock trailing through the RCA on Bureau-administered lands and the interrelated and interdependent effects of crossing the Bruneau River on private lands were not considered in the original consultation for the 71 Desert

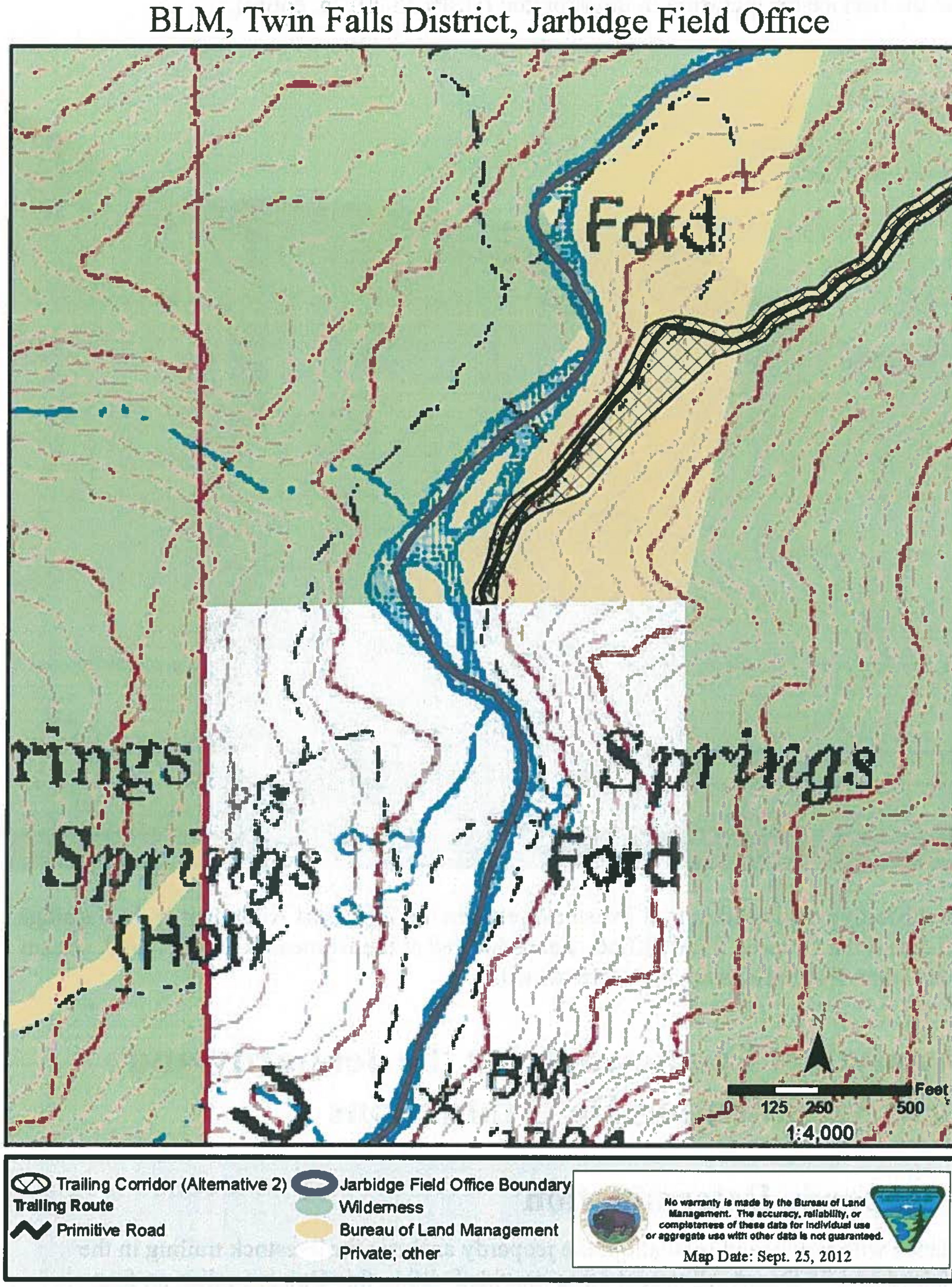

Figure 2. Location of the livestock trailing route across the Bruneau River near Indian Hot Springs in the 71 Desert Allotment area.

Allotment (USBLM 2003, entire; USFWS 2004a, entire), the Bureau submitted a supplemental analysis to the Service for inclusion in this Opinion (USBLM 2012b, entire).

Figure 3. Primitive road used to trail livestock between the 71 Desert Allotment in the Jarbidge Field Office and the Bruneau Field Office. Lands located at the Bruneau River livestock stream crossing at Indian Hot Springs are privately owned.

2.2 Analytical Framework for the Jeopardy and Adverse Modification Determinations

2.2.1 Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis for livestock trailing in the Wilkins Island and 71 Desert Allotment areas provided within this Opinion relies on four components:

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 relationship of the action area to the survival and recovery of the bull trout.
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 bull trout.
4. *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the bull trout.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the bull trout's current status, taking into account any cumulative effects, to determine if 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.

As discussed below under the *Status of the Species*, interim recovery units have been designated for the bull trout for purposes of recovery planning and application of the jeopardy standard. Per Service national policy (USFWS 2006, entire), it is important to recognize that the establishment of recovery units does not create a new listed entity. Jeopardy analyses must always consider the impacts of a proposed or ongoing action on the survival and recovery of the species that is listed. While a proposed or ongoing Federal action may have significant adverse consequences to one or more recovery units, this would only result in a jeopardy determination if these adverse consequences reduce appreciably the likelihood of both the survival and recovery of the listed entity; in this case, the coterminous U.S. population of the bull trout.

The joint Service and National Marine Fisheries Service (NMFS) *Endangered Species Consultation Handbook* (USFWS and NMFS 1998, p. 4-38), which represents national policy of both agencies, further clarifies the use of recovery units in the jeopardy analysis:

> When an action appreciably impairs or precludes the capacity of a recovery unit from providing both the survival and recovery function assigned to it, that action may represent jeopardy to the species. When using this type of analysis, include in the biological opinion a description of how the action affects not only the recovery unit's capability, but the relationship of the recovery unit to both the survival and recovery of the listed species as a whole.

The jeopardy analysis in this Opinion conforms to the above analytical framework.

2.2.2 Adverse Modification Determination

This 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 statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this Opinion relies on four components:

1. The *Status of Critical Habitat*, which evaluates the rangewide condition of designated critical habitat for the bull trout in terms of 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 ongoing Federal actions 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.
4. *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action areas on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determinations, the effects of the eight ongoing Federal actions on bull trout critical habitat are evaluated in the context of the rangewide condition of the critical habitat, taking into account any cumulative effects, to determine if the critical habitat rangewide would remain functional (or would retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the bull trout.

The analyses in this Opinion place an emphasis on using the intended rangewide recovery function of bull trout critical habitat and the role of the eight action areas relative to that intended function as the context for evaluating the significance of the effects of the eight ongoing Federal actions, taken together with cumulative effects, for purposes of making the adverse modification determinations.

2.3 Status of the Species and Critical Habitat

This section presents information about the regulatory, biological and ecological status of the bull trout and its critical habitat that provides context for evaluating the significance of probable effects caused by one of the eight ongoing actions (livestock trailing in the Wilkins Island Allotment area) on bull trout and all eight ongoing actions on designated critical habitat.

2.3.1 Bull Trout

2.3.1.1 Listing Status

The coterminous United States population of the bull trout was listed as threatened on November 1, 1999 (64 FR 58910). The threatened bull trout occurs in the Klamath River Basin of south-central Oregon, the Jarbidge River in Nevada, north to various coastal rivers of Washington to the Puget Sound, east throughout major rivers within the Columbia River Basin to the St. Mary-Belly River, and east of the Continental Divide in northwestern Montana (Cavender 1978, pp. 165-166; Bond 1992, p. 4; Brewin and Brewin 1997, pp. 209-216; Leary and Allendorf 1997, pp.

715-720). The Service completed a 5-year Review in 2008 and concluded that the bull trout should remain listed as threatened (USFWS 2008, p. 53).

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 U.S. coterminous population of the bull trout discusses the consolidation of these DPSs, plus two other 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 58930):

> 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 interim recovery units 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.

Thus, as discussed above under the *Analytical Framework for the Jeopardy and Adverse Modification Determinations*, the Service's jeopardy analysis for the proposed Project will involve consideration of how the Project is likely to affect the Jarbidge interim recovery unit for the bull trout based on its uniqueness and significance as described in the DPS final listing rule cited above, which is herein incorporated by reference. However, in accordance with Service national policy, the jeopardy determination is made at the scale of the listed species.

2.3.1.1.1 Reasons for Listing

Though wide ranging in parts of Oregon, Washington, Idaho, and Montana, bull trout in the interior Columbia River basin presently occur in only about 45 percent of the historical range (Quigley and Arbelbide 1997, p. 1177; Rieman et al. 1997, p. 1119). Declining trends due to the combined effects of habitat degradation and fragmentation, blockage of migratory corridors, poor water quality, angler harvest and poaching, entrainment into diversion channels and dams, and introduced nonnative species (e.g., brook trout, *Salvelinus fontinalis*) have resulted in declines in range-wide bull trout distribution and abundance (Bond 1992, p. 4; Schill 1992, p. 40; Thomas 1992, pp. 9-12; Ziller 1992, p. 28; Rieman and McIntyre 1993, pp. 1-18; Newton and Pribyl 1994, pp. 2, 4, 8-9; Idaho Department of Fish and Game in litt. 1995, pp. 1-3). Several local extirpations have been reported, beginning in the 1950s (Rode 1990, p. 1; Ratliff and Howell 1992, pp. 12-14; Donald and Alger 1993, p. 245; Goetz 1994, p. 1; Newton and Pribyl 1994, p. 2; Berg and Priest 1995, pp. 1-45; Light et al. 1996, pp. 20-38; Buchanan and Gregory 1997, p. 120).

Land and water management activities such as dams and other diversion structures, forest management practices, livestock grazing, agriculture, road construction and maintenance, mining, and urban and rural development continue to degrade bull trout habitat and depress bull trout populations (USFWS 2002a, p. 13).

2.3.1.2 Species Description

Bull trout (*Salvelinus confluentus*), member of the family Salmonidae, are char native to the Pacific Northwest and western Canada. The bull trout and the closely related Dolly Varden

(*Salvelinus malma*) were not officially recognized as separate species until 1980 (Robins et al. 1980, p. 19). Bull trout historically occurred in major river drainages in the Pacific Northwest from the southern limits in the McCloud River in northern California (now extirpated), Klamath River basin of south central Oregon, and the Jarbidge River in Nevada to the headwaters of the Yukon River in the Northwest Territories, Canada (Cavender 1978, p. 165-169; Bond 1992, p. 2-3). To the west, the bull trout's current range includes Puget Sound, coastal rivers of British Columbia, Canada, and southeast Alaska (Bond 1992, p. 2-3). East of the Continental Divide bull trout are found in the headwaters of the Saskatchewan River in Alberta and the MacKenzie River system in Alberta and British Columbia (Cavender 1978, p. 165-169; Brewin and Brewin 1997, pp. 209-216). Bull trout are wide spread throughout the Columbia River basin, including its headwaters in Montana and Canada.

2.3.1.3 Life History

Bull trout exhibit resident and migratory life history strategies throughout much of the current range (Rieman and McIntyre 1993, p. 2). Resident bull trout complete their entire life cycle in the streams where they spawn and rear. Migratory bull trout spawn and rear in streams for 1 to 4 years before migrating to either a lake (adfluvial), river (fluvial), or, in certain coastal areas, to saltwater (anadromous) where they reach maturity (Fraley and Shepard 1989, p. 1; Goetz 1989, pp. 15-16). Resident and migratory forms often occur together and it is suspected that individual bull trout may give rise to offspring exhibiting both resident and migratory behavior (Rieman and McIntyre 1993, p. 2).

Bull trout have more specific habitat requirements than other salmonids (Rieman and McIntyre 1993, p. 4). Watson and Hillman (1997, p. 248) concluded that watersheds must have specific physical characteristics to provide habitat requirements for bull trout to successfully spawn and rear. It was also concluded that these characteristics are not necessarily ubiquitous throughout these watersheds, thus resulting in patchy distributions even in pristine habitats.

Bull trout are found primarily in colder streams, although individual fish are migratory in larger, warmer river systems throughout the range (Fraley and Shepard 1989, pp. 135-137; Rieman and McIntyre 1993, p. 2 and 1995, p. 288; Buchanan and Gregory 1997, pp. 121-122; Rieman et al. 1997, p. 1114). Water temperature above 15°C (59°F) is believed to limit bull trout distribution, which may partially explain the patchy distribution within a watershed (Fraley and Shepard 1989, p. 133; Rieman and McIntyre 1995, pp. 255-296). Spawning areas are often associated with cold water springs, groundwater infiltration, and the coldest streams in a given watershed (Pratt 1992, p. 6; Rieman and McIntyre 1993, p. 7; Rieman et al. 1997, p. 1117). Goetz (1989, pp. 22, 24) suggested optimum water temperatures for rearing of less than 10°C (50°F) and optimum water temperatures for egg incubation of 2 to 4°C (35 to 39°F).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools (Goetz 1989, pp. 22-25; Pratt 1992, p. 6; Thomas 1992, pp. 4-5; Rich 1996, pp. 35-38; Sexauer and James 1997, pp. 367-369; Watson and Hillman 1997, pp. 247-249). Jakober (1995, p. 42) observed bull trout overwintering in deep beaver ponds or pools containing large woody debris in the Bitterroot River drainage, Montana, and suggested that suitable winter habitat may be more restrictive than summer habitat. Bull trout prefer relatively stable channel and water flow conditions (Rieman and McIntyre 1993, p.

6). Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover (Sexauer and James 1997, pp. 368-369).

The size and age of bull trout at maturity depend upon life history strategy. Growth of resident fish is generally slower than migratory fish; resident fish tend to be smaller at maturity and less fecund (Goetz 1989, p. 15). Bull trout normally reach sexual maturity in 4 to 7 years and live as long as 12 years. Bull trout are iteroparous (they spawn more than once in a lifetime), and both repeat- and alternate-year spawning has been reported, although repeat-spawning frequency and post-spawning mortality are not well documented (Leathe and Graham 1982, p. 95; Fraley and Shepard 1989, p. 135; Pratt 1992, p. 8; Rieman and McIntyre 1996, p. 133).

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Migratory bull trout frequently begin spawning migrations as early as April, and have been known to move upstream as far as 250 kilometers (km) (155 miles (mi)) to spawning grounds (Fraley and Shepard 1989, p. 135). Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p.1) and, after hatching, juveniles remain in the substrate. Time from egg deposition to emergence may exceed 200 days. Fry normally emerge from early April through May depending upon water temperatures and increasing stream flows (Pratt 1992, p. 1).

The iteroparous reproductive system of bull trout has important repercussions for the management of this species. Bull trout require two-way passage up and downstream, not only for repeat spawning, but also for foraging. Most fish ladders, however, were designed specifically for anadromous semelparous (fishes that spawn once and then die, and therefore require only one-way passage upstream) salmonids. 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.

Bull trout are opportunistic feeders with food habits primarily a function of size and life history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macro zooplankton and small fish (Boag 1987, p. 58; Goetz 1989, pp. 33-34; Donald and Alger 1993, pp. 239-243). Adult migratory bull trout are primarily piscivores, known to feed on various fish species (Fraley and Shepard 1989, p. 135; Donald and Alger 1993, p. 242).

2.3.1.3.1 Population Dynamics

The draft bull trout Recovery Plan (USFWS 2002a, pp. 47-48) defined core areas as groups of partially isolated local populations of bull trout with some degree of gene flow occurring between them. Based on this definition, core areas can be considered metapopulations. A metapopulation is an interacting network of local populations with varying frequencies of migration and gene flow among them (Meefe and Carroll 1994, p. 188). In theory, bull trout metapopulations (core areas) can be composed of two or more local populations, but Rieman and Allendorf (2001, p. 763) suggest that for a bull trout metapopulation to function effectively, a minimum of 10 local populations are required. Bull trout core areas with fewer than 5 local populations are at increased risk of local extirpation, core areas with between 5 and 10 local populations are at intermediate risk, and core areas with more than 10 interconnected local populations are at diminished risk (USFWS 2002a, pp. 50-51).

The presence of a sufficient number of adult spawners is necessary to ensure persistence of bull trout populations. In order to avoid inbreeding depression, it is estimated that a minimum of 100 spawners are required. Inbreeding can result in increased homozygosity of deleterious recessive alleles which can in turn reduce individual fitness and population viability (Whitesel et al. 2004, p. 36). For persistence in the longer term, adult spawning fish are required in sufficient numbers to reduce the deleterious effects of genetic drift and maintain genetic variation. For bull trout, Rieman and Allendorf (2001, p. 762) estimate that approximately 1,000 spawning adults within any bull trout population are necessary for maintaining genetic variation indefinitely. Many local bull trout populations individually do not support 1,000 spawners, but this threshold may be met by the presence of smaller interconnected local populations within a core area.

For bull trout populations to remain viable (and recover), natural productivity should be sufficient for the populations to replace themselves from generation to generation. A population that consistently fails to replace itself is at an increased risk of extinction. Since estimates of population size are rarely available, the productivity or population growth rate is usually estimated from temporal trends in indices of abundance at a particular life stage. For example, redd counts are often used as an indicator of a spawning adult population. The direction and magnitude of a trend in an index can be used as a surrogate for growth rate.

Survival of bull trout populations is also dependent upon connectivity among local populations. Although bull trout are widely distributed over a large geographic area, they exhibit a patchy distribution even in pristine habitats (Rieman and McIntyre 1993, p. 7). Increased habitat fragmentation reduces the amount of available habitat and increases isolation from other populations of the same species (Saunders et al. 1991, p. 22). Burkey (1989, p. 76) concluded that when species are isolated by fragmented habitats, low rates of population growth are typical in local populations and their probability of extinction is directly related to the degree of isolation and fragmentation. Without sufficient immigration, growth of local populations may be low and probability of extinction high. Migrations also facilitate gene flow among local populations because individuals from different local populations interbreed when some stray and return to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished in this manner.

In summary, based on the works of Rieman and McIntyre (1993, pp. 9-15) and Rieman and Allendorf (2001, pp. 756-763), the draft bull trout Recovery Plan identified four elements to consider when assessing long-term viability (extinction risk) of bull trout populations: (1) number of local populations, (2) adult abundance (defined as the number of spawning fish present in a core area in a given year), (3) productivity, or the reproductive rate of the population, and (4) connectivity (as represented by the migratory life history form).

2.3.1.4 Status and Distribution

As noted above, in recognition of available scientific information relating to their uniqueness and significance, five population 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: (1) Jarbidge River, (2) Klamath River, (3) Coastal-Puget Sound, (4) St. Mary-Belly River, and (5) Columbia River. Each of these segments 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 units is provided below. A comprehensive discussion of these topics is found in the draft bull trout Recovery Plan (USFWS 2002a, entire; 2004a, c; entire).

Central to the survival and recovery of the bull trout is the maintenance of viable core areas (USFWS 2002a, p. 54). 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, and, in some cases, their use of spawning habitat. Each of the population segments listed below consists of one or more core areas. One hundred and twenty one core areas are recognized across the United States range of the bull trout (USFWS 2005, p. 9).

A core area assessment conducted by the Service for the 5 year bull trout status review determined that of the 121 core areas comprising the coterminous listing, 43 are at high risk of extirpation, 44 are at risk, 28 are at potential risk, 4 are at low risk and 2 are of unknown status (USFWS 2008, p. 29).

2.3.1.4.1 Jarbidge River

This population segment currently contains a single core area with six local populations. The 2005 draft recovery plan states that less than 500 resident and migratory adult bull trout, representing about 50 to 125 spawners, are estimated to occur within the core area (USFWS 2004c, p. 16). The current condition of the bull trout in this segment is attributed to the effects of livestock grazing, roads, angler harvest, timber harvest, and the introduction of nonnative fishes (USFWS 2004c, p. iii). The draft bull trout Recovery Plan identifies the following conservation needs for this segment: (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 fish 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 2004c, p. 62-63). Currently this core area is at high risk of extirpation (USFWS 2005, p. 9).

Since the draft recovery plan was written, updated information is available on bull trout population in the Jarbidge River Distinct Population Segment (Allen et al. 2010, entire). The most recent study, conducted by the U.S. Geological Survey (USGS) in 2006 and 2007 to examine the distribution and movement of bull trout in the Jarbidge River system, captured 349 bull trout in 24.8 miles of habitat in the East and West Forks of the Jarbidge River, and in Fall, Slide, Dave, Jack, and Pine creeks. In 2007, they captured 1,353 bull trout in 15.5 miles of habitat in the West Fork Jarbidge River and its tributaries and 11.2 miles of habitat in the East Fork Jarbidge River and its tributaries (Allen et al. 2010, p. 6). The study results indicate that almost four times the number of bull trout estimated in the draft Recovery Plan inhabit the Jarbidge core area; and that these fish show substantial movements between tributaries, increased abundance with increasing altitude, and growth rates indicative of a high-quality habitat (Allen et al. 2010, p. 20).

Fluvial bull trout have been documented to use the mainstem Jarbidge River; therefore, bull trout may also use the Bruneau River for foraging, migration, and overwintering habitat. Bull trout use of the Bruneau River has not been documented (USFWS 2004c, p. 30). However, there are no known physical barriers preventing fish movement between the Jarbidge and Bruneau Rivers. Once in the Bruneau River, fish passage is physically unrestricted for approximately 40 miles downstream to Buckaroo Ditch Dam at Hot Springs, Idaho. The Jarbidge River Recovery Team identified the need for research to determine whether or not fluvial bull trout use foraging, migration, and overwintering habitat outside of the Jarbidge River core area within the mainstem Bruneau River.

2.3.1.4.2 Klamath River

This population segment currently contains three core areas and 12 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 nonnative fishes. Bull trout populations in this unit face a high risk of extirpation (USFWS 2002b, p. iv). The draft bull trout Recovery Plan (USFWS 2002b, p. v) identifies the following conservation needs for this unit: (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 strategies, and (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 3,250 adults currently to 8,250 adults are needed to provide for the persistence and viability of the three core areas (USFWS 2002b, p. vi).

2.3.1.4.3 Coastal-Puget Sound

Bull trout in the Coastal-Puget Sound population segment exhibit anadromous, adfluvial, fluvial, and resident life history patterns. The anadromous life history form is unique to this unit. This population segment currently contains 14 core areas and 67 local populations (USFWS 2004d, p. iv; 2004e, pp. iii-iv). Bull trout are distributed throughout most of the large rivers and associated tributary systems within this unit. With limited exceptions, bull trout continue to be present in nearly all major watersheds where they likely occurred historically within this unit. Generally, bull trout distribution has contracted and abundance has declined, especially in the southeastern part of the unit. The current condition of the bull trout in this population segment 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, angler harvest, and the introduction of nonnative species. The draft bull trout Recovery Plan (USFWS 2004d, pp. ix-x) identifies the following conservation needs for this unit: (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.

2.3.1.4.4 St. Mary-Belly River

This population segment currently contains six core areas and nine local populations (USFWS 2002c, p. v). Currently, bull trout are widely distributed in the St. Mary River drainage and occur in nearly all of the waters that were 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 2002c, p. 37). The current condition of the bull trout in this population segment is primarily attributed to the effects of dams, water diversions, roads, mining, and the introduction of nonnative fishes (USFWS 2002c, p. vi). The draft bull trout Recovery Plan (USFWS 2002c, pp. v-ix) identifies the following conservation needs for this unit: (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) maintain and restore 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 unit are comprised mostly of migratory fish whose habitat is mainly in Canada.

2.3.1.4.5 Columbia River

The Columbia River population segment 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, p. 1177). This population segment 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 populations within these core areas varies from poor to good, but generally all have been subject to the combined effects of habitat degradation, fragmentation and alterations associated with one or more of the following activities: dewatering, road construction and maintenance, mining and grazing, blockage of migratory corridors by dams or other diversion structures, poor water quality, incidental angler harvest, entrainment into diversion channels, and introduced nonnative species.

The Service has determined that of the total 97 core areas in this population segment, 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, pp. 1-94).

The draft bull trout Recovery Plan (USFWS 2002a, p. v) identifies the following conservation needs for this population segment: (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) maintain and restore suitable habitat conditions for all bull trout life history stages and strategies, and (4) conserve genetic diversity and provide opportunities for genetic exchange.

2.3.1.5 Previous Consultations and Conservation Efforts

2.3.1.5.1 Consultations

Consulted-on effects are those effects that have been analyzed through section 7 consultation as reported in a biological opinion. These effects are an important component of objectively characterizing the current condition of the species. To assess consulted-on effects to bull trout, we analyzed all of the biological opinions received by the Region 1 and Region 6 Service Offices from the time of bull trout's listing until August 2003; this summed to 137 biological opinions. Of these, 124 biological opinions (91 percent) applied to activities affecting bull trout in the Columbia Basin population segment, 12 biological opinions (9 percent) applied to activities affecting bull trout in the Coastal-Puget Sound population segment, 7 biological opinions (5 percent) applied to activities affecting bull trout in the Klamath Basin population segment, and one biological opinion (< 1 percent) applied to activities affecting the Jarbidge and St. Mary-Belly population segments (Note: these percentages do not add to 100, because several biological opinions applied to more than one population segment). The geographic scale of these consultations varied from individual actions (e.g., construction of a bridge or pipeline) within one basin to multiple-project actions occurring across several basins. Additional consultations since 2003 regarding the Jarbidge River population segment include effects of post-fire emergency stabilization and rehabilitation activities, noxious weed control actions, ongoing livestock grazing in Bureau allotments, recreational special use permits, a riparian habitat improvement project, installation of a fiber optic line, and shrub planting projects on bull trout.

Our analysis showed that we consulted on a wide array of actions which had varying levels of effect. Many of the actions resulted in only short-term adverse effects, some with long-term beneficial effects. Some of the actions resulted in long-term adverse effects. No actions that have undergone consultation were found to appreciably reduce the likelihood of survival and recovery of the bull trout. Furthermore, no actions that have undergone consultation were anticipated to result in the loss of local populations of bull trout.

2.3.1.5.2 Regulatory mechanisms

The implementation and effectiveness of regulatory mechanisms vary across the coterminous range. Forest practices rules for Montana, Idaho, Oregon, Washington, and Nevada include streamside management zones that benefit bull trout when implemented.

2.3.1.5.3 State Conservation Measures

State agencies are specifically addressing bull trout through the following initiatives:

- Washington Bull Trout and Dolly Varden Management Plan developed in 2000.
- Montana Bull Trout Restoration Plan (Bull Trout Restoration Team appointed in 1994, and plan completed in 2000).
- Oregon Native Fish Conservation Policy (developed in 2004).
- Nevada Species Management Plan for Bull Trout (developed in 2005).
- State of Idaho Bull Trout Conservation Plan (developed in 1996). The watershed advisory group drafted 21 problem assessments throughout Idaho which address all 59 key watersheds. To date, a conservation plan has been completed for one of the 21 key watersheds (Pend Oreille).

2.3.1.5.4 Habitat Conservation Plans

Habitat Conservation Plans (HCP) have resulted in land management practices that exceed State regulatory requirements. Habitat conservation plans addressing bull trout cover approximately 472 stream miles of aquatic habitat, or approximately 2.6 percent of the Key Recovery Habitat across Montana, Idaho, Oregon, Washington, and Nevada. These HCPs include: Plum Creek Native Fish HCP, Washington Department of Natural Resources HCP, City of Seattle Cedar River Watershed HCP, Tacoma Water HCP, and Green Diamond HCP.

2.3.1.5.5 Federal Land Management Plans

PACFISH is the "Interim Strategy for Managing Anadromous Fish-Producing Watersheds and includes Federal lands in Western Oregon and Washington, Idaho, and Portions of California."

INFISH is the "Interim Strategy for Managing Fish-Producing Watersheds in Eastern Oregon and Washington, Idaho, Western Montana, and Portions of Nevada." Each strategy amended Forest Service Land and Resource Management Plans and Bureau of Land Management Resource Management Plans. Together PACFISH and INFISH cover thousands of miles of waterways within 16 million acres and provide a system for reducing effects from land management activities to aquatic resources through riparian management goals, landscape scale interim riparian management objectives, Riparian Habitat Conservation Areas (RHCAs), riparian standards, watershed analysis, and the designation of Key and Priority watersheds. These interim strategies have been in place since 1992 and are part of the management plans for Bureau of Land Management and Forest Service lands.

The Interior Columbia Basin Ecosystem Management Plan (ICBEMP) is the strategy that replaces the PACFISH and INFISH interim strategies when federal land management plans are revised. The Southwest Idaho Land and Resource Management Plan (LRMP) is the first LRMP under the strategy and provides measures that protect and restore soil, water, riparian and aquatic resources during project implementation while providing flexibility to address both short- and long-term social and economic goals on 6.6 million acres of National Forest lands. This plan includes a long-term Aquatic Conservation Strategy that focuses restoration funding in priority subwatersheds identified as important to achieving Endangered Species Act, Tribal, and Clean Water Act goals. The Southwest Idaho LRMP replaces the interim PACFISH/INFISH strategies and adds additional conservation elements, specifically, providing an ecosystem management foundation, a prioritization for restoration integrated across multiple scales, and adaptable active, passive and conservation management strategies that address both protection and restoration of habitat and 303(d) stream segments.

The Southeast Oregon Resource Management Plan (SEORMP) and Record of Decision is the second LRMP under the ICBEMP strategy which describes the long-term (20+ years) plan for managing the public lands within the Malheur and Jordan Resource Areas of the Vale District. The SEORMP is a general resource management plan for 4.6 million acres of Bureau of Land Management administered public lands primarily in Malheur County with some acreage in Grant and Harney Counties, Oregon. The SEORMP contains resource objectives, land use allocations, management actions and direction needed to achieve program goals. Under the plan, riparian areas, floodplains, and wetlands will be managed to restore, protect, or improve their natural functions relating to water storage, groundwater recharge, water quality, and fish and wildlife values.

The Northwest Forest Plan covers 24.5 million acres in Washington, Oregon, and northern California. The Aquatic Conservation Strategy (ACS) is a component of the Northwest Forest Plan. It was developed to restore and maintain the ecological health of watersheds and the aquatic ecosystems. The four main components of the ACS (Riparian Reserves, Watershed Analysis, Key Watersheds, and Watershed Restoration) are designed to operate together to maintain and restore the productivity and resiliency of riparian and aquatic ecosystems.

It is the objective of the Forest Service and the Bureau of Land Management to manage and maintain habitat and, where feasible, to restore habitats that are degraded. These plans provide for the protection of areas that could contribute to the recovery of fish and, overall, improve riparian habitat and water quality throughout the basin. These objectives are accomplished through such activities as closing and rehabilitating roads, replacing culverts, changing grazing and logging practices, and re-planting native vegetation along streams and rivers.

2.3.1.6 Conservation Needs

The recovery planning process for the bull trout (USFWS 2002a, p. 49) has identified the following conservation needs (goals) for bull trout recovery: (1) maintain the current distribution of bull trout within core areas as described in recovery unit chapters, (2) maintain stable or increasing trends in abundance of bull trout as defined for individual recovery units, (3) restore and maintain suitable habitat conditions for all bull trout life history stages and strategies, and (4) conserve genetic diversity and provide opportunity for genetic exchange.

The draft bull trout Recovery Plan (USFWS 2002a, p. 62) identifies the following tasks needed for achieving recovery: (1) protect, restore, and maintain suitable habitat conditions for bull trout, (2) prevent and reduce negative effects of nonnative fishes, such as brook trout, and other nonnative taxa on bull trout, (3) establish fisheries management goals and objectives compatible with bull trout recovery, (4) characterize, conserve, and monitor genetic diversity and gene flow among local populations of bull trout, (5) conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, (6) use all available conservation programs and regulations to protect and conserve bull trout and bull trout habitats, (7) assess the implementation of bull trout recovery by management units, and (8) revise management unit plans based on evaluations.

Another threat now facing bull trout is warming temperature regimes associated with global climate change. Because air temperature affects water temperature, species at the southern margin of their range that are associated with cold water patches, such as bull trout, may become restricted to smaller, more disjunct patches or become extirpated as the climate warms (Rieman et al. 2007, p. 1560). Rieman et al. (2007, pp. 1558, 1562) concluded that climate is a primary determining factor in bull trout distribution. Some populations already at high risk, such as the Jarbidge, may require “aggressive measures in habitat conservation or restoration” to persist (Rieman et al. 2007, p. 1560). Conservation and restoration measures that would benefit bull trout include protecting high quality habitat, reconnecting watersheds, restoring flood plains, and increasing site-specific habitat features important for bull trout, such as deep pools or large woody debris (Kinsella 2005, entire).

2.3.2 Bull Trout Critical Habitat

2.3.2.1 Legal Status

Ongoing litigation resulted in the U.S. District Court for the District of Oregon granting the Service a voluntary remand of the 2005 critical habitat designation. Subsequently the Service published a proposed critical habitat rule on January 14, 2010 (75 FR 2260) and a final rule on October 18, 2010 (75 FR 63898). The rule became effective on November 17, 2010. A justification document was also developed to support the rule and is available on our website (http://www.fws.gov/pacific/bulltrout). The scope of the designation involved the species’ coterminous range, which includes the Jarbidge River, Klamath River, Coastal-Puget Sound, St.

Mary-Belly River, and Columbia River population segments (also considered as interim recovery units)[2].

Rangewide, the Service designated reservoirs/lakes and stream/shoreline miles in 32 critical habitat units (CHU) as bull trout critical habitat (see Table 2). Designated bull trout critical habitat is of two primary use types: (1) spawning and rearing (SR); and (2) foraging, migrating, and overwintering (FMO).

Table 2. Stream/shoreline distance and reservoir/lake area designated as bull trout critical habitat by state.

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

Compared to the 2005 designation, the final rule increases the amount of designated bull trout critical habitat by approximately 76 percent for miles of stream/shoreline and by approximately 71 percent for acres of lakes and reservoirs.

This rule also identifies and designates as critical habitat approximately 1,323.7 km (822.5 miles) of streams/shorelines and 6,758.8 ha (16,701.3 acres) of lakes/reservoirs of unoccupied habitat to address bull trout conservation needs in specific geographic areas in several areas not occupied at the time of listing. No unoccupied habitat was included in the 2005 designation. These unoccupied areas were determined by the Service to be essential for restoring functioning migratory bull trout populations based on currently available scientific information. These unoccupied areas often include lower mainstem river environments that can provide seasonally important migration habitat for bull trout. This type of habitat is essential in areas where bull trout habitat and population loss over time necessitates reestablishing bull trout in currently unoccupied habitat areas to achieve recovery.

The final rule continues to exclude some critical habitat segments based on a careful balancing of the benefits of inclusion versus the benefits of exclusion. Critical habitat does not include: (1)

[2] The Service's 5 year review (USFWS 2008, p. 9) identifies six draft recovery units. Until the bull trout draft recovery plan is finalized, the current five interim recovery units are in affect for purposes of section 7 jeopardy analysis and recovery. The adverse modification analysis does not rely on recovery units.

waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended, in which bull trout is a covered species on or before the publication of waters adjacent to non-Federal lands covered by legally operative incidental take permits for habitat conservation plans (HCPs) issued under section 10(a)(1)(B) of the Endangered Species Act of 1973, as amended, in which bull trout is a covered species on or before the publication of this final rule; (2) waters within or adjacent to Tribal lands subject to certain commitments to conserve bull trout or a conservation program that provides aquatic resource protection and restoration through collaborative efforts, and where the Tribes indicated that inclusion would impair their relationship with the Service; or (3) waters where impacts to national security have been identified (75 FR 63898). Excluded areas are approximately 10 percent of the stream/shoreline miles and 4 percent of the lakes and reservoir acreage of designated critical habitat. Each excluded area is identified in the relevant CHU text, as identified in paragraphs (e)(8) through (e)(41) of 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. Because exclusions reflect the often complex pattern of land ownership, designated critical habitat is often fragmented and interspersed with excluded stream segments.

2.3.2.2 Conservation Role and Description of Critical Habitat

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

As previously noted, 32 CHUs within the geographical area occupied by the species at the time of listing are designated under the final rule. Twenty-nine of the CHUs contain all of the physical or biological features identified in this final rule and support multiple life-history requirements. Three of the mainstem river units in the Columbia and Snake River basins contain most of the physical or biological features necessary to support the bull trout's particular use of that habitat, other than those physical and biological features associated with Primary Constituent Elements (PCEs) 5 and 6, which relate to breeding habitat (see list below).

The primary function of individual CHUs is to maintain and support core areas, which (1) contain bull trout populations with the demographic characteristics needed to ensure their persistence and contain the habitat needed to sustain those characteristics (Rieman and McIntyre 1993, p. 19); (2) provide for persistence of strong local populations, in part, by providing habitat conditions that encourage movement of migratory fish (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); (3) are large enough to incorporate genetic and phenotypic diversity, but small enough to ensure connectivity between populations (MBTSG 1998, pp. 48-49; Rieman and McIntyre 1993, pp. 22-23); and (4) are distributed throughout the historic range of the species to preserve both genetic and phenotypic adaptations (MBTSG 1998, pp. 13-16; Rieman and Allendorf 2001, p. 763; Rieman and McIntyre 1993, p. 23).

The Olympic Peninsula and Puget Sound CHUs are essential to the conservation of amphidromous bull trout, which are unique to the Coastal-Puget Sound population segment. These CHUs contain marine 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 PCEs that are critical to adult and subadult foraging, migrating, and overwintering.

In determining which areas to propose as critical habitat, the Service considered the physical and biological features that are essential to the conservation of bull trout and that may require special management considerations or protection. These features are the PCEs laid out in the appropriate quantity and spatial arrangement for conservation of the species. The PCEs of designated critical habitat are:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.
2. Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including, but not limited to, permanent, partial, intermittent, or seasonal barriers.
3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 to 15°C (36 to 59°F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.
6. In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.
7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departures from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.

Activities that cause adverse effects to critical habitat are evaluated to determine if they are likely to "destroy or adversely modify" critical habitat by no longer serving the intended conservation role for the species or retaining those PCEs that relate to the ability of the area to at least periodically support the species. Activities that may destroy or adversely modify critical habitat are those that alter the PCEs to such an extent that the conservation value of critical habitat is appreciably reduced (75 FR 63898:63943). 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 National Marine Fisheries Service 1998, pp. 4-39). Thus, 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, Jarbidge River, Columbia River, Coastal-Puget Sound, and Saint Mary-Belly River population segments. However, we consider all 32 CHUs to contain features or areas essential to the conservation of the bull trout (75 FR 63898:63901, 63944). Therefore, if a proposed or ongoing action would alter the physical or biological features of critical habitat to an extent that appreciably reduces the conservation function of one or more critical habitat units for bull trout, a finding of adverse modification of the entire designated critical habitat area may be warranted (75 FR 63898:63943).

2.3.2.3 Current Rangewide Condition of Bull Trout Critical Habitat

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.

The primary land and water management activities impacting the physical and biological features essential to the conservation of bull trout include timber harvest and road building, agriculture and agricultural diversions, livestock grazing, dams, mining, urbanization and residential development, and nonnative species presence or introduction (75 FR 2282).

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 (Dunham and Rieman 1999, p. 652; Rieman and McIntyre 1993, p. 7).

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, p. 141; MBTSG 1998, pp. ii - v, 20-45).

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, p. 857; Rieman et al. 2006, pp. 73-76).

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

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

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

2.3.2.4 Previous Consultations for Critical Habitat

The Service has formally consulted on the effects to bull trout critical habitat throughout its range. Section 7 consultations include actions that continue to degrade the environmental baseline in many cases. However, long-term restoration efforts have also been implemented that provide some improvement in the existing functions within some of the critical habitat units. Within the Jarbidge River Basin, formal and informal consultations have been completed on the effects of actions such as post-fire emergency stabilization and rehabilitation activities, noxious weed control actions, recreational special use permits, a riparian habitat improvement project, installation of a fiber optic line, and shrub planting projects on PCEs of bull trout critical habitat.

2.4 Overview of the Environmental Baseline of the Action Areas

This section assesses the effects of past and ongoing human and natural factors that have led to the current status of the species, its habitat and ecosystem in the action areas. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the action area that have already undergone section 7 consultations, and the impacts of state and private actions which are contemporaneous with this consultation.

2.4.1 Bull Trout

2.4.1.1 Status of the Bull Trout in the Wilkins Island Allotment Livestock Trailing Action Area

Bull trout in the Jarbidge River system exhibit both resident and fluvial life histories. Resident populations are present primarily in the headwater streams. Fluvial migrants spawn and rear in the headwater streams, with adult fish otherwise inhabiting suitable habitat in the West and East Forks of the Jarbidge River, and to a lesser extent, the mainstem Jarbidge River.

The East Fork Jarbidge River near the designated livestock stream crossing area for the Wilkins Island Allotment area livestock trailing is considered as FMO habitat for bull trout. The East Fork of the Jarbidge River local population consists of both resident and fluvial fish. Spawning and rearing habitat, including habitat for resident fish, is primarily located in the upper headwaters and tributaries (Dave Creek, Cougar Creek, Fall Creek) above approximately 6,900 feet, which is mostly on National Forest System land upstream of the action area (Allen et al. 2010, entire). However, fluvial bull trout are also present in the lower reaches of the East Fork on Bureau-administered land, including within the action area. Although fewer fish are present in the lower reaches, this habitat is important as foraging, migrating, and overwintering habitat (USFWS 2010, p. 607). In 2007, fish from the Dave Creek and Jack Creek local populations were observed in the East Fork, including near Murphy Hot Springs (Allen et al. 2010, p. 55). Although use of this habitat may only be seasonal, it is an important component of critical habitat for fluvial fish and important in maintaining overall metapopulation function (USFWS 2010, p. 603).

2.4.1.2 Factors Affecting Bull Trout in the Wilkins Island Allotment Livestock Trailing Action Area

Within the Jarbidge River Watershed, lands are owned and managed by the Bureau, U.S. Forest Service, State of Idaho, and private land owners. Eighty-nine percent of the watershed is public land, with State of Idaho endowment lands (3 percent) and private lands (8 percent) composing the remainder of the watershed. The primary uses of public lands that may affect bull trout and its habitat include livestock grazing, land/realty actions (including authorization for the construction, operation, and maintenance of roads and power lines), and recreation. Uses on private land that may affect bull trout and its habitat include residential development (home sites and small communities), pasture, and rangeland. Historic uses of public, State, and private lands that affected the Jarbidge population of bull trout in the past (and to a lesser extent currently) include construction of dams and water diversions, mineral extraction, and timber harvest (USFWS 2004c, pp. 35-55). In addition, the Jarbidge River Canyon is part of the Bruneau-Jarbidge Wilderness area. Compliance with wilderness guidelines will further ensure that habitat parameters within the wilderness are maintained in a high quality condition, including aquatic and riparian habitat conditions important for bull trout.

Environmental Baseline for Relevant Indicators
The Framework to Assist in Making Endangered Species Act Determinations of Effects for Individual or Grouped Actions at the Bull Trout Subpopulation at a Watershed Scale (USFWS 1998b, entire) was used to describe baseline conditions and evaluate effects to bull trout and its critical habitat for the Wilkins Island and 71 Desert Allotment areas livestock trailing actions (see environmental baseline and effects matrices in Appendix A and Appendix B of this Opinion). Environmental baseline conditions are described below by individual watershed condition indicators (WCIs) in the East Fork Jarbidge River. These WCIs are important for the survival and recovery of bull trout. The most relevant indicators are discussed in detail below and will be carried forward in the Effects Analysis section of this Opinion.

Wilkins Island Allotment Livestock Trailing Area - East Fork Jarbidge River
Temperature. Functioning at Risk. In the East Fork Jarbidge River, daily high water temperatures can exceed 20°C from late June into September, which is greater than the 15°C maximum water temperature for bull trout spawning and rearing. Data collected just upstream of Murphy Hot Springs between 1997 and 2001 showed that average 7 day maximum temperature in August of each year exceeded 19°C. The 7 day average maximum temperature for the East

Fork Jarbidge River was 24.1°C, with the highest temperature (26.4°C) observed near Murphy Hot Springs. (USBLM 2003, pp. 37, 106). In addition, Rocky Mountain junipers are increasing in the RCA; these conifers lack the height to provide the level of channel shading provided by the cottonwood trees that are gradually being replaced by junipers. Temperatures are not expected to return to pre-disturbance levels within two generations under current management (USBLM 2003, p. 111). Therefore, a determination of functioning at risk is given here.

Sediment/Turbidity. Properly functioning. Recent data on sediment and substrate composition are not available. However, the Bureau did conduct surveys of several short stream reaches in the Jarbidge River Watershed in late summer 2005 (BLM 2006, as cited in USFS and USBLM 2012, p. 5). Three sites on the East Fork Jarbidge River were sampled by measuring surface fines directly over subjectively selected potential bull trout spawning gravels. These sampling sites were selected as they were representative of larger stream reaches identified for aquatic habitat data collection by the Service (USFWS 2004a, p. 73). Two reaches were upstream of Murphy Hot Springs, with one of the reaches being above the confluence of the East Fork Jarbidge River and Dave Creek, and the other below the confluence. The other reach was downstream of Murphy Hot Springs and upstream of the confluence with the West Fork Jarbidge River. Percent surface fines upstream of the confluence with Dave Creek were 13 percent, with 16 percent below the confluence. Upstream of the confluence with the West Fork, the percent surface fines were 9 percent. As a result, it appears that Dave Creek is a sediment source to the East Fork Jarbidge River. The unsurfaced road that parallels the East Fork Jarbidge River is also a likely contributor of sediment, as is the road leading west out of Murphy Hot Springs. Service criterion (USFWS 1998b, p. 22) classifies streams with less than 20 percent surface fines as properly functioning.

Chemical Contaminants and Nutrients. Properly functioning. There are no Clean Water Act-designated 303(d) reaches identified within the East Fork Jarbidge River or its tributaries. There are no other known major contributors or chemical contamination or nutrients.

Substrate embeddedness in rearing areas. Functioning at risk. Data on cobble embeddedness is not available for the lower East Fork Jarbidge River. Based on the data from the Bureau (USBLM 2006, as cited in USFS and USBLM 2012, p. 18), which found percent surface fines to be less than 20 percent in selected spawning gravels upstream, substrate would be classified as functioning appropriately. However, given the uncertainty in how percent surface fines correlate to embeddedness in downstream reaches, a conservative baseline condition of functioning at risk was given (USFS and USBLM 2012, p. 18).

Streambank Condition. Functioning at risk. Areas of the streambank along the East Fork Jarbidge River have been impacted by use and maintenance of the existing Jarbidge Road. This degraded streambank condition will be maintained as long as the road is located within the RCA. In addition, previous crossing events at the livestock crossing site have impacted both banks where cattle move into and out of the East Fork Jarbidge River due to compaction and reduced streambank vegetation associated with livestock trampling. Therefore, a determination of functioning at risk is given here.

Local Population Size. Functioning at risk. The East Fork Jarbidge River and its tributaries contain the East Fork Jarbidge River (including Cougar and Fall creeks), Dave Creek, and Slide Creek local populations (USFWS 2004c, p. 18). Although initial population estimates for bull trout in the Jarbidge River core area were low (~500), the study conducted by USGS (Allen et al. 2010, p. 15) found the total population size to be over 1,700. Further, the USGS study also found substantial movements between local populations. As a result, it is expected that the local population size in the East Fork Jarbidge River watershed has greater than 50 adults, but fewer than the several thousand suggested by the Service (USFWS 1998b, p. 20) to be classified as functioning appropriately. Thus, a conservative baseline condition of functioning at risk was given.

Growth and Survival. Functioning at risk. Limited long-term data on the ratio of adult to juvenile bull trout is available. Allen et al. (2010, p. 20) documented annual and seasonal growth rates and concluded that populations in the upper East Fork Jarbidge River and Dave Creek had length-frequency distributions indicative of healthy populations with good growth potential. Further, the annual growth rates were indicative of good habitat conditions. However, given that this is based on a temporally limited dataset, a conservative determination of functioning at risk is given here.

Life History Diversity/Isolation. Functioning at risk. The East Fork Jarbidge River and Dave Creek support both resident and migratory life history forms of bull trout. Movement has been observed between the tributaries in the upper East Fork, the East Fork, Dave Creek, and the West Fork. However, it is unknown what percentage of the population is composed of fluvial bull trout, and warm water temperatures may seasonally prevent movement between the East and West Forks and between tributaries (USFWS 2004c, p. 39). Therefore, the baseline condition of this indicator is functioning at risk.

Persistence and Genetic Integrity. Functioning at risk. Limited genetics data indicate there are at least two genetically differentiated groups of bull trout in the East and West Fork watersheds (Dave Creek and West Fork Jarbidge River); however, further genetic research is needed to ensure the current local population designations accurately represent local population structure (USFWS 2004c, pp. 16, 69). As discussed above for Life History Diversity/Isolation, movement has been observed between the local populations; bull trout movement is limited, at least seasonally, by warm water temperatures. Furthermore, although Allen et al. (2010, p. 15) documented a larger number of fish than previously known, the sizes of the local populations are still relatively small. As a result, the baseline condition for this indicator is functioning at risk.

2.4.2 Bull Trout Critical Habitat

As previously described, the primary land and water management activities impacting the physical and biological features essential to the conservation of bull trout (e.g., PCEs) include timber harvest and road building, agriculture and agricultural diversions, livestock grazing, dams, mining, urbanization and residential development, and nonnative species presence or introduction. The current condition of bull trout critical habitat may vary from good to poor. Descriptions of the environmental baseline for bull trout critical habitat for each of the eight individual actions addressed in this Opinion are presented in the Bull Trout Critical Habitat

Project Descriptions, Environmental Baseline, and Effects of the Analyses section below. Information on bull trout critical habitat pertinent to each individual action is consolidated under a single heading specific to each individual action to allow for improved continuity of this batched Opinion.

2.5 Effects of the Ongoing Actions

Effects of the action considers the direct and indirect effects of an action on the listed species and/or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action. These effects are considered along with the environmental baseline and the predicted cumulative effects to determine the overall effects to the species. Direct effects are defined as those that result from the proposed or ongoing action and directly or immediately impact the species or its habitat. Indirect effects are those that are caused by, or will result from, the proposed or ongoing action and are later in time, but still reasonably certain to occur. An interrelated activity is an activity that is part of the proposed or ongoing action and depends on the action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation.

2.5.1 Bull Trout

2.5.1.1 Effects of the Wilkins Island Allotment Livestock Trailing Action on Bull Trout

Spring livestock trailing across the East Fork Jarbidge River may impact bull trout through trampling or displacement of adult or subadult fish while livestock cross the East Fork Jarbidge River as well as by impacts to individual fish associated with increased suspended sediment and nutrient levels. As described above, the East Fork Jarbidge River near the designated stream crossing area is FMO habitat for bull trout. Bull trout are not likely to be present in the crossing area during the fall because the crossing events will occur when bull trout are in spawning areas, which are located more than 12 miles upstream of the crossing. Because bull trout individuals are not present in the crossing area during fall livestock crossings, the impacts from the livestock trailing in fall are limited to habitat-related impacts. However, bull trout may be impacted during spring livestock stream crossings when bull trout may be moving through the Wilkins Island Allotment stream crossing area as they travel to spawning and rearing habitat in higher elevation stream reaches.

Direct and Indirect Effects

Trampling. About 400 to 500 cattle may cross the East Fork Jarbidge River during two annual spring and two annual fall livestock trailing events. As bull trout may be present in the crossing area during the spring livestock stream crossing events, individual fish may be killed or injured from direct trampling. However, any bull trout that are present in the stream crossing when livestock begin to cross the stream are likely to leave the crossing, and avoid physical injury or death by trampling. The use of herders to ensure all livestock cross at the designated area and are removed from the RCA after the stream crossing is completed will further reduce the potential for direct trampling impacts to individual bull trout. Therefore, direct injury or mortality of individual bull trout due to trampling during spring livestock crossings of the East Fork Jarbidge River is extremely unlikely to occur (discountable). Bull trout are not present in the stream crossing area during fall livestock crossings; therefore, direct injury or mortality of individual bull trout due to trampling during fall livestock trailing will not occur.

Displacement. Fish that are near a stream crossing site when livestock are present may be disturbed by the activity and flush from the disturbance. In the process of flushing they can become more exposed to predators, injure themselves in low water areas, become disoriented and stressed. In the longer term, fish that have established territories in habitat specific areas in a river become knowledgeable about all the features in that area. If displaced, they may have to search out new areas for feeding, hiding or favorable water quality. In the time it takes them to do that, they can be subjected to a greater risk of predation, competition with other fish, greater stress and decreased physical condition.

The movement of cattle across the East Fork Jarbidge River in spring is likely to temporarily displace bull trout in the action area. Impacts to individual bull trout related to displacement will be short-term (each livestock stream crossing event will be less than 1 hour in duration), localized (displacement will occur from the 100-foot wide livestock stream crossing area), and will occur twice each spring. Displaced bull trout may move upstream of the designated crossing area where the habitat is virtually undisturbed and contains abundant pools, hiding cover and forage for bull trout until the disturbance at the designated stream crossing has ceased. In addition, the habitat located downstream of the designated stream crossing also provides good habitat for any displaced fish, although this area downstream of the crossing has been subject to more disturbances due to private land uses (residences at Murphy Hot Springs) and roads (ongoing use and maintenance of the Jarbidge Road). Potential effects are expected to be temporary, sublethal, without injury, and affected bull trout are expected to recover quickly once the trailing-related disturbance ends. However, some adverse effects are likely to occur to individual bull trout due to harassment associated with spring livestock trailing activities. Bull trout are not present in the stream crossing area during fall livestock crossings; therefore, harassment of individual bull trout due to displacement during fall livestock trailing will not occur.

Loss of Cover. Cover for fish (overhanging banks, coarse woody debris, and submerged and emergent vegetation) provide areas to rest protected from detection. They may also offer microhabitats of cooler water, lower current velocity and provide areas for prey to breed and live. A loss of access to these areas or modifications of these sites can temporarily reduce the protection from predation, increase energy costs and reduce feeding efficiency.

Livestock trampling associated with trailing near streams or with stream crossings alter streambanks, exposing soil to erosion, destroying overhanging banks, and potentially destabilizing banks which may lead to channel widening and reduced pool depth (Bowers et al. 1979, pp. 8-11; Leonard et al. 1997, pp. 22, 32). As channels widen, habitat is simplified, and cover is reduced. In addition, cattle standing and walking in streams displace substrate, potentially affecting its suitability for spawning or its use as cover by juvenile bull trout.

Annual spring and fall livestock stream crossings are expected to maintain the current condition of streambanks at the existing stream crossing site, which are degraded due to past OHV and livestock trailing activities. Active herding of cattle to keep animals within the trailing route bisecting the 0.3 acres of the RCA minimizes the risk of destruction or degradation of streambanks. Some vegetation where the trailing route bisects the RCA is expected to be altered or removed through hoof action during livestock trailing activities. Due to the short duration (up to 1 hour during each of the two trailing events in spring and the two trailing events in fall) and the limited area (0.3 acres within the RCA) of the trailing activities, relatively little vegetation will actually be removed from the RCA along the East Fork Jarbidge River by the livestock trailing action. Recovery of riparian vegetation at the stream crossing site is expected to be limited due to the continued disturbance regime at this site associated with annual trailing events. However, effects to bull trout and its habitat are minimized as a relatively small area of streambank is used for the livestock stream crossing (about 100 feet). It is also expected that herders rapidly retrieve any errant individual cattle back onto the designated trailing route before extensive streambank damage would occur in the RCA. Although trailing activities will be of short duration and be confined to a limited area, some adverse effects are likely to occur to individual bull trout due to loss of vegetation cover and the possibility of some further short-term degradation of streambanks at the crossing site associated with both spring and fall livestock trailing activities. Therefore, it is likely that the livestock trailing action will result in some localized adverse effects to bull trout.

Sediment-related Effects Livestock trampling generally decreases vegetation cover that protects soil from erosion. As grazing intensity increases, biological crusts decline (Belnap et al. 2001, pp. 44, 49-50), and soils are exposed to erosion. Eroding soils are then likely to be transported to stream channels where they can increase turbidity and fines in the substrate in streams that support bull trout and its habitat. Trampling also increases soil compaction which results in decreased infiltration (Belsky et al. 1999, pp. 420-422). Decreased infiltration results in more rapid runoff, further reducing habitat quality for bull trout.

Sediment is a very important stressor to salmonids and can affect them in both direct and indirect ways. Bull trout are highly susceptible to sediment inputs and require the lowest turbidity and suspended sediment levels of all salmonids for spawning, incubation, and juvenile rearing. The Service knows of no positive effects to salmonids from increased sediment; while the potential negative impacts of increased suspended sediment on bull trout and other salmonids have been well documented (Bakke et al. 2002, p.1; Newcombe and MacDonald 1991, pp. 72-73; Newcombe and Jensen 1996, pp. 700-715, Bash et al. 2001, p. 24).

Suspended sediment/turbidity can cause lethal, sublethal, and behavioral effects in juvenile and adult salmonids depending on the duration and intensity (Newcombe and Jensen 1996, pp. 700-715). Increased levels of suspended sediment may cause moderate physiological stress (Newcombe and Jensen 1996, pp. 698-702). Increased turbidity levels may trigger effects ranging from minor to moderate physiological stress, including increased rates of coughing and respiration, particle build-up on gills, and temporary injury associated with avoidance or moving to less turbid areas. Lethal effects can occur if suspended sediment concentrations reach 22,026 mg/l at any one time, or remain at concentrations of 3,000 mg/l for 3 hours (Newcombe and Jensen 1996, pp. 698-702).

Social (Berg and Northcote 1985, p. 1410) and feeding behavior can be disrupted by increased levels of suspended sediment. Fish may avoid high concentrations of suspended sediments altogether (Hicks et al. 1991, p. 483-485). Even small elevations in suspended sediment may reduce feeding efficiency and growth rates of some salmonids (Sigler et al. 1984, p. 142). Based on their experiments with juvenile rainbow trout (*Oncorhynchus mykiss)*, Suttle et al. (2004, p.

973) concluded that "fine sediment deposition, even at low concentrations, can decrease growth and survival of juvenile salmonids." They found "no threshold below which fine-sediment addition is harmless."

Increased sediment and suspended solids have the potential to affect primary production and benthic invertebrate abundance, due to reductions in photosynthesis within murky waters. Thus, food availability for fish may be reduced as sediment levels increase (Cordone and Kelley 1961, pp. 189-190; Lloyd et al. 1987, p. 18; Henley et al. 2000, pp. 129-133). Sediment can also reduce health of in-stream plants, reducing cover for fish making them more vulnerable to predation (Waters 1995, pp. 111-116). Pools, which are an essential habitat type, can be filled by sediment and degraded or lost (Megahan 1982, p. 114).

The proposed action will have the potential to temporarily degrade the water quality of the East Fork Jarbidge River during spring and fall stream crossings. The hardened substrate at the crossing site will reduce the amount of sediment that may be suspended during individual trailing events. However, a short-term increase in suspended and deposited sediment, and associated turbidity, is expected when cattle wade across the stream. Project design features being applied by the Bureau to avoid or reduce introduction of sediment into the water, including limiting the duration and area of the stream crossing, should also minimize the amount of sediment entering the water. It is expected that there will be a single sediment plume released for each stream crossing event (2 in spring and 2 in fall each year). However, these sediment plumes are expected to be localized and of short duration, allowing fish present during the spring stream crossings to find suitable habitat nearby. Elevated-sediment levels that could adversely affect bull trout and its habitat are expected to extend no further than 600 feet downstream of the 100 foot wide stream crossing site, and, based on Bureau data (Bureau 2003, p. 38), will return to near baseline levels within 24 hours, and are expected to fully return to baseline levels in 30 to 48 hours. Short-term sublethal effects to individual bull trout during spring crossings include irritation to gills associated with elevated sediment levels up to 48 hours of individual spring trailing events. Similarly, short-term effects to bull trout habitat are also expected to occur during and immediately following spring and fall stream crossings associated with elevated sediment levels.

In addition, the Service cannot accurately determine how far turbidity pulses are likely to persist. Using a worst-case scenario, the Service assumes the sublethal turbidity plumes associated with this action may extend up to 600 feet (about 183 meters) downstream before reaching insignificant levels. Trailing-related sediment plumes are expected to dissipate within a few minutes to several hours following trailing events. This conclusion is based on information provided by the Bureau (USBLM 2012b, p. 3; USBLM 2003, p. 38), as well as information available in the literature.

Turbidity pulses are expected to be sporadic and temporary in nature. The relatively small amount of sediment expected to be generated, combined with localized and infrequent nature of the turbidity pulses should ensure turbidity remains at sublethal levels. Therefore, the turbidity increases are likely to cause minor behavioral effects when bull trout may be present in spring, such as avoidance of sediment plumes within the action area. If fish are displaced, it is anticipated they will migrate short distances to an area with better habitat conditions for up to a few hours in any given day.

In response to elevated levels of suspended sediment during spring crossing events, a reasonable expectation would be that, in order to avoid adverse effects, bull trout juveniles and adults may move away from turbid areas, if possible. Bisson and Bilby (1982, pp. 371-374) found that juvenile coho salmon (*Oncorhynchus kisutch*) avoided increasingly turbid waters in a laboratory setting. Relocating to avoid sediment may have indirect adverse effects on bull trout. Salmonids exhibit a dominance hierarchy where the dominant fish (usually the largest) maintain the most desirable territories (i.e., defended area) in terms of available cover and food sources (Gilmour et al. 2005, p. 263). Subordinate fish may be excluded from food and cover resources and show reduced fitness and survival (Gilmour et al. 2005, p. 263). Berg and Northcote (1985, pp. 1415-1416) found that dominance hierarchies broke down and territories were not defended when juvenile coho salmon were exposed to short-term sediment pulses. We assume that bull trout behave similarly to other studied salmonids. Based on this assumption, we expect bull trout that abandon territories to avoid turbidity associated with the project may temporarily suffer increased competition, loss of cover, stress, and reduced feeding efficiency.

The effects to bull trout, during the period between maximum observed turbidity and the return to pre-project levels, should be behavioral, including avoidance and potential effects to feeding rates. It is very probable that any fish inhabiting the action area during spring crossing events will suffer mild to moderate alarm reactions and short-term abandonment of the site. At greater than approximately 600 feet below the project footprint, sediment effects on bull trout are expected to be insignificant (e.g., effects cannot be meaningfully measured, detected, or evaluated).

Stored sediment that is transported as a result of livestock crossing the stream will contribute to off-site deposition. However, the reach directly below the project area is a transport reach; sediment deposition is not expected to occur in this downstream reach. It is expected that trailing-related sediment deposition downstream of the stream crossing area will likely be so low it cannot be meaningfully measured, detected, or evaluated; therefore, effects of downstream deposition on bull trout following spring or fall crossing events will be insignificant.

The Service stresses that all impacts associated with increased turbidity will be temporary and localized in nature, with most effects occurring during and immediately after livestock cross the stream. Project design features presented as part of the proposed action are intended to minimize release or introduction of sediment to the East Fork Jarbidge River. In addition, the limited duration of individual livestock crossing events and the small area of the stream crossing site are not expected to result in any long-term effects to stream substrates from sediment delivery following spring or fall stream crossing events. Prolonged exposure to increased suspended sediment/turbidity levels will not occur, and all sediment-related potential effects to bull trout are expected to be sublethal; we do not anticipate any mortality associated with increased suspended sediment/turbidity. It is likely most bull trout will have moved out of the action area while livestock are within the stream crossing site in spring, but any that are present within or below the crossing site will be subject to increased turbidity levels as described. No bull trout will be directly affected by fall stream crossings as individual fish will be upstream in headwater spawning and rearing habitat streams during fall stream crossing events.

<u>*Nutrient-related Effects*</u> When grazing animals become concentrated near water bodies or when they have unrestricted long-term access to streams for watering, sediment and nutrient loading can be high and bacteriological quality of surface water can be affected adversely (Brooks et al.

1997, p. 230). Livestock feces and urine deposited in the stream during stream crossings can increase levels of phosphorous and nitrogen in the water column. Increased levels of these nutrients have been demonstrated to cause extensive growth of bacteria on aquatic insects, which resulted in high mortality levels in insect populations (Lemly 1998, p. 237). Decreased densities of aquatic insects effects bull trout by reducing available food, thereby lowering the growth rate of fish. Reduced food availability may also displace trout to other stream reaches. Nutrients from animal wastes can also stimulate aquatic algae and plant growth, which may be either beneficial or adverse depending on the degree of growth. For example, at moderate levels of growth, algae and plants can provide food as a basis for the aquatic food chain. However, high levels of algae and aquatic plants can result in stream eutrophication and subsequent reduction of dissolved oxygen levels, which adversely affects bull trout.

Nutrient impacts vary based on specific site conditions that include: precipitation, runoff, vegetation cover, grazing density, proximity to stream, and length of grazing use. Water quality data showed that when livestock trailed across the East Fork Jarbidge, fecal coliform rates spiked to 1,600 to 4,400 colonies at the crossing point and 100 m (328 feet) downstream, respectively; but returned to near background levels (10 to 20 colonies) within 24 hours (USBLM 2003, p. 121). A short-term increase in phosphorus and nitrogen from cattle defecating and urinating in the stream is expected when cattle wade across the stream. Thus, the livestock trailing action has the potential to temporarily degrade the water quality of the East Fork Jarbidge River during spring and fall stream crossings. Based on Bureau data (Bureau 2003, p. 38), these short-term adverse effects are expected to be limited in duration and area; elevated nutrient levels are expected to return to near pre-trailing levels within 24 hours, and are expected to fully return to baseline levels in 30 to 48 hours. Short-term sublethal effects to individual bull trout during spring crossings include irritation to gills associated with elevated nutrient levels up to 48 hours of individual spring trailing events. Similarly short-term effects to bull trout habitat are also expected to occur during and immediately following spring and fall stream crossings related to elevated nutrient levels.

Project design features being applied by the Bureau to avoid or reduce impacts to water quality, including limiting the duration and area of the stream crossing, should minimize the amount of cattle waste (and associated nutrients) entering the water. Thus, prolonged exposure of bull trout or its prey to increased nutrient levels will not occur, and all nutrient-related potential effects to bull trout are expected to be sublethal. While we do not anticipate any bull trout mortality associated with increased nutrient levels related to livestock trailing activities, some temporary displacement or localized reduction of prey densities may occur associated with increased nutrient levels in the East Fork Jarbidge River. Therefore, some short-term adverse effects to bull trout are likely to occur.

Effects of Interrelated and Interdependent Actions Interrelated actions are those that are a part of a larger action and depend on the larger action for their justification. Interdependent actions are those actions that have no independent utility apart from the action under consideration. The Service has not identified any interrelated or interdependent actions associated with the Wilkins Island Allotment area livestock trailing action.

Summary of Effects The Wilkins Island Allotment area livestock trailing action may adversely affect individual bull trout during spring stream crossings through trailing-related displacement and elevated sediment and nutrient levels. Direct livestock trampling of individual bull trout which may result in injury or death of bull trout is extremely unlikely to occur (discountable); therefore, direct trampling is not likely to adversely affect bull trout.

Effects due to displacement and associated with elevated sediment and nutrient levels are expected to be temporary, sublethal, without injury; and affected bull trout are expected to recover quickly. However, short-term but potentially adverse effects to individual bull trout may occur due to harassment of bull trout (displacement due to disturbance and short-term elevated sediment and nutrient levels during spring trailing events) and impacts to bull trout habitat (short-term elevated sediment and nutrient levels during spring and fall livestock trailing events that may temporarily affect local prey densities). Therefore, livestock trailing in the Wilkins Island Allotment area may adversely affect bull trout.

2.5.2 Bull Trout Critical Habitat

2.5.2.1 Bull Trout Critical Habitat Effects Analyses Overview

The most effective way to evaluate the impact an activity will have on bull trout critical habitat is to analyze the effects that the activity will have on the primary constituent elements (PCEs) of the critical habitat. The effects of Idaho Bureau activities that have undergone Section 7 consultation were largely evaluated using the Bull Trout Matrix of Pathways and Indicators (matrix) (USFWS 1998b). The matrix includes indicators that also correspond to the bull trout critical habitat PCEs. The matrix contains 23 indicators, four of which are tied to subpopulation characteristics and 19 which are tied to habitat. Twenty of the twenty three indicators are directly or indirectly related to one or more of the nine PCEs, and each PCE corresponds to one or more indicators (Table 3). The *refugia* indicator is relevant to all PCEs because in order for the refugia indicator to be rated "functioning appropriately" most if not all of the PCEs must be present.

Table 3. PCEs for bull trout critical habitat and the associated matrix indicators

PCE #	PCE Description	Associated Matrix Indicators
1	Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.	Floodplain connectivity, sediment, substrate embeddedness, chemical contamination/nutrients, off-channel habitat, streambank condition, change in peak/base flows, increase in drainage network, road density and location, disturbance history, riparian conservation areas, and refugia
2	Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.	Physical barriers, substrate embeddedness, average wetted width/maximum depth ratio, change in peak/base flows, persistence and genetic integrity, temperature, chemical contamination/nutrients, and refugia

PCE #	PCE Description	Associated Matrix Indicators
3	An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.	Sediment, substrate embeddedness, chemical contamination/nutrients, large woody debris, off-channel habitat, floodplain connectivity, streambank condition, riparian conservation areas, and refugia
4	Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.	Sediment, substrate embeddedness, large woody debris, pool frequency and quality, large pools, off-channel habitat, average wetted width/maximum depth ratio, streambank condition, riparian conservation areas, floodplain connectivity, road density and location, disturbance regime, and refugia
5	Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.	Temperature, off-channel habitat, floodplain connectivity, average wetted width/maximum depth ratio, streambank condition, change in peak/base flows, road density and location, disturbance history, riparian conservation areas, and refugia
6	In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.	Sediment, substrate embeddedness, streambank condition, riparian conservation areas, floodplain connectivity, increase in drainage network, road density and location, disturbance regime, and refugia
7	A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.	Change in peak/base flows, streambank condition, floodplain connectivity, increase in drainage network, road density and location, disturbance history, riparian conservation areas, and refugia
8	Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.	Temperature, chemical contamination/nutrients, streambank condition, riparian conservation areas, floodplain connectivity, increase in drainage network, road density and location, disturbance regime, and refugia
9	Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately	Persistence and genetic integrity

PCE #	PCE Description	Associated Matrix Indicators
	temporally and spatially isolated from bull trout.	

For a detailed discussion of the relationship of the matrix indicators to the individual PCEs, see pages 4-8 of the Bureau's Assessment (USBLM 2012a, entire).

For the eight actions addressed in this Opinion, changes in hydrology and temperature caused by changing climate have the potential to negatively impact aquatic ecosystems in Idaho, with salmonid fishes being especially sensitive. Average annual temperature increases due to increased carbon dioxide are affecting snowpack, peak runoff, and base flows of streams and rivers (Mote et al. 2003, p. 45). Increases in water temperature may cause a shift in the thermal suitability of aquatic habitats (Poff et al. 2002, p. iii). For species that require colder water temperatures to survive and reproduce, warmer temperatures could lead to significant decreases in available suitable habitat. Increased frequency and severity of flood flows during winter can affect incubating eggs and alevins in the streambed and over-wintering juvenile fish. Eggs of fall spawning fish, such as bull trout, may suffer high levels of mortality when exposed to increased flood flows (ISAB 2007, p. iv).

2.5.2.2 Project Descriptions, Environmental Baselines, and Effects Analyses of Bureau Actions on Bull Trout Critical Habitat

As previously described in this Opinion, project descriptions, environmental baseline conditions, and effects analyses for Bureau actions on bull trout critical habitat have been consolidated in this section by each individual action to increase organization and clarity of the information presented. Of the eight Bureau actions analyzed in this Opinion, detailed descriptions for the six ongoing actions and their environmental baseline conditions are included in the three original biological assessments. A statement is included under each of the six activity descriptions below regarding changes in the environmental baseline since the original consultations were completed, including any measures that may avoid, minimize, or mitigate adverse effects to bull trout critical habitat, and the extent of the geographic area affected by the actions (i.e., the action areas). In addition, information on the current environmental baseline condition and effects of the two livestock trailing actions on bull trout critical habitat are also included below. Descriptions of the eight individual Bureau actions, current environmental baseline conditions, and their effects on bull trout critical habitat are as follows.

2.5.2.2.1 Coeur d'Alene RMP (OALS# 1-9-06-F-0092)

<u>Activity Description.</u> The purpose of the CdA Resource Management Plan (RMP) is to provide a single, comprehensive land use plan that will guide management of the 96,770 acres of public lands and interests administered by the Bureau's CdA FO. The plan provides objectives, land use allocations, and management direction to maintain, improve, or restore resource conditions and to provide for the economic needs of local communities over the long term. The CdA RMP addresses land-use issues and conflicts, specifies where and under what circumstances particular activities will be allowed on public lands, and incorporates the mandate of multiple uses in accordance with the Federal Land Policy and Management Act of 1976. Activities implemented under the CdA RMP include forest vegetation treatments, commercial forestry, wood products harvesting, livestock grazing, mineral development, off-highway vehicle use, right-of-way (ROW) authorizations, and use permits. The CdA RMP does not describe how particular

programs or projects will be implemented or prioritized; rather, those decisions are deferred to more detailed implementation-level planning. Individual projects proposed for the CdA FO are required to be consistent with the RMP and undergo individual Section 7 consultation if they "may affect" species listed under the Act.

The CdA RMP planning area is in the panhandle region of northern Idaho, which encompasses the five northernmost Idaho counties: Boundary, Bonner, Kootenai, Benewah, and Shoshone. The planning area is bordered on the west by the Washington state line, on the north by the Canadian border, on the east by the Montana state line, and on the south by Latah and Clearwater Counties, Idaho. The proposed action and the environmental baseline have not changed sufficiently to result in any effects beyond those considered in the 2006 biological assessment (USBLM 2006, entire) and 2006 biological opinion (USFWS 2006, entire).

Status of Critical Habitat in the CdA RMP Action Area. The CdA RMP contains two bull trout critical habitat units (CHUs): the Clearwater River Unit (Unit 21) and the Coeur d'Alene River Basin Unit (Unit 29).

The Clearwater River CHU is located east of Lewiston, Idaho, and extends from the Snake River confluence at Lewiston on the west to headwaters in the Bitterroot Mountains along the Idaho–Montana border on the east in Nez Perce, Latah, Lewis, Clearwater, Idaho, and Shoshone Counties. In the Clearwater River CHU, 2,702.1 km (1,679.0 mi) of streams and 6,721.9 ha (16,610.1 ac) of lake and reservoir surface area are designated as critical habitat. The subunits within this unit provide spawning, rearing, foraging, migratory, connecting, and overwintering habitat.

The Clearwater River CHU contains several large and stable core area populations of bull trout. Fluvial and resident bull trout are the predominant life history forms known to occur within this CHU with several adfluvial populations occurring in headwater lakes. This CHU includes five critical habitat subunits: Middle–Lower Fork Clearwater River; South Fork Clearwater River; Selway River; Lochsa River (and Fish Lake); and the North Fork Clearwater River (and Fish Lake).

The Coeur d'Alene River Basin Unit is located in Kootenai, Shoshone, Benewah, Bonner, and Latah Counties in Idaho, and includes the entire Coeur d'Alene Lake basin in northern Idaho. A total of 821.5 km (510.5 mi) of streams and 12,606.9 ha (31,152.1 ac) of lake surface area are designated as critical habitat. There are no subunits within the Coeur d'Alene River Basin CHU. This unit provides spawning, rearing, foraging, migratory, connecting, and overwintering habitat.

The Coeur d'Alene River Basin CHU is essential maintaining bull trout distribution in the area as bull trout local populations that were known to be historically present have not been recently documented in large portions of the Coeur d'Alene Lake basin. Reestablishing local populations that are broadly distributed throughout the CHU has been identified as necessary for bull trout recovery. The bull trout population that occurs in this CHU (currently primarily located in the headwaters of the upper Saint Joe River system, which is a major tributary to Coeur d'Alene Lake) has been isolated from other bull trout populations for at least 10,000 years by natural falls on the Spokane River (the outflow of Coeur d'Alene Lake). Losing this population would represent a loss of unique genetic and adaptive characteristics and result in a significant gap in range of bull trout with no opportunity for natural recolonization.

Effects Analysis. The March 2006 biological assessment (USBLM 2006, entire) and the subsequent November 30, 2006 biological opinion (USFWS 2006, entire) prepared for the CdA

RMP analyzed effects of the RMP on a number of physical habitat attributes that correspond to bull trout critical habitat PCEs. In particular, the biological assessment addressed physical barriers, riparian habitat, bank stability, substrate, overhead cover, water quality, and water quantity. The activities implemented under the CdA RMP have the potential to negatively affect all of these physical habitat attributes which can result in impacts to PCEs 1-8. However, the RMP minimizes these adverse effects through conservation measures, best management practices (BMPs), and the Coeur d'Alene Native Fish Strategy (CNFISH). The focus of CNFISH is to protect, maintain, or restore riparian conservation areas (RCAs) on Bureau lands by establishing riparian management objectives (RMOs) and implementing conservation measures. In spite of implementing CNFISH and BMPs, some adverse effects to critical habitat are still likely to occur.

The majority of the designated critical habitat associated with Bureau lands in the CdA FO is migratory habitat for bull trout and is extremely limited. However, the CdA FO does manage designated critical habitat used by bull trout for spawning and rearing along Lost Lake Creek, Little Lost Lake Creek, and Lund Creek in the Little North Fork Clearwater River watershed.

Forestry practices have the potential to increase sediment (PCEs 1, 2, 3, 4, and 6) in bull trout streams. Roads contribute the greatest amount of sediment (Waters 1995, p. 35), but skid trails and soil exposed during harvest also contribute fine sediment. Increased sedimentation primarily affects bull trout critical habitat by reducing the quality of intragravel incubation habitat. Increased sedimentation in substrate (PCE 6) decreases egg-to-fry survival. Fine sediment in the gravel reduces interstitial flow which decreases the amount of oxygen available to incubating eggs and increases the concentration of metabolic wastes around incubating eggs. Fine sediment can also entomb incubating eggs making it impossible for fry to emerge from redds.

Timber harvest may also increase water yield (PCEs 1, 2, 5, 7, and 8) which can lead to stream scour. Stream scour reduces the amount of appropriately-sized spawning substrate available to bull trout and reduces available prey (Shellberg et al. 2010, pp. 637-638). The RCAs will serve to buffer the effects of increased water yield, but localized scouring is still likely. Timber harvest in riparian areas may reduce streamside canopy levels which reduces shade and can ultimately result in increased stream temperatures (PCE 5) and reduced large woody debris (PCE 4). However, timber harvest is only allowed in RCAs when necessary to attain RMOs, so any effect on stream temperature and in-channel large wood is likely to be minimal.

Minerals management actions include construction and reclamation of mine sites, reserve pits, compressor stations, product enhancement and disposal facilities; locatable mineral exploration and development; mineral material sales; and geophysical exploration. These actions have the potential to significantly alter riparian areas, contribute fine sediment to streams, and degrade water quality (PCE 8). The CNFISH contains measures to minimize surface occupancy within RCAs. When locating within RCAs is necessary, CNFISH provides measures for using construction methods that reduce effects on habitat.

Suppressing wildfires often requires using retardant and heavy equipment. When retardant enters streams it reduces water quality (PCE 8). Retardant is toxic to aquatic organisms, so it can kill or alter the behavior of bull trout or their prey. CNFISH requires avoidance of delivering retardant chemicals to water, unless necessary for safety reasons. Various fire suppression activities, such as heavy equipment use or camp placement, can alter habitat by increasing fine sediment input and removing stream shade. CNFISH provides measures to reduce the potential for these impacts.

Implementing prescribed fires may also have a negative effect on designated bull trout critical habitat. Prescribed fires may result in a slight increase in fine sediment delivery to bull trout critical habitat or a small temporary loss of stream shade. However, CNFISH requires that prescribed fires contribute to attainment of RMOs, and prescribed fires will be conducted under appropriate fuel loading and moisture levels, resulting in controlled understory burns.

Applying herbicides to control noxious weeds is likely to result in some impairment of water quality. However, CNFISH requires that herbicides be applied in a manner that does not prevent attainment of RMOs and avoids adverse effects on native fish. Effects of herbicide application on PCE 8 will be short term, because if herbicides do enter the water, it will be in low concentrations in isolated areas and they will be rapidly diluted.

Land exchanges that include bull trout habitat may have some indirect effects to designated bull trout critical habitat. If land with bull trout critical habitat is exchanged, conservation measures outlined in the CdA RMP will no longer apply to the exchanged lands. Conversely, if the CdA FO acquires lands containing bull trout critical habitat, conservation measures in the RMP will apply to the acquired lands. The RMP lists habitat for species listed under the Act as a priority for retention or acquisition.

Use permits and rights-of-way (ROWs) are generally issued for activities such as road construction and maintenance or facilities development. These activities remove vegetation and expose bare soil, greatly increasing the risk of fine sediment delivery to streams, and if riparian vegetation is removed, stream shade and overhead cover may be reduced. As discussed above, increased sedimentation affects bull trout critical habitat by impacting incubation habitat. The CNFISH identifies RCAs as areas to avoid when authorizing ROWs. There will likely be situations where RCAs cannot be avoided; however, conservation measures in the CdA RMP will apply to all construction and maintenance activities, greatly reducing potential impacts. Culverts at road crossings can create a fish passage barrier (PCE 2); however, CNFISH requires fish passage to be provided when a crossing is constructed replaced, or reconstructed. A short-term increase in fine sediment will result from culvert or bridge replacement when streams are diverted into a temporary channel, when they are diverted back into the original channel, and at the time of the first high flow event following installation (USFWS 2006, p. 75). Diverting streams during crossing replacement is also likely to temporarily affect PCE 3 by creating a short-term reduction in forage by placing the stream in a relatively "sterile" temporary channel and reworking the original channel. However, once the water is turned back into its original channel, the substrate will be recolonized (Churchel and Batzer 2006, p. 268). There will be a long-term improvement to habitat following installation of new; appropriately-sized (sized for 100-year flood event) crossings by allowing near-natural channel function.

Activities associated with the recreation program are likely to have some level of adverse effects on bull trout critical habitat. In particular, use, construction, and maintenance of motorized and non-motorized trails that cross or are in close proximity to critical habitat are likely to deliver fine sediment to streams, disturb substrate, and alter streambanks (PCEs 1, 3, 4, 5, 6, 7, and 8) at fords, and eliminate some riparian vegetation which may reduce stream shading. The effects of increased fine sediment have been detailed above. Disturbance of substrate can reduce its suitability for spawning and incubation. Altered streambanks can lead to increased bank erosion which increases sediment delivery and may increase width/depth ratio which results in decreased habitat quality by creating wide, shallow habitat with little complexity. Decreased shading results in increased solar radiation which may increase water temperature. However, proper implementation of CNFISH will limit these effects to a small number of locations where trails get extremely close to streams or cross streams. In particular, none of the trails associated with the Little North Fork River, Lost Lake Creek, Little Lost Lake Creek, and Lund Creek cross bull trout streams on Bureau land. Since these effects will be localized and minimal on the aforementioned streams, they are not expected to impact critical habitat to the point that the potential for bull trout survival or recovery is reduced.

The above activities all have the potential to remove some streamside vegetation. Streamside vegetation removal may result in increased water temperatures by increasing the amount of solar radiation reaching the water surface. Increased water temperatures can reduce habitat suitability for bull trout. Bull trout do not initiate spawning until temperatures drop below 9° C and rearing juvenile bull trout require temperatures below 12° C (Poole et al. 2001, p. 5). However, the RCAs and the measure requiring treatments within RCAs to benefit riparian management objectives (RMOs) decrease the likelihood that significant increases in temperature will result from implementing the CdA RMP.

Effects Determination. As noted in the above effects discussion, implementing the CdA RMP will have small-scale adverse effects on designated bull trout critical habitat by allowing activities that may deliver fine sediment to streams, reduce water quality, reduce shade leading to increased water temperature, and result in localized channel scour in locations that may impact bull trout critical habitat. However, the conservation measures, BMPs, and CNFISH will limit these effects to small areas for short periods, and ultimately result in a long-term benefit to bull trout critical habitat. Therefore, implementing the CdA RMP "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.2 Ongoing Activities in the Jarbidge Watershed—Wildfire Suppression (OALS# 1-5-03-F-114)

Activity Description. The proposed action is to suppress wildfires that occur in the Jarbidge River watershed (USBLM 2003, entire). Four wheel drive engines and bull dozers would be the primary on the ground equipment used for suppression. Engines will likely pump water from the Jarbidge River or tributaries to fill tanks and transport water to the fire. Most water tenders can haul up to 10,000 gallons of water. Hose lays in which water is pumped directly from streams may also be used. Bull dozers will be used to construct fire line. Back burning between the fire line and the wild fire may also be used as a suppression tactic. Aerial suppression would consist of water bucket drops and retardant drops. Helicopters may dip water from the Jarbidge River in a few locations. Retardant will not be dropped in canyons or perennial streams and bull dozers will not construct fire line across perennial streams. In steep canyons, hand crews will be used to suppress fires and water drops may be used. Hand crews may use chainsaws to cut shrubs and trees. The Bureau will initiate emergency consultation with the Service in the event that wildfire suppression efforts may affect designated critical habitat or bull trout. Conservation measures that will be implemented as part of the proposed action include: Berms created during fire line construction will be leveled off, water bars will be constructed on fire lines on steep slopes and the fire lines on steep slopes will be seeded with a mixture of grass seed, and a knowledgeable resource advisor will be assigned to the fire.

Status of Critical Habitat in the Jarbidge Field Office Action Area. The Jarbidge Field Office area includes a single bull trout CHU: the Jarbidge River Unit. The Jarbidge River CHU encompasses the Jarbidge and Bruneau River basins, which drain into the Snake River within C.J. Strike Reservoir upstream of Grand View, Idaho. The Jarbidge River CHU is located approximately 70 miles north of Elko within Owyhee County in southwestern Idaho and in Elko County in northeastern Nevada. The Jarbidge River CHU includes 245.2 km (152.4 mi) of streams designated as critical habitat. The Jarbidge River CHU contains six local populations of resident and migratory bull trout and provides spawning, rearing, foraging, migratory, connecting, and overwintering habitat.

The Jarbidge River CHU is essential to bull trout conservation. Jarbidge River bull trout are a high conservation priority for maintaining the maximum genetic diversity and evolutionary potential of the species across its range. The ecological setting of this CHU is unique. It is the southernmost extent of the species' range. The loss of bull trout in this CHU would result in a substantial modification of the species' range. Bull trout in the Jarbidge area are isolated from the rest of the species' range due to a combination of physical barriers that have been in place for over a century and habitat that has been unsuitable for much of this same period of isolation. Although recognized as being within the Snake River complex, recent genetic analyses conducted by the Service's Abernathy Fish Technology Center indicate that genetic characteristics of bull trout in the Jarbidge area do differ from other populations. Local genetic adaptations of this southernmost bull trout population may be a very desirable trait in the face of global climate change.

Effects Analysis. The February 27, 2003 biological assessment (USBLM 2003, entire) and the subsequent November 17, 2004 biological opinion (USFWS 2004a, entire) prepared for fire suppression, and other ongoing activities, analyzed effects of fire suppression activities on a number of physical habitat attributes including water quantity, water quality, and substrate. Wildfire suppression activities have the potential to negatively affect each of these attributes which have the potential to impact PCEs 1 through 8. However, the proposed action includes several fire suppression guidelines that will greatly reduce or minimize these potential effects. Examples of suppression guidelines include: Do not use bull dozers within RCAs, refrain from using chemicals within RCAs, and keep fuel at least 100 feet away from live streams and riparian areas. The only exception to these guidelines would be if one of the prohibited actions was necessary to protect life or property. In spite of implementing these guidelines, adverse effects to critical habitat are still likely to occur.

Fire engines will leave existing roads when necessary, but avoid RCAs except for established crossings and access points to withdraw water from streams. Withdrawal of water from streams to fill fire engines and for hose lays will reduce the quantity of water (PCE 8) within streams for a short period of time and is likely to impact water quality (PCE 8) and substrate (PCE 6). The only designated critical habitat where fire engine water withdrawal will occur, due to limited access, is in the East Fork Jarbidge and West Fork Jarbidge rivers. Water may be withdrawn from Dave Creek for hose lays and helicopter bucket withdrawals may occur in a few locations in the Jarbidge River. These streams are large enough that a short-term reduction in flow while filling a fire engine or using a hose lay is not expected to reduce the ability of the critical habitat to support the survival and recovery of bull trout populations in the Jarbidge River system. Turbidity is likely to increase from fine sediment that is washed into the stream during pumping and during rain events and spring runoff at the disturbed access points. Fines in the substrate are likely to increase for a short distance downstream of the pumping access points. The impact to critical habitat resulting from increased turbidity and fines in the substrate will likely be minimal since the habitat in these locations is only used for foraging, migration, and overwintering. Therefore, critical habitat effects resulting from increased fine sediment are not expected to reduce the ability of the critical habitat to support the survival and recovery of Jarbidge River bull trout. Finally, when water is pumped from streams there is a risk that small amounts of fuel may be spilled into streams. The amount would be small, since the pumps used along streams hold a small volume of fuel, and dilution would occur rapidly, so critical habitat is expected to continue to support survival and recovery of Jarbidge River bull trout.

As described above, bull dozers will be used to construct fire line, but they will avoid perennial streams. However, it is likely that fire line will be constructed across dry channels and as a result fine sediment will be transported downstream into designated critical habitat. Post-fire rehabilitation of fire lines will limit the length of time these effects are realized. The first year following the fire sediment will be contributed to critical habitat during storm events and spring runoff resulting in increased turbidity (PCE 8) and substrate embeddedness (PCEs 1, 2, 3, 4, and 6). However, the amount of sediment transported to critical habitat will decrease with each subsequent year as seeds take root and vegetation covers the disturbed area. Fines in the substrate are likely to increase for a short distance downstream of the confluence with dry channels. The impact to critical habitat resulting from increased turbidity and fines in the substrate will likely be minimal since the habitat in these locations is only used for foraging, migrating, and overwintering. Therefore, critical habitat effects resulting from increased fine sediment are not expected to reduce the ability of the critical habitat to support the survival and recovery of Jarbidge River bull trout.

Back burning can have a variety of effects. The removal of vegetation by fire increases the potential for soil erosion and its subsequent suspension in the water column and deposition in streams (PCEs 1, 2, 3, 4, 6, and 8) designated as bull trout critical habitat. Back burning can also have short-term negative effects on water quality. The back burn fire itself can increase water temperatures (PCE 5) and increase ammonium levels (PCE 8) from smoke gases absorbed into surface waters. Phosphate levels can be increased as phosphate is leached from ash and delivered to streams.

As noted in the activity description, fire retardant will not be dropped into canyons or on perennial streams. However, retardant may be dropped on dry channels and be transported downstream to critical habitat when surface water returns to the dry channels. These channels only tend to flow water during large storm events or spring runoff. During these periods, flows are higher in downstream critical habitat which dilutes retardant being carried downstream decreasing its effect on the critical habitat. The use of fire retardant will temporarily degrade water quality (PCE 8), but the toxicity of any retardant transported into designated critical habitat will rapidly diminish as it mixes with relatively large volumes of water. The temporary and localized nature of degraded water quality within critical habitat resulting from fire retardant will allow the designated critical habitat to continue to support survival and recovery of Jarbidge River bull trout.

Fire suppression will also consist of constructing hand fire lines in RCAs. Hand fire line may be constructed up to the edge of perennial streams, including designated critical habitat. As a result, fine sediment will likely be delivered to critical habitat from these hand fire lines. The impact to critical habitat resulting from increased turbidity and fines in the substrate will likely be minimal since the habitat in these locations is only used for foraging, migrating, and overwintering. Therefore, critical habitat effects resulting from increased fine sediment are not expected to reduce the ability of the critical habitat to support the survival and recovery of Jarbidge River bull trout. Also, hand crews may fall trees and shrubs as necessary while constructing fire line which will result in a slight decrease in stream shade. Removal of trees and shrubs will be limited to a narrow band perpendicular to the stream, so the decrease in stream shade will be minimal and any subsequent increase in stream temperature is expected to be immeasurable.

Effects Determination. As noted in the above effects discussion, wildfire suppression in the Jarbidge River watershed will have small-scale adverse effects on designated bull trout critical habitat by allowing activities that may deliver fine sediment to streams and reduce water quality. However, fire suppression guidelines will function to reduce or minimize these effects. Therefore, carrying out wildfire suppression activities "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.3 Ongoing Activities in the Jarbidge Watershed—Diamond A Grazing Allotment (OALS# 1-5-03-F-114)

Activity Description. The Diamond A Allotment lies between the Jarbidge River and the Bruneau River, and contains nearly 130,140 acres. Approximately 110,120 acres are Federal and approximately 22,300 acres are within the Bruneau River watershed. The allotment is divided into nine use areas and is managed under a coordinated resource management plan written in 1984. The allotment includes pastures in Idaho and Nevada. Permits for the Diamond A Grazing Allotment authorize 8,546 AUMs of livestock grazing (800 cattle and 70 horses) to three permittees, from March 1 to February 28 (USBLM 2003, entire). Cattle are generally grazing Forest Service lands from July 1 into September, so most of the cattle use of this allotment occurs from fall through spring. Most of the horse use occurs from late-November to May. A number of guidelines have been added to the permits as triggers to move cattle in order to provide for recovery of aquatic habitat and maintenance of upland habitat. Meeting any one of the guidelines is the trigger for moving all livestock from the pasture for the year within 5 days. Guidelines include:

1. Grazing on riparian herbaceous species is limited to leave a median stubble height on key species. Stream segments where the riparian zone was rated as Functional and Functional-at-risk (FAR) upward trend may be grazed to 4 inches (in.) median stubble height (upland species). Stream segments classified FAR downward trend, FAR no trend, or nonfunctional would be managed to a median stubble height of ≥ 6 in. (Clary and Webster 1989, pp. 2, 8). Key species may include but are not limited to: Kentucky bluegrass, small-wing sedge, wooly sedge, Nebraska sedge, and hairgrass. Baltic rush and spike rush are excluded as key riparian species. An interdisciplinary team will select key species.
2. Browsing on current year's leaders on available twigs of key riparian browse species is not to exceed 50 percent. Limiting the nipping of current year's leaders on available woody species should protect growth form, reproduction, and age class structure. Key browse species may include, but are not limited to: aspen, willows, rose, or currant. Key riparian woody species will be determined by an interdisciplinary team.

3. Bank alteration not to exceed 10 percent on known fish-bearing streams. Manage livestock on known or suspected non-fish bearing streams so that no more than 20 percent of the streambank is altered. These guidelines are subject to change after validation of fish presence or absence.
4. No more than 40 percent use in the uplands in general on key forage species. Key forage species may include but are not limited to: Idaho fescue, bluebunch wheatgrass, Sandberg bluegrass, or bottlebrush squirreltail. Selection of key species will be done by an interdisciplinary team.
5. No more than 50 percent nipping in the uplands on key woody species. Key woody species may include: aspen, wild rose, chokecherry, currant, snowberry, or sagebrush in important wildlife habitats. The species to monitor will be determined by an interdisciplinary team. Key areas for all upland monitoring will be in areas readily accessible to livestock.
6. In key seeded areas, grazing use is limited to 50 percent on key seeded species. Key herbaceous seeded species include crested wheatgrass and intermediate wheatgrass.

Status of Critical Habitat in the Diamond A Grazing Allotment Action Area. Within the Diamond A Grazing Allotment, designated critical habitat includes Deer Creek, which provides spawning and rearing (SR) habitat, and the West Fork Jarbidge and Jarbidge rivers, which provide foraging, migration, and overwintering (FMO) habitat for bull trout. Refer to the "Status of Critical Habitat in the Jarbidge Field Office Area" description in section 2.5.2.2 (Wildfire Suppression) above for additional information on critical habitat within the Jarbidge River CHU.

Effects Analysis Process. The relationship between grazing activities and their effect to fish and fish habitat is complex and, at times, includes synergistic and interrelated relationships. To assist the reader in understanding how grazing activities act through cause and effect pathways to result in effects to fish, the Service developed a source document (Appendix C - Assessing the Effects of Grazing on Bull Trout and Their Habitat) that identifies and evaluates those pathways based on published information and commonly accepted rationales. By creating a source document, relevant portions can be incorporated by reference, without substantially increasing the narrative of this Opinion. Figure 4 and Table 4 summarize the results of the evaluation presented in Appendix C.

Effects Analysis. The February 27, 2003 biological assessment (USBLM 2003, entire) and the subsequent November 17, 2004 biological opinion (USFWS 2004a, entire) prepared for livestock grazing, and other ongoing activities, analyzed effects of livestock grazing on a number of physical habitat attributes including soil cover, water quantity, water quality, substrate, cover, bank stability, channel morphology, and nutrients. Livestock grazing has the potential to negatively affect each of these attributes which have the potential to impact PCEs 1 through 8. However, the proposed action includes six guidelines, identified above, that will greatly reduce these potential effects. In spite of implementing these guidelines, adverse effects to critical habitat are still likely to occur.

In the Diamond A Allotment, access to designated bull trout critical habitat is limited by steep topography and fences. However, it is still likely that cattle will access up to 0.9 miles of bull trout critical habitat where adverse effects are likely to occur. These 0.9 miles of critical habitat constitute about 0.6 percent of the approximately 152 miles of bull trout critical habitat located within the Jarbidge Watershed. Effects to designated bull trout critical habitat are most likely to occur in the Buck Creek Pasture where livestock can trail down the Deer Creek Grade road to the West Fork Jarbidge River, in the South Buck Creek Pasture livestock can access Deer Creek and the WF Jarbidge River, in the Winter Pasture where livestock can access the Jarbidge River Canyon, and in the Dorsey/Columbet Pasture where livestock can access the Jarbidge River by walking down Columbet Creek. Deer Creek provides spawning and rearing (SR) habitat while the West Fork Jarbidge and Jarbidge rivers provide FMO habitat for bull trout. A variety of effects to bull trout critical habitat may occur along Deer Creek, the West Fork Jarbidge River, and the Jarbidge River. Grazing can reduce soil cover, alter streambanks, reduce riparian cover, increase sedimentation, lead to increased stream temperature, and displace substrate.

Livestock trampling generally decreases soil cover. As grazing intensity increases, biological crusts decline (Belnap et al. 2001, pp. 49-50), and soils are exposed to erosion. Eroding soils are then likely to be transported to stream channels where they can increase turbidity (PCE 8) and fines in the substrate (PCEs 1, 2, 3, 4, and 6) in streams that are bull trout critical habitat. Trampling also increases soil compaction which results in decreased infiltration. Decreased infiltration results in more rapid runoff (PCE 8) and decreased water storage (PCEs 1 and 8) which ultimately results in decreased base flows. Refer to the original biological opinion (USFWS 2004a, pp. 50-56) and Appendix C, Section 2.2.1 for a full discussion of the effects of soil compaction and changes in sediment input on bull trout and its habitat.

Effect Pathway	Grazing Activity	Environmental Change	Consequences to Bull Trout
Pathway 1	Grazing on streamside vegetation	Less shade	Increased stream temperatures
Pathway 2	Grazing on streamside vegetation	Less overhanging vegetation thereby less food/habitat for prey	Less aquatic and terrestrial food for bull trout
Pathway 3	Livestock use of streambank (section 2.1.2)	Decreased bank stability leading to	Lower number of undercut banks and pools Increased width to depth ratio Increased sediment in water and substrate
Pathway 4	Walking or loafing in stream	Trampling of redds	Decrease bull trout population
Pathway 5	Walking or loafing in stream	Displacement of juveniles from cover increasing predation risk	Decrease juvenile survival
Pathway 6	Urinating or defecating in stream	Lowered water quality	Decrease prey populations
Pathway 7	Activities causing compaction (section 2.2.1)	Increased runoff and erosion	Causes stream incision and and triggers pathways 3, 6, 8
Pathway 8	Activities causing compaction (section 2.2.1)	Decreased infiltration	Decreases stream flow, lowers water table and triggers pathways 1 and 3
Pathway 9	Grazing on riparian and upland vegetation	Shifts in plant community	Reduces woody debris and triggers pathways 3 and 7

Figure 4. Summary of Effect Pathways 1-9 that may be triggered by grazing activities and the possible environmental results and consequences to bull trout/aquatic habitat as established and validated in Sections 2.1 and 2.2 in Appendix C.

Table 4. Variables which influence the degree of impact that grazing can have on bull trout or their habitat separated by Effect Pathways (pathways are summarized in Appendix C, Figure 1 and described fully in Appendix C, Section 2.0). [3]

Effect pathway # and element that may be affected by grazing	Variables that influence the degree of impact that grazing can have on bull trout or their habitat							
	Amount of stream access	Vegetation type	Slope and aspect	Elevation	Soil condition, type, and moisture content	Habitat suitability for spawning	Habitat suitability for juveniles	Management considerations
1 Stream temperature	✓	✓	✓					✓
2 Prey abundance	✓	✓			✓			✓
3 Bank condition and sediment load	✓	✓	✓	✓	✓			✓
4 Redd Trampling	✓	✓				✓		✓
5 Juvenile displacement	✓	✓					✓	✓
6 Stream nutrient levels	✓	✓						✓
7 Runoff and erosion		✓	✓		✓			✓
8 Infiltration Rate		✓	✓		✓			✓
9 Plant community		✓			✓			✓

[3] For a detailed explanation of how these variables influence degree of effect, see Appendix C, Section 3.0.

Livestock accessing streams to water or to forage along the stream alter streambanks, exposing soil to erosion, destroying overhanging banks, and potentially destabilizing banks (PCEs 1, 3, 4, 5, 6, 7, and 8) which may lead to channel widening (PCE 4) and reduced pool depth (PCE 4). As channels widen, habitat is simplified (PCE 4), and cover (PCE 4) is reduced. Persistent heavy grazing in riparian areas results in changes in plant species composition from riparian-dependent species to more xeric species which results in weakened root masses for bank stability and decreased stream shade. Decreased stream shade is ultimately likely to result in increases in stream temperature (PCE 8). Riparian vegetation delivers organic material to the stream, which accounts for a significant amount of a stream's nutrient energy. Allochthonous material provided by riparian vegetation is a primary source of food for aquatic invertebrates (PCE 3) which are an important source of food for bull trout. Livestock grazing that reduces stubble height below 4 inches will likely lessen the sediment trapped by herbaceous vegetation, reduce ground cover, and increase soil compaction and degrade water quality. In addition, cattle standing and walking in streams displace substrate, potentially affecting its suitability for spawning or its use as cover by juvenile bull trout. Livestock also affect water quality in bull trout critical habitat through urination or defecation in the stream. Refer to the original biological opinion (USFWS 2004a, pp. 49-58) and Appendix C, Sections 2.1 and 2.2 for a full discussion of effects of grazing on bull trout and its habitat, including streamside vegetation, bank, stability, water quality, channel morphology, and prey.

All of the effects described above have the potential to occur in critical habitat associated with the Jarbidge River, West Fork Jarbidge River, and Deer Creek. However, access to these streams is extremely limited due to steep topography and in some cases fencing, so the effects are expected to be limited to short segments of stream for short periods. In areas where livestock do access streams, implementation of the six guidelines described in the activity description will help reduce adverse effects.

Effects Determination. As noted in the above effects discussion, grazing livestock on the Diamond A Allotment will have small-scale adverse effects on designated bull trout critical habitat because cattle access to streams is extremely limited due to steep topography and fencing. In cases where livestock do access streams, implementation of guidelines will help reduce adverse effects. Therefore, grazing livestock on the Diamond A Allotment "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.4 Ongoing Activities in the Jarbidge Watershed—Poison Butte Grazing Allotment (OALS# 1-5-03-F-114)

Activity Description. The 2003 assessment stated that the Poison Butte Allotment consists of 72,700 acres and is divided into 27 pastures. Approximately 48,500 acres in 16 pastures are within the Jarbidge River watershed. However, in 2005, the Dave's Island Pasture was separated from the Poison Butte Allotment and transferred from CE Brackett Cattle Co. to Bert and Paul Brackett. Dave's Island Pasture was designated its own allotment and named "Little Island Allotment (#00438)". Pursuant to Federal District Court Order by Magistrate Judge Williams on April 11, 2003, (CV 02 251 S MHW), the Little Island Allotment currently is managed in non-use status, and will remain so until the livestock grazing permit is renewed. Therefore, the Dave's Island Pasture has been removed from analyses of the effects of ongoing livestock grazing in the Poison Butte Allotment on bull trout critical habitat. Effects of livestock grazing in the Dave's Island Pasture (currently known as the Little Island Allotment) are not addressed further in this Opinion[4].

The proposed action is to continue to authorize 6,360 AUMs on the base grazing permit for livestock grazing from March 1st to February 28th. An additional 8,633 AUMs may also be authorized. Livestock access to streams is generally limited by steep topography, and in some cases fences. The six guidelines included in the activity description for the Diamond A Allotment also apply to the Poison Butte Allotment.

The permit holder meets with the Jarbidge FO annually to discuss the upcoming season of use. Grazing management will be adaptive in response to monitoring information. Adjustments in pasture rotations, timing, season of use and numbers will be based on the previous year's monitoring data.

As described for the Diamond A Allotment above, refer to the original biological opinion (USFWS 2004a, pp. 49-58), Appendix C of this Opinion, and Figure 1 and Table 4 above for more information on the relationship between grazing activities and their effect on bull trout and their habitat.

Status of Critical Habitat in the Poison Butte Grazing Allotment Action Area. Within the Poison Butte Grazing Allotment, designated critical habitat includes Dave Creek, which provides SR habitat and the East Fork Jarbidge and Jarbidge rivers, which provide FMO habitat for bull trout. Refer to the "Status of Critical Habitat in the Jarbidge Field Office Area" description in section 2.5.2.2 (Wildfire Suppression) above for additional information on critical habitat within the Jarbidge River CHU.

Effects Analysis. The February 27, 2003 biological assessment (USBLM 2003, entire) and the subsequent November 17, 2004 Service biological opinion (USFWS 2004a, entire) prepared for livestock grazing, and other ongoing activities, analyzed effects of livestock grazing on a number of physical habitat attributes including soil cover, water quantity, water quality, substrate, cover, bank stability, channel morphology, and nutrients. Livestock grazing has the potential to negatively affect each of these attributes which have the potential to impact PCEs 1 through 8. However, the proposed action includes six guidelines, identified above, that will greatly reduce these potential effects. In spite of implementing these guidelines, adverse effects to critical habitat are still likely to occur.

In the Poison Butte Allotment, it is likely that cattle will access up to 0.3 miles of bull trout critical habitat where adverse effects are likely to occur. These 0.3 miles of critical habitat constitute about 0.2 percent of the approximately 152 miles of bull trout critical habitat located within the Jarbidge Watershed. Effects to designated bull trout critical habitat associated with this allotment are most likely to occur when cattle access the Jarbidge River from the Inside Lakes, Rock Corral, South Sheep, and Poison Butte pastures; and when they access the East Fork Jarbidge River from the South Sheep and West Nevada Strip pastures. The Jarbidge and East Fork Jarbidge rivers provide FMO habitat for bull trout.

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[4] The Bureau has not requested inclusion of the Little Island Allotment in this or other section 7 consultations.

Livestock trampling generally decreases soil cover. As grazing intensity increases, biological crusts decline (Belnap et al. 2001, pp. 49-50), and soils are exposed to erosion. Eroding soils are then likely to be transported to stream channels where they can increase turbidity (PCE 8) and fines in the substrate (PCEs 1, 2, 3, 4, and 6) in streams that are bull trout critical habitat. Trampling also increases soil compaction which results in decreased infiltration. Decreased infiltration results in more rapid runoff (PCE 8) and decreased water storage (PCEs 1 and 8) which ultimately results in decreased base flows. Refer to the original biological opinion (USFWS 2004a, pp. 50-56) and Appendix C, Section 2.2.1 for a full discussion of the effects of soil compaction and changes in sediment input on bull trout and its habitat.

Livestock accessing streams to water or to forage along the stream alter streambanks, exposing soil to erosion, destroying overhanging banks, and potentially destabilizing banks (PCEs 1, 3, 4, 5, 6, 7, and 8) which may lead to channel widening (PCE 4) and reduced pool depth (PCE 4). As channels widen, habitat is simplified (PCE 4), and cover (PCE 4) is reduced. Persistent heavy grazing in riparian areas results in changes in plant species composition from riparian-dependent species to more xeric species which results in weakened root masses for bank stability and decreased stream shade. Decreased stream shade is ultimately likely to result in increases in stream temperature (PCE 8). Riparian vegetation delivers organic material to the stream, which accounts for a significant amount of a stream's nutrient energy. Allochthonous material provided by riparian vegetation is a primary source of food for aquatic invertebrates (PCE 3) which are an important source of food for bull trout. Livestock grazing that reduces stubble height below 4 inches will likely lessen the sediment trapped by herbaceous vegetation , reduce ground cover, and increase soil compaction, and degrade water quality. In addition, cattle standing and walking in streams displace substrate, potentially affecting its suitability for spawning or its use as cover by juvenile bull trout. Livestock also affect water quality in bull trout critical habitat through urination or defecation in the stream. Refer to the original biological opinion (USFWS 2004a, pp. 49-58) and Appendix C, Sections 2.1 and 2.2 for a full discussion of effects of grazing on bull trout and its habitat, including streamside vegetation, bank, stability, water quality, channel morphology, and prey.

All of the effects described above have the potential to occur in critical habitat associated with the Jarbidge River and East Fork Jarbidge River. However, access to these streams is extremely limited due to steep topography and in some cases fencing, so the effects are expected to be limited to short segments of stream for short periods. In areas where livestock do access streams, implementation of the six guidelines described in the activity description will help reduce adverse effects.

Effects Determination. As noted above, grazing livestock on the Poison Butte Allotment will have small-scale adverse effects on designated bull trout critical habitat because cattle access to streams is extremely limited due to steep topography and fencing. In cases where livestock do access streams, implementation of guidelines will help reduce adverse effects. Therefore, grazing livestock on the Poison Butte Allotment "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.5 Ongoing Activities in the Jarbidge Watershed—Wilkins Island Grazing Allotment (OALS# 1-5-03-F-114)

Activity Description. The Wilkins Island Allotment contains 14,057 acres grazed by cattle. Approximately 7,620 acres are Federal land managed by the Jarbidge FO. On Bureau lands, the allotment has 773 preference AUMs. The number of cattle varies annually, and grazing is authorized from March 1st to February 28th. However, actual use is usually split between spring and fall. Cattle are turned out in May to early June and are trailed to summer range on the Humboldt National Forest by early July. The cattle return to Bureau-administered lands in October and are usually removed by early November. The allotment is divided into three pastures: the Rattlesnake, Chimney, and Billy Martin pastures. The six guidelines included in the activity description for the Diamond A Allotment also apply to the Wilkins Island Allotment.

As described for the Diamond A Allotment above, refer to the original biological opinion (USFWS 2004a, pp. 49-58), Appendix C of this Opinion, and Figure 1 and Table 4 above for more information on the relationship between grazing activities and their effect on bull trout and their habitat.

Status of Critical Habitat in the Wilkins Island Grazing Allotment Action Area. Within the Wilkins Island Grazing Allotment, designated critical habitat includes the West Fork Jarbidge and East Fork Jarbidge rivers, which provide FMO habitat for bull trout. Refer to the "Status of Critical Habitat in the Jarbidge Field Office Area" description in section 2.5.2.2 (Wildfire Suppression) above for additional information on critical habitat within the Jarbidge River CHU.

Effects Analysis. The February 27, 2003 biological assessment (USBLM 2003, entire) and the subsequent November 17, 2004 biological opinion (USFWS 2004a, entire) prepared for livestock grazing, and other ongoing activities, analyzed effects of livestock grazing on a number of physical habitat attributes including soil cover, water quantity, water quality, substrate, cover, bank stability, channel morphology, and nutrients. Livestock grazing has the potential to negatively affect each of these attributes which have the potential to impact PCEs 1 through 8. However, the proposed action includes six guidelines, identified above, that will greatly reduce these potential effects. In spite of implementing these guidelines, adverse effects to critical habitat are still likely to occur.

In the Wilkins Island Allotment, it is likely that cattle will access up to 0.3 miles of bull trout critical habitat where adverse effects are likely to occur. These 0.3 miles of critical habitat constitute about 0.2 percent of the approximately 152 miles of bull trout critical habitat located within the Jarbidge Watershed. Effects to designated bull trout critical habitat associated with this allotment are most likely to occur when cattle access the East Fork Jarbidge River from the Rattlesnake Pasture, when cattle access the West Fork Jarbidge River from the Billy Martin Pasture, and if cattle access SR habitat in Dave Creek if a gate is left open, allowing cattle access to the Dave Island Pasture of the Poison Butte grazing allotment. The East Fork Jarbidge and West Fork Jarbidge rivers provide FMO habitat for bull trout.

Livestock trampling generally decreases soil cover. As grazing intensity increases, biological crusts decline (Belnap et al. 2001, pp. 49-50), and soils are exposed to erosion. Eroding soils are then likely to be transported to stream channels where they can increase turbidity (PCE 8) and fines in the substrate (PCEs 1, 2, 3, 4, and 6) in streams that are bull trout critical habitat. Trampling also increases soil compaction which results in decreased infiltration. Decreased infiltration results in more rapid runoff (PCE 8) and decreased water storage (PCEs 1 and 8) which ultimately results in decreased base flows. Refer to the original biological opinion (USFWS 2004a, pp. 50-56) and Appendix C, Section 2.2.1 for a full discussion of the effects of soil compaction and changes in sediment input on bull trout and its habitat.

Livestock accessing streams to water or to forage along the stream alter streambanks, exposing soil to erosion, destroying overhanging banks, and potentially destabilizing banks (PCEs 1, 3, 4, 5, 6, 7, and 8) which may lead to channel widening (PCE 4) and reduced pool depth (PCE 4). As channels widen, habitat is simplified (PCE 4), and cover (PCE 4) is reduced. Persistent heavy grazing in riparian areas results in changes in plant species composition from riparian-dependent species to more xeric species which results in weakened root masses for bank stability and decreased stream shade. Decreased stream shade is ultimately likely to result in increases in stream temperature (PCE 8). Riparian vegetation delivers organic material to the stream, which accounts for a significant amount of a stream's nutrient energy. Allochthonous material provided by riparian vegetation is a primary source of food for aquatic invertebrates (PCE 3) which are an important source of food for bull trout. Livestock grazing that reduces stubble height below 4 in. will likely lessen the sediment trapped by herbaceous vegetation, reduce ground cover, and increase soil compaction, and degrade water quality. In addition, cattle standing and walking in streams displace substrate, potentially affecting its suitability for spawning or its use as cover by juvenile bull trout. Livestock also affect water quality in bull trout critical habitat through urination or defecation in the stream. Refer to the original biological opinion (USFWS 2004a, pp. 49-58) and Appendix C, Sections 2.1 and 2.2 for a full discussion of effects of grazing on bull trout and its habitat, including streamside vegetation, bank, stability, water quality, channel morphology, and prey.

All of the effects described above have the potential to occur in critical habitat associated with the West Fork Jarbidge and East Fork Jarbidge rivers. However, access to these streams is extremely limited due to steep topography and in some cases fencing, so the effects are expected to be limited to short segments of stream for short periods. In areas where livestock do access streams, implementation of the six guidelines described in the activity description will help reduce adverse effects.

Effects Determination. As noted above, grazing livestock on the Wilkins Island Allotment will have small-scale adverse effects on designated bull trout critical habitat because cattle access to streams is extremely limited due to steep topography and fencing. In cases where livestock do access streams, implementation of guidelines will help reduce adverse effects. Therefore, grazing livestock on the Wilkins Island Allotment "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.6 Implementation of the Bureau's Jarbidge Resource Area Resource Management Plan, as Amended by INFISH (OALS# 1-5-99-F-003)

Activity Description. The June 15, 1998 biological assessment (USFS and USBLM 1998, entire) described effects of implementation of a variety of Forest Service and Bureau land-use plans, including the Jarbidge Resource Area RMP, on bull trout and other fish species listed under the Act. The Jarbidge Resource Area RMP was signed in 1985 and was amended by INFISH in 1995. The Jarbidge Resource Area RMP was prepared in order to provide the Bureau with a comprehensive framework for managing 1,690,473 acres of public land and to ensure that public lands will be managed in accordance with the Federal Land Policy and Management Act of 1976. The RMP provides guidance for managing livestock grazing, wild horses, wildlife, riparian habitat, fisheries resources, minerals, land and realty transactions, recreation, wilderness, specially designated lands, fire, cultural resources, paleontological resources, and forested lands.

The RMP provides guidelines for managing riparian and aquatic habitat that conserve and restore aquatic resources. Guidelines include establishing riparian buffers, maintaining instream flows, designing grazing strategies to meet aquatic needs, avoiding ground disturbing activities in riparian areas, maintaining roads to minimize aquatic impacts, and coordinating habitat improvement projects with Idaho Department of Fish and Game. However, none of the RMP guidelines are more restrictive than direction provided in INFISH (USFS and USBLM 1998, entire). INFISH provides direction for managing riparian habitat including: riparian management goals, riparian management objectives, riparian habitat conservation areas, and standards and guidelines. The focus of the riparian management goals is to maintain or restore water quality, stream channel integrity, channel processes, sediment regime, instream flows, water table, plant communities, and riparian vegetation. The riparian management objectives describe good salmonid habitat by identifying values for pool frequency, water temperature, large woody debris, bank stability, lower bank angle, and width/depth ratio. The riparian habitat conservation areas are delineated around water bodies based on whether or not a stream is fish-bearing, perennial, or seasonal; and size of ponds, lakes, reservoirs, and wetlands. Standards and guidelines are provided to protect riparian resources relative to management of timber, roads, grazing, recreation, minerals, fire/fuels, lands, and restoration.

Status of Critical Habitat in the Jarbidge Resource Area RMP Action Area. Refer to the "Status of Critical Habitat in the Jarbidge Field Office Area" description in section 2.5.2.2 (Wildfire Suppression) above for an overview of bull trout critical habitat within the Jarbidge Resource Area RMP action area.

Effects Analysis. The June 15, 1998 biological assessment (USFS and USBLM 1998, entire) and the subsequent April 27, 2001 biological opinion (USFWS 2001, entire) prepared for the Jarbidge Resource Area RMP analyzed effects of the RMP on a number of physical habitat attributes that correspond to bull trout critical habitat PCEs. In particular, the biological assessment addressed water quality, riparian habitat, large wood, water quantity, substrate, overhead cover, physical barriers, and bank stability. The activities implemented under the Jarbidge RMP have the potential to affect all of these physical habitat attributes which can result in impacts to PCEs 1-8. However, the Jarbidge RMP as amended by INFISH minimizes these adverse effects by providing direction for managing riparian habitat including: Riparian management goals, riparian management objectives, riparian habitat conservation areas, and standards and guidelines. The focus of this direction is to protect, maintain, or restore RCAs on Bureau lands. In spite of implementing this direction, adverse effects to critical habitat are still likely to occur.

The majority of the designated critical habitat associated with Bureau lands in the Jarbidge FO is migratory habitat for bull trout. However, the Jarbidge FO does manage designated critical habitat used by bull trout for spawning and rearing along Dave Creek, a tributary to the East Fork Jarbidge River.

Forestry practices have the potential to increase sediment (PCEs 1, 2, 3, 4, and 6) in bull trout streams. Roads contribute the greatest amount of sediment (Waters 1995, p. 35), but skid trails and soil exposed during harvest also contribute fine sediment. Increased sedimentation primarily affects bull trout critical habitat by reducing the quality of intragravel incubation habitat. Increased sedimentation in substrate (PCE 6) decreases egg-to-fry survival. Fine sediment in the gravel reduces interstitial flow which decreases the amount of oxygen available to incubating eggs and increases the concentration of metabolic wastes around incubating eggs. Fine sediment can also entomb incubating eggs making it impossible for fry to emerge from redds.

Timber harvest may also increase water yield (PCEs 1, 2, 5, 7, and 8) which can lead to stream scour. Stream scour reduces the amount of appropriately-sized spawning substrate available to bull trout and reduces available prey (Shellberg et al. 2010, pp. 637-638). The RCAs will serve to buffer the effects of increased water yield, but localized scouring is still likely. Timber harvest in riparian areas may reduce streamside canopy levels which reduces shade and can ultimately result in increased stream temperatures (PCE 5) and reduced large woody debris (PCE 4). However, timber harvest is only allowed in RCAs when necessary to attain RMOs, so any effect on stream temperature is likely to be minimal.

Livestock grazing is another activity with potential to negatively affect designated bull trout critical habitat. These effects are described in detail above for the Diamond A, Poison Butte, and Wilkins Island allotments.

Minerals management actions include construction and reclamation of mine sites, reserve pits, compressor stations, product enhancement and disposal facilities; locatable mineral exploration and development; mineral material sales; and geophysical exploration. These actions have the potential to significantly alter riparian areas, contribute fine sediment to streams, and degrade water quality (PCE 8). The Jarbidge RMP as amended by INFISH contains standards and guidelines for minerals management which reduce effects on habitat.

Suppressing wildfires often requires using retardant and heavy equipment. When retardant enters streams it reduces water quality (PCE 8). Retardant is toxic to aquatic organisms, so it can kill or alter the behavior of bull trout or their prey. The Jarbidge RMP as amended by INFISH requires avoidance of delivering retardant chemicals to water, unless necessary for safety reasons. Various fire suppression activities, such as heavy equipment use or camp placement, can alter habitat by increasing fine sediment input and removing stream shade. INFISH provides measures to reduce the potential for these impacts.

Implementing prescribed fires may also have a negative effect on designated bull trout critical habitat. Prescribed fires may result in a slight increase in fine sediment delivery to bull trout critical habitat or a small temporary loss of stream shade. However, INFISH requires that prescribed fires contribute to attainment of Riparian Management Objectives (RMOs), and prescribed fires will be conducted under appropriate fuel loading and moisture levels, resulting in controlled understory burns.

Applying herbicides to control noxious weeds is likely to result in some impairment of water quality (PCE 8). However, INFISH requires that herbicides be applied in a manner that does not prevent attainment of RMOs and avoids adverse effects on native fish. Effects of herbicide application on PCE 8 will be short term, because if herbicides do enter the water, it will be in low concentrations in isolated areas and they will be rapidly diluted.

Land exchanges that include bull trout habitat may have some indirect effects to designated bull trout critical habitat. If land with bull trout critical habitat is exchanged, direction outlined in the

Jarbidge RMP as amended by INFISH will no longer apply to the exchanged lands. Conversely, if the Jarbidge FO acquires lands containing bull trout critical habitat, direction in the RMP will apply to the acquired lands.

Use permits and ROWs are generally issued for activities such as road construction and maintenance or facilities development. These activities remove vegetation and expose bare soil, greatly increasing the risk of fine sediment delivery to streams, and if riparian vegetation is removed, stream shade and overhead cover may be reduced. As discussed above, increased sedimentation affects bull trout critical habitat by impacting incubation habitat. INFISH provides standards and guidelines for avoiding effects that would retard or prevent attainment of RMOs. Culverts at road crossings can create a fish passage barrier (PCE 2); however, INFISH requires fish passage to be provided when a crossing is constructed replaced, or reconstructed. A short-term increase in fine sediment will result from culvert or bridge replacement when streams are diverted into a temporary channel, when they are diverted back into the original channel, and at the time of the first high flow event following installation. Based on previous Service analyses (2004b, pp. 30, 50), we anticipate that suspended sediment levels will return to pre-project levels within 600 feet of culvert or bridge replacement projects using conservation measures for sediment control. Diverting streams during crossing replacement is also likely to temporarily affect PCE 3 by creating a short-term reduction in forage by placing the stream in a relatively "sterile" temporary channel and reworking the original channel. However, once the water is turned back into its original channel, it is expected that the substrate will be recolonized (Churchel and Batzer 2006, p. 268). There will be a long-term improvement to habitat following installation of new; appropriately-sized (sized for 100-year flood event) crossings by allowing near-natural channel function.

Activities associated with the recreation program and harvesting special forest products are likely to have some level of adverse effects on bull trout critical habitat. In particular, use, construction, and maintenance of motorized and non-motorized trails that cross or are in close proximity to critical habitat are likely to deliver fine sediment to streams, disturb substrate and alter streambanks (PCEs 1, 3, 4, 5, 6, 7, and 8) at fords, and eliminate some riparian vegetation which may reduce stream shading. The effects of increased fine sediment have been detailed above. Disturbance of substrate can reduce its suitability for spawning and incubation. Altered streambanks can lead to increased bank erosion which increases sediment delivery and may increase width/depth ratio which results in decreased habitat quality by creating wide, shallow habitat with little complexity. Decreased shading results in increased solar radiation which may increase water temperature. However, proper implementation of the Jarbidge RMP as amended by INFISH will limit these effects to a small number of locations where trails get extremely close to streams or cross streams. Since these effects will minimal on all designated critical habitat in the Jarbidge FO, they are not expected to impact critical habitat to the point that the potential for bull trout survival or recovery is reduced.

The above activities all have the potential to remove some streamside vegetation. Streamside vegetation removal may result in increased water temperatures by increasing the amount of solar radiation reaching the water surface. Increased water temperatures can reduce habitat suitability for bull trout. Bull trout do not initiate spawning until temperatures drop below 9° C and rearing juvenile bull trout require temperatures below 12° C (Poole et al. 2001, p. 5). However, the RCAs and the conservation measure requiring treatments within RCAs to benefit RMOs decrease the likelihood that significant increases in temperature will result from implementing the Jarbidge RMP as amended by INFISH.

Effects Determination. As noted in the above effects discussion, implementing the Jarbidge RMP as amended by INFISH will have small-scale adverse effects on designated bull trout critical habitat by allowing activities that may deliver fine sediment to streams, reduce water quality, reduce shade leading to increased water temperature, and result in localized channel scour in locations that may impact bull trout critical habitat. However, the riparian management goals, RMOs, riparian habitat conservation areas, and standards and guidelines contained within the Jarbidge RMP as amended by INFISH will limit these effects to small areas for short periods, and ultimately result in a long-term benefit to bull trout critical habitat. Therefore, implementing the Jarbidge RMP "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.7 Wilkins Island Allotment Livestock Trailing (OALS# 1-5-98-I-315, as cited in OALS# 1-5-03-F-114)

Activity Description. The livestock trailing corridor for the Wilkins Island Allotment area bisects critical habitat in the RCA along the East Fork Jarbidge River at an existing stream crossing site. Approximately 400 to 500 cattle will be actively herded across the East Fork Jarbidge River twice in spring (May/June) and twice in fall (September/October) annually at the established 100-foot wide crossing site south of Murphy Hot Springs, Idaho (USBLM 2012b, pp. 1-2).

Status of Critical Habitat in the Wilkins Island Livestock Trailing Action Area. Descriptions of habitat parameters in the environmental baseline section for bull trout in this Opinion are applicable to current conditions of PCEs of critical habitat for the Wilkins Island Allotment livestock trailing action. In addition, the description of the condition of bull trout habitat for the Wilkins Island Allotment in the Bureau's 2003 Assessment (USBLM 2003, pp. 85-89) is also applicable to critical habitat condition for livestock trailing in the Wilkins Island Allotment area. Furthermore, the "Status of Critical Habitat in the Jarbidge Field Office Area" description in section 2.5.2.2 (Wildfire Suppression) provides an overview of bull trout critical habitat in the Jarbidge River watershed, which includes the Wilkins Island Allotment livestock trailing action area.

Activities that have impacted PCEs of bull trout critical habitat within the Jarbidge River watershed include livestock grazing, land/realty actions (including authorization for the construction, operation, and maintenance of roads and power lines), recreation, residential development (home sites and small communities), past construction of dams and water diversions, past mineral extraction, and past timber harvest (USFWS 2004c, pp. 35-55). Factors affecting critical habitat for the Wilkins Island Allotment livestock trailing action are similar to those described above for the species in section 2.5.1.1. The Bureau provided information regarding the condition of the habitat in the action area and the factors that influence the habitat condition (USBLM 2012b, entire). In summary, the environmental baseline, as presented in Appendix A, indicates that 15 of the 20 pathways and indicators applicable to critical habitat are functioning at risk. Therefore, PCEs 1, 2, 3, 4, 5, 6, 7, 8, and 9 which correspond with these 15 indicators, are also categorized as functioning at risk; no PCEs are categorized as functioning appropriately in the subwatershed.

Effects Analysis. Livestock trampling generally decreases vegetation cover that protects soil from erosion. As ground disturbance (such as from livestock trailing) increases, biological crusts decline (Belnap et al. 2001, pp. 44, 49-50), and soils are exposed to erosion. Eroding soils are then likely to be transported to stream channels where they can increase turbidity and fines in the substrate (PCEs 1, 2, 3, 4, and 6) in streams that are bull trout critical habitat. Livestock trampling during trailing actions also increases soil compaction which results in decreased infiltration (Belsky et al. 1999, pp. 420-422). Decreased infiltration results in more rapid runoff (PCE 8) and decreased water storage (PCEs 1 and 8) which ultimately results in decreased base flows.

Livestock trampling associated with trailing near streams or during stream crossings alter streambanks, exposing soil to erosion, destroying overhanging banks, and potentially destabilizing banks (PCEs 1, 3, 4, 5, 6, 7, and 8) which may lead to channel widening (PCE 4) and reduced pool depth (PCE 4) (Bowers et al. 1979, pp. 8-11; Leonard et al. 1997, pp. 22, 32). As channels widen, habitat is simplified (PCE 4), and cover (PCE 4) is reduced. In addition, cattle standing and walking in streams displace substrate, potentially affecting its suitability for spawning or its use as cover by juvenile bull trout.

In addition, livestock trailing activities may degrade water quality (Bowers et al. 1979, p. 9; Fleischner 1994, pp. 635-636; Belsky et al. 1999, pp. 420-422). Livestock feces and urine deposited in the stream during stream crossings can increase levels of phosphorous and nitrogen in the water column (PCE 1, 2, 3, and 8). Increased levels of these nutrients have been demonstrated to cause extensive growth of bacteria on aquatic insects, which resulted in high mortality levels in insect populations (Lemly 1998, p. 237). Decreased densities of aquatic insects effects bull trout critical habitat by reducing available food (PCE 3). Nutrients from animal wastes can also stimulate aquatic algae and plant growth, which may be either beneficial or adverse depending on the degree of growth. For example, at moderate levels of growth, algae and plants can provide food as a basis for the aquatic food chain (PCE 3). However, high levels of algae and aquatic plants can result in stream eutrophication and subsequent reduction of dissolved oxygen levels (PCE 1, 2, 3, and 8), which adversely affects bull trout.

Effects to bull trout critical habitat from livestock trailing associated with the Wilkins Island Allotment will primarily be associated with short-term elevated sediment and nutrient levels associated with annual livestock crossings of the East Fork Jarbidge River. These short-term adverse effects are expected to be limited in duration and area due to project design features. Elevated nutrient levels are expected to return to pre-trailing levels within 24 hours. In addition, elevated-sediment levels that could adversely affect PCEs will occur no further than 600 feet downstream of the 100 foot wide stream crossing site, and will return to baseline levels within 24 hours. The 100 foot wide stream crossing site and the 600 foot downstream area that will have short-term elevated sediment levels during and immediately following stream crossing events (700 feet total) constitutes less than 0.1 percent of the 152 miles of bull trout critical habitat located within the Jarbidge watershed. However, livestock trailing will result in adverse effects to PCE 1, 2, 3, 4, 6, and 8 associated with short-term elevated sediment and nutrient levels during and following annual spring and fall livestock crossing of the East Fork Jarbidge River. Therefore, some short-term adverse effects are likely to occur in a small portion of the total critical habitat designated within the Jarbidge watershed.

Effects Determination. Spring and fall livestock trailing activities in the Wilkins Island Allotment area will adversely affect designated bull trout critical habitat through short-term elevated sediment and nutrient levels associated with annual livestock crossings of the East Fork Jarbidge River. While implementation of project design features will reduce the duration and severity of these adverse effects, localized short-term adverse effects will occur associated with spring and fall crossings of the East Fork Jarbidge River. Therefore, livestock trailing in the Wilkins Island Allotment area "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.5.2.2.8 71 Desert Allotment Livestock Trailing

Activity Description. In the 71 Desert Allotment area, up to 1,000 cattle will annually be trailed along a primitive road in the spring (February/March) and again in the fall (November) through 2.3 acres of bull trout critical habitat along the Bruneau River. In addition, these 1,000 cattle will annually cross the Bruneau River both in spring and in fall at an established stream crossing site on private land near Indian Hot Springs, Idaho. For additional details, see the full activity description previously provided in this Opinion (see section 2.1.2) or the Bureau's supplemental information (USBLM 2012b, pp. 5-6).

Status of Critical Habitat in the 71 Desert Livestock Trailing Action Area As previously described, *The Framework to Assist in Making Endangered Species Act Determinations of Effects for Individual or Grouped Actions at the Bull Trout Subpopulation at a Watershed Scale* (USFWS 1998b, entire) was used to describe baseline conditions and evaluate effects to bull trout and its critical habitat for the 71 Desert Allotment area livestock trailing action (see Appendix B of this Opinion). In addition, the description of the condition of bull trout habitat for the Seventy One Desert Allotment in the Bureau's 2003 Assessment (USBLM 2003, Effects Framework, pp. 126-129) is applicable to critical habitat condition for livestock trailing in the 71 Desert Allotment area. Furthermore, the "Status of Critical Habitat in the Jarbidge Field Office Area" description in section 2.5.2.2 (Wildfire Suppression) above provides an overview of bull trout critical habitat in the Jarbidge River watershed, which includes the 71 Desert Allotment livestock trailing action area.

Environmental baseline conditions are described below by individual WCIs in the Bruneau River. Twenty of the twenty three indicators for this livestock trailing action as shown in Appendix B of this Opinion are directly or indirectly related to one or more of the nine PCEs identified for bull trout critical. In general, habitat parameter data for bull trout and its critical habitat in the 71 Desert Allotment area are limited as the Bruneau River is located within a deep, isolated canyon (the Bruneau River Canyon) with limited access points. Therefore, current environmental baseline conditions are largely unknown; for the purposes of this Opinion, environmental baseline conditions have been in part estimated using professional judgment and observations of Bureau journeyman-level Fisheries Biologists. Estimates of the current condition of pertinent WCIs for critical habitat are as follows.

Temperature. Properly functioning. The Bureau collected water temperature data in the Bruneau River below the confluence of the Jarbidge River from September 1, 2011 through July 1, 2012 (Bureau unpublished data, as cited in USBLM 2012b, p. 5). These data show water temperatures in the Bruneau River during the spring (February/March) and fall (November) crossing events ranged from 2 to 15°C; these water temperatures are suitable for supporting bull trout. The Bruneau River is currently unsuitable for bull trout during several months of the year due to naturally-occurring warm summer water temperatures (USFWS 2004c, p. 39). Adequate surveys to document species presence have not been conducted in the Bruneau River during the periods when water temperatures are favorable for bull trout. Presumably, bull trout would migrate out of the Bruneau River in spring and would not return until October or November following spawning in the headwaters. Water temperatures are suitable for bull trout in the Bruneau River from mid-October through mid-June. Therefore, a determination of properly functioning is given here.

Sediment/Turbidity. Functioning at risk. IDEQ has determined that sediment in either the suspended form or as measured by the percent surface fines surrogate are not impairing the Bruneau River, and subsequently delisted the Bruneau River for sediment. (IDEQ 2000, pp. 62-63). However, this was based on a limited dataset. In addition, it is expected that sediment levels, particularly turbidity, are elevated over historic levels (pre-1880) during peak flows in spring when bull trout may be present in the Bruneau River. Therefore, a conservative determination of functioning at risk is given here.

Chemical Contaminants and Nutrients. Properly functioning. The 2000 TMDL established 303(d) reaches in the Bruneau River, with reaches on a seasonal basis having nutrients as a listed pollutant. However, water sampling sites in the Bruneau River near the confluence of Hot Creek had very low concentrations of chemical constituents. These concentrations were reflective of the state of the river in the upstream canyons, including that portion of the river near Indian Hot Springs where livestock trailing occurs. Thus, a properly functioning determination was given.

Substrate embeddedness in rearing areas. Properly functioning. There are no data available for substrate embeddedness in the Bruneau River. However, the TMDL report for the Bruneau River indicates that concentrations of suspended sediment are very low throughout the subbasin; therefore, it is likely that substrate embeddedness in the portion of the Bruneau River upstream of the TMDL report sampling sites may also be relatively low. In addition, the Bureau (USBLM 2006, as cited in USBLM 2012b, p. 17) found percent surface fines to be less than 20 percent in selected spawning gravels in headwater streams above the Bruneau River. In addition, the vast majority of the Bruneau River below the mouth of the Jarbidge River is a heavily armored, cobble and boulder dominated canyon transport reach, conducive to moving all substrates through the system and allowing little accumulation of material reach (Mays, pers. comm. 2012). Recent observations in the Bruneau River Canyon, including the livestock trailing area, did not note any high accumulations of fine sediment covering or embedding the cobble and gravel in this reach. Thus, a properly functioning determination was given.

Pool Frequency. Properly functioning. Observations by Bureau fisheries biologists suggest that current sediment levels cycling through the mainstem Bruneau River are low and do not appear to have resulted in a loss of pool numbers through filling with sediment. As described above, the vast majority of the Bruneau River below the mouth of the Jarbidge River is a heavily armored transport reach, allowing for little accumulation of material such as sediment (Mays, pers. comm. 2012). Thus, a properly functioning determination was given.

Streambank Condition. Functioning at risk. Observations by Bureau fisheries biologists suggest that the Bruneau River reach is properly functioning for streambank bank condition because much of the streambanks are composed of cobble and boulder. Only a very small section near the downstream end of the Bruneau River reach is accessible to cattle or other bank-altering influences; this section is located on a private inholding. However, at this localized crossing site located on private land, the baseline condition at the crossing site is functioning at risk due to previous crossing events that have resulted in a dished-out pattern on both banks where cattle move into and out of the Bruneau River as well as partially to completely bare streambanks associated with livestock trampling. This degraded streambank condition will be maintained as long as annual livestock trailing continues. Therefore, a conservative determination of functioning at risk is given here.

Persistence and Genetic Integrity. Functioning at risk. Bull trout use in the Bruneau River has not been documented, although there are no known physical barriers preventing fish movement between the Bruneau River and upstream areas in the Jarbidge River watershed known to contain bull trout (USFWS 2004c, p. 30). As discussed above for Life History Diversity/Isolation, movement has been observed between the local populations; bull trout movement is limited, at least seasonally, by warm water temperatures. Bull trout have evolved to avoid the high summer temperatures by migrating upstream in spring before temperatures increase and back downstream from headwaters spawning reaches in October and November after mainstem overwintering habitats have cooled again. Furthermore, although Allen et al. (2010, p. 15) documented a larger number of fish than previously known, the sizes of the local populations are still relatively small. Thus, a conservative estimate for the baseline condition of functioning at risk is given for this indicator.

Activities that have impacted PCEs of bull trout critical habitat within the Jarbidge River watershed include livestock grazing, land/realty actions (including authorization for the construction, operation, and maintenance of roads and power lines), recreation, residential development (home sites and small communities), past construction of dams and water diversions, past mineral extraction, and past timber harvest (USFWS 2004c, pp. 35-55). Factors affecting critical habitat for the 71 Desert Allotment livestock trailing action are similar to those described above under the species in section 2.5.1.2. The Bureau provided information regarding the condition of the habitat in the action area and the factors that influence the habitat condition (USBLM 2012b, entire). In summary, the environmental baseline, as presented in Appendix B, indicates that of the 8 pathways and indicators with environmental baseline data available that are applicable to critical habitat, 4 pathways and indicators (persistence and genetic integrity, sediment/turbidity, physical barriers, and streambank condition) are functioning at risk. Therefore, PCEs 1, 2, 3, 4, 5, 6, 7, 8, and 9 which correspond with these 4 indicators, are also categorized as functioning at risk.

Effects Analysis. Factors affecting critical habitat for the 71 Desert Allotment livestock trailing actions are similar to those described above under the species as well as for the livestock trailing action in the Wilkins Island Allotment area. As described above, livestock trampling generally decreases vegetation cover that protects soil from erosion. Eroding soils transported to stream channels can increase turbidity and fines in the substrate (PCEs 1, 2, 3, 4, and 6) in streams that are bull trout critical habitat. Livestock trampling during trailing actions also increases soil compaction which results in decreased infiltration (Belsky et al. 1999, pp. 420-422). Decreased infiltration results in more rapid runoff (PCE 8) and decreased water storage (PCEs 1 and 8) which ultimately results in decreased base flows.

Livestock trampling associated with trailing near streams or with stream crossings alter streambanks, exposing soil to erosion, destroying overhanging banks, and potentially destabilizing banks (PCEs 1, 3, 4, 5, 6, 7, and 8) which may lead to channel widening (PCE 4) and reduced pool depth (PCE 4) (Bowers et al. 1979, pp. 8-11; Leonard et al. 1997, pp. 22, 32). As channels widen, habitat is simplified (PCE 4), and cover (PCE 4) is reduced. In addition, livestock trailing activities may increase soil compaction (Bowers et al. 1979, p. 9) and degrade water quality (Bowers et al. 1979, p. 9; Fleischner 1994, pp. 635-636; Belsky et al. 1999, pp. 420-422). In addition, cattle standing and walking in streams displace substrate, potentially affecting its suitability for spawning or its use as cover by juvenile bull trout. Livestock feces and urine deposited during stream crossings can also increase levels of phosphorous and nitrogen in the water column (PCE 1, 2, 3, and 8), decreasing densities of aquatic insects (PCE 3) used by foraging bull trout.

Effects to designated bull trout critical habitat associated with the 71 Desert Allotment livestock trailing activities are most likely to occur in the spring and fall when cattle may access the Bruneau River RCA as they are trailed down the Indian Hot Springs Road. Livestock trailing is expected to result in some localized degradation of streambank condition over the long-term through localized streambank trampling by individual errant cattle on the nearby 2.3 acres of RCA located on Bureau-administered lands. In addition, sediment and nutrients may be washed into the Bruneau River if precipitation events occur during or following annual livestock trailing through the RCA, which will result in short-term elevated sediment and nutrient levels in the Bruneau River.

Effects of interrelated and interdependent actions (associated with the Federal action of issuing a livestock trailing permit) are expected to occur at the livestock crossing of the Bruneau River on private land. Effects to PCEs for critical habitat are associated with streambank degradation and short-term elevated sediment and nutrient levels during and following annual spring and fall livestock crossing of the Bruneau River. Short-term effects on PCEs of critical habitat from elevated sediment and nutrient levels during livestock stream crossing events may also extend downstream approximately 0.1 mile to the RCA on Bureau-administered land.

As described above for the Wilkins Island trailing proposal, elevated sediment and nutrient levels associated with trailing activities are expected to return to pre-trailing levels within 24 hours and will be limited in area (about 600 feet downstream of the privately-owned livestock crossing site or the Bureau RCA trailing route). In addition, effects to bull trout critical habitat will occur within an area that encompasses less than 0.1 percent of the 40 miles of bull trout critical habitat located on the Bruneau River and the 152 miles of bull trout critical habitat located within the Jarbidge watershed. Maintaining the current degraded streambank conditions will adversely affect PCEs 1, 3, 4, 5, 6, 7, and 8. In addition, livestock trailing will also result in short-term adverse effects to PCE 1, 2, 3, 4, 6, and 8 associated with the short-term elevated sediment and nutrient levels during and following annual spring and fall livestock crossing of the Bruneau River.

<u>Effects Determination.</u> Spring and fall livestock trailing activities in the 71 Desert Allotment area will have adverse effects on designated bull trout critical habitat in 2.3 acres of RCA habitat on Bureau administered lands. Adverse effects will result from annual trailing thought the RCA on Bureau-administered lands that may degrade streambank condition and short-term elevated sediment and nutrient levels associated with washing of sediment and nutrients into the Bruneau

River during subsequent precipitation during or following trailing events. Adverse effects to bull trout critical habitat may also occur associated with interrelated and interdependent livestock crossing of the Bruneau River at the existing stream crossing site located on the adjacent private inholding. While implementation of project design features will reduce the duration and severity of these adverse effects, some localized short-term adverse effects will occur associated with spring and fall trailing through the RCA on Bureau-administered land. Therefore, livestock trailing in the 71 Desert Allotment area "may affect, and is likely to adversely affect" designated critical habitat for bull trout.

2.6 Cumulative Effects

The implementing regulations for section 7 define cumulative effects to include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action areas considered in this Opinion. Future Federal actions that are unrelated to livestock trailing in the Wilkins Allotment area that may affect bull trout and the eight actions that may affect bull trout critical habitat are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

2.6.1 Bull Trout

2.6.1.1 Cumulative Effects

Many of the categories of on-going activities with potential effects to bull trout were identified in the Status of the Species section of this Opinion. Non-Federal actions that may affect bull trout in the Wilkins Island Allotment livestock trailing area include timber harvest, livestock grazing in riparian areas, livestock trailing across streams, recreation (including off highway vehicle use) in riparian areas, and diversion of water for irrigation and livestock watering. We anticipate that cumulative effects associated with livestock trailing in the Wilkins Island Allotment area as described in the original biological opinion addressing ongoing livestock grazing in the allotment remain unchanged (USBLM 2003, entire). We assume many of the threats identified previously in this Opinion will continue to impact the bull trout, including climate change.

Warming of the global climate seems quite certain. Changes have already been observed in many species' ranges consistent with changes in climate (ISAB 2007, p. iii; Hansen et al. 2001, p. 767). Global climate change threatens bull trout throughout its range in the coterminous United States. Downscaled regional climate models for the Columbia River basin predict a general air temperature warming of 1.0 to 2.5 °C (1.8 to 4.5 °F) or more by 2050 (Rieman et al. 2007, p. 1552). This predicted temperature trend may have important effects on the regional distribution and local extent of habitats available to salmonids (Rieman et al. 2007, p. 1552), although the relationship between changes in air temperature and water temperature are not well understood. Bull trout spawning and early rearing areas are currently largely constrained by low fall and winter water temperatures that define the spatial structuring of local populations or habitat patches across larger river basins; habitat patches represent networks of thermally suitable habitat that may lie in adjacent watersheds and are disconnected (or fragmented) by intervening stream segments of seasonally unsuitable habitat or by actual physical barriers (Rieman et al. 2007, p. 1553). With a warming climate, thermally suitable bull trout spawning and rearing areas are predicted to shrink during warm seasons, in some cases very dramatically, becoming even more isolated from one another under moderate climate change scenarios (Rieman et al. 2007, pp. 1558–1562; Porter and Nelitz 2009, pp. 5–7). Climate change will likely interact with other stressors, such as habitat loss and fragmentation (Rieman et al. 2007, pp. 1558–1560; Porter and Nelitz 2009, p. 3); invasions of nonnative fish (Rahel et al. 2008, pp. 552–553); diseases and parasites (McCullough et al. 2009, p. 104); predators and competitors (McMahon et al. 2007, pp. 1313–1323; Rahel et al. 2008, pp. 552–553); and flow alteration (McCullough et al. 2009, pp. 106–108), rendering some current spawning, rearing, and migratory habitats marginal or wholly unsuitable. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features necessary for bull trout survival and recovery in some areas.

2.6.2 Bull Trout Critical Habitat

2.6.2.1 Cumulative Effects

Many of the categories of on-going activities with potential effects to bull trout critical habitat were identified in the Status of Critical Habitat section of this Opinion. Non-Federal actions that may affect bull trout critical habitat in the eight ongoing action areas include timber harvest, livestock grazing, recreation (including off highway vehicle use) in riparian areas, fire suppression, construction and maintenance of roads, herbicide use, dam operations, and water diversions. We anticipate that cumulative effects associated with six of the eight action areas as described in the original three biological opinions remain unchanged. We further anticipate that cumulative effects associated with livestock trailing actions in the Wilkins Island and 71 Desert Allotment areas will remain unchanged as described in the original biological opinion addressing ongoing livestock grazing in the Wilkins Island and 71 Desert Allotments (USBLM 2003, entire).

We assume many of the threats to critical habitat identified previously in this Opinion will continue to impact critical habitat, including climate change. Cumulative effects of climate change on bull trout critical habitat are similar to those described above for the species. Over a period of decades, climate change may directly threaten the integrity of the essential physical or biological features described in PCEs 1, 2, 3, 5, 7, 8 and 9.

2.7 Conclusion

2.7.1 Bull Trout

2.7.1.1 Conclusion

The Service has reviewed the current status of the bull trout, the environmental baseline in the action area, effects of the ongoing action, and cumulative effects. It is our biological opinion that livestock trailing in the Wilkins Island Allotment area is not likely to jeopardize the continued existence of the bull trout in the East Fork of the Jarbidge River core area, the Jarbidge Recovery Unit, or the Jarbidge Distinct Population Segment (DPS) of bull trout.

The Service concludes that direct and indirect effects to bull trout would be limited to sublethal harassment to adult and subadult bull trout. These effects are anticipated to occur only within the action area and should be minimized by design features incorporated into the livestock trailing permits. That portion of the East Fork of the Jarbidge River located within the livestock trailing area has not been thoroughly surveyed for bull trout, but the assumption is, based on available data, that bull trout occur in low densities throughout the action area. Individual bull trout may be affected through harassment during spring livestock crossings of the East Fork Jarbidge River. Therefore, some adverse sub-lethal effects to individual bull trout from livestock trailing activities in the Wilkins Island Allotment area are likely to occur.

The Service expects that the numbers, distribution, and reproduction of bull trout in the livestock trailing action area or in the Jarbidge River DPS will not be significantly changed as a result of this livestock trailing action. Bull trout survival within the action area should not be appreciably altered because data indicate that the predicted environmental concentrations of sediment and nutrients associated with livestock crossing the streams should be rapidly diluted downstream from the point of the stream crossing. Displacement of individual bull trout is expected to be localized and short-term. Therefore, the Service has concluded that the survival and recovery of bull trout populations will not be jeopardized by the Wilkins Island Allotment area livestock trailing action in the Bureau's Jarbidge Field Office.

2.7.2 Bull Trout Critical Habitat

2.7.2.1 Conclusion

The Service has reviewed the current status of bull trout critical habitat, the environmental baseline in the action areas, effects of the ongoing actions, and cumulative effects, and it is our conclusion that the eight ongoing actions are not likely to destroy or adversely modify designated critical habitat for bull trout. The eight ongoing actions will result in some short-term adverse effects to the PCEs of critical habitat but should return to baseline conditions over the long-term. We expect that project design criteria should reduce the magnitude of adverse effects to PCEs 1, 2, 3, 4, 5, 6, 7, 8, and 9, but not eliminate them. The eight ongoing actions will not impact the functionality of critical habitat rangewide in providing for conservation of the bull trout.

2.8 Incidental Take Statement

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without specific exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm in the definition of take in the Act means an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to listed species by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The Bureau has a continuing duty to regulate the activity covered by this incidental take statement. If the Bureau fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Bureau must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

2.8.1 Form and Amount or Extent of Take Anticipated

Bull trout are known to occupy the Wilkins Island Allotment livestock trailing action area. Bull trout are expected to be present when the two annual livestock crossings of the East Fork Jarbidge River occur in May or June. It is difficult for the Service to anticipate the exact number of individual bull trout that will be taken as a result of livestock trailing activities. Therefore, to address take associated with elevated sediment and nutrient levels associated with livestock trailing activities in eh Wilkins Island Allotment area, we will use the amount of habitat affected as a surrogate per activity.

The two annual spring livestock crossings on the East Fork Jarbidge River on Bureau-administered land will take less than 1 hour to complete each individual stream crossing event (USBLM 2012b, p. 3). For the livestock stream crossing of the East Fork Jarbidge River, we anticipate that all adult and sub-adult bull trout present within 600 feet downstream of the crossing (i.e., the assumed downstream extent of sediment and nutrient effects) will be subject to take in the form of harassment and harm from direct exposure to the increased levels of suspended sediment, turbidity, and nutrients. Elevated suspended sediment and nutrient levels may result in direct injury (gill irritation, physiological stress, reduced feeding efficiency), and may also result in harassment and an increased likelihood of injury by causing bull trout to move out of areas of elevated suspended sediment and nutrient levels. Moving out of the areas (harassment) may cause loss of territories, increase competition and stress, and reduce feeding efficiency. Incidental take of bull trout associated with elevated sediment and nutrient level effects from livestock trailing and stream crossings is primarily anticipated to occur within 24 hours of livestock crossing the stream. Effects are expected to be minor and temporary. Project design features incorporated into the Wilkins Island Allotment area livestock trailing action are expected to reduce the level of anticipated take. Incidental take of bull trout redds, eggs or alevins will not occur as environmental conditions at the East Fork Jarbidge River are not conducive to bull trout reproduction (e.g., water temperatures in the vicinity of the livestock crossing site are greater than 20°C during bull trout spawning periods).

If incidental take anticipated by this document is exceeded, all project activities will cease and the Bureau will immediately contact the Service to determine if consultation should be reinitiated. Authorized take will be exceeded if:

1. Livestock trailing within the RCA (inclusive of stream crossings) does not comply with project design features, or occurs outside of the trailing permit-specified locations or the

specified seasonal time period as described in the Bureau's livestock trailing description (USBLM 2012b, entire) on any individual trailing event, or

2. Livestock stream crossings during individual livestock trailing events occur within a time window longer than 1 hour in duration.

2.8.2 Effect of the Take

In the accompanying Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the continued existence of the bull trout across its range. Anticipated take may be reduced because the Wilkins Island Allotment area livestock trailing action includes conservation measures to avoid and reduce adverse effects. In addition, adverse effects will be short in duration and limited in scope. The Wilkins Island Allotment area livestock trailing action is not expected to reduce the reproduction, status, and distribution of bull trout in the action area, and will not appreciably reduce the likelihood of survival and recovery of the Jarbidge River Distinct Population Segment.

2.8.3 Reasonable and Prudent Measures

The Service concludes that the following reasonable and prudent measures are necessary and appropriate to minimize the take of bull trout caused by the two livestock trailing actions.

1. Minimize the potential for harassment of bull trout and disruption of riparian and aquatic habitat from project activities.

2.8.4 Terms and Conditions

1. The Bureau shall ensure that livestock trailing activities shall occur as described in the Bureau's livestock trailing EA (DOI-BLM-ID-T010-2012-0004-EA) and associated trailing permits.
2. Individual livestock stream crossing events shall be completed in the minimum amount of time possible within the allowable 1 hour stream crossing time window.

2.8.5 Reporting and Monitoring Requirement

In order to monitor the impacts of incidental take, the Federal agency or any applicant must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [(50 CFR 402.14 (i)(3)].

1. Upon locating dead, injured, or sick bull trout not anticipated by this Opinion, as a result of livestock trailing activities, such activities shall be terminated. Please notify the Service within 24 hours. Additional protective measures will be developed through discussions with the Service.

2. During livestock trailing activities, promptly notify the Service of any emergency or unanticipated situations arising that may be detrimental for bull trout relative to the trailing activities.

2.9 Conservation Recommendations

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

The Service encourages the Bureau to implement the conservation recommendations for bull trout as described in the original biological opinions for the six of the eight actions addressed in this Opinion[5] (USFWS 2004a, pp. 74-77; USFWS 2001, pp. 74-76). In addition, we recommend the following conservation recommendation be implemented for the eight Bureau actions, as applicable.

- Use preventative procedures to ensure that aquatic nuisance species are not spread through the implementation of Bureau actions.
- Continue to monitor for bull trout in the East Fork Jarbidge River subwatershed in an attempt to broaden the understanding of bull trout use in the subwatershed.
- Collaboratively work with partners to determine bull trout use and current habitat condition in the Bruneau River.
- Continue to identify and implement riparian restoration actions to improve current conditions for bull trout and its critical habitat.

To remain informed about actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

2.10 Reinitiation Notice

This concludes reinitiation of formal consultation on six Bureau ongoing actions (the CdA RMP, ongoing fire suppression actions in the Jarbidge FO area, ongoing livestock grazing in the Diamond A Allotment, ongoing livestock grazing in the Poison Butte Allotment, ongoing livestock grazing in the Wilkins Island Allotment, and implementation of the Jarbidge Resource Area RMP as amended by INFISH) to address bull trout critical habitat. This consultation also addresses the effects of livestock trailing associated with the Wilkins Island Allotment area and the 71 Desert Allotment areas on bull trout critical habitat, as well as the effects of livestock trailing in the Wilkins Island Allotment area on bull trout. 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 maintained (or is authorized by law) and if:

1. The amount or extent of incidental take is exceeded.

[5] No conservation recommendations for bull trout were provided in USFWS 2006.

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 that was not considered in this Opinion.

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.

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4. APPENDICES

Appendix A.

East Fork Jarbidge River Environmental Baseline Summary and Anticipated Effects of Livestock Trailing on Bull Trout and its Critical Habitat

Watershed Condition Indicator Pathways		Environmental Baseline Condition			Effects of the Action		
	Indicator	Properly Functioning	Functioning at Risk	Not Properly Functioning	Restore	Maintain	Degrade
SPECIES							
Subpopulation Characteristics Within Subpopulation Watersheds	Subpopulation size		X			X	
	Growth and survival		X			X	
	Life history diversity and isolation		X			X	
	Subpopulation trend		X			X	
	Persistence and genetic integrity		X			X	
HABITAT							
Water Quality	Temperature		X			X	
	Sediment/Turbidity	X				Long Term	Short Term
	Chemical contamination/nutrients	X				Long Term	Short Term
Habitat Access	Physical barriers		X			X	
Habitat Elements	Substrate embeddedness in rearing areas		X			Long Term	Short Term
	Large woody debris		X			X	
	Pool frequency	X				X	
	Pool quality		X			X	
	Off-channel habitat	X				X	
	Refugia	X				X	
Channel Condition & Dynamics	Wetted width/maximum depth ratio in scour pools in a reach		X			X	
	Streambank condition		X			X	
	Floodplain connectivity		X			X	
Flow/ hydrology	Change in peak/base flows		X			X	
	Increase in drainage network		X			X	
Watershed conditions	Road density & location		X			X	
	Disturbance history		X			X	
	Riparian Habitat Conservation Area		X			X	
	Disturbance regime		X			X	
Integration of species and habitat			X			X	

Appendix B.

Bruneau River Environmental Baseline Summary and Anticipated Effects of Livestock Trailing on Bull Trout and its Critical Habitat

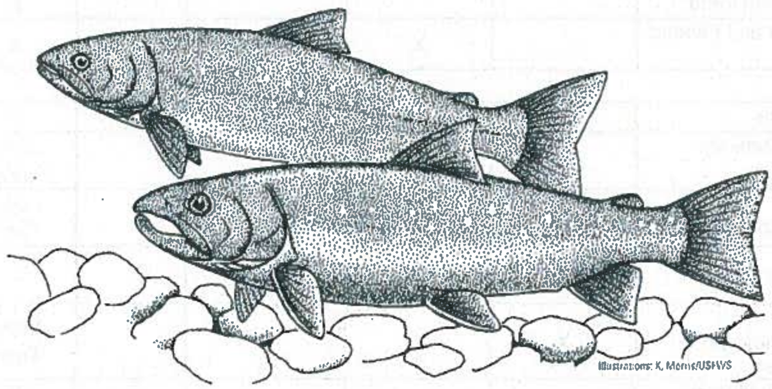
Watershed Condition Indicator Pathways		Environmental Baseline Condition			Effects of the Action		
	Indicator	Properly Functioning	Functioning at Risk	Not Properly Functioning	Restore	Maintain	Degrade
SPECIES							
Subpopulation Characteristics Within Subpopulation Watersheds	Subpopulation size		X			X	
	Growth and survival		X			X	
	Life history diversity and isolation		X			X	
	Subpopulation trend*					X	
	Persistence and genetic integrity		X			X	
HABITAT							
Water Quality	Temperature	X				X	
	Sediment/Turbidity		X			Long Term	Short Term
	Chemical contamination/nutrients	X				Long Term	Short Term
Habitat Access	Physical barriers		X			X	
Habitat Elements	Substrate embeddedness in rearing areas	X				Long Term	Short Term
	Large woody debris*					X	
	Pool frequency	X				X	
	Pool quality*					X	
	Off-channel habitat*					X	
	Refugia*					X	
Channel Condition & Dynamics	Wetted width/maximum depth ratio in scour pools in a reach*					X	
	Streambank condition		X			Long Term	Short Term
	Floodplain connectivity*					X	
Flow/ hydrology	Change in peak/base flows*					X	
	Increase in drainage network*					X	
Watershed conditions	Road density & location*					X	
	Disturbance history*					X	
	Riparian Habitat Conservation Area*					X	
	Disturbance regime*					X	
Integration of species and habitat*						X	

* = No environmental baseline data available

Appendix C.

ASSESSING THE EFFECTS OF GRAZING ON BULL TROUT AND THEIR HABITAT

An alternative approach – the effects and the variables influencing those effects



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1.0 INTRODUCTION

This paper is one of the products resulting from a collaborative effort between Theresa Doumitt with ATW Consulting and Doug Laye with the U.S. Fish and Wildlife Service. Our intention was to create a tool for individuals who use and manage public lands to increase the efficiency and thoroughness of their assessments of impact. This document is targeted specifically at the effects of grazing on bull trout (*Salvelinus confluentus*) and their habitat, but the overall concept has a wide range of possible applications.

By researching and organizing some of the available literature; we identified (based on current understanding) the effects created when livestock and fish share part of the same ecosystem. This document is considered a work in progress to be revised and updated as new information comes available through ongoing research.

The primary goals of this paper are to:

- clearly identify and validate the ways, proven and suspected, in which grazing affects bull trout and their habitat (thereby establishing the effect pathways in section 2.0); and
- describe and confirm with research, where support is available, the variables which influence the degree of expression of these effects (in section 3.0).

Since research is limited on the effects of grazing on bull trout, studies performed with other members of the trout family (*Salmonidae)* are utilized. Members of this family of fish include salmon, trout, char, grayling, and freshwater whitefish.

2.0 IDENTIFICATION AND VALIDATION OF THE PATHWAYS BY WHICH GRAZING AFFECTS BULL TROUT AND THEIR HABITAT

Discussion of the effects begins with the individual activities of grazing in order to clearly establish the causes of each effect. The discussion is divided into two sections based on timing: activities which create immediate changes in habitat or conditions for bull trout and activities which result in delayed changes in habitat or conditions. 'Immediate changes' occur at the same time as the activity and are the result of activities in the stream or on the streambank. 'Delayed changes' occur at a later time than the activity and are the result of activities in the **uplands*** or within the **riparian area** (excluding the stream and its bank).

Activities which create immediate changes:

- Grazing on streamside vegetation
- Walking on the streambank
- Walking or loafing in the stream
- Urinating or defecating in the stream
- Using or creating trails to the stream

Activities which lead to delayed changes:

- Bedding in riparian areas and uplands
- Using or creating trails in riparian area/uplands
- Using salt or mineral supplement
- Using corrals, loading chutes, or weaning areas
- Using, maintaining, or constructing/developing alternative watering structures
- Maintaining or installing fences
- Using roads to transport cattle to/from allotment
- Implementing monitoring plan – determining range-readiness, utilization, bank alteration,...
- Urinating or defecating in riparian areas/uplands
- Grazing on riparian and upland vegetation

***NOTE** – all words in bold, sage-colored font (**that look like this**) are defined in the Glossary.

In our review of the above activities and the subsequent changes in the environment that are triggered, three facts became clear: one activity can create several different changes in the environment, different activities can have common consequences, and the relationships between the activities and the resulting changes are complex and non-linear. In an attempt to simplify the effects of grazing in a manner that can be clearly discussed and evaluated, each of the above activities and its resulting changes were dissected individually to reveal somewhat of a linear pathway. This method resulted in nine unique pathways that will be referred to as Effect Pathways. These nine Effect Pathways (summarized in Figure 1 and described in detail in Section 2.1 and 2.2) are concise explanations of the chain of events triggered by the activities of grazing.

Figure 1. Summary of Effect Pathways 1-9 that may be triggered by grazing activities and the possible environmental results and consequences to bull trout/aquatic habitat as established and validated in Sections 2.1 and 2.2.

Effect Pathway	Grazing Activity	Environmental Change	Consequences to Bull Trout
Pathway 1	Grazing on streamside vegetation	Less shade	Increased stream temperatures
Pathway 2	Grazing on streamside vegetation	Less overhanging vegetation thereby less food/habitat for prey	Less aquatic and terrestrial food for bull trout
Pathway 3	Livestock use of streambank (section 2.1.2)	Decreased bank stability leading to	Lower number of undercut banks and pools Increased width to depth ratio Increased sediment in water and substrate
Pathway 4	Walking or loafing in stream	Trampling of redds	Decrease bull trout population
Pathway 5	Walking or loafing in stream	Displacement of juveniles from cover increasing predation risk	Decrease juvenile survival
Pathway 6	Urinating or defecating in stream	Lowered water quality	Decrease prey populations
Pathway 7	Activities causing compaction (section 2.2.1)	Increased runoff and erosion	Causes stream incision and and triggers pathways 3, 6, 8
Pathway 8	Activities causing compaction (section 2.2.1)	Decreased infiltration	Decreases stream flow, lowers water table and triggers pathways 1 and 3
Pathway 9	Grazing on riparian and upland vegetation	Shifts in plant community	Reduces woody debris and triggers pathways 3 and 7

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Even though these pathways are depicted as linear and independent, as discussed previously we acknowledge that they are quite interconnected and complex, and have been reduced into simplistic pathways for ease of discussion and presentation. For example, the activity of 'grazing on streamside vegetation' can be a trigger for Pathways 1-6, but for simplicity sake it is discussed where it is thought to be the primary cause for effect (in Pathways 1-3). This interrelatedness is depicted below in Table 1 and also becomes more apparent in Section 3 when some of the variables (affecting degree of effect) are shown to be the same.

Table 1. Grazing activities, the location of the discussion of the activity's effects, and the different pathways that can, in actuality, be triggered by that activity.

ACTIVITY	DISCUSSED IN PATHWAY	CAN TRIGGER PATHWAY
Grazing on streamside vegetation	1, 2, 3	1-6
Walking on the streambank	3	3-6
Walking or loafing in the stream	4, 5	4-6
Urinating or defecating in the stream	6	4-6
Using or creating trails to the stream	3	3,6,7,8
Using, maintaining, or constructing watering structures	8	1,3,8
Urinating or defecating in riparian areas/uplands	7	6,7
Grazing on riparian and upland vegetation	9	3,7,9
Other 7 activities (listed in Section 2.2.1)	7, 8	1,3,6,7,8

In Section 2.1 and 2.2 (that follows) there are simplified summary tables depicting each of the individual Effect Pathways. Below each summary table is a discussion section that offers further support and explanation. A more detailed explanation of the variables influencing degree of activation of the pathways can be found in Section 3.

2.1 ACTIVITIES WITH IMMEDIATE CHANGES

2.1.1 Grazing on streamside vegetation (Effects of reduction of plant matter)

Grazing along streams, by reducing the amount of overhanging vegetation (Platts 1991, pg 393), can act through two different pathways to cause potential effects to bull trout or their habitat. Pathway 1 and Pathway 2 are displayed in a simple table below (Table 2). More detailed discussion of the pathways is offered below the table in a narrative format.

Table 2. Simple display of Effect Pathway 1 and Effect Pathway 2 – effects of reduced plant matter.

	Immediate Change	Resulting Change	Effects on Bull Trout or their Habitat
PATHWAY 1 Changes to temperature	decreases stream shading and exposes more water surface to solar radiation	increases stream temperature in the summer (VanVelson 1979, pg 53; Platts and Raleigh 1984, pg 1107; Li et al. 1994, pg 633; Tait et al. 1994, pg 48; Zoellick 2004, pg 24)	increased stream temperature can decrease trout occurrence (Barton et al. 1985, pg 377); decrease trout densities (Tait et al. 1994, pg 51); decrease productivity/biomass production (Bisson and Davis 1976, pg 767-768; Platts and Nelson 1989a, pg 455-456); decrease growth rate by inhibiting appetite (Wurtsbaugh and Davis 1977, pg 97) and increasing metabolic rate (Li et al. 1994, pg 637), and increase the risk of invasion of other fish species (Bayley and Li 2008, pg 143)
PATHWAY 2 Reduction of prey	reduces plant matter available (Gunderson 1968, pg 513; Van Velson 1978, pg 54; Clary and Kinney 2002, pg 139) as habitat and food for terrestrial insects and as leaf litter for food for aquatic insects (Chapman and Demory 1963, pg 144; Minshall 1967, pg 147)	decreases terrestrial prey available to salmonids (Baxter et al. 2005, pg 201; Saunders and Fausch 2007, pg 1223) and affects the type and quantity of aquatic insects present.	less prey results in reduced fish biomass (Saunders and Fausch 2007, pg 1225).

Discussion

How do plants affect water temperature? Stream temperatures are determined by a complex relationship between stream shading, width and depth of the stream, water source temperature, water flow volume, and air temperature. "Rooted streamside plants…provide shade, food, and nutrients for aquatic and riparian species" (Winegar 1977, pg 12; Thomas et al. 1979, pg 7; Kauffman and Krueger 1984, pg 431; Belsky et al. 1999, pg 3). By simply reducing the overhanging vegetation, grazing can decrease the insulative effects that overstory provides to the stream. Bull trout are believed to be one of the most thermally sensitive species of trout (Rieman and McIntyre 1993, pg 7; Selong et al. 2001, pg 1026), and water temperature has been proven to be the primary factor determining whether bull trout occur in a stream (Barton et al. 1985, pg 364; Dunham et al. 2003, pg 894). Because of this sensitivity, warmer summer stream temperatures can trigger a variety of effects for bull trout depending on the severity of thermal change. Studies also found that an increase in stream temperature caused trout to fed less (Wurtsbaugh and Davis 1977, pg 97). Reduced cover provided by overhanging vegetation, roots, and undercut banks has been linked to lower fish production (Bisson and Davis 1976, pg 767-768; Platts and Nelson 1989a, pg 455-456;). However by decreasing livestock access to the streamside vegetation (through fencing); VanVelson (1978, pg 53-54) showed that overhanging vegetation can recover and lead to reduced stream temperatures and increased trout production. See the discussion in Section 3.1 for variables that influence the degree of effect that grazing can have on overhanging vegetation.

How do plants affect bull trout prey? Grazing streamside vegetation also reduces the amount of plant matter which can affect the food chain that supports fish growth and survival in two ways:

- By decreasing the habitat for terrestrial insects (a food item for bull trout). Shaw and Clary (1996, pg 149) found that willow (*Salix* sp.) height and density (which provide cover for trout prey) were greater in ungrazed or moderately grazed pastures than those pastures grazed season long. Bayley and Li (2008, pg 26) found that the increased cover and potential food supply within grazing exclosures resulted in increased trout densities as compared to grazed reaches.
- By decreasing the **detritus** that gets deposited into the stream. Detritus from streamside plants is a primary food source for aquatic insects that become food for fish (Minshall 1967, pg 144) and is the source of about 50% of the nutrients that are the basis for the stream food chain (Chapman and Demory 1963, pg 145; Cummins 1974, pg 639). Cummins and Spengler (1978, pg 3) found that riparian vegetation is the largest source of detritus providing up to 60% of the organic matter that enters the stream. This organic matter is necessary to support headwater stream communities (Kauffman and Krueger 1984, pg 430).

Chapman and Demory (1963, pg 145) showed that reducing overhanging vegetation can decrease both aquatic and terrestrial insect populations. When comparing high-intensity, short duration grazing to season-long grazing; Saunders and Fausch (2007, pg 1222) actually found three times more vegetative biomass and twice as many terrestrial **invertebrates** falling into the streams in less grazed sites. These reductions in plant and prey availability resulted in half the trout biomass production. This study and overall evidence reviewed by Platts (1991, pg 400) both showed that grazing can have substantial effects on the productivity of the fish within a stream.

2.1.2 Grazing on streamside vegetation (Effects on bank stability), Walking on the streambank, and Using/creating trails to the stream

In addition to triggering Effect Pathways 1 and 2, 'Grazing on streamside vegetation' can also damage individual plants or change the vegetative community (Schultz and Leininger 1990, pg 297; Greene and Kauffman 1995, pg 307; Clary 1999, pg 218) leading to decreased bank stability. The two other activities in this category 'walking along the stream's edge' and '**active or passive trailing** to or through the stream' can create immediate changes that initiate the same chain of events affecting the streambank. Therefore these three activities are combined into a single pathway, Pathway 3 (Table 3), because of their primary and immediate effect on bank stability.

Table 3. Simple display of Effect Pathway 3 – effects of streamside use on bank stability/sediment.

	Immediate Change	Resulting Change	Effects on Bull Trout or their Habitat
PATHWAY 3 Changes in stream characteristics and sedimentation levels	Reduces vegetative root mats and causes shearing of the bank into the stream which decreases streambank stability.	Decreases the number of undercut banks (Gunderson 1968, pg 510-511; Overton et al. 1994, pg 13) and leads to the creation of wider and shallower streams (increase width to depth ratio) (Overton et al. 1994, pg 13). Wider, shallower streams are more susceptible to subsurface ice formation and freezing throughout the water column (Platts 1991, pg 398; Cunjak 1996, pg 277).	Reduced numbers of pools and undercut banks that provide protective cover from predators (Beschta and Platts 1986, pg 371; Belsky et al. 1999, pg 25), decreased overall fish production (Boussu 1954, pg 239; Gunderson 1968, pg 512; Lanka et al. 1987, pg 27; Scarnecchia and Bergersen 1987, pg 315; Wesche et al. 1987, pg 152; Kozel et al. 1989, pg 180; Li et al. 1994, pg 627; Bayley and Li 2008, pg 143-144), and decreased winter survival (Platts 1991, pg 398; Cunjak and Randall 1993, pg 50).
		Increases sediment (Platts 1991, pg 404) that settles out of the water and covers the surface of the stream bed and fills in the spaces between gravel (Megahan et al. 1980, pg 380; Lisle 1982, pg 1650; Beschta and Platts 1986, pg 374-375; Bjornn and Reiser 1991, pg 98).	Reduced survival of eggs and emerging fry (Phillips et al. 1975, pg 461; Chapman 1988, pg 13; Reiser and White 1988, pg 434; Bjornn and Reiser 1991, pg 98) and interferes with the development of eggs and fry (Cordone and Kelley 1961, pg 199; Sorensen et al. 1977, pg36; Alabaster and Lloyd 1982, pg 2; Reiser and White 1988, pg 435).
		Increases sediment in water column.	Depending on concentration and duration of suspended sediment, effects on bull trout can include: decrease in abundance (Watson and Hillman 1997, pg 245), abandonment of cover (Gradall and Swenson 1982, pg 394), sediment avoidance (seeking refugia) (Lawrence and Scherer 1974, pg 25), short-term reduction in feeding success (Sorensen et al. 1977, pg36; Alabaster and Lloyd 1982, pg 2), elevated physiological stress that increases susceptibility to disease (Sorensen et al. 1977, pg 36; Alabaster and Lloyd 1982, pg 1), reduction of growth rate (Alabaster and Lloyd 1982, pg 1), modification of natural movements (Bjorn and Reiser 1991, pg 85), and reduction in the abundance of food organisms available to the fish (Cordone and Kelley 1961, pg 205; Sorensen et al. 1977, pg 36; Langer 1980, pg 5; Alabaster and Lloyd 1982, pg 2).

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Discussion

Walking on streambanks, accessing the stream by trails, or creating trails can cause shearing of the bank into the stream simply from the sharpness and pressure of livestock hooves (Behnke and Zarn 1976, pg 5; Platts 1978, pg 501; Dahlem 1979, pg 32; Clary and Webster 1990, pg 209; Trimble 1993, pg 451; Trimble and Mendel 1995, pg 224). Shearing of the bank increased sediment being deposited into the stream and changes the stream width, bank angle, bank retreat, and root biomass (Clary and Kinney 2002, pg 139).

How can changes in vegetation create bank instability? When vegetation is grazed too long or consistently too late into the growing season (not allowing recovery time before winter):

- plant vigor and productivity is diminished (Vallentine 1990, pg 331; Archer and Smeins 1991, pg 109; Thurow 1991, pg 150; Ehrhart and Hansen 1998, pg 9),
- roots can die back (Vallentine 1990, pg 331; Ehrhart and Hansen 1998, pg 9),
- seed development can cease (Ehrhart and Hansen 1998, pg 9), and
- individual plants can be damaged or destroyed (Vallentine 1990, pg 331).

This damage can alter species composition of streamside vegetation leading to the reduction or elimination of woody and hydric herbaceous vegetation (with deeper, more vast roots) (Platts 1991, pg 393). This riparian vegetation is subsequently replaced by upland or nonnative vegetation (with shallower roots and less ability to bind the soil) (Stebbins 1981, pg 75-85; Archer and Smeins 1991, pg 109-115, 119-130; Thurow 1991, pg 150; Fleischner 1994, pg 631). This process reduces the complex root masses and above-ground structures (Dunaway et al 1994, pg 47; Clary 1999, pg 218; Clary and Kinney 2002, pg 144) that serve to retard streambank erosion by filtering sediments out of the water and maintaining/building streambanks (Meehan et al. 1977, pg 138; Winegar 1977, pg 11; Platts 1991, pg 396). Kleinfelder et al. (1992, pg 1920) and Dunaway et al. (1994, pg 47) showed that the density of herbaceous plant roots is responsible for most of the soil stability found in streambanks. "During floods these vegetative root mats reduce water velocity along stream edge, causing sediment to settle out and become part of the bank. Where streamside vegetation is insufficient and protective mats are absent, the banks erodes (Platts 1981a, pg 5) and the stream usually responds by adjusting its channel width" (Platts 1991, pg 397). Severity of effect is a function of soil type, plant community, and interactions between these factors (Dunaway et al. 1994, pg 47).

How do unstable banks affect bull trout? Regardless if decreased plant vigor or trampling is the cause of unstable banks, the results are the same: wider, shallower streams; less pools and undercut banks; and increased sediment in the water column and substrate. These changes in the stream channel affects the fish production, survival, and reproduction. "Stream width normally decreases when domestic livestock is eliminated from the surrounding area" (Gunderson 1968, pg 513; Platts 1981a, pg 6; Platts and Nelson 1985a, pg 377) and water depth increased slightly (10%) to markedly (500%) (Gunderson 1968, pg 513; Platts 1981a, pg 6).

Wider, shallower streams results in elevated water temperature in the summer and decreased number of pools and undercut banks that offer protection to bull trout from predators (Beschta and Platts 1986, pg 371; Vallentine 1990, pg 51). Research has also found that wider, shallower channels are less likely to drift-over with snow in the winter, therefore increasing the possibility of surface and subsurface ice formation (Chisholm et al. 1987, pg 182). Snow cover can provide insulation against low air temperatures (Needham 1969, pg 54); and prevent the loss of stream-bed heat, prevent sub-surface ice formation, provide for stable water temperatures, and enable a free-flowing channel under the snow (Chisholm et al. 1987, pg 181). There are two types of subsurface ice, frazil and anchor ice, which form within the water column. Frazil is extremely soft and composed of fine crystals that undulate in the current, clump at the surface of the water, or present itself as stationary, slushy mass occupying the entire depth of the water. Anchor ice coats unmovable objects in the stream bed and is composed of larger, more granular, rigid crystals than frazil ice (Maciolek and Needham 1952, pg 206). Sub-surface ice formation could affect stream life through the mortality of

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juvenile and adult fish (Tack 1938, pg 26; Maciolek and Needham 1952, pg 202; Cunjak 1996, pg 273) and mortality of eggs (Reiser and Wesche 1979, pg 58).

Grazed watersheds typically have higher stream sediment levels than ungrazed watersheds (Lusby 1970, pg 256; Platts 1991, pg 8). Increased sedimentation is the result of grazing effects on soils (compaction), vegetation (elimination), hydrology (channel incision, overland flow), and bank erosion (sloughing) (Platts 1981a, pg 6; Platts 1981b, pg 17; Kauffman et al. 1983a, pg 683; Lee et al. 1997, pg 9-28).

What does sediment do? Sediment can profoundly affect the productivity and complexity of a stream (Cordone and Kelly 1961, pg 208; McNeil and Ahnell 1964, pg 1). Negative effects extend from interference with spawning, egg and alevin survival, rearing habitat to adult holding habitat. Sediment settling out of the water onto trout redds can reduce the survival of salmonids eggs and alevins (Phillips et al. 1975, pg 461; Chapman 1988, pg 13; Reiser and White 1988, pg 434) by smothering and trapping them. In a healthy stream, young trout hide in the interstitial spaces between cobbles and boulders to avoid predation and to avoid the extreme cold of winter surface flows (Heggenes 1990, pg 341). Deposition of silt on spawning beds can fill these interstitial spaces in stream bed material impeding water flow, reducing dissolved oxygen levels, restricting waste removal, reducing survival of emerging fry, and blocking juvenile use of the area (Chapman 1988, pg 18; Bjornn and Reiser 1991, pg 98).

Increased sediment can also cause a loss of pool depth (where both adults and juveniles may reside), can decrease aquatic invertebrate production (by decreases the amount of substrate suitable for invertebrates), and can cause channels to braid (Megahan et al. 1980, pg 380; Lisle 1982, pg 1650; Beschta and Platts 1986, pg 371). Sediment has also been shown to affect trout occurrence (Watson and Hillman 1997, pg 245; Zoellick and Cade 2006, pg 269), decrease channel stabilization, and modify channel shape and complexity (Meehan 1991, pg 2 and 9; Lee et al. 1997, pg 9-28).

Sediment in the water column (suspended sediment) can reduce light penetration to plants and reduce oxygen carrying capacity of the water. The effect of suspended sediment on juvenile and adult fish has been well documented (Newcombe and MacDonald 1991, pg 74-77). Depending on concentration and duration of exposure to sediment; different effects can be expressed:

- Behavorial effects – abandonment of cover, sediment avoidance (seeking refuge from sediment),
- Sublethal effects – short-term reduction in feeding success, increase in physiological stress and stress-related disease, and
- Lethal effects – reduced growth rate and fish densities, abrades gills, increased predation, and death (with long enough exposure to high levels).

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2.1.3 Walking or loafing in the stream

Livestock walking or loafing in the stream may result in effect to bull trout through two different pathways (see Table 4).

Table 4. Simple display of Effect Pathway 4 and Effect Pathway 5 – changes caused by in-stream use.

	Immediate Change	Resulting Change	Effects on Bull Trout or their Habitat
PATHWAY 4 Changes in reproduction	stepping on redds and pre-emergent fry (Roberts and White 1992, pg 454; Ballard and Krueger 2005, pg 276; Gregory and Gamett 2009, pg 364)	-	increases mortality rates of embryos and alevins (Roberts and White 1992, pg 454)
PATHWAY 5 Changes in survival	relocating juvenile bull trout from protective cover into open water	-	increases their susceptibility to predation

Discussion

What are alevin and fry? There are four life stages of the bull trout: egg, alevin, fry and adult. The first two stages are not mobile. Eggs are laid by the female and fertilized by the male. The eggs are deposited in redds (nests that adult trout build in the gravel). The timing of development of embryos inside the eggs depends on water temperature. Bull trout eggs require a long incubation period (100-145 days) compared to other salmon and trout, and hatch in late winter or early spring (USFWS 1998, pg 1). When the eggs hatch, tiny fish called alevins emerge. Alevins stay within the gravel of the redd while continuing to develop feeding only on their yolk sacs. The stage when trout begin to swim and start eating is called 'fry'. Fry remain in the stream bed for up to three weeks before emerging (USFWS 1998, pg 1). The word 'juvenile' is the general term used to refer to young trout from the fry stage up until sexual maturity. Bull trout reach sexual maturity between four and seven years of age.

How does wading affect trout? Grazing livestock with access to streams where bull trout are spawning and depositing eggs can disturb spawning fish and trample redds. During the spawning period for bull trout, livestock presence in the stream can disturb adults that are initiating or tending redds by displacing them and affecting their breeding behavior. It is suspected that this disturbance only temporarily impairs their reproductive behavior. During the incubation period for bull trout, livestock presence in stream can have huge effects on the survival of the eggs and pre-emergent fry, since there is a large number concentrated into a small area and they have no ability to move. Trampling can destroy eggs and pre-emergent fry dislodging them or directly killing them. Gregory and Gamett (2009, pg 361) found that during the 14–21-day grazing period, 12–78% of the simulated redds were affected by trampling and as stocking intensity increased, impacts increased. Roberts and White (1992, pg 450) showed that a single wading event was responsible for 43% mortality and twice-daily wading events caused mortality of 96% of pre-hatching embryos in a simulated bed. Ballard and Krueger (2005, pg 274) showed that the time cattle spent in close proximity to salmon redds was small (<0.01%) in relation to the total time spent grazing the allotment. Even though the contact time was minimal, two out of 14 redds observed over the two-year project were trampled by cattle.

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Trout use rooted and free-floating vegetation as cover (Boussu 1954, pg 239). Livestock wading into streams or occupying streamside habitat are likely to displace juvenile bull trout from protective streamside cover and other preferred habitat increasing their predation risks. Frid and Dill (2002, pg 11) argue that disturbance can indirectly affect both fitness and population dynamics by the costs caused by lost energy and lost opportunity. They stated that on an individual basis disturbances can affect prey behavior in regards to vigilance, fleeing, and habitat selection.

2.1.4 Urinating or defecating in the stream

When livestock urinate or defecate directly into the stream, these contaminants can affect bull trout through the mechanism explained in Pathway 6 (see Table 5).

Table 5. Simple display of Effect Pathway 6 – changes caused by increased nutrients.

	Immediate Change	Resulting Change	Effects on Bull Trout or their Habitat
PATHWAY 6 Changes in prey	increase phosphorus and nitrogen concentrations in the water column (Brooks et al. 1997, pg 227; Lemly 1998, pg 232)	increases bacteria growth on the gills and bodies of aquatic insects and can cause significantly lower density of insects occurring downstream (up to 66 percent less) (Lemly 1998, pg 234-235; Lemly and King 2000, pg 91).	decreases densities of aquatic insects reducing the food available for bull trout thereby lowering the growth rate and potentially displacing trout to other stream reaches

Discussion

How does livestock urine and feces affect bull trout? "When grazing animals become concentrated near water bodies or when they have unrestricted long-term access to streams for watering; sediment and nutrient loading can be high and bacteriological quality of surface water can be affected adversely (Brooks et al. 1997, pg 230). Feces and urine deposited in the stream increased nutrient levels in the water column, specifically phosphorous and nitrogen. These increased levels were demonstrated to cause extensive growth of bacteria on aquatic insects which resulted in high mortality levels in insect populations. In some cases entire hatches were lost (Lemly 1998, pg 237).

Nutrients from animal wastes can also stimulate aquatic algae and plant growth, however moderate levels of growth provide food as a basis for the aquatic food chain. Bauer and Burton (1993, pg 8-9) found that "the risk of nutrient enhancement is low in arid rangelands where animal wastes are distributed and runoff is comparatively light". In contrast, Alderfer and Robinson (1947, pg 948) observed high runoff rates in heavily grazed pastures and very little runoff in ungrazed areas. Nutrient impacts vary based on specific site conditions that include: precipitation, runoff, vegetation cover, grazing density, proximity to stream, and length of grazing use.

Livestock grazing can also cause increases in bacteria/protozoa levels (due to urination and defecation in the water) in areas where cattle are concentrated near water (Doran et al. 1981, pg 166; Gary et al. 1983, pg 123; Tiedeman 1987, pg 328-329; Taylor et al. 1988, pg 491; Hall and Amy 1990, pg 293). Bacteria can also enter the stream through runoff events via overland flow (Doran and Linn 1979, pg 985; Milner et al. 1992, pg 35). However in arid rangelands coliform contamination may be low (Bauer and Burton 1993, pg 10), because bacteria was found to stay within a few feet of the manure on dry rangelands at grazing intensity of 2 ha/AUM (Buckhouse and Gifford 1976, pg 109). No research was found on effects of coliforms on fish, so this action has not been identified to a pathway.

2.2 ACTIVITIES WITH DELAYED CHANGES

2.2.1 Bedding in riparian areas and uplands; Using or creating trails in riparian area and uplands; Using salt or mineral supplement; Using corrals, loading chutes, or weaning areas; Using, maintaining, or constructing/developing alternative watering structures; Maintaining or installing fences; Using roads to transport cattle to/from allotment; and Implementing monitoring plan

The first six activities (listed above) can cause compaction of the soil in areas where cattle congregate or frequent (Trimble and Mendel 1995, pg 234). Using Roads to Transport Cattle to/from Allotment and Implementing Monitoring Plan also results in compaction of roads and trails. Compaction can affect bull trout through two different pathways (see Table 6).

Table 6. Simple display of Effect Pathway 7 and Effect Pathway 8 – changes in the input of sediment, pollutants, and flood energy that gets channeled into the stream; and changes in water storage and stream base flows – all caused by compaction.

	Delayed Change	Resulting Change	Effects on Bull Trout or their Habitat
PATHWAY 7 Changes in input to stream channel	increased surface runoff and soil erosion (Alderfer and Robinson 1947, pg 948; Warren et al. 1986b, pg 1340; Valentine 1990, pg 47; Trimble and Mendel 1995, pg 236; Krueger et al. 2002, pg 5,7,8)	elevates the amount of sediment and pollutants getting channeled into the stream and increases the flood energy causing channel incision (downcutting) with narrowing of riparian zone (Clary and Webster 1989, pg 7; Buckhouse and Elmore 1993, pg 49; Simon and Rinaldi 2006, pg 361)	causing the same 'Effects on Bull Trout' as discussed in Pathway 3 and 6, and channel downcutting can result in lowering of the water table as detailed in the 'Resulting Effects' and 'Effects on Bull Trout' in Pathway 8
PATHWAY 8 Changes in water storage	reduced infiltration of precipitation into the soil (Alderfer and Robinson 1947, pg 948; Warren et al. 1986b, pg 1340; Wentz and Wood 1986 pg 365; Usman 1994, pg 69; Trimble and Mendel 1995, pg 235)	decreases water table (Platts and Raleigh 1984, pg 1108) and groundwater recharge resulting in warmer stream temperatures and overall shallower streams and pools	causing the same 'Effects on Bull Trout' as discussed in Pathway 1 and 3

Discussion

What is soil compaction and how does it lead to erosion? Soil compaction is the packing together of soil particles by forces exerted at the soil surface. This compression of the soil particles results in an increase in bulk density by decreasing pore space. Grazing, trailing, and repetitive use of the same site by livestock decreases the porosity of the soil through the pressure of their hooves (Heady and Child 1994, pg 63-67). Orodho et al. (1990, pg 11) found that "heavy" grazing in New Mexico caused an 8% increase in soil bulk density. Other studies that describe increases in soil bulk density associate with grazing included Kauffman and Krueger (1984, pg 434), Naeth et al. (1990, pg 157), Tollner et al. (1990, pg 75), and Vallentine (1990, pg 46).

"Soil erosion is the detachment and movement of soil or rock by wind, water, ice, or gravity" (Krueger et al. 2002, pg 7). Instead of absorbing rainfall, compacted soil resists penetration of water droplets. This resistance increases the impacts that raindrops have on the soil by increasing sheet erosion and increasing runoff created by a rain event (Krueger et al. 2002, pg 7). High rates of runoff have been observed in

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heavily grazed sites compared to ungrazed areas (Alderfer and Robinson 1947, pg 948). This enhanced run-off from the uplands increases the erosive force that rainfall events have on the stream bank through the elevated sediment load and surface flow that gets funneled directly into the stream channel (Trimble and Mendel 1995, pg 246). Simon and Rinaldi (2006, pg 361) found that channel incision can result from disturbances (such as compaction) that affect "available force, stream power or flow energy, or change erosional resistance".

What is infiltration and how does it affect streams? Infiltration is the downward movement of water through soil. Since compacted soil does not allow rain droplets to penetrate through the soil surface as does non-compacted soil, the following effects are possible.

- Significantly decreased infiltration rate and increased sediment production that is caused by bare soil produced from intense grazing (Alderfer and Robinson 1947, pg 948; Warren et al. 1986a, pg 491).
- Greater water loss and lower water tables – Water losses are high from heavily grazed pastures, whereas ungrazed areas lose little water due to runoff (Alderfer and Robinson 1947, pg 948). Therefore less precipitation penetrates the soil resulting in lower water table levels and reduced stream flows. Li et al. (1994, pg 639) found that "grazing can cause streams to become intermittent through lowering of the water table due to diminished interaction of the stream channel with the riparian vegetation and lowered water permeability of riparian soils due to compaction."
- Groundwater supplies are not replenished at the same levels (Thurow 1991, pg 144-145, 151) which can also reduce stream flows.
- Warmer, summer water temperatures and overall shallower streams and pools caused by lower stream base flow.
- Soil supports less vegetation growth because of the lower moisture (Krueger et al. 2002, pg 6).

Management considerations can be implemented to decrease the degree of compaction created by grazing. See section 3.1.4 for discussion of these variables.

2.2.2 Using, Maintaining, or Constructing/developing alternative watering structures

Constructing/Developing Alternative Watering Structures can have additional effects other than compaction. Developing watering structures from the same water sources that feed bull trout streams can decrease water tables and stream base flows (Li et al. 1994, pg 638). This dewatering works through a similar mechanism as discussed in Deacon et al. (2007, pg 693-694) and creates the same 'Resulting Effects' and 'Effects on Bull Trout' as discussed in Effect Pathway 8.

2.2.3 Urinating or defecating in riparian area and uplands

If density and distribution of grazing is not well-managed; then urinating and defecating in riparian and upland areas can increase nutrient concentrations that gets channeled into the stream and results in the same effects detailed in Effect Pathway 6. Even though the activity is similar and the subsequent effects are the same as in Effect Pathway 6, this activity is listed separately because of the location of the activity and its requirement of a precipitation event to trigger the mechanism.

Manure and urine deposited on land near surface waters can transport contaminants to streams through leeching and surface runoff (Krueger et al. 2002, pg 9). As much as 75 to 95% of the nutrients that grazing animal eats may be returned to the pasture in feces and urine (which has more nitrogen and is susceptible to leeching) in highly concentrated patches (Whitehead 1995 cited in Krueger et al. 2002). Nutrient concentration also depends on how skewed the distribution of urine patches and dung pats are relative to natural water courses or groundwater tables (West et al. 1989, pg 788-789).

2.2.4 Grazing on riparian and upland vegetation

If timing, density, and distribution of livestock are not well managed; then grazing can impact plant communities by causing decreased plant vigor and/or changes in soil characteristics that lead to effects on bull trout through Pathway 9 (see Table 7).

Table 7. Simple display of Effect Pathway 9 – changes in plant community.

	Delayed Change	Resulting Change	Effects on Bull Trout or their Habitat
PATHWAY 9 Changes in plant community	changes in the plant community (to include shallower rooted and non-native species) (Leopold 1924, pg 1; Schultz and Leininger 1990, pg 297)	decreases vegetative cover that protects and binds the soil and conserves soil moisture and nutrients (Krueger et al. 2002, pg 4-5)	causing the same 'Effects on Bull Trout' as discussed in Pathway 3 and 7.
		impedes plant succession which decreases large woody debris contribution to stream (Fleischner 1994, pg 633; Belsky et al. 1999, pg 32)	less large woody debris in the stream channel creates simpler stream structure with less protective cover increasing the possibility of trout predation and decreasing the quality of habitat (Kozel et al 1989, pg 180).

Discussion

How can grazing affect plant communities? Grazing can create significant differences in vegetative communities (Schultz and Leininger 1990, pg 297). "For plants to remain vigorous they must have time for growth, seed development, and storage of carbohydrates. Continual grazing during the plant's growth period eventually causes the roots to die back, reduces its vigor, and ceases seed development; which, in turn, can change the plant community to less productive and less palatable species" (Vallentine 1990, pg 331; Ehrhart and Hansen 1998, pg 9). Routine grazing too late in the growing season can change plant communities by the elimination of individual plants that are not able to recover from grazing. Myers (1989, pg 118) observed that nine grazing operations that had healthy riparian zones allowed for 36 days vegetation regrowth versus 21 days of regrowth for operations with unhealthy riparian zones. Marlow et al. (1991, pg 261-262) found that failure to allow for regrowth after grazing, over time, will not only impact vegetation in the riparian area, but will also reduce the vigor of the upland plants and may change plant communities. This shift in vegetation happens through selection of preferred forage. For example, when grasses (*Gramineae* family) are preferred, shrubs may be more competitive and eventually may dominate (Krueger et al. 2002, pg 5). In this way grazing can affect succession as well as plant communities within the ecosystem (Fleischner 1994, pg 633; Collins and Glenn 1995, pg 114-118,137).

How can changes in plant communities cause erosion and affect water storage? When hydric, deeply rooted herbaceous vegetation dies out and is replaced by upland or non-native species with shallower roots (less ability to bind the soil), erosion can increase. Alterations in plant communities are also assisted by the changes in soil characteristics and erosion caused by grazing. These changes and improper grazing management can reduce preferred forages and promote their replacement by invasive species (Archer and Smeins 1991, pg 123-124).

Another part of the plant community that can be affected by grazing is ground cover (leaf cover plus plant litter). Ground cover is important for many reasons. In regards to stream health; ground cover intercepts, absorbs, and retains moisture. These actions allow for greater infiltration of water and greater disbursement of surface water flow (Osborn 1955, pg 133-135). Ground cover is also the primary protection

against both impact of raindrops and sheet erosion (Osborn 1955, pg 128, 133-135; Blackburn et al. 1986, pg 34; Farmer et al. 1999, pg 299). When ground cover is at or near its successional potential, it can ensure any additional sediment contributed to streams (from upland and riparian areas due to livestock grazing) is minimized. When vegetative cover is compromised by heavy grazing high water loss can occur as was found by Alderfer and Robinson (1947, pg 948). They attributed the high rates of runoff from the heavily grazed area to the lack of soil cover and compaction of the surface layer of the soil. Reduction in vegetative cover makes the soil more susceptible to erosive factors, increases runoff, and decreases soil moisture and nutrients (Krueger et al. 2002, pg 7). Less vegetative cover also reduces leaf litter which decreases organic matter and moisture in the soil (Belsky et al. 1999, pg 30). For soil and watershed protection the most important elements seem to be total ground cover, dispersion of ground cover, and quality of ground cover (Osborn 1955, pg 133-135; Blackburn et al. 1986, pg 32-34; Simanton et al. 1991, pg 281; Watters et al. 1996, pg 282-283; Goodrich and Reid 1999, pg 317).

How can changes in plant community affect the structure of the stream channel? **In addition to increasing erosive factors when riparian vegetation is replaced with more xeric plants, stream channels may begin to braid or trench (depending on soil and substrate composition) (Platts and Raleigh 1984, pg 1108). Also when succession of riparian vegetation is hindered by grazing, input of large woody debris into the stream channel is decreased (Fleischner 1994, pg 633; Belsky et al. 1999, pg 32). When input of large woody debris is decreased and its influences on stream channel are diminished, then the channel structure becomes more simple (Gregory et al. 1991, pg 548-549).**

NOTE – A simplistic review of the Effect Pathways can be found in Figure 1. This synopsis is offered to summarize the previous discussion and serve as a reference for the reader as they move into the degree of effects discussion in section 3.0.

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3.0 DISCUSSION OF THE VARIABLES WHICH INFLUENCE THE DEGREE OF THESE EFFECTS

The purpose of this section is to clarify the factors influencing the degree that each pathway (discussed earlier) is activated. By doing this, we create a means of individualizing the discussion of effects for the unique qualities of the area being assessed.

The activities which immediately trigger Effect Pathways 1-6 all occur in the stream or on the streambank. If livestock cannot access the stream and its bank, then these activities cannot occur, and the only effects that need to be analyzed are those initiated by the activities that trigger Effect Pathways 7-9 (which indirectly included Effect Pathways 1, 3, and 6 (see Figure 1).

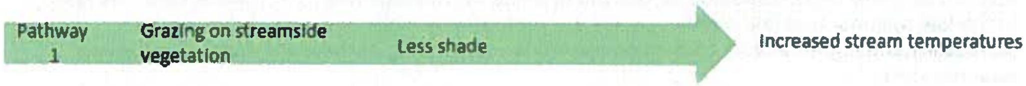
If livestock can only access part of the stream, then immediate effects of these streamside activities need to be evaluated on those sections (and in some cases downstream of those sections). Therefore accessibility of the stream is the first variable evaluated within each of the first six pathways and is an essential variable in analysis.

In the following discussion, the variables influencing severity of each effect are identified. Through this identification, it is found that some variables affect multiple pathways. These commonalties represent the complexity and interconnectedness of the pathways and are summarized in Table 8.

Table 8. Variables which influence the degree of impact that grazing can have on bull trout or their habitat separated by Effect Pathways (pathways are summarized in Figure 1 and described fully in Section 2.0). For example, the 'amount of stream access' can influence the degree of effect that grazing has on streamside vegetation and, in turn, on 'stream temperature'. For a detailed explanation of how these variables influence degree of effect, see Section 3.0.

Effect pathway # and element that may be affected by grazing	Variables that influence the degree of impact that grazing can have on bull trout or their habitat							
	Amount of stream access	Vegetation type	Slope and aspect	Elevation	Soil condition, type, and moisture content	Habitat suitability for spawning	Habitat suitability for juveniles	Management considerations
1 Stream temperature	✓	✓	✓					✓
2 Prey abundance	✓	✓			✓			✓
3 Bank condition and sediment load	✓	✓	✓	✓	✓			✓
4 Redd Trampling	✓	✓				✓		✓
5 Juvenile displacement	✓	✓					✓	✓
6 Stream nutrient levels	✓	✓						✓
7 Runoff and erosion		✓	✓		✓			✓
8 Infiltration Rate		✓	✓		✓			✓
9 Plant community		✓			✓			✓

3.1 VARIABLES FOR EFFECT PATHWAY 1



Decreased shading is triggered by grazing on over-hanging vegetation and the variables that affect the degree of activation of this pathway are:

- Accessibility of the streambank
- Vegetation type – desirability, height, and amount/diversity
- Slope and aspect
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; and adaptive management based on monitoring

See sections below for a more detailed discussion of each of the above variable.

3.1.1 Accessibility of the streambank

There are natural and man-made conditions that exist which exclude or minimize livestock access to the stream and its banks. These barriers include:

a) Steep terrain adjacent to the stream that provides less access than low gradient terrain,
b) Larger **boulders** lining the stream armour the banks and provide less access than smaller **cobble**.
c) Dense vegetation that allows less access than sparse vegetation,
d) Large amounts of large woody debris in the riparian area which provides less accessibility to streams and their banks than those with clear understory,
e) High stream flows in the spring that limit access as opposed to low summer flows that allow access,
f) Man-made barriers (well-placed trees, shrubs, boulders,...) that discourage livestock from accessing the stream, and
g) Properly located and well-maintained fences that prevent access by excluding livestock from the stream and protecting the riparian area, the fish, and their habitat (Platts and Rinne 1985, pg 118).

In 20 studies reviewed by Platts (1991, pg 400), he found that areas previously degraded by grazing were improved when livestock were restricted from the habitat. In an Oregon study Storch (1979, pg 56) revealed that trout comprised 77% of the total fish population in a section of stream within a fenced area that excluded grazing, but only 24% of the population outside the exclosure.

3.1.2 Vegetation type

Each vegetation type plays an important role in forming and protecting the aquatic habitat (Platts 1983, pg 184 and 187) and is susceptible to damage by improper grazing (Platts 1991, pg 396). The quantity and type of riparian vegetation affects the riparian area's ability to perform its natural functions of storing water, recharging aquifers, filtering chemicals and organic wastes, trapping sediment, building and maintaining banks, and reducing stream flow energy (Ehrhart and Hansen 1998, pg 3). Different vegetation offers various amounts of shading for streams, and the categories below are one way of evaluating degree of effect on vegetation.

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a) **Desirability** – If the streamside vegetation is undesirable, then livestock will feed on it less and therefore the overhanging vegetation will be less impacted. Food preference may differ depending on the season of use. In the spring cattle prefer the succulent herbaceous species and are naturally more dispersed across the uplands (Platts and Nelson 1985b, pg 554; Ehrhart and Hansen 1999, pg 10). In the late summer and fall, woody species are preferred by cattle because of the greater palatability and higher protein content compared to surrounding herbaceous species (Kovalchik and Elmore 1992, pg 114).

b) **Height** – Grasses offer less shading and are more easily affected by grazing, whereas mature trees are beyond the grazers reach and thereby less impacted by grazing. The effects of grazing are therefore more evident where herbaceous vegetation provides the only shade to stream. However in riparian areas where woody vegetation of accessible height (like shrubs, young trees, and woody vines) make up the majority of stream cover, grazing can impact overhanging cover. Vegetation needed for shading also depends on stream size. Grasses are sufficient for cover only on very small streams (1st and 2nd-order streams), but brush (such as willow) is required for larger streams (3rd through 5th-order streams) (Platts 1991, pg 399).

   Cattle often begin to browse woody species when stubble height of palatable herbaceous species falls below approximately 4 inches (Hall and Bryant 1995, pg 6) or when herbaceous forage quality has diminished due to curing. Others suggest that approximately 6-8 inches of herbaceous residual stubble height may be needed to protect woody plants, especially during late season grazing (Clary and Leininger 2000, pg 569)." For further discussion of stubble height, see section 3.1.4f.

c) **Amount and diversity of vegetation** – If streamside vegetation is dense (depending on the move triggers and intensity, season, and length of grazing); the possible negative effects of reduced vegetation can be negated by the sheer abundance of vegetation. In addition to density of vegetation, diversity of vegetation can absorb effects created by grazing. Riparian communities comprised of one primary vegetation (monoculture) are suspected to provide less insulative effects and be more easily impacted than riparian areas comprised of more diverse, multi-canopied vegetation.

3.1.3 Slope and Aspect

The direction in which the surface of the stream faces can be a variable influencing the degree of effect that grazing on streamside vegetation can have on stream temperature. Streams on southerly-facing slopes are more vulnerable to temperature shift caused by removal of overhanging plant matter because of their increased exposure to the sun as well as the overall lower amount of vegetation supported on southerly slopes (Renner 1936, pg 29).

3.1.4 Management considerations/Grazing strategy

As Kauffman (1995, pg 29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991, pg 403). In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing** – The season of use of an area can have substantial influence on the degree of effect that grazing has on stream temperature. In the spring it is easier to keep livestock out of the stream when they naturally prefer herbaceous vegetation in the floodplains and uplands (Siekert et al. 1985, pg 278; Marlow and Pogacnik 1986, pg 212; Clary and Booth 1993, pg 493; Del Curto et al. 2000, pg 42) and when the cooler temperatures prevent loitering in the riparian (Ehrhart and Hansen 1998, pg 10). Also because livestock is attracted to the uplands, there is less browsing on willows and other woody plants (Kovalchik and Elmore 1992, pg 114; Clary 1999, pg 218). Shaw and Clary (1996, pg 148) found that willow height and density were greatest in pastures grazed in spring as compared to pastures grazed season long or grazed in the fall, and Lucas et al (2004, pg 466) found that herbaceous species richness and diversity were significantly greater during the cool season grazing at light to moderate levels. Therefore when spring grazing occurs in areas where riparian vegetation is comprised mostly of shrubs, then the effects on overhanging vegetation is minimized.

Mid-season (summer) grazing is considered the most injurious to the plant community unless management considerations are implemented to minimize riparian use and livestock congregation. Woody species browse is more likely (Buckhouse and Elmore 1993, pg 50; Krueger 1996, pg 161) and reduction in plant vigor is most possible, because of repeated and intense use caused by congregation (Ehrhart and Hansen 1998, pg 16). This is the period of greatest stress in the plant community, because plants are completing the carbohydrate storage process that maintains them during the dormant cycle (Leonard et al. 1997, pg 30). However effects on overhanging vegetation can be minimized; if conditions are monitored closely, alternative watering sources exist, the use is short-term, the use is rotated across years, and enough soil moisture remains for regrowth of plants (before the end of the growing season) (Ehrhart and Hansen 1998, pg 15 and 17). Myers (1989, pg 118) documented nine grazing operations with healthy riparian zones allowed for 36 days of vegetation regrowth versus 21 days for unsuccessful operations.

Late season (fall) grazing is also a time when woody species browse is more like because of the reduced palatability of herbaceous species and inclement weather can cause congregation in bottoms (Buckhouse and Elmore 1993, pg 50; Green and Kauffman 1995, pg 312; Krueger 1996, pg 161). Regrowth of overhanging vegetation is least likely to occur with fall grazing decreasing the vegetation's ability to fulfill its riparian role (sediment trapping, bank building and maintenance, flow energy dissipation (Ehrhart and Hansen 1998, pg 3). The impacts of fall grazing are lessened in riparian systems that are comprised mainly of herbaceous plants (Ehrhart and Hansen 1998, pg 12), since woody species are typically more palatable at this time of year. Plus if herbaceous species are grazed on, the herbaceous seeds have already set, so grazing has less impact than earlier in development (Gillen et al. 1985, pg 208).

b) **Distribution of grazing** – Livestock will spend a greater amount of time in riparian areas (even though it typically represent 20% of the forage) unless measure are taken to influence their distribution (Bryant 1982, pg 781-783; Roath and Krueger 1982, pg 101-103; Platts and Nelson 1985c, pg 8-10). Management considerations implemented simultaneously can spread the distribution of livestock across the rangelands reducing the time they spend in the riparian and the impacts of grazing on streamside vegetation (Leonard et al 1997, pg 42; Ehrhart and Hansen 1998, pg 20). These practices also insure proper forage utilization and include:

   b1) The use of alternate water sources that are monitored and maintained throughout the grazing period (Riparian Habitat Committee 1982, pg 6; Miner et al 1992, pg 37 and 38; Clawson 1993, pg 63),

   b2) The placement of mineral supplement at least ¼ mile and preferably ½ mile away from heavily used trails, roads, water, and concentration areas (Riparian Habitat Committee 1982, pg 6; Ehrhart and Hansen 1998, pg 23),

   b3) The use of active trailing techniques to herd livestock into unutilized areas while preventing overutilization of riparian areas (Riparian Habitat Committee 1982, pg 6), and

   b4) The use of drift fences in mountainous terrain to deflect movement patterns in areas where livestock tend to use riparian areas as travel corridors (Ehrhart and Hansen 1998, pg 26).

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Miner et al. (1992, pg 38) found that under winter conditions, the amount of time livestock spent drinking or loafing in the stream was reduced by more than 90% in the presence of a watering tank. McInnis and McIver (2001, pg 651) "found that off-stream water and salt attracted cows to the uplands enough to significantly reduce uncovered and unstable streambanks from 9% in non-supplemented pastures to 3% in supplemented pastures." Platts and Nelson (1985b, pg 553) also saw evidence that placing salt away from streams decreased grazing use of the riparian area. Several studies showed that frequent herding of livestock was a successful technique in lessening the time grazers spent in the riparian area (Storch 1979, pg 57; Masters et al. 1996a, pg 193; Masters et al. 1996b, pg 197), but Ehrhart and Hansen (1998, pg 25) warned that "poorly conducted trailing can be more detrimental than leaving livestock in riparian areas." Ehrhart and Hansen (1998, pg 23) provide anecdotal evidence that salt, when used in conjunction with alternate water sources, can help distribute livestock over open range and can reduce the impacts of grazing on trout habitat.

c) **Intensity of grazing** – The length of time grazing is allowed and number of livestock present are variables affecting the reduction of streamside vegetation. Marlow et al. (1991, pg 263) found "the most critical aspect in any grazing plan for the protection of the riparian areas is the length of time cattle have access to a particular stream reach." After reviewing 34 allotments in SW Montana, Myers (1989, pg 119) concluded that the duration of livestock is a key factor in determining the impact on riparian health.

There is an abundance of research showing the detrimental effects of heavy grazing on plant health, and other research that documents that light to moderate use maintains overall plant health. Holechek et al. (2006, pg 8) defined light grazing as 0-30% use of forage by weight, conservative grazing as 31-40% use, moderate grazing as 41-50% use, and heavy grazing as 51-60% use. In their review of 20 studies in the western North America that had some degree of replication, it was concluded that grazing can have a positive impact on forage plants compared to exclusion, if average long-term use did not exceed 40%. In central Idaho when light (20–25% use) or medium (35–50% use) grazing was applied to historically heavier grazed rangeland; Clary (1999, pg 218) observed narrowing and deepening of the streams, substrate embeddedness decreased, streambank stability increased, and streamside willow communities increased in both height and cover. Biondini et al (1998, pg 469) designed an eight-year study of moderate (residual vegetation of 50%) and heavy grazing treatments (residual vegetation of 10%) and found that heavy grazing lead to decline in standing dead biomass, litter biomass, and peak root biomass. They also concluded that moderate grazing seemed to be sustainable and compatible with the maintenance of range conditions.

When comparing foothills streams in west central Wyoming; Saunders and Fausch (2007, pg 1216) found that areas with high-intensity, short-duration grazing had much greater vegetative biomass than areas that were grazed season-long. Vegetation biomass was up to three times greater. No single management approach was best in all situations, but the light to moderate grazing treatments appears to be successful at maintaining riparian communities (Lucas et al. 2004, pg 466).

d) **Annual pasture use** – Rest or deferred use of pastures at different annual intervals can be an effective tool to minimize the reduction of over-hanging vegetation and ensure riparian plant communities remain vigorous. "For plants to remain vigorous they must have time for growth, seed development, and storage of carbohydrates. Continual grazing during the plant's growth period eventually can change the plant community to less productive and less palatable species" (Vallentine 1990, pg 331; Ehrhart and Hansen 1998, pg 9). Leonard et al. (1997, pg 33) gave examples of the success of the rest or deferred use system in protecting riparian areas, but stress that livestock must be moved from pasture to pasture quickly for this system to be effective. Platts (1991, pg 411) rates this system as fair for stream and riparian rehabilitation potential and recommends that utilization of riparian grasses and woody species must be carefully monitored in pastures grazed during summer and fall, as shifts in palatability may lead to increased use of these plants. A study in Nevada by Myers and Swanson (1995, pg 428) found that a switch to deferred grazing strategy resulted in improved riparian and stream condition. Leonard et al. (1997, pg 34-35) described the benefits of different deferred grazing techniques, which included improved willow reproduction, increased bank stability, improved plant vigor, and stabilized streambanks.

e) **Location of concentrated use areas** – Placing bedding grounds, corrals, livestock turnout points, loading chutes, weaning area,... away from riparian areas not only reduces congregational grazing on vegetation (Riparian Habitat Committee 1982, pg 6; Gillen et al. 1985, pg 209), it also allows sediment from these areas to get captured by vegetation (if ground cover is healthy) before reaching the stream channel.

f) **Adaptive management based on monitoring** – Individualized grazing plans that prescribe use based on the unique conditions of the given area can enable the improvement and rehabilitation of the riparian areas "as long as techniques are accompanied by clear objectives and an adequate monitoring system" (Krueger 1996, pg 160-161,164; Ehrhart and Hansen 1998, pg 5). Efficient movement between pastures and at end-of-year removal is also an essential element to protect properly functioning riparian systems and allow for recovery of degraded riparian habitats (Leonard et al. 1997, pg 33-34).

Selection of sound forage utilization standards (woody browse, stubble height, and bank alteration) that determines the amount of vegetation cover that is left after grazing is an important factor to riparian health. "It is important to remember that vegetation which exists on site at the end of the growing season or at the end of a grazing period, whichever comes last, is what matters since this is essentially what will be available for its protective effect during the next runoff period" (Ehrhart and Hansen 1998, pg 8). Basing these utilization standards on the current status of the riparian community can allow maintenance of existing vegetative conditions or more conservative standards can allow seral stages to progress (Holechek et al. 2004). Clary et al. (1996, pg 139) concluded that different stubble heights are needed to fulfill the two processes of sedimentation: deposition (trapping sediment requires <6 inches) and sediment retention (bank building requires 8-12 inches. Clary (1999, pg 218) found when using a 6" stubble height virtually all measurements of streamside variables move "closer to those beneficial for salmonid fisheries". Clary and Leininger (2000, pg 562) reported that maintaining a minimum stubble height can help preserve forage plant vigor, retain herbaceous forage to reduce browsing on willows, limit bank trampling, stabilize sediment, and maintain cattle gains. However the stubble height that is required to achieve these benefits ranges from 4" to 8" depending on the riparian conditions and responses (Clary and Webster 1990, pg 210; Clary and Booth 1993, pg 493; Clary 1999, pg 218). Bengeyfield (2006, pg 6) concluded that stream-bank alteration is the most powerful of the triggers, and that only streams that met stream-bank alteration levels showed significant improvement in the stream channel.

Diligent monitoring and efficient movement of livestock when standards are approached are as important to minimizing impact on streamside vegetation as the standards themselves. As Bengeyfield (2006, pg 6) found in his work with riparian improvement in southwestern Montana, "the key to successfully improving stream conditions in the presence of livestock is having the commitment of the agencies, the permittees, and the riders."

NOTE – From this point forward within section 3, if a variable is the same as the one defined previously (in Effect Pathway 1, section 3.1), then the reader will be referred back to the above discussion. For example, 'Accessibility of the streambank' is a variable in Pathways 1-6 and it is only discussed in detail in section 3.1.1.

3.2 VARIABLES FOR EFFECT PATHWAY 2

Decrease in vegetative biomass that serves as habitat and food for prey species can be caused by grazing on overhanging vegetation. The variables affecting degree of activation of this pathway are:

- Accessibility of the streambank
- Vegetation type – desirability, height, and amount/diversity
- Soil condition, type, and moisture content
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; and adaptive management based on monitoring

3.2.1 Accessibility of the streambank

See variable discussion in section 3.1.1.

3.2.2 Vegetation type

Different vegetation offers various amounts of habitat for terrestrial prey and detritus for food for aquatic prey. The categories below are one way of evaluating the influence that vegetation type has on degree of effect of this pathway.

a) **Desirability –** See variable discussion in section 3.1.2a.
b) **Height –** Vegetation; such as grasses, forbs, and shrubs; offer more cover and food for prey species for fish than do mature trees, but are more easily affected by grazing because of their accessibility. Mature trees offer less cover for terrestrial insects that become food for bull trout, but still provide detritus for food for aquatic insects. Also mature trees are, for the most part, beyond the grazers reach and thereby less susceptible to the impacts of grazing.
c) **Amount and diversity of vegetation –** If streamside vegetation is dense (depending on the move triggers and intensity, season, and length of grazing); then the possible negative effects of reduced vegetation can be absorbed by the shear abundance of vegetation. Plus riparian communities comprised of one primary vegetation (monoculture) can be expected to provide less diversity of species (in this instance, insect species); than riparian areas comprised of more diverse, multi-canopied vegetation. In streams with fine substrate, woody debris and organic matter can provide necessary food and hiding places for stream insects (Reice 1974, pg 1271-1272; Reice 1980, pg 580; Dudley and Anderson 1982, pg 10).

3.2.3 Soil condition, type, and moisture content

The type of soil is a factor in determining the level of effect that grazing has on the food chain of the stream. In areas dominated by granite (which provides little nutrients to streams); streamside vegetation provides habitat for terrestrial insects and leaf litter, a principal food source, for aquatic invertebrate (Minshall 1987, pg 147). More nutrient-rich soils provide an additional source of nutrient input to support the aquatic food chain.

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3.2.4 Management considerations/Grazing strategy

See variable discussion in section 3.1.4.

3.3 VARIABLES FOR EFFECT PATHWAY 3

Pathway 3	Livestock use of streambank (section 2.1.2)	Decreased bank stability leading to	Lower number of undercut banks and pools Increased width to depth ratio Increased sediment in water and substrate

Decreased bank stability along with the physical shearing of the bank into the stream is reduced by minimizing the time livestock spend in the riparian area. The variables that affect the degree of effect of Pathway 3 include:

- Accessibility of the streambank
- Vegetation type – desirability, height, and amount/diversity
- Slope and aspect
- Elevation
- Soil condition, type, and moisture content
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; adaptive management based on monitoring; and condition of stream crossings/access points

3.3.1 Accessibility of the streambank

See variable discussion in section 3.1.1.

3.3.2 Vegetation type

Severity of effect of bank stability is a function of soil type, plant community, and interactions between these two factors (Dunaway et al. 1994, pg 47). Different vegetation offers various amounts of stability to the streambank soil through their root structure. The categories below are one way of evaluating the influence that vegetation type has on degree of effect of this pathway.

a) **Desirability** – See variable discussion in section 3.1.2a.

b) **Height** – Because of the accessibility of the plant; grasses, **forbs**, shrubs, and young trees are more prone to the impact of grazing than mature trees. Each vegetation type plays an important role in forming and protecting the aquatic habitat (Platts 1983, pg 184 and 187) and is susceptible to damage by improper grazing (Platts 1991, pg 396). Trees provide shade (through canopy), streambank stability (through size and mass of root system), high quality pools and riffles (when mature and fall into stream), control slope and stability of channel (through large mass), prevents channel degradation thereby protecting spawning gravel (through depositing large amounts of organic debris into stream). Brush provides cover (through low overhang), protects from erosion, provides stream stability (through root system and litter fall); and grasses reduces erosion and increase stream bank stability (through forming vegetative mats), help create undercut banks (through gradual erosion of well-sodded banks), and help rebuild damaged banks (through trapping sediment in root systems of grasses and other plants) (Platts 1991, pg 396). However Daniels and Gilliam (1996, pg 246) determined that riparian areas comprised of grass removed 50%–60% of the sediment that entered the buffer and were more effective filters than mixed hardwood and pine buffers.

c) **Amount and diversity of vegetation** – The greater the amount and diversity of plant life, then the more complex the root system is that is maintaining and rebuilding the streambank. Leonard et al (1997, pg 7) stated that a "mix of vegetation increases channel roughness and dissipates stream energy. Willows and other large woody vegetation filter larger water-borne organic material, and their root systems provide bank stabilization." Sedges and rushes are species known to be strongly-rooted (Manning et al. 1989, pg 311; Platts and Nelson 1989b, pg 73; Kleinfelder et al. 1992, pg 1920; Dunaway et al. 1994, pg 47). "Sedges (*Cyperaceae* family), rushes (*Juncaceae* family), grasses, and forbs capture and filter out finer sediment, while their root masses help stabilize banks and colonize filtered sediments. On sites with potential for both woody and herbaceous vegetation, combined plant diversity greatly enhances stream function" (Leonard et al 1997, pg 7). Dunaway et al. (1994, pg 47) also found that sedges and rushes had the lowest erosion rates followed by mixed herbaceous species, but that soil texture also factored in to the degree of erosion effect. Sovell et al. (2000, pg 637) found that riparian sites dominated by mature trees (characterized by steep slopes, bare banks, little understory vegetation) had fine sediment-dominated streambeds. They suspect that lack of vegetative ground cover, due to almost complete canopy cover, may have reduced filtering of upland sediment and promoted erosion of streambank soils causing increased sediment to be deposited in the stream channel.

3.3.3 Slope and Aspect

The steepness of the terrain surrounding the stream affects the amount of erosion that can be caused by grazing and thereby the amount of sediment that gets channeled into the stream. Renner (1936, pg 28) found that erosion increased as gradient increased for all slopes that were accessible to livestock. The direction in which the slope of the terrain faces can be a variable influencing the degree of effect that grazing has on sediment that gets channeled into the stream. In northern latitudes southerly-facing slopes are exposed to more sunlight for longer periods of time than are other slopes. In a study in the Boise River Watershed in Idaho, Renner (1936, pg 13) revealed that the order of solar exposure from greatest to less exposure is as follows: south, southeast, east, southwest, west, northwest, northeast, and north. He also found that south-facing slopes are more vulnerable to erosion; because of their inherently shallower soil, lower litter cover, and overall lower amount of vegetation supported on these slopes (Renner 1936, pg 29). The areas of greater plant density had less erosion, because of the protection provided by both the vegetation and the litter cover. Since south-facing slopes have less litter and vegetation, the erosive impacts of grazing (sediment created during runoff events) can be more pronounced on these slopes.

3.3.4 Elevation

Elevation can be a variable of bank stability especially with a late season grazing strategy that doesn't allow enough time for the streamside vegetation to recover before winter begins. "Chisholm et al. (1987, pg 176) showed that middle-elevation streams (8366' to 9514') in Wyoming experience harsher winter conditions than high-elevation streams because of a lack of snow-bridge formation. Jakober et al. (1998, pg 223) also documented harsher winter conditions in mid-elevation stream where frequent freezing and thawing led to variable surface ice cover and frequent super-cooling. The insulating effects of a healthy overstory during winter as well as summer are important, because of the potential for summer stream heating and winter freezing (Platts and Nelson 1989a, pg 450)." Without the insulative effects of overstory, subsurface ice is more prone to form. See explanation of subsurface ice in section 2.1.2. Subsurface ice and ice flow is suspected to have an erosive effect that degrades streambank conditions.

3.3.5 Soil condition, type, and moisture

Severity of effect of bank stability is a function of soil type, plant community, and interactions between these two factors (Dunaway et al. 1994, pg 47). Silt has a negative effect on erosion in communities of sedges, rushes, or grasses; but has no effect on mixed sedge communities (Dunaway et al. 1994, pg 47). They also found that as percent clay in the soil increased, so did erosion. With sections of stream that are classified as Rosgen A and B type channels, with large cobble and well armored streambanks, streamside vegetation does not play as an important role in streambank stability. Clarifying the site specific nature of this variable, Buckhouse (1996, pg 36) warned that in areas with poorly-drained soil in seasons when soil moisture is high, the risk of compaction is greater than in areas of well-drained soils.

Soil moisture is a primary variable determining the streambanks susceptibility to erosion (Wolman 1959, pg 204; Hooke 1979, pg 60). The effects of trampling on streambanks have been found to be significantly correlated with soil moisture content (Marlow and Pogacnik 1985, pg 279; Marlow et al. 1987, pg 291). These researchers discovered that the greatest amount of bank damage occurs when soil moisture exceeds 10% and suggested that a primary guideline for grazing riparian areas would be to limit livestock use to periods where soil moisture was <10%. Trimble and Mendel (1995, pg 246) found that "most studies recommend that cattle be excluded from the riparian zone until the banks are allowed to dry. Cooke and Reeves (1976, pg 6-8,188-189) discussed the effect of formation of trails along floodplains. "Although formed by compression and displacement, their form and alignment would conceivably allow them to transport a greater depth and velocity of water during overbank flows so that such trails might be expected to be eroded (Trimble and Mendel 1995, pg 246)."

3.3.6 Management considerations/Grazing strategy

As Kauffman (1995, pg 29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991, pg 403). In addition, "grazing management strategies must also consider the sensitivity of different riparian areas to disturbance, and their resiliency, or ability to recover, once degraded. Sensitive riparian areas experience a high degree of natural stress (or any natural attribute that makes them more sensitive to disturbance, such as non-cohesive granitic soils), and therefore can tolerate little management-induced stress without degradation" (Leonard et al. 1997, pg 9). In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing** – In addition to the variable discussion found in section 3.1.4a, the season of use can have further effect on bank stability. An additional advantage to early use is that in the spring, plants have time to recover growth if grazers are removed while there are still sufficient moisture and appropriate temperatures (Clary and Webster 1990, pg 210; Kovalchik and Elmore 1992, pg 116; Buckhouse and Elmore 1993, pg 48; Elmore and Kauffman 1994, pg 222-223; Buckhouse 1995, pg 36). Therefore plants can recover in time to grow and provide stability for runoff events. However, a disadvantage to spring use for bank stability, is that soil moisture is high and depending on the soil type, the time that livestock spends in the riparian area can have elevated negative consequences. Another disadvantage to spring use is that this is a critical period for plant growth and development, so the possibility of increased impact on plant vigor or plant communties exist (Ehrhart and Hansen 1999, pg 11).

In the summer, dry months livestock tend to utilize riparian vegetation more, but the soil moisture is typically less, so if managed closely and grazing periods are short, then the risk of compaction and bank trampling is decreased (Ehrhart and Hansen 1998, pg 17).

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b) **Distribution of grazing** – See variable discussion in section 3.1.4b.

c) **Intensity of grazing** – In addition to the variable discussion in section 3.1.4c, streambank stability can be further impacted by the intensity of grazing chosen. Clary and Kinney (2002, pg 141 and 144) found that plant root biomass changed depending on the type of grazing strategy. Light and moderate grazing treatments show slightly less root biomass than ungrazed sites and had similar bank retreat as ungrazed sites (averaging 1.4"). Heavy, season-long grazed sites showed a 32% decrease in root biomass than the other grazing treatments and averaged 4.7" of bank retreat. They also observed that the streambanks in their study area were well-vegetated with a variety of plant species, but even in the presence of strong root systems; bank alteration and channel widening were significant with season-long, heavy grazing.

Kauffman et al. (1983a, pg 685) found that grazing intensity of 25-30 MAS/AUM created significantly greater streambank erosion and disturbance than in ungrazed areas. Similar moderate grazing (3.2 ha/AUM) was found in another study area to have minimal streambank disturbance (Buckhouse et al. 1981, pg 340). This information shows that each riparian site has a unique response to disturbance, so this is why tailoring the management plan is so crucial.

d) **Annual pasture use** – Rest or deferred use of pastures at different annual intervals can be an effective tool to minimize the reduction of streambank stability and ensure riparian plant communities remain vigorous. Sovell et al. (2000, pg 634) found higher turbidity levels in streams on continuously grazed sites than on rotationally grazed sites. They concluded that rotational grazing may reduce sediment abundance by effectively decreasing grazing intensity along streams. See further discussion of this variable in section 3.1.4d.

e) **Location of concentrated use areas** – See variable discussion in section 3.1.4e.

f) **Adaptive management based on monitoring** – In addition to the information provided regarding this variable in section 3.1.4f, a further discussion of bank alteration is offered. Bank alteration is discussed here as it is used as a utilization standard. Bank alteration is the procedure for estimating the percent of the linear length of streambank that has been altered by herbivores walking along or crossing the stream during the current grazing season (Burton et al. 2008, pg 18). Bank alteration can occur when large herbivores walk along streambanks or across streams causing shearing that results in a breakdown of the streambank and subsequent widening of the stream channel. It also exposes bare soil, increasing the risk of erosion of the streambank. In this way bank alteration can affect streambank stability, and therefore is a strong indicator of disturbance within the riparian area (Burton et al. 2008, pg 4). Bengeyfield (2006, pg 5-6) observed narrower channel width and deeper depths over a seven-year period when streambank alterations was 20% or less.

Adaptive management can lessen the potential impacts that grazing can have on bull trout and their habitat. For example, adjusting the date that livestock are brought onto pastures based on range readiness will allow soil moistures to lessen and thereby decrease the susceptibility of streambanks to alterations and shearing.

g) **Condition of stream crossings and water access points** – Stabilizing or hardened access and crossing points on the stream can minimize streambank trampling (Ehrhart and Hansen 1998, pg 22). Kellogg (1995 cited in Ehrhart and Hansen 1998) reported evidence that cattle prefer stable footing and clean water, and will travel considerable distances for such access sites. Leonard et al. (1997, pg 43) reported that locating narrow watering gaps in rocky areas (natural or man-made) can minimize trampling of banks and streambeds and discourage loafing in the stream.

3.4 VARIABLES FOR EFFECT PATHWAY 4

The effects of Pathway 4 are completely eliminated if livestock do not have access to the stream during the spawning and incubation periods for bull trout or if they are removed before this period. If livestock are grazing during this timeframe, then the following variables affect the degree of effect that grazing will have on the reproductive efforts of bull trout:

- Accessibility of the streambank
- Vegetation type
- Suitability of habitat for spawning -- gradient, flow, gravel size,...
- Management considerations/Grazing strategy -- timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; adaptive management based on monitoring; and condition of stream crossings/access points

3.4.1 Accessibility of the streambank

See variable discussion in section 3.1.1.

3.4.2 Vegetation type

The type of vegetation present on the streambank is a variable that affects redd trampling via the desirability and accessibility of the plant to grazers. If the streamside vegetation is undesirable, then livestock will feed on it less and therefore the amount of time they spend in the riparian area impacting redds will also lessen. See discussion in section 3.1.2 for further details on this variable.

3.4.3 Suitability of habitat for spawning – gradient, flow, gravel size,...

There are natural conditions that exist that make segments of the stream unsuitable spawning habitat. "Substrate composition, cover, water quality, and water quantity are important habitat elements for salmonids before and during spawning" (Bjornn and Reiser 1991, pg 89). If a section of the stream is known to not support bull trout spawning, then this section is not susceptible to spawning impact from grazers' presence. Also there is general consensus among fisheries biologist that **resident** bull trout spawning does not occur in stream segments with gradients greater than 10%. Bonneau et al. (1995, pg 584-585) actually stated that 8% gradient was the uppermost extent of bull trout migration. Therefore to be on the conservative side, sections of stream with gradients >10% are not susceptible to spawning impact from grazers because spawning is not thought to occur in stream reaches with this degree of slope.

The **migratory** forms of bull trout are much larger than the resident form and have different preferences for spawning habitat. Sanborn et al. (1998, pg 1) reported that migratory bull trout spawn in low gradient areas (<2%) that have gravel/cobble substrate, water depths between 0.1 and 0.6m, and water velocities from 0.1 to 0.6 meters/second. Migratory bull trout are extremely particular regarding spawning habitat and prefer 2% gradient, but will tolerate up to 4% gradient (T. Weaver, personal communication).

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3.4.4 Management considerations/Grazing strategy

As Kauffman (1995, pg 29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991, pg 403). In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing** – In addition to the variable discussion found in section 3.1.4a, the timing of grazing can have further effects on redd trampling. Elimination of redd trampling can be achieve by changing the scheduled grazing period to end before known bull trout spawning in the area begins. Also Roberts and White (1992, pg 450) found that the effects of wading on trout eggs and pre-emergent fry depended on stage of egg or fry development. "Wading killed fewest eggs between fertilization and the start of chorion softening (except for a short period during blastopore closure when mortality increased slightly). Wading killed the most eggs or fry from the time of chorion softening to the start of emergence from the gravel."

b) **Distribution of grazing** – See variable discussion in section 3.1.4b, but basically if efforts are made to insure that livestock is well-distributed across the rangelands and thereby minimizing the time they spend in the riparian; then the risk to trout redds are also minimized.

c) **Intensity of grazing** – The greater the number of livestock and the longer their duration of presence on pastures during bull trout spawning, the greater the likelihood of trampling effect (Gregory and Gamett 2009, pg 384). Roberts and White (1992, pg 450) found that the frequency of wading increases the fatal effects on trout redds. Twice-daily wading killed up to 96% of eggs and pre-emergent fry, whereas daily wading killed up to 43%.

d) **Annual pasture use** – See variable discussion in section 3.1.4d, but more specifically if a pasture is being rested/deferred from grazing during the spawning season of bull trout, then the threat of redd impact is eliminated when rested or limited to the time period that the pasture is in deferred use.

e) **Location of concentrated use areas** – See variable discussion in section 3.1.4e.

f) **Adaptive management based on monitoring** – In addition to the information provided in section 3.1.4f, management practices can have further effects on the degree of redd trampling. Reduction of impacts on redds can be achieved by excluding known spawning areas from livestock access.

g) **Condition of stream crossings and water access points** – See variable discussion in section 3.3.6g, but basically in the presence of hardened, well established crossings; livestock may utilize these points more often and lessen their random access of the stream. Less random access will lessen the probability of redd impact.

3.5 VARIABLES FOR EFFECT PATHWAY 5

Pathway 5	Walking or loafing in stream	Displacement of juveniles from cover increasing predation risk	Decrease juvenile survival

As with Pathway 4 the effects of Pathway 5 are completely eliminated if livestock do not have access to the stream. For the segment of the stream where livestock do have access, then the following variables affect the degree of relocation and subsequent elevated exposure to predation:

- Accessibility of the streambank
- Vegetation type – desirability, height, and amount/diversity
- Suitability of habitat for juveniles
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; adaptive management based on monitoring; and condition of stream crossings/access points

3.5.1 Accessibility of the streambank

See variable discussion in section 3.1.1.

3.5.2 Vegetation type

The type of vegetation present on the streambank is a variable that affects juvenile displacement. The categories below are one way of evaluating the influence that vegetation type has on degree of effect of this pathway.

a) **Desirability** – If the streamside vegetation is undesirable, then livestock will feed on it less and therefore the amount of time they spend in the riparian area impacting juvenile will also lessen. See discussion in section 3.1.2a for further details on the seasonal effects of this variable.

b) **Height** – Overhanging grasses offer more protective cover for bull trout than mature trees, but less than dense streamside shrubs. See discussion in section 3.1.2b for further details of this variable.

c) **Amount and diversity of vegetation** – If streamside vegetative cover is dense; then this affords more protective cover than sparse vegetation. Plus riparian communities comprised of one primary vegetation (monoculture, like mature pines) can be expected to provide overall less cover than riparian areas comprised of more diverse, multi-canopied vegetation.

3.5.3 Suitability of habitat for juveniles

There are natural conditions that exist that make segments of the stream unsuitable habitat for juvenile bull trout. If a section of the stream is known to not support juvenile bull trout, then this section cannot receive harassment impact from grazers' presence. Rearing habitat factors for juvenile bull trout include cold summer water temperatures (15 °C), an abundance and complexity of protective cover, unembedded cobble substrate, steady streamflow, and overall channel stability (Sanborn et al. 1998, pg i-ii).

3.5.4 Management considerations/Grazing strategy

As Kauffman (1995,pg29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991,pg 403). Management efforts that improve riparian and in-channel conditions (high bank stability, more undercut banks, deeper pools, high amounts of large woody debris,...) and minimize use of the stream can decrease the level of harassment that young trout experience. In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing –** The season of use of an area can have a substantial influence on the degree of effect that grazing could have on displacement of juveniles from cover. For details on how season of use can affect the time that livestock spend in the riparian environment, see variable discussion in section 3.1.4a.

b) **Distribution of grazing –** See variable discussion in section 3.1.4b, but basically if efforts are made to insure that livestock is well-distributed across the rangelands and thereby minimizing the time they spend in the riparian; then the risk to juvenile trout are also minimized.

c) **Intensity of grazing –** The greater the number of livestock and the longer their duration of presence on pastures, the greater the likelihood of their effects on juvenile trout. See further variable discussion in section 3.1.4c.

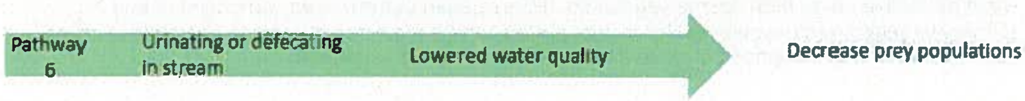
d) **Annual pasture use –** See variable discussion in section 3.1.4d, but more specifically if a pasture is being rested/deferred from grazing, then the threat of harassing juveniles is eliminated when rested or limited to the time period that the pasture is in deferred use.

e) **Location of concentrated use areas –** See variable discussion in section 3.1.4e.

f) **Adaptive management based on monitoring –** See variable discussion in section 3.3.6f.

g) **Condition of stream crossings and water access points –** See variable discussion in section 3.3.6g; but basically in the presence of hardened, well established crossings, livestock may utilize these points more often and lessen their random access of the stream. Less random access will lessen the probability of displacement of juveniles.

3.6 VARIABLES FOR EFFECT PATHWAY 6



By decreasing livestock presence in the stream and properly managing the intensity and distribution of grazing in the riparian, the effects of this pathway can be reduced. The variables affecting the amount of contaminants that are contributed to the stream are:

- Accessibility of the streambank
- Vegetation type – desirability, height, and amount/diversity
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; adaptive management based on monitoring; and condition of stream crossings/access points

3.6.1 Accessibility of the streambank

See variable discussion in section 3.1.1.

3.6.2 Vegetation type

The type of vegetation present on the streambank is a variable that affects the amount of nutrient that get directly deposited into the stream via the desirability and accessibility of the plants to grazers. If the streamside vegetation is undesirable, then livestock will feed on it less and spend less time in the riparian area. See discussion in section 3.1.2 for further details on the seasonal variations within this variable.

3.6.3 Management considerations/Grazing strategy

As Kauffman (1995, pg 29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991, pg 403). Management efforts that minimize use of the stream can decrease the level of nutrients that get deposited into the stream. In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing** – The season of use of an area can have a substantial influence on the degree of effect that grazing could have on nutrient input. See variable discussion in section 3.1.4a.

b) **Distribution of grazing** – See variable discussion in section 3.1.4b, but basically if efforts are made to insure that livestock are well-distributed across the rangelands and time spent in the riparian area is minimized; then the nutrient input into the stream is also minimized.

c) **Intensity of grazing** – The greater the number of livestock and the longer their duration of presence on pastures, the greater the likelihood of effects on nutrient levels in the stream. See further variable discussion in section 3.1.4c.

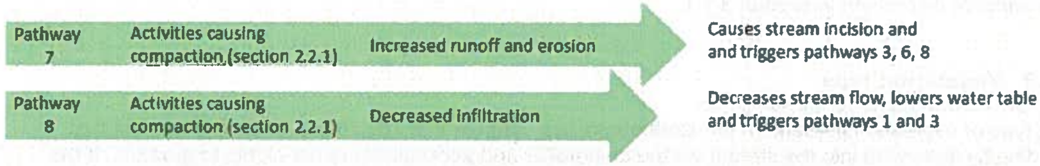
d) **Annual pasture use** – See variable discussion in section 3.1.4d, but more specifically if a pasture is being rested/deferred from grazing, then the threat of nutrient input is eliminated when rested or limited to the time period that the pasture is in deferred use. Also when a pasture is being grazed the grazing strategy chosen can affect nutrient input into the stream. Sovell et al. (2000, pg 636) found higher fecal coliform in streams on continuously grazed sites than on rotationally grazed sites. They concluded that rotational grazing may reduce fecal coliform abundance by effectively decreasing grazing intensity along streams.

e) **Location of concentrated use areas** – See variable discussion in section 3.1.4e.

f) **Adaptive management based on monitoring** – See variable discussion in section 3.1.4f.

g) **Condition of stream crossings and water access points** – See variable discussion in section 3.3.6g.

3.7 VARIABLES FOR EFFECT PATHWAY 7 AND 8



Compaction of the soil is the trigger for both Effect Pathway 7 and 8. Therefore the variables that influence degree of effect are the same for both pathways, and include:

- Slope and aspect
- Vegetation type – desirability, height, and amount/diversity
- Soil condition, type, and moisture content
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; adaptive management based on monitoring; and condition of stream crossings/access points

3.7.1 Slope and aspect

The degree of soil erosion associated with compaction caused by livestock grazing is related to slope gradient and aspects of the site being grazed (Meehan and Platts 1978, pg 275). Southerly slopes show a higher degree of erosion than other slopes due to the overall shallower soil, lower litter and humus levels, and plant types and densities (Renner 1936, pg 29). Gradient is of minor importance to erosion, in and of itself, but when other factors, such as grazing come into play, the amount of erosion increases as the gradient increases (Renner 1936, pg 28).

3.7.2 Vegetation type

In addition to the discussion in section 3.1.2, if the vegetation is desirable, then livestock will feed on it more and this preference can increase the level of compaction of the soil around it. In the summer months compaction can be increased around vegetation that provides shade, especially in areas where livestock congregate.

The degree of soil erosion associated with livestock grazing is related to type and density of the vegetation, and as the vegetation deteriorates the susceptibility of the soil to erosion increases (Heede 1977, pg 15; Meehan and Platts 1978, pg 275). Packer (1953, pg 29-30) and Alderfer and Robinson (1947, pg 946) found that livestock reduced ground cover density and increased bare soil openings, which in turn caused increased runoff and erosion levels. Warren et al. (1986a, pg 491) found that lack of vegetation caused by intense grazing lead to significantly increased sediment production and significantly decreased infiltration. If vegetative cover is healthy and abundant, then it can perform its natural function of protecting soil moisture and trapping sediment. If vegetation is diverse and one type of vegetation is impacted by grazing, then other vegetation types can absorb some of the effects of erosion. In a pasture comprised of one, primary vegetation; if this vegetation is preferred by grazers, then there is no fail-safe to protect the soil as in a more diverse, vegetative community.

3.7.3 Soil condition, type, and moisture content

Meehan and Platts (1978, pg 275) found that the degree of soil erosion associated with livestock grazing is related to the condition of the soil and the accessibility of the soil to livestock. Well-drained soils reduce the possibility of compaction (Clary and Webster 1989, pg 2-3). Wet soil is more susceptible to compaction, because wet particles disintegrate more easily (Proffitt et al. 1993, pg 317, 328). Bare soil is more susceptible to erosion than well-vegetated soil. Clary and Webster (1989, pg 2) found that the greatest grazing effects occurred in Rosgen B type channels (with medium to fine-textured, easily eroded soil materials) and most type C channels (typically associated with meadow complexes that are attractive to livestock). Warren et al. (1986a, pg 491) found that intense grazing lead to significantly decreased infiltration rate and significantly increased sediment production on a site with a silty clay surface soil devoid of vegetation. They also found that the damage caused by grazing was increased if the soil was moist. For further details regarding the soil moisture component of this variable, see discussion in section 3.3.5.

3.7.4 Management considerations/Grazing strategy

As Kauffman (1995, pg 29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991, pg 403). When making management decisions regarding livestock density, distribution, and duration; soil condition and type should also be considered to reduce potential compaction and erosion effects. In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing** – In addition to the variable discussion found in section 3.1.4a, the season of use can have further effect on compaction. One disadvantage to spring use in regards to compaction and subsequent erosion/runoff is that the soil moisture is high. Depending on the soil type, the time that livestock spends on the pasture can have elevated negative consequences. Another disadvantage to spring use is decreased plant vigor and plant communities, because this is a critical period for plant growth and development (Ehrhart and Hansen 1998, pg 11). If plants are lost, bare soil or less desirable species (species with less soil-holding capacity) occurrence can result in increased runoff and erosion. However an advantage of spring grazing is that plants have time to recover growth if grazers are removed while there are still sufficient moisture and appropriate temperatures (Clary and Webster 1990, pg 210; Kovalchik and Elmore 1992, pg 116; Buckhouse and Elmore 1993, pg 49; Elmore and Kauffman 1994, pg 222-223; Buckhouse 1995, pg 36). This time for growth enables vegetation an opportunity to recover in order to perform its natural function of dissipating energy of flowing water and thereby reducing erosive effects (Ehrhart and Hansen 1998, pg 3).

   In the summer the soil moisture is typically less, so if managed closely and grazing periods are short, then the risk of compaction and bank trampling is decreased (Ehrhart and Hansen 1998, pg 17).

b) **Distribution of grazing** – See variable discussion in section 3.1.4b, but basically if efforts are made to insure that livestock is well-distributed; then risk of compaction and the subsequent effects are minimized.

c) **Intensity of grazing** – The greater the number of livestock and the longer their duration of presence on pastures, increases the likelihood of compaction and subsequent effects. Warren et al. (1986a, pg 491) found that the deleterious impact of compaction due to grazing generally increased as stocking rate increased. See further variable discussion in section 3.1.4c.

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d) **Annual pasture use –** See variable discussion in section 3.1.4d, but more specifically if a pasture is being rested/deferred from grazing, then the threat of compaction is eliminated when rested or limited to the time period that the pasture is in deferred use. Furthermore, natural processes, such as soil wetting and drying cycles and grazing recovery periods can restore the physical condition of the soil (Weltz and Wood 1986, pg 368; Heady and Child 1994, pg 68-69; Greenwood and McKenzie 2001, pg 1232; Wheeler et al. 2002, pg 49). However Warren et al. (1986a, pg 491) found that on heavily grazed sites, thirty days of rest were insufficient to allow hydrologic recovery.

e) **Location of concentrated use areas –** See variable discussion in section 3.1.4e.

f) **Adaptive management based on monitoring –** See variable discussion in section 3.3.6f.

g) **Condition of stream crossings and water access points –** See variable discussion in section 3.3.6g.

3.8 VARIABLES FOR EFFECT PATHWAY 9

Variables affecting the expression of effects of this pathway include:

- Vegetation type – desirability, height, and amount/diversity
- Soil condition, type, and moisture content
- Management considerations/Grazing strategy – timing, distribution, and intensity of grazing; annual pasture use; location of concentrated use areas; and adaptive management based on monitoring

3.8.1 Vegetation type

The categories below are one way of evaluating the influence that vegetation type has on degree of effect of this pathway.

a) **Desirability –** If the vegetation is desirable, then livestock will feed on it more increasing the potential effect on plant vigor. See variable discussion in section 3.1.2a.

b) **Height –** Because of the accessibility of the plant; grasses, forbs, shrubs, and young trees are more prone to impact on plant vigor caused by grazing than mature trees. Kauffman et al. (1983b, pg 685) described shrub use as generally light, except on willow-dominated gravel bars, where they concluded that succession was retarded by grazing. Of the 10 plant communities that were sampled, four showed significant differences in species composition and productivity. Green and Kauffman (1995, pg 307) analyzed 10 year of data from the same area that included fall grazing at a rate of 1.3 to 1.8 ha/AUM. They reported extreme variability between a plant communities response to grazing pressure, but found that in heavily grazed communities, conditions favored early successional stage and exotic plants. In exclosures in the same plant communities, they observed that competitive and competitive, stress-tolerant species were favored and exotics decreased. They also reported that the woody species height was significantly reduced in grazed area versus ungrazed counterparts (pg 312) as did Shaw and Clary (1996, pg 148).

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c) **Amount and diversity of vegetation** – Depending on the grazing strategy selected; if vegetation is abundant and diverse, then the possible negative effects on plant vigor and changes to the soil can be negated by the sheer quantity and variety of vegetation. In a pasture comprised of one, primary vegetation; if this vegetation is preferred by grazers, then there is no fail-safe to protect the soil as in a more diverse, vegetative community.

Kauffman et al. (1983b, pg 890) explained that in areas with vegetation levels high enough to produce litter layer accumulation, the increased soil moisture also increased the abundance of hydric plants and decreased the abundance of xyric plants. Shaw and Clary (1996, pg 148) and Green and Kauffman (1995, pg 312) concluded that density and growth of woody species was decreased as well as reproduction was less vigorous on grazed site than ungrazed. Glinski (1977, pg 120-122) and Crouch (1979, pg 1) also observed that grazing on woody vegetation prevented the regeneration and produced even-aged non-reproducing vegetation community. Fleischner (1994, pg 633) also found that regeneration of some woody vegetation (such as willow, cottonwood (*Populus* sp.), and aspen (*Populus sp.*)) is inhibited by grazing on seedlings.

Sovell et al. (2000, pg 637) found that riparian sites dominated by mature trees (characterized by steep slopes, bare banks, little understory vegetation) had fine sediment-dominated streambeds. They suspect that lack of vegetative ground cover, due to almost complete canopy cover, may have reduced filtering of upland sediment and promoted erosion of streambank soils causing increased sediment to be deposited in the stream channel.

3.8.2 Soil condition, type, and moisture content

In addition to the effects that grazing can have on the amount of vegetative cover and compaction of soil (discussed in section 3.7.3), grazing can also change the moisture content of the soil. For further details regarding the soil moisture component of this variable, see discussion in section 3.3.5. Decreased plant and liter cover caused by grazing results in more bare ground and a decrease in nutrients and moisture that enter the soil through infiltration (Krueger et al. 2002, pg 7). Changes in moisture and nutrient content of the soil affect the type and amount of vegetation that can be supported. Therefore shifts in plant communities and plant densities can occur as a result of decreased soil moisture and nutrient content.

3.8.3 Management considerations/Grazing strategy

As Kauffman (1995, pg 29) stated effective management of salmonid habitats begins at the ridgeline (watershed boundary) and not at the streambank. Any grazing strategy, if it is to work, must be tailored to fit the needs of the vegetation, terrain, class or kind of livestock, the particular ranching operation, streambank, stream channels, water quality, and streamside vegetation (Platts 1991, pg 403). Also "understanding the physiological and ecological requirements of key woody species is essential in designing a proper management program (Thomas et al. 1979, pg 13). This includes determining the effects of grazing on the particular growth characteristics of the species involved and the probable outcomes in community change (Leonard et al. 1997, pg 7)." In reviewing the influence that management considerations and grazing strategy have on degree of effect, the following variables were identified.

a) **Timing of grazing** – In addition to the variable discussion found in section 3.1.4a, the season of use can have further effect on plant communities. In the spring plants have time to recover growth if grazers are removed while there are still sufficient moisture and appropriate temperatures (Clary and Webster 1990, pg 210; Kovalchik and Elmore 1992, pg 116; Buckhouse and Elmore 1993, pg 49; Elmore and Kauffman 1994, pg 222-223; Buckhouse 1995, pg 36). This time for grow enables vegetative cover an opportunity to recover and progress in successional stage. Another disadvantage to spring use is decreased plant vigor and plant communities, because this is a critical period for plant growth and development (Ehrhart and Hansen 1998, pg 11). If plants are lost, bare soil or less desirable species (species with less soil-holding capacity) occurrence can result in increased runoff and erosion.

b) **Distribution of grazing** – See variable discussion in section 3.1.4b, but basically if efforts are made to insure that livestock is well-distributed; then the risk of community change can be minimized.

c) **Intensity of grazing** – The greater the number of livestock and the longer their duration of presence on pastures, the greater the likelihood of affecting soil condition or plant vigor and prompting community change. See further variable discussion in section 3.1.4c.

d) **Annual pasture use** – See variable discussion in section 3.1.4d, but more specifically if a pasture is being rested/deferred from grazing, then the threat of reduced plant vigor is eliminated when rested or limited to the time period that the pasture is in deferred use. Kauffman et al. (1983b, pg 690) noted that species recovery was observed after three years of cessation of grazing on rangelands that were heavily grazed.

e) **Location of concentrated use areas** – See discussion in section 3.1.4e that explains how this variable can serve to reduce impacts on the riparian plant community. This variable can actually represent increased effects on plant vigor and soils in the uplands, because it brings concentrated use activities into the uplands.

f) **Adaptive management based on monitoring** – In addition to variable discussion in section 3.1.4f, Clary and Webster (1990, pg 210) concluded that regardless of current seral stage, 4 to 6" of residual stubble or regrowth is recommended to meet the requirements of plant vigor maintenance. As with all these variables the specific of the site must be taken into consideration. For example, growing season may vary between sites, and as reported in the Blue Mountains of Oregon, regrowth of herbaceous vegetation does not normally occur after July (Gillen et al. 1985, pg 208), so any livestock use of riparian vegetation in the summer and fall would need to be closely managed.

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4.0 GLOSSARY

AUM – an abbreviation for Animal Unit Month. An animal Unit Month is the minimum area of land necessary to sustain grazing by one cow for one month.

Ha – an abbreviation for a hectare. A hectare is a unit of area equal to 10,000 square meters (107,639 sq ft), and is commonly used for measuring land area.

MAS – an abbreviation for Meters of Accessible Streambank. Meters of Accessible Streambank is a measurement used to quantify the intensity of grazing use with the numbers of animals per length of streambank (MAS/AUM) rather than density of animals per unit area (ha/AUM).

Alevin – larval fish that have hatched from the eggs, but have not yet emerged from the nesting area. Alevins eat the contents of their yolk sac while their digestive systems are developing. At this stage, the fish are not prepared to hunt live prey, and are completely dependent on the yolk sacs. Alevins stay within the gravel of the redd while continuing to develop.

Bank retreat – when the streambank face at the water's edge erodes away causing widening of the stream channel.

Biomass – the mass (weight) of living biological organisms in a given area at a given time. Biomass can refer to species biomass, which is the mass of one or more species, or to community biomass, which is the mass of all species in the community. It can include microorganisms, plants or animals. The mass can be expressed as the average mass per unit area or as the total mass in the community. It might be measured in grams per square meter or tonnes per square kilometre, or it might be measured as the total mass present in a system such as a lake. How biomass is measured depends on why it is being measured. An example of measurement of fish biomass is the mass in kilogram of fish per hectare. An example of invertebrate biomass is grams per fish, and an example of aboveground vegetation biomass is grams of vegetation per square meters.

Boulder – a rock greater than 10 inches in diameter.

Braided – a condition when the channel of a stream divides into a network of smaller channels separated by small and often temporary islands. Braided channels can result from deposition of sediments. Braided rivers, in contrast to meandering rivers, occur when a threshold level of sediment load or slope is reached. An increase in sediment load will over time increase the slope of the river, so these two conditions can be considered synonymous and consequently a variation of slope.

Cobble – gravel that ranges in size from 2.5 to 10 inches in diameter.

Coliform (fecal) – bacteria derived from feces, the most common being Escherichia coli (E. coli).

Detritus – non-living organic material that typically includes fragments of dead organisms, fecal material, leaf litter,... Detritus is typically colonized by communities of microorganisms which act to decompose or remineralize the material. In terrestrial systems detritus refers to leaf litter and other organic matter intermixed with soil and is also known as humus. In aquatic systems detritus refers to organic material suspended in water.

Dewatering – removal or draining of the groundwater or surface water from a stream by pumping or redirection.

Embeddedness – The degree to which cobble are surrounded or covered by fine sediment, usually expressed as a percentage.

Forb – an herbaceous flowering plants that is not a grass, sedge, or rush. They are native, nongrass, broadleaf, herbaceous range plants eaten by livestock, and are responsible for a great deal of animal production in arid and semiarid regions. Includes saltbush (*Atriplex* sp.), sage (*Artemisia* sp.), shinoak (*Quercus* sp.), clover (*Trifolium* sp.), milkweed (*Asclepias* sp.), etc.

Fry – the stage when trout have fully absorbed their yolk sac, begin to swim, and start eating. Bull trout fry may remain in the stream bed for up to three weeks before emerging.

Green line – the first perennial vegetation above the stable low water line of a stream or body of water.

Groundwater – water located beneath the surface in spaces in the soil. An unconsolidated water deposit is called an aquifer if the quantity of water is useable. The depth at which soil pore spaces and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, and can form wetlands.

Herbaceous vegetation – plants that have leaves and stems that die down at the end of the growing season to the soil level. They have no persistent woody stem above ground. Herbaceous vegetation can include annual, biennial, or perennial plants.

Hydric herbaceous vegetation – herbaceous vegetation (see above definition) that is relates to or requires an abundance of moisture.

Interstitial spaces – the small openings or spaces between the gravel of the stream bed.

Invertebrates – animals without a backbone some of which include insect, worms, snails,...

Juvenile – general term used to refer to young trout from the 'fry' life stage up until sexual maturity.

Mechanism – the processes involved in or responsible for an action, reaction, or effect. In this case the process triggered by the action of the cattle that creates an effect on bull trout or their habitat.

Migratory form of bull trout – bull trout that leave their natal tributaries to mature elsewhere. The fluvial form of bull trout mature in large rivers. The adfluvial form of bull trout mature in lakes. The anadromous form of bull trout mature in the ocean.

Monoculture – refers to an area where only one primary species of plant occurs. Single species stands of trees that occur naturally show a diversity in tree sizes with dead trees mixed with mature and young trees.

Nonnative vegetation – non-indigenous plants that adversely affect the habitat they invade economically, environmentally, or ecologically. They disrupt by dominating an area from loss of natural processes.

Order (stream) – a system of ranking a stream and its tributaries from the headwaters to its mouth that describes its general characteristics. Stream order is expressed as a ranking from 1 to 7.

Overhanging vegetation – live plants that extend over the stream to create shade and/or protective cover for fish.

Pool – an area in the stream that has deeper water and reduced water velocity.

Prey – an organism taken by a predator as food.

Pre-emergent fry – the stage when trout begin to swim and start eating is called 'fry'. Fry remain in the stream bed for up to three weeks before emerging, this stage is called pre-emergent fry.

Production or productivity – refers to the rate of creation of biomass in an ecosystem. It is usually expressed in units of mass per unit surface per unit time, for instance grams per square meter per day. Productivity of plants is called primary productivity, while that of animals is called secondary productivity.

Reach (stream) – A designated segment of stream often identifying where monitoring is conducted.

Redds – nests that bull trout build in the gravel where they lay their eggs.

Resident form of bull trout – bull trout that are restricted to headwater streams for their entire lives.

Riparian area – the plant community along stream margins which are characterized by plants that require an abundance of water. In this paper when the phrase riparian area is used it is speaking of the plant community along the streams margin that does not include the immediate streamside vegetation.

Rosgen A and B type channels – Rosgen channel typing is a method used to classify stream channels through consideration of water surface slope, entrenchment, width/depth ratio, and sinuosity. Using these characteristics streams can be placed in categories A-G. For example, streams with channel type A have 4-10% slope, are well entrenched, have low width/depth ratios, and are totally confined (laterally). The streamflows at the bankfull stage are typically described as step/pools with attendant plunge or scour pools.

Salmonids – Members of a family of fish that include salmon, trout, char, grayling, and freshwater whitefish.

Seral – stages of progression found in ecological succession where a system moves toward its climax community. An example of seral communities in succession is a recently logged coniferous forest. At first grasses, heaths and herbaceous plants will be abundant. A few years later shrubs will start to appear; and several years later, the area is likely to be crowded with young tree. Each of these stages can be referred to as a seral community.

Sheet erosion – the detachment of soil particles by raindrop impact and their removal downslope by water flowing over land as a sheet instead of in definite channels. The impact of the raindrop breaks apart the soil. After the surface pores are filled with sand, silt, or clay; overland surface flow of water begins due to the lowering of infiltration rates. Once the rate of falling rain is faster than infiltration, runoff takes place.

Stocking rates – the quantity of livestock grazed on a given area of land. Stocking rates are expressed in terms of number of stock per hectare or acre.

Streambank stability – the capacity of a stream channel to transport water and sediment that is inputted into the stream without changing its dimensions (width, depth, slope,...). Bank stability is measured by the percentage of any stream reach that has >90% stability.

Substrate – the material (sand, cobble, boulders,...) which makes up streambed.

Succession – the series of changes in an ecological community that occur over time after a disturbance.

Trailing (active) – the movement of livestock on rangelands through the use of horse and rider.

Trailing (passive) – the movement of livestock on rangelands on their own accord.

Undercut bank – a part of the stream bank that has been carved away by the water so that a protusion of the upper portion of the bank overhangs the water's surface.

Upland vegetation – in mountainous terrain the upland vegetation is the vegetation that occurs on the higher land outside of the riparian area.

Utilization – the amount of vegetation removed by grazing animals.

Uplands – in mountainous terrain the uplands refer to the area of higher land outside the riparian zone.

Vigor (plant vigor) – the ability of a plant to survive, grow, and reproduce.

Water column – a conceptual column of water from the stream surface to stream bed.

Water table – see explanation under 'groundwater'.

Width to depth ratio – a measurement of channel condition where the width of the stream is compared to the depth of the stream. For bull trout a width to depth ratio of <10 is considered functioning appropriately (Lee et al. 1999).

Woody debris (large woody debris) – debris contributed from trees of a certain size that occur within the riparian area. Woody debris adds structure and habitat to the stream channel for the short and long-term benefit for fish and fish habitat.

Woody vegetation – a plant that has its structure made up of wood. Woody vegetation is typically perennial and has the main stem, larger branches, and roots covered by a layer of thickened bark. Woody plants are trees, shrubs, or lianas. Lianas include various long-stemmed, woody vines that are rooted in the soil at ground level and use trees as well as other means of vertical support to climb up to the canopy.

Xeric plants – plants that require little water to survive and grow and that typically occupy areas of low moisture.

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