United States Department of the Interior

FISH AND WILDLIFE SERVICE

Eastern Idaho Field Office
4425 Burley Dr., Suite A
Chubbuck, Idaho 83202
Telephone (208) 237-6975
http://IdahoES.fws.gov

Jay Winfield, District Ranger
Salmon-Cobalt Ranger District
Salmon-Challis National Forest
311 McPherson Street
Salmon, Idaho 83467

AUG 0 4 2016

Subject: Biological Opinion for Effects to Bull Trout from Livestock Grazing on the Indian Ridge Allotment, Salmon-Challis National Forest, Lemhi County, Idaho, and Concurrence for Effects to Bull Trout Designated Critical Habitat (01EIFW00-2016-F-0652)

Dear Mr. Winfield:

This letter transmits the U.S. Fish and Wildlife Service's (Service) biological opinion (Opinion) on effects of the Salmon-Challis National Forest's (Forest) proposed authorization of livestock grazing on the Indian Ridge Cattle and Horse Allotment in Lemhi County, Idaho, to bull trout (*Salvelinus confluentus*), a species listed as threatened under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq. [Act]).

In a letter dated April 13, 2016, and received by the Service on April 20, 2016, the Forest requested consultation under section 7 of the Act. Your letter included a biological assessment (Assessment) describing effects of the subject action on bull trout and its designated critical habitat. Through the Assessment, the Forest determined that proposed livestock grazing was likely to adversely affect bull trout. In the attached Opinion, the Service finds that effects of the proposed livestock grazing are not likely to jeopardize the coterminous United States population of bull trout. If conditions change such that the analysis in the enclosed Opinion is no longer accurate, reinitiation of formal consultation may be necessary.

The Forest also determined that the proposed livestock grazing may affect, but is not likely to adversely affect, bull trout designated critical habitat. The Service concurs with your determination for bull trout designated critical habitat and presents our rationale below.

Proposed Action

The proposed action is the grazing of up to 140 cow/calf pairs on the Hull Creek, Hughes Creek, and Indian Ridge Units of the 50,313 acres of National Forest System lands in the Indian Ridge Cattle and Horse Allotment (Allotment) between approximately May 23 and October 30. The units will be grazed in a rotational grazing system which requires that livestock not be in any one

unit for the entire grazing season, but be moved amongst the units. Active trailing of livestock within the Allotment will occur along Forest roads (Assessment, pp. 10-11).

Proposed conservation measures designed to reduce the degree of impact to bull trout and its designated critical habitat will be implemented as part of the Allotment's annual operation instructions (Assessment, p. 12). The conservation measures include the use of riders once every 2 weeks to move livestock away from streams, salting, and fencing to further limit livestock use of bull trout designated critical habitat. Additionally, adhering to annual use indicators for greenline stubble height, bank alteration, woody browse use, and upland plant utilization is expected to improve habitat conditions for bull trout. Using status of the indicators (triggers) to determine when livestock need to be moved from the unit will reduce the level of grazing intensity and the duration of livestock use in the unit. The majority of livestock trailing will be active/supervised and utilize existing roads, thereby limiting the duration and areal extent of potential impacts.

The condition of riparian and aquatic habitat within most of the action area, as assessed through habitat indicators, are within the range of condition considered to be appropriate to fully support bull trout conservation needs (Assessment, pp. 27-41). The Forest indicates any impacts from past livestock grazing strategies within the action area are not continuing to occur, and natural features, including steep terrain and dense woody riparian vegetation, limit livestock access to streams throughout much of the Allotment (Assessment, pp. 30-41).

Proposed monitoring will be effective in identifying future trends of habitat conditions within the action area. This monitoring will be effective in identifying both the occurrence and causal mechanisms of any changed conditions which would initiate responsive modification of grazing management strategies for the Allotment under the adaptive management strategy (outlined in the Assessment, pp. 16-17).

Designated Critical Habitat Presence in the Action Area

The Allotment encompasses approximately 41.26 kilometers (25.64 miles) of bull trout designated critical habitat in Indian Creek, Corral Creek, Hull Creek, Hughes Creek, Ditch Creek, and North Fork Salmon River (Assessment, p. 24). Critical habitat is designated in those areas the Service determines to have habitat components necessary for the conservation of the bull trout. The streams in the action area provide for bull trout migration and movement within the watersheds, and as areas for foraging, overwintering, spawning, and rearing.

Potential Impacts and Effects from the Proposed Action

Livestock have the potential to impact fish habitat by impacting stream temperature through reduction in plant shading, reducing complex bank structure by shearing overhanging banks, and increasing sediment in the stream gravel through bank degradation. Impacts can be reduced to a point where their effect to bull trout designated critical habitat are insignificant using move triggers, management of cattle with fences, active removal of cattle from riparian areas, and other measures to disperse livestock away from streamside areas. The Forest has included an array of measures that reduce the impacts of the proposed livestock grazing and trailing to an insignificant level (Assessment, pp. 12-17). Additionally, steep terrain and dense woody riparian vegetation limit livestock access to the streams in much of the Allotment.

Concurrence

Based on the Service's review of the Assessment, we concur with the Forest's determination that the action outlined in the Assessment and this letter, may affect, but is not likely to adversely affect bull trout designated critical habitat. This concurrence is based on the existing condition of bull trout habitat within most of the action area, use of a rotational grazing system to limit intensity, duration, and frequency of potential livestock-caused impacts, and proposed conservation measures that reduce the impacts of grazing to bull trout habitat to an insignificant level by limiting livestock use of streamside areas. The physical and biological features of bull trout designated critical habitat are likely to be maintained in the condition they were at the time of designation of critical habitat, or improve, under the proposed action. This concludes informal consultation on the effects of the proposed action on bull trout designated critical habitat. Further consultation pursuant to section 7(a)(2) of the Act is not required.

Reinitiation of consultation on this action may be necessary if: (1) new information reveals effects of the action that may affect bull trout designated critical habitat in a manner or to an extent not considered in the Assessment, (2) the action is subsequently modified in a manner that causes an effect to designated critical habitat for bull trout that was not considered in the analysis, or (3) a new species is listed or critical habitat is designated that may be affected by the proposed action. If you have any questions regarding this consultation, please contact Evan Ohr of our Eastern Idaho Field Office at (208) 237-6975 ext. 115 or contact our office at the letterhead address above.

Sincerely,

for Dennis Mackey
Acting State Supervisor

Enclosure

cc: SCNF, Salmon (Garcia)
NMFS, Salmon (Murphy)

BIOLOGICAL OPINION
FOR THE
INDIAN RIDGE CATTLE AND HORSE ALLOTMENT
LEMHI COUNTY, IDAHO

01EIFW00-2016-F-0652

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

Supervisor Sandy F

Date 8/4/16

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INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) biological opinion (Opinion) on the effects to the threatened bull trout (*Salvelinus confluentus*) from the Salmon-Challis National Forest's (Forest) proposed livestock grazing authorization for the Indian Ridge Allotment (Allotment) in Idaho. This Opinion was prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 USC 1531 et seq.; [Act]). The Forest's April 13, 2016, request for consultation was received on April 20, 2016.

This Opinion is primarily based on the Forest's *Aquatic Species Biological Assessment for the Indian Ridge Cattle and Horse Allotment* (USFS 2016, entire), dated April 12, 2016, and other sources of information cited herein. The biological assessment (Assessment) is incorporated by reference in this Opinion.

Consultation History

In 2010, the Forest completed a biological assessment for this grazing allotment, and in June of that year the Service issued a biological opinion regarding the proposed grazing activities that concluded the proposed action was not likely to jeopardize the bull trout and was not likely to adversely affect proposed bull trout critical habitat. The current Assessment incorporates updated information on the Federal action and resource conditions within the Allotment. This Opinion supersedes the June 2010 biological opinion.

In the April 12, 2016, Assessment, the Forest determined the proposed action may affect and is likely to adversely affect bull trout, and may affect, but is not likely to adversely affect bull trout designated critical habitat. The Service has reviewed the basis for the not likely to adversely affect determination for designated critical habitat and concurs with this finding for reasons discussed in the transmittal letter for this Opinion. Therefore, designated critical habitat for bull trout will not be discussed further.

A chronology of this consultation is presented below. A complete decision record for this consultation is on file at the Service's Eastern Idaho Field Office in Chubbuck, Idaho.

January 2013	The Forest notifies the Service at a Level 1 meeting of their intent to reinitiate consultation due to permit expiration and a change of the baseline condition.
June 2013 through December 2015	The Service receives and comments on several versions of the draft biological assessment. The draft assessment is discussed at Level 1 meetings in June 2013, December 2013, March 2015, and December 2015.

April 2016 The Service receives the final biological assessment for consultation from the Forest.

PURPOSE AND ORGANIZATION OF THIS BIOLOGICAL OPINION

In accordance with the requirements of section 7(a)(2) of the Act and its implementing regulations, the formal consultation process culminates in the Service's issuance of an Opinion that sets forth the basis for a determination as to whether the proposed Federal action is likely to jeopardize the continued existence of listed species or to destroy or adversely modify critical habitat, as appropriate. The regulatory definition of jeopardy and a description of the formal consultation process are provided at 50 CFR[1] 402.02 and 402.14, respectively. If the Service finds that the action is not likely to jeopardize a listed species, but anticipates that it is likely to cause incidental take of the species, then the Service must identify that take and exempt it from the prohibitions against such take under section 9 of the Act through an Incidental Take Statement.

Analytical Framework for the Jeopardy Analysis

In accordance with policy and regulation, the jeopardy analysis for bull trout in this Opinion relies on four components:

1. *Status of the Species*, which evaluates the rangewide condition of the bull trout, the factors responsible for that condition, and its survival and recovery needs;

2. *Environmental Baseline*, which supplements the findings of the *Status of the Species* analysis by specifically evaluating the condition of bull trout in the action area, the factors responsible for that condition, and the role of the action area in the survival and recovery of the bull trout;

3. *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 bull trout; and

4. *Cumulative Effects*, which evaluates the effects of future, non-Federal activities reasonably certain to occur in the action area on 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 bull trout 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 bull trout in the wild, at the rangewide scale.

Interim recovery units were defined in the final listing rule for bull trout for use in completing jeopardy analyses (USFWS 1999, p. 58910). Subsequently, the Recovery Plan for the

[1] CFR represents the Code of Federal Regulations which is a codification of the general and permanent rules published in the Federal Register by Executive departments and agencies of the Federal Government. It is published by the Office of the Federal Register National Archives and Records Administration. More information can be found at http://www.gpoaccess.gov/cfr/index.html

Coterminous United States Population of Bull Trout (*Salvelinus confluentus*), released by the Service in September 2015, formally established six bull trout recovery units, each of which is individually necessary to conserve the entire listed entity (USFWS 2015, p. 33). Pursuant to Service policy, when an action 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, the biological opinion describes 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 following analysis uses this approach and considers the role of the action area and core area (discussed below under the *Status of the Species* section) in the function of the recovery unit as context for evaluating the effects of the proposed Federal action, together with any cumulative effects, on the survival and recovery of the bull trout to make the jeopardy determination. Please note that consideration of the recovery units for purposes of the jeopardy analysis is done within the context of making the jeopardy determination at the scale of the entire listed species in accordance with Service policy (USFWS 2006).

I. DESCRIPTION OF THE PROPOSED ACTION

A. Action Area

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." An action includes activities or programs "directly or indirectly causing modifications to the land, water, or air" (50 CFR 402.02). In this case, the area where land, water, or air is likely to be affected includes those National Forest System lands within the Indian Ridge Allotment located in Lemhi County, Idaho (Figures 1 and 2). Some small parcels of private land are located within the Allotment boundary, but the effects of the action are not expected to extend onto those parcels. Because the proposed action is designed to avoid or minimize potential impacts of livestock grazing to bull trout and its habitat, potential water column effects due to livestock activity on the Allotment, such as changes in sediment level and in water temperature, likely are localized and insignificant (i.e., the effects are not able to be meaningfully measured, detected, or evaluated), and contained wholly within the boundary of the Allotment.

Trailing of livestock onto the Allotment is by open public road. Therefore, the potential trailing routes onto the Allotment are not included in the action area. No Federal authorization is required to access the Allotment.

Figure 1. Indian Ridge Allotment Vicinity Map

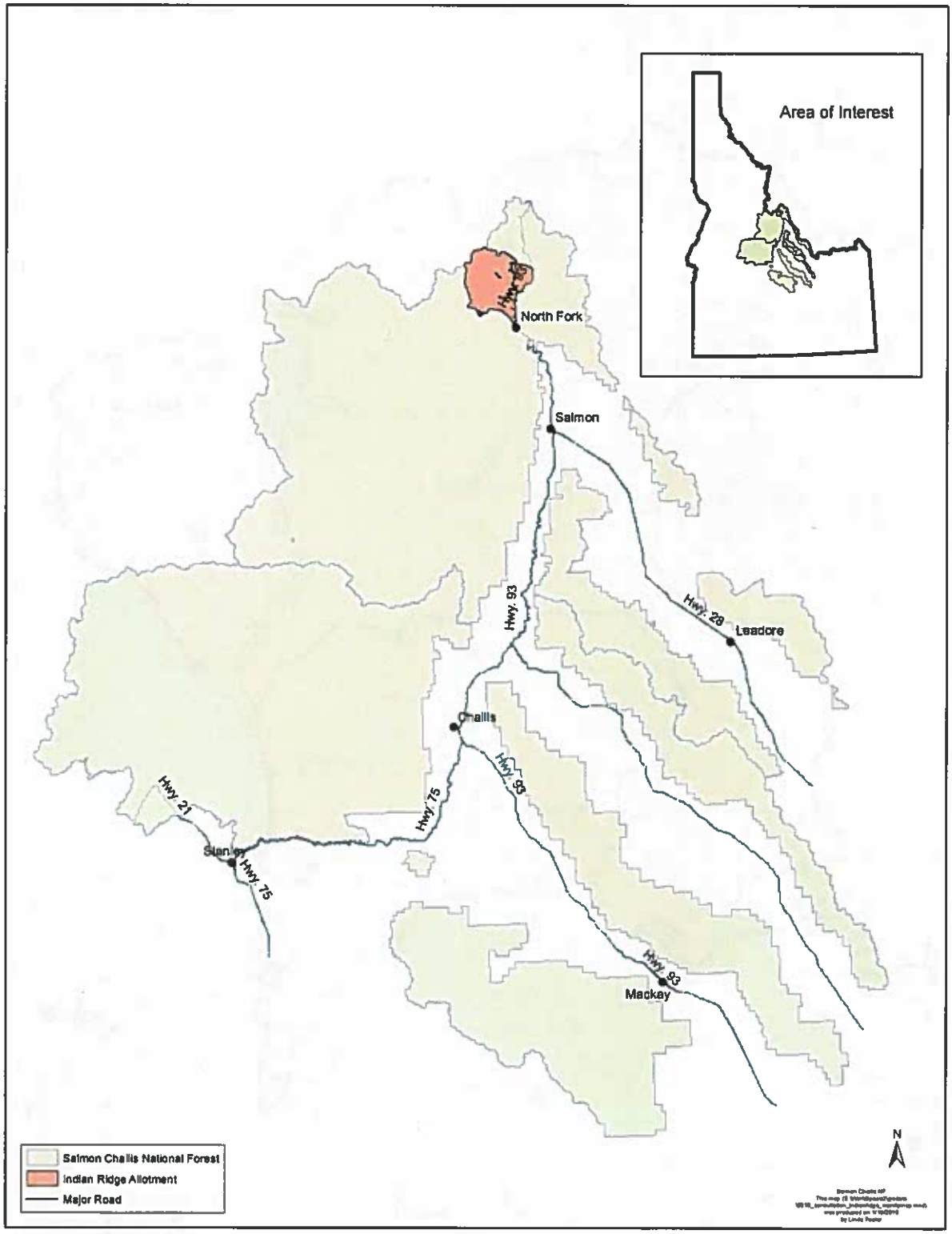
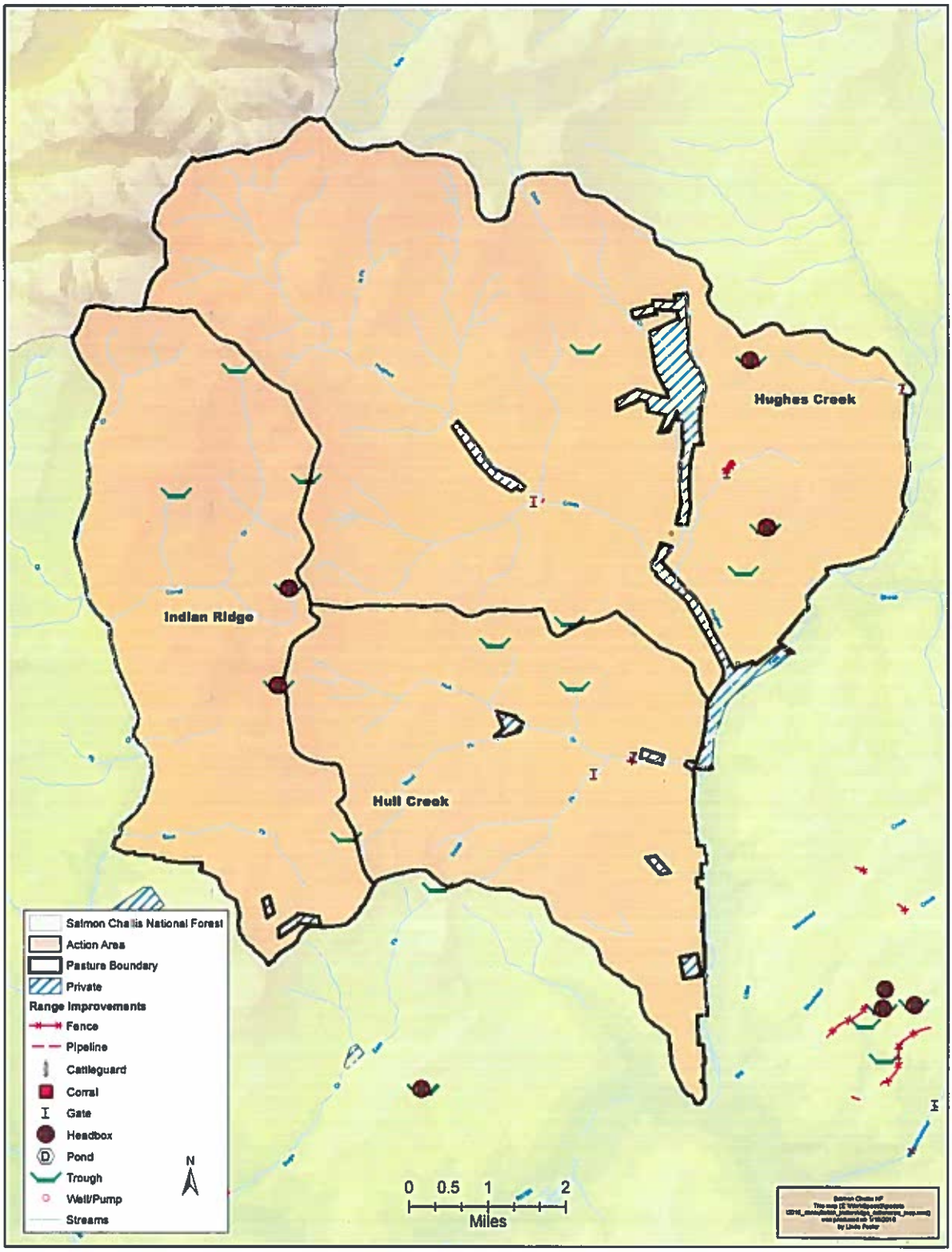


Figure 2. Indian Ridge Allotment Action Area



B. Proposed Action

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" (50 CFR 402.02).

The Forest's proposed action is ongoing authorization of term grazing permit 80115 which allows one permittee to graze 140 cow/calf pairs from May 23 to October 30. The number of livestock can vary, but use of the Allotment is limited to 539 Head Months. The grazing permit may be reissued following expiration or waiver provided: 1) grazing activities on the Allotment are consistent with the grazing management described in the Assessment and this Opinion; 2) reissuance of permits would be identical to or more conservative than the grazing management described in this document as to not trigger the need to reinitiate consultation at that time; and 3) other triggers requiring reinitiation of consultation are not met. This consultation covers the issuance of grazing permits following expiration or waiver as long as conditions 1 and 2 above are met (Assessment, p. 10).

The Forest proposes to authorize grazing of the Allotment in a manner consistent with information contained in the Assessment (pp. 10-17). The 50,313 acre Allotment consists of three units: Hull Creek, Hughes Creek, and Indian Ridge. These units will be grazed in a rest rotation system. The Hull Creek and Hughes Creek Units are rested on a rotating basis every other year, while the Indian Ridge Unit is grazed every year (Assessment, p. 10). The grazing rotation is displayed in Table 1 below.

Table 1. Unit Rotations

Year 1 (odd years)	Year 2 (even years)
Hull Creek Unit	Hughes Creek Unit
Indian Ridge Unit	Indian Ridge Unit
Hughes Creek Unit (Rest)	Hull Creek Unit (Rest)

In general, units will be entered when the range is ready (correct forage conditions). The May 23 on date (the first date livestock can enter the Allotment) can be delayed if forage grasses have not reached the desired growth stage. Forest staff will monitor to determine the on date in years with less favorable growing conditions. Movements from one unit to the next will be triggered by the prescribed unit off date (the date livestock must leave the unit) or status of designated annual use indicators (Assessment, p. 10). Livestock will be moved to the next unit or off the Allotment if any of the annual use indicators or other permit terms and conditions are met.

The Forest has designated annual use indicators to increase the likelihood that livestock grazing does not prevent attainment of riparian resource objectives. Annual use indicators the Forest will use include stubble height, bank alteration, and woody browse use (Table 2; Assessment, pp. 14-15).

Table 2. Annual Use Indicators

Key Area Locations	Unit – Creek	Monitoring Attribute	Annual Use Indicator	Key Species	Trigger
MIM M244	Hughes Creek – West Fork Hughes	Browse use	30%	Alder	25%
		Greenline stubble	4 in.	Hydric spp.	5 in.
		Bank alteration	20%	N/A	25%
MIM M308	Hull Creek – Hull	Browse Use	20%	Alder	15%
		Greenline stubble	6 in.	Hydric spp.	7 in.
		Bank alteration	20%	N/A	25%
Upland Sites	All Units	Utilization	50%	Upland grass species	45%
Riparian Areas	All Units	Utilization by Key Species	50%	Riparian grass species	45%

Where riparian resource objectives are being met, the annual use indicators are 50 percent browse use of multi-stemmed species, 30 percent browse use of single-stemmed species, and a 4 inch greenline stubble height. Where riparian resource objectives are not being met, the annual use indicators are 30 percent browse use of multi-stemmed species, 20 percent browse use of single-stemmed species, and a 6 inch greenline stubble height. Where bank stability is 90 percent or greater, the bank alteration annual use indicator is 20 percent. Where bank stability is between 70 percent and 89 percent, the bank alteration annual use indicator is 10 percent to 20 percent. Annual use indicators will be monitored by Forest personnel as close to the unit off date as possible. Forest personnel will work with the permittee prior to the first unit move to help him or her recognize the triggers. Triggers will be used by the permittee as a tool to help ensure annual use indicators are met (Assessment, p. 15). Triggers represent a level of livestock utilization or bank alteration that is reached prior to reaching the required annual use indicators. When triggers are reached, the permittee will begin moving livestock from the unit.

Livestock will enter the Allotment from private land on or after May 23 either by supervised trailing on open public roads or by trucking directly into the Allotment. All livestock will be removed from the Allotment by October 30. Due to the timbered nature of the Allotment, staggered removal is necessary. Therefore, every year exit off the Allotment will begin in the middle of September and 95 percent of the livestock will be removed by mid to late October. The remaining 5 percent (7 head) will be removed as they are found throughout the timbered areas (Assessment, p. 11). Although most livestock will be actively trailed from the Indian Ridge Unit via FS RD 60088 and FS RD 60091 to the permittee's private land in lower Hughes Creek, a small number of livestock are expected to return along the same route to private land through unsupervised trailing (drift).

Grazing management is fully described in the Assessment (pp. 10-12).

C. Term of Action

The existing grazing permit for the Allotment was issued on June 18, 2013, and expires December 31, 2022. The Forest intends to continue to authorize grazing on the Allotment, as described and analyzed in the Assessment and this Opinion, through the life of the existing permit and potentially reissuance of the permit. In the Assessment, the Forest considered the effects of the proposed action through the 2025 grazing season (Assessment, p. 10). On that basis, the Service considers this consultation to extend to December 31, 2025, provided there are no changes to the proposed action that trigger reinitiation of this consultation.

D. Proposed Conservation Measures

The Forest has identified specific management actions to reduce the degree of impact from livestock grazing on bull trout and its habitat. The Service considers these measures essential to limit impacts to bull trout and its habitat and to achieve resource objectives for bull trout on the Allotment. If any of these measures are not implemented, there may be effects of the action that were not considered in this Opinion, and reinitiation of consultation may be required. The Forest proposes to implement the measures listed below (and in the Assessment, p. 12) as part of the Allotment's annual operating instructions (AOI).

1. A rest rotation system will be used on the Hughes Creek and Hull Creek Units. Resting a unit each year provides benefits to riparian vegetation. This will help meet the long term riparian resource objective for greenline successional status.
2. The Allotment on date may be varied so that livestock will be turned on the Allotment at range readiness. This will reduce the potential for bank alteration by having livestock dispersed throughout the uplands and away from the riparian areas. This will help meet long term riparian resource objectives for bank stability because upland vegetation will provide sufficient forage to help distribute livestock grazing away from riparian areas.
3. Annual use indicators identified in terms and conditions of the term grazing permit will dictate when livestock are moved between units or off the Allotment. This will help the Forest meet the established long term riparian resource objectives. The permittee is responsible for moving livestock to meet annual use indicators. Annual use indicators will be monitored by Forest Service personnel.
4. Permittees will salt at least 0.25 mile away from creeks. This will continue to reduce potential impacts on spawning areas and designated critical habitat.
5. Permittees will distribute livestock away from streams and associated riparian areas (ride) at least once every 2 weeks, reducing potential impacts on spawning areas and designated critical habitat.
6. Fences and water developments have been located to reduce livestock use on streams and their associated riparian areas (Figure 2). This will continue to reduce impacts on spawning areas and designated critical habitat.

The Service finds the above conservation measures adequate to limit the duration and extent of potential livestock impacts because of the limited access of livestock to riparian areas due to the steep topography and the dense woody riparian vegetation, the documented livestock use patterns, and the existing highly stable streambanks.

II. STATUS OF THE BULL TROUT

This section presents information about the regulatory, biological, and ecological status of bull trout at a rangewide scale that provides context for evaluating the significance of probable effects caused by the proposed action.

A. Regulatory Status

1. Listing Status

The coterminous United States population of bull trout was listed as threatened under the Act on November 1, 1999 (USFWS 1999, p. 58910). The threatened bull trout occurs in the Klamath River Basin of south-central Oregon and in the Jarbidge River in Nevada, north to various coastal rivers of Washington to the Puget Sound and east throughout major rivers within the Columbia River Basin to the St. Mary-Belly River, east of the Continental Divide in northwestern Montana (USFWS 1999, pp. 58910-58916).

The bull trout was initially listed as three separate Distinct Population Segments (DPSs) (USFWS 1999, p. 58910). The preamble to the final listing rule 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 (USFWS 1999, p. 58910):

> "*Although this rule consolidates the five bull trout DPSs into one listed taxon, based on conformance with the DPS policy for purposes of consultation under section 7 of the Act, we intend to retain recognition of each DPS in light of available scientific information relating to their uniqueness and significance. Under this approach, these DPSs will be treated as 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.*"

Please note that consideration of the interim recovery units for purposes of the jeopardy analysis is done within the context of making the jeopardy determination at the scale of the entire listed species in accordance with Service policy (USFWS 2006). See the analytical framework for the jeopardy determination discussed above that explains the use of recovery units in the jeopardy analysis.

2. Threats

Throughout its range, the bull trout is threatened by the combined effects of habitat degradation, fragmentation, and alterations associated with dewatering, road construction and maintenance, mining, and grazing; the blockage of migratory corridors by dams or other diversion structures; poor water quality; incidental angler harvest; entrainment (a process by which aquatic organisms are pulled through a diversion or other device) into diversion channels; and introduced nonnative species (USFWS 1999, p. 58912).

3. Climate Change

Climate change represents a relatively new threat to bull trout. The current change in world climate is trending toward warmer temperatures (Intergovernmental Panel on Climate Change 2007). Because bull trout are dependent on cold water temperatures, changes toward higher average temperatures could effectively reduce its available habitat (Rieman et al. 2007, p. 4). Rieman et al. (2007, p. 14) found that a change of 0.6° to 5° Celsius (C) could reduce the percent of large habitat patches by 27 to 97 percent across the bull trout's range.

In central Idaho, habitat may be affected less by climate change than other areas of the bull trout's range because of the wide range in elevation of current habitat distribution. Given the broad range of the estimate above for reduction of large habitat patches, it is difficult to reasonably interpret what impact the actual changes to bull trout habitat are likely to have on the survival and recovery of the bull trout throughout its range. Rieman et al. (2007, p. 17) caution that their results cannot be extrapolated directly for management of bull trout without consideration of many other factors. Until better models are developed on which to base an understanding of climate change-related effects on the bull trout, Rieman et al. (2007, p. 17) suggest continuation of bull trout conservation efforts to maximize its resiliency.

B. Survival and Recovery Needs

1. Recovery Planning

Between 2002 and 2004, three separate draft recovery plans were completed. The 2002 draft recovery plan addressed bull trout populations within the Columbia, Saint Mary-Belly, and Klamath River basins (USFWS 2002a, 2002b, 2002c), and included individual chapters for 24 separate recovery units (later referred to as management units). In 2004, draft recovery plans were developed for the Coastal-Puget Sound drainages in western Washington (USFWS 2004a) and for the Jarbidge River in Nevada (USFWS 2004b). Those draft plans were not finalized, but have served to identify recovery actions across the range of the species and to provide a framework for implementing numerous recovery actions by our partner agencies, local working groups, and others with an interest in bull trout conservation (USFWS 2015, p. 2).

The Service released the final bull trout recovery plan in September 2015 (USFWS 2015, entire). The final plan incorporated and built upon new information collected on status of bull trout, factors affecting the species, and ongoing conservation efforts across the range of the species since the draft 2002 and 2004 recovery planning efforts. The 2002 and 2004 draft recovery plans

provide life history information, habitat characteristics, reasons for decline, and distribution and abundance of bull trout subpopulations covered by those draft plans. The 2015 final recovery plan, utilizing new information and reanalysis, identified six biologically-based recovery units (USFWS 2015, p. 33). Recovery actions for each of the six recovery units include:

- Protect, restore, and maintain suitable habitat conditions for bull trout;
- Minimize demographic threats to bull trout by restoring connectivity or populations where appropriate to promote diverse life history strategies and conserve genetic diversity;
- Prevent and reduce negative effects of nonnative fishes and other nonnative taxa on bull trout;
- Work with partners to conduct research and monitoring to implement and evaluate bull trout recovery activities, consistent with an adaptive management approach using feedback from implemented, site-specific recovery tasks, and considering the effects of climate change (USFWS 2015, pp. 50-53).

A Recovery Unit Implementation Plan (RUIP) was developed for each unit, and the Service's Bull Trout Recovery Implementation Team is currently developing guidance on implementation of the RUIPs. While the 2015 final recovery plan supersedes and replaces the previous draft recovery plans, the 2002 and 2004 draft recovery plans still provide important information on bull trout status and life history.

Each of the six recovery units consists of one or more core areas. Approximately 109 occupied core areas are recognized across the coterminous United States range of the bull trout. In addition, six historically occupied core areas, and two "research needs areas" are identified (USFWS 2105, p. 34). The occupied core areas can be described as simple or complex, and are composed of one or more local populations. See definitions below.

Core Area: a geographic area within a recovery unit occupied by one or more local bull trout populations. Core areas are functionally similar to a metapopulation, in that bull trout within a core area are much more likely to overlap in their use of rearing, foraging, migratory, and overwintering habitat, and in some cases in their use of spawning habitat, than are bull trout from separate core areas.

- Simple Core Area: a geographic area occupied by one bull trout local population. Simple core areas are small in scope, isolated from other core areas by natural barriers, and may contain unique genes or life history adaptations.
- Complex Core Area: a geographic area containing multiple bull trout local populations. Complex core areas are found in large watersheds, have multiple life history forms, and have migratory connectivity between spawning and rearing habitat and foraging, migrating, and overwintering habitat.

Local Population: a group of bull trout within a core area that spawn within a particular stream or portion of a stream system. A local population is considered to be the smallest group of fish that is known to represent an interacting reproductive unit.

C. Rangewide Status and Distribution

The six biologically-based recovery units of the coterminous United States population of bull trout, each of which is individually necessary to conserve the entire listed entity (USFWS 2015, p. 33), are: (1) Coastal Recovery Unit, (2) Klamath Recovery Unit, (3) Mid-Columbia Recovery Unit, (4) Upper Snake Recovery Unit, (5) Columbia Headwaters Recovery Unit, and (6) Saint Mary Recovery Unit. A summary of the current status of the bull trout within these units is provided below.

1. Coastal Recovery Unit

The Coastal Recovery Unit is divided into three geographic regions in western Oregon and Washington: the Puget Sound, Olympic Peninsula, and the Lower Columbia River. Bull trout in the Coastal Recovery Unit exhibit anadromous, adfluvial, fluvial and resident life history patterns. The anadromous life history form is unique to Puget Sound and Olympic Peninsula regions. This recovery unit contains 21 occupied core areas and 85 local populations, including the Clackamas River core area where bull trout had been extirpated and were reintroduced in 2011. Four historically occupied core areas that could be re-established have been identified. This recovery unit also contains ten shared foraging, migrating, and overwintering (FMO) habitats which are outside core areas and allow for the continued natural population dynamics in which the core areas have evolved. Four core areas within the Coastal Recovery Unit have been identified as current population strongholds: Lower Skagit, Upper Skagit, Quinault River, and Lower Deschutes River. These are the most stable and largest bull trout populations in the recovery unit.

The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, loss of functioning estuarine and nearshore marine habitats, development and related impacts (e.g., flood control, floodplain disconnection, bank armoring, channel straightening, loss of instream habitat complexity), agriculture (e.g., diking, water control structures, draining of wetlands, channelization and the removal of riparian vegetation, livestock grazing), fish passage (e.g., dams, culverts, instream flows) residential development, urbanization, forest management practices (e.g., timber harvest and associated road building activities), connectivity impairment, mining, and the introduction of nonnative species. Conservation measures or recovery actions implemented include relicensing of major hydropower facilities that have provided upstream and downstream fish passage or completely removed dams, land acquisition to conserve bull trout habitat, floodplain restoration, culvert removal, riparian revegetation, levee setbacks, road removal, and projects to protect and restore important nearshore marine habitats.

2. Klamath Recovery Unit

The Klamath Recovery Unit, located in southern Oregon, is the most significantly imperiled recovery unit, having experienced considerable extirpation and geographic contraction of local populations and declining demographic condition, and natural re-colonization is constrained by dispersal barriers and presence of nonnative brook trout (USFWS 2015, p. 39). This recovery unit currently contains three core areas and eight local populations. Nine historic local populations of bull trout have been extirpated, and restoring additional local populations will be necessary to achieve recovery (USFWS 2015, p. B7). All three core areas have been isolated from other bull trout populations for the past 10,000 years.

The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, habitat degradation and fragmentation, past and present land use practices, agricultural water diversions, nonnative species, and past fisheries management practices. Conservation measures or recovery actions implemented include removal of nonnative fish (e.g., brook trout, brown trout, and hybrids), acquiring water rights for instream flows, replacing diversion structures, installing fish screens, constructing bypass channels, installing riparian fencing, culvert replacement, and habitat restoration.

3. Mid-Columbia Recovery Unit

The Mid-Columbia Recovery Unit is located in eastern Washington, eastern Oregon, and portions of central Idaho. The Mid-Columbia Recovery Unit is divided into four geographic regions: Lower Mid-Columbia, Upper Mid-Columbia, Lower Snake, and Mid-Snake. This recovery unit contains 24 occupied core areas, two historically occupied core areas, one research needs area, and seven FMO habitats. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, agricultural practices (e.g., irrigation, water withdrawals, livestock grazing), fish passage (e.g., dams, culverts), nonnative species, forest management practices, and mining. Conservation measures or recovery actions implemented include road removal, channel restoration, mine reclamation, improved grazing management, removal of fish barriers, and instream flow requirements.

4. Upper Snake Recovery Unit (includes the action area)

The Upper Snake Recovery Unit is located in central Idaho, northern Nevada, and eastern Oregon. The Upper Snake Recovery Unit is divided into seven geographic regions: Salmon River, Boise River, Payette River, Little Lost River, Malheur River, Jarbidge River, and Weiser River. This recovery unit contains 22 core areas and 206 local populations, with almost 60 percent of local populations being present in the Salmon River Geographic Region. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, dams, mining, forest management practices, nonnative species, and agriculture (e.g., water diversions, grazing). Conservation measures or recovery actions implemented include instream habitat restoration, instream flow requirements, screening of irrigation diversions, and riparian restoration.

5. Columbia Headwaters Recovery Unit

The Columbia Headwaters Recovery Unit is located in western Montana, northern Idaho, and the northeastern corner of Washington. The Columbia Headwaters Recovery Unit is divided into five geographic regions: Upper Clark Fork, Lower Clark Fork, Flathead, Kootenai, and Coeur d'Alene. This recovery unit contains 35 bull trout core areas, of which 15 are complex core areas and 20 are simple core areas. The 20 simple core areas are each represented by a single local population, many of which may have persisted for thousands of years despite small populations and their isolation (USFWS 2015, p. D1). Fish passage improvements within the recovery unit have reconnected previously fragmented habitats. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, mining and contamination by heavy metals, nonnative species, modified instream flows, migratory barriers (e.g., dams), habitat fragmentation, forest practices (e.g., logging, roads), agriculture practices (e.g., irrigation, livestock grazing), and residential development. Conservation measures or recovery actions implemented include habitat improvement, fish passage, and removal of nonnative species. Unlike the other recovery units, the Columbia Headwaters Recovery Unit does not overlap with salmon distribution. Therefore, bull trout within the Columbia Headwaters Recovery Unit do not benefit from the recovery actions for salmon (USFWS 2015, p. D41).

6. Saint Mary Recovery Unit

The Saint Mary Recovery Unit is located in Montana, but is heavily dependent on resources in southern Alberta, Canada. Most of the watershed in this recovery unit is located in Canada. The United States portion includes headwater spawning and rearing habitat and the upper reaches of FMO habitat. This recovery unit contains four core areas and eight local populations. The current condition of the bull trout in this recovery unit is attributed to the adverse effects of climate change, the Saint Mary Diversion operated by the Bureau of Reclamation (e.g., entrainment, fish passage, instream flows), and nonnative species. The primary issue precluding bull trout recovery in this recovery unit relates to impacts of water diversions, specifically at the Bureau of Reclamation's Milk River Project.

D. Life History

Bull trout exhibit both resident and migratory life history strategies. Both resident and migratory forms may be found together, and either form may produce offspring exhibiting either resident or migratory behavior. Resident bull trout complete their entire life cycle in the tributary (or nearby) streams in which they spawn and rear. The resident form tends to be smaller than the migratory form at maturity and also produces fewer eggs. Migratory bull trout spawn in tributary streams where juvenile fish rear 1 to 4 years before migrating to either a lake (adfluvial form), a river (fluvial form), or saltwater (anadromous) to rear as subadults or to live as adults. Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years. Growth varies depending upon life history strategy. Resident adults range from 150 to 300 millimeters (6 to 12 inches) total length, and migratory adults commonly reach 600 millimeters (24 inches) or more. They are iteroparous (they spawn more than once in a lifetime), and both repeat- and alternate-year spawning have been reported, although repeat-spawning frequency and post-spawning mortality are not well documented.

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 salmonids (fishes that spawn once and then die, and therefore require only one-way passage upstream). Therefore, even dams or other barriers with fish passage facilities may be a factor in isolating bull trout populations if they do not provide a downstream passage route.
Additional information about the bull trout's life history can be found in the final listing rule (USFWS 1999).

E. Habitat Characteristics

Bull trout have more specific habitat requirements than most other salmonids. Habitat components that influence bull trout distribution and abundance include water temperature, cover, channel form and stability, valley form, spawning and rearing substrate, and migratory corridors. Watson and Hillman (1997, p. 247-250) concluded that watersheds must have specific physical characteristics to provide the habitat requirements necessary for bull trout to successfully spawn and rear and that these specific characteristics are not necessarily present throughout these watersheds. Because bull trout exhibit a patchy distribution, even in pristine habitats, fish should not be expected to simultaneously occupy all available habitats.

Migratory corridors link seasonal habitats for all bull trout life histories. The ability to migrate is important to the persistence of bull trout. Migrations facilitate gene flow among local populations when individuals from different local populations interbreed, or stray, to nonnatal streams. Local populations that are extirpated by catastrophic events may also become reestablished by bull trout migrants.

Cold water temperatures play an important role in determining bull trout habitat, as these fish are primarily found in colder streams (below 15° C and 59° Fahrenheit (F)), and spawning habitats are generally characterized by temperatures that drop below 9° C (48° F) in the fall. Thermal requirements for bull trout appear to differ at different life stages. Spawning areas are often associated with cold-water springs, groundwater infiltration, and the coldest streams in a given watershed. Optimum incubation temperatures for bull trout eggs range from 2° to 4° C (35° to 39° F; Buchanan and Gregory 1997, p. 122), whereas optimum water temperatures for rearing range from about 7° to 8° C (44° to 46° F; Goetz 1989, p. 39). In Granite Creek, Idaho, Bonneau and Scarnecchia (1996, p. 629-630) observed that juvenile bull trout selected the coldest water available in a plunge pool, 8° to 9° C (46° to 48° F), within a temperature gradient of 8° to 15° C (46° to 60° F). In a landscape study relating bull trout distribution to maximum water temperatures, Dunham et al. (2003, pp. 899-900) found that the probability of juvenile bull trout occurrence does not become high (i.e., greater than 75 percent) until maximum temperatures decline to 11° to 12° C (52° to 54° F).

Although bull trout are found primarily in cold streams, occasionally these fish are found in larger, warmer river systems throughout the Columbia River Basin. Factors that can influence bull trout ability to survive in warmer rivers include availability and proximity of cold water patches and food productivity. In the Little Lost River, Idaho, bull trout have been collected in

water having temperatures up to 20° C (68° F); however, the trend in the relationship between temperature and species composition shows that bull trout made up less than 50 percent of all salmonids when maximum summer water temperature exceeded 15° C (59° F) and less than 10 percent of all salmonids when temperature exceeded 17° C (63° F; Gamett 1999, pp. 28-29).

All life history stages of bull trout are associated with complex forms of cover, including large woody debris, undercut banks, boulders, and pools. Maintaining bull trout habitat requires stability of stream channels and maintenance of natural flow patterns. Juvenile and adult bull trout frequently inhabit side channels, stream margins, and pools with suitable cover. These areas are sensitive to activities that directly or indirectly affect stream channel stability and alter natural flow patterns. For example, altered stream flow in the fall may disrupt bull trout during the spawning period, and channel instability may decrease survival of eggs and alevins in the gravel from winter through spring. Increases in fine sediment can reduce egg survival and emergence.

Bull trout typically spawn from August to November during periods of decreasing water temperatures. Preferred spawning habitat consists of low-gradient stream reaches with loose, clean gravel. Redds are often constructed in stream reaches fed by springs or near other sources of cold groundwater. Depending on water temperature, incubation is normally 100 to 145 days (Pratt 1992, p. 5), and after hatching, alevins remain in the substrate. Time from egg deposition to emergence of fry may surpass 200 days. Fry normally emerge from early April through May, depending on water temperatures and increasing stream flows.

Migratory forms of the bull trout appear to develop when habitat conditions allow movement between spawning and rearing streams and larger rivers or lakes where foraging opportunities may be enhanced (Frissell 1993, pp. 347-351). Benefits to migratory bull trout include greater growth in the more productive waters of larger streams and lakes, greater fecundity resulting in increased reproductive potential, and dispersing the population across space and time so that spawning streams may be recolonized should local populations suffer a catastrophic loss. In the absence of the migratory bull trout life form, isolated populations cannot be replenished when disturbance makes local habitats temporarily unsuitable, the range of the species is diminished, and the potential for enhanced reproductive capabilities are lost (Rieman and McIntyre 1993, p. 11).

Additional information about the bull trout's habitat requirements can be found in the final listing rule (USFWS 1999, pp. 58911-58912).

F. Diet

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, mysids, and small fish. Adult migratory bull trout feed on various fish species. Fish growth depends on the quantity and quality of food that is eaten, and as fish grow, their foraging strategy changes in quantity, size, or other characteristics. Bull trout that are 110 millimeters (4.3 inches) long or longer commonly have fish in their diet (Shepard et al. 1984, p.

38), and bull trout of all sizes have been found to eat fish half their length (Beauchamp and Van Tassell 2001, p. 210).

Migration allows bull trout to move to or with a food source, access optimal foraging areas, and exploit a wider variety of prey resources. Migratory bull trout begin growing rapidly once they move to waters with abundant forage that includes fish (Shepard et al. 1984, p. 49). As these fish mature they become larger-bodied predators and are able to travel greater distances in search of prey species of larger size and in greater abundance. In Lake Billy Chinook, as bull trout became increasingly piscivorous with increasing size, the prey species changed from mainly smaller bull trout and rainbow trout for bull trout less than 450 millimeters (17.7 inches) in length to mainly kokanee for bull trout greater in size (Beauchamp and Van Tassell 2001, p. 213).

Additional information on the bull trout's diet can be found in the final listing rule (USFWS 1999).

G. Previously Consulted-on Effects

1. Rangewide

Consulted-on effects are effects that have been analyzed in section 7 consultations and reported in a biological opinion. In 2003, the Service reviewed all of the biological opinions issued by the Region 1 and Region 6 Service offices, from the time of bull trout listing until August 2003; this summed to 137 biological opinions. The Service completed section 7 consultations on many programs and actions that benefit bull trout. While some of the beneficial programs were small-scale actions such as removing passage barriers and installing 'fish friendly' crossing structures, some were large, such as restoring habitat conditions in degraded streams and riparian areas. Three consultations that had broad and long-term benefits to bull trout were consultations on documents that amended Forest Plans and provided standards and guidelines related to federally listed anadromous and native inland fish on National Forest Service lands in Idaho.

The majority of consultations on projects that resulted in adverse effects were for effects that were short-term and very local. Overall, our review showed that we consulted on a wide array of actions which had varying levels of effect and that none 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. This is still true as of the date of this Opinion.

Between August 2003 and July 2006, the Service issued 198 opinions that included analyses of effects to the bull trout. These opinions also reached "not likely to jeopardize" determinations and the Service concluded that the continued long-term survival and existence of the species had not been appreciably reduced rangewide due to these actions. All opinions issued after July 2006 also reached "not likely to jeopardize" determinations. Since July 2006, a review of the data in our national Tracking and Integrated Logging System reveals this trend is still true to date; no jeopardy opinions have been issued for the bull trout.

2. Eastern Idaho

For this Opinion, the Eastern Idaho Office examined the record for biological opinions issued since 2003 for those action areas that overlap any or all of the following eight bull trout core areas: Upper Salmon River, Pahsimeroi River, Lemhi River, Middle Salmon River-Panther, Little Lost River, Middle Fork Salmon River, Lake Creek, and Opal Creek (USFWS 2016, entire).

Approximately 67 biological opinions have been issued across the eight bull trout core areas. Six of them are broad-scale, program-level opinions. In three of those six, no take was anticipated or none has occurred. In the remaining opinions, varying amounts of lethal and nonlethal take of adult bull trout, juvenile bull trout, and bull trout redds were anticipated. In each of those actions, less take than was anticipated has been detected (USFWS 2016, p. 1). All 67 opinions concluded that the proposed actions would not be likely to jeopardize the coterminous U.S. population of bull trout.

III. ENVIRONMENTAL BASELINE FOR THE BULL TROUT

The preamble to the implementing regulations for section 7 (USFWS 1986, p. 19932) contemplates that the evaluation of ". . . the present environment in which the species or critical habitat exists, as well as the environment that will exist when the action is completed, in terms of the totality of factors affecting the species or critical habitat . . . will serve as the baseline for determining the effects of the action on the species or critical habitat." The regulations at 50 CFR 402.02 define the environmental baseline to include "the past and present impacts of all Federal, State, or private actions and other human activities in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process." The analysis presented in this section supplements the above *Status of the Species* evaluations by focusing on the current condition of the bull trout in the action area, the factors responsible for that condition, inclusive of the factors cited above in the regulatory definition of the environmental baseline, and the role the action area plays in the survival and recovery of the bull trout. Relevant factors on lands surrounding the action area that are influencing the condition of the bull trout were also considered in completing the status and baseline evaluations herein.

A. Status of Bull Trout in the Middle Salmon River–Panther Core Area

The action area for this consultation lies entirely within the Salmon River basin, one of the seven geographic regions within the Upper Snake Recovery Unit (USFWS 2015, p. 41). The Upper Snake Recovery Unit encompasses portions of central Idaho, northern Nevada, and eastern Oregon, and includes the Salmon River, Malheur River, Jarbidge River, Little Lost River, Boise River, Payette River, and Weiser River drainages (USFWS 2015, p. E1). The Upper Snake Recovery Unit contains 22 bull trout core areas and a total of 206 local populations (USFWS 2015, p. E1).

1. Population Information

The Salmon River basin contains 10 of the 22 core areas in the Upper Snake Recovery Unit and 123 of the 206 local populations. Connectivity within the Salmon River core areas is mostly intact. Most core areas in the basin contain large bull trout populations and many occupied stream segments. The Salmon River basin supports adfluvial, fluvial, and resident populations of bull trout (USFWS 2015, pp. E1-E2). The action area for this consultation lies within the Middle Salmon River-Panther core area, one of the largest core areas in the Salmon River basin.

Middle Salmon River-Panther Core Area

This core area encompasses 557,450 hectares (1,377,500 acres) and includes the Salmon River and Panther Creek drainages that extend from the confluence of the main Salmon River with the Lemhi River, to its confluence with the Middle Fork Salmon River (USFWS 2002b, p. 13; USFWS 2015, p. E92). This core area has 3758 kilometers (2,335 miles) of streams (USFWS 2005, p. 83) and at least 19 local populations (USFWS 2015, p. E92). Migratory bull trout may persist in some of these local populations, but most populations appear to exhibit resident life history expression (USFWS 2002b, p. 66; USFWS 2015, p. E92).

In 2005, the Idaho Department of Fish and Game (IDFG) reported population numbers for the Middle Salmon River-Panther Core Area (IDFG 2005, p. 32) that were based on an extensive modeling effort (IDFG 2005; High et al. 2008). A corrected table (Meyer 2009, *in litt*) showed an approximate population of 72,732 (± 24,772) bull trout (adults and young) for the core area. Using an assumption that 10 percent of the total number is comprised of adult fish (Meyer 2009, pers. comm.), that would suggest an adult population in the core area of approximately 7,300 adults (±2,500). More recent information provided by IDFG indicates a stable trend in bull trout abundance within this core area (USFWS 2015, p. E92).

In the 2005 conservation status assessment (USFWS 2005) the Middle Salmon River-Panther Core Area final rank was "at risk". While not the most imperiled (at high risk), the core area was considered at risk because of very limited and/or declining numbers, range, and/or habitat, making bull trout in this core area vulnerable to extirpation. The bull trout 5-year review (USFWS 2008) also determined the core area to be "at risk" overall.

The Service has issued 19 biological opinions addressing Federal actions specific to this core area: 4 for water diversions (Otter Creek, Lower Salmon River, Middle Salmon River, and Blackbird Mine diversions and settling basins), 2 for mining operations (Idaho Cobalt Mine, and Beartrack Mine), 2 for ongoing activities at a watershed-level, including grazing, (Panther Creek Ongoing Activities and the BLM Travel Plan), 10 for grazing in specific allotments (Indian Ridge, Fourth of July Creek, South Fork Williams Creek, Deer-Iron, Carmen Creek, Morgan Creek-Prairie Basin, North Basin, Hat Creek, Cow Creek, and Forney Allotments), and 1 for emergency wildfire response (Mustang Fire). Each of these opinions found that the actions analyzed were not likely to jeopardize the coterminous U.S. population of bull trout. The aggregate amount or extent of take of bull trout and bull trout redds caused by these Federal actions is estimated by the Service to be at the scale of 164 to 214 bull trout (mostly juveniles), and includes both lethal and nonlethal take, and 92 to 257 bull trout redds. Take of redds was anticipated to result from livestock trampling, while take of adult and juvenile bull trout was

anticipated to result from entrainment or stranding at water diversions. Surveys conducted from 2010 to date have not found any take of bull trout redds caused by the actions addressed in the opinions. Limited surveys have found no take of bull trout due to entrainment at a diversion.

2. Habitat Information

Bull trout habitat quantity and quality in the Salmon River basin have been altered through time by influences including past timber harvest, livestock grazing, and mining, and more recently by residential development (USFWS 2002b, pp. 31, 44, 48; USFWS 2015, p. E1). Both wildfire and fire suppression have had effects on bull trout habitat components within the basin (USFWS 2002b, p. 33). Road densities in the Salmon River basin are relatively low, with 64 percent of the basin having no roads or low road density (USFWS 2002b, pp. 40-41). Bull trout and its habitat can be negatively affected by water diversions. Over 770 known diversions exist in the Salmon River basin (USFWS 2002b, pp. 36-37), but there are no major dams in the Salmon River basin, and connectivity within Salmon River core areas is mostly intact (USFWS 2015, p. E2).

<u>Middle Salmon River–Panther Core Area</u>
Impacts to bull trout habitat from past livestock grazing and water diversions (primarily for agriculture) are prevalent in this core area (USFWS 2002b, pp. 34, 37). Although portions of the Middle Salmon River–Panther Core Area are within wilderness or other designated roadless areas, roads have been established in the floodplains of some streams, resulting in increased peak flows, reduced off-channel habitat, and elevated sediment loads (USFWS 2002b, pp. 41-42). Reported road density of this core area is 0.7 mile/square mile (USFWS 2005, p. 49). Past mining activities have impacted stream channel conditions and water quality. Ongoing release of contaminants to some streams is a concern (USFWS 2002b, p. 46).

B. Status of Bull Trout in the Action Area

1. Population Information

The action area encompasses five streams which support populations of bull trout: North Fork Salmon River, Hughes Creek, Salzer Creek, Indian Creek, and Corral Creek (Assessment, p. 26). Bull trout populations within the Allotment belong to the North Fork Salmon River and Indian Creek local populations, 2 of 19 local populations in the Middle Salmon River–Panther Core Area (USFWS 2015, p. E92). The 2015 bull trout recovery plan is silent on the specific roles of these two bull trout local populations in the survival and recovery of the listed species, but the recovery approach identified in the plan is intended to ensure adequate, long-term conservation of genetic diversity, life history features, and broad geographical representation of bull trout populations, while acknowledging that a small number of local population extirpations could occur without preventing recovery of the species (USFWS 2015, p. 45).

Bull trout populations within the action area are believed to be depressed from historical numbers due in part to migration barriers associated with irrigation practices on private lands. Based on fisheries monitoring data from a long-term monitoring site on Hughes Creek, the Forest estimates bull trout densities of less than 1 fish per 100 square meters (Assessment, p. 27).

Fluvial bull trout are known to use North Fork Salmon River and are suspected to use Hughes Creek and Indian Creek (Assessment, p. 27). The Assessment indicates all life stages of bull trout are present in the action area. Bull trout populations are increasing to stable and have the resilience to recover from short-term disturbances (Assessment, pp. B2, B3, B13, B14). Although brook trout occur in North Fork Salmon River, Hughes Creek, Indian Creek, and Corral Creek and can be a threat to bull trout due to potential competition and hybridization, the probability for displacement or hybridization to occur in these streams is considered low (USFWS 2002b, pp. 160-162; Assessment, pp. B3, B14).

The Allotment contains 21.65 miles[2] of bull trout spawning habitat in Corral Creek, Hughes Creek, Indian Creek, North Fork Salmon River, and Salzer Creek as displayed below in Table 3.

Table 3. Bull Trout Spawning Streams and Miles

Corral Creek	0.14 miles
Hughes Creek	6.92 miles
Indian Creek	6.86 miles
North Fork Salmon River	6.46 miles
Salzer Creek	1.27 miles

The identified lengths reflect continuous mapping reaches and are likely a significant overestimate of actual suitable spawning habitat within the action area because of the discontinuous occurrence of suitable combinations of stream gradient, stream substrate, water depth, and water velocity. Information on bull trout spawning within the action area is limited. The potential for a stream to contain spawning bull trout is based on known or suspected presence of bull trout identified through electrofishing surveys. IDFG believes North Fork Salmon River supports fluvial bull trout spawning and Hughes and Indian Creeks have the potential to support fluvial bull trout spawning within the action area. Bull trout populations in the action area exist in close proximity to other spawning and rearing groups (Assessment, pp. B3, B14). Migratory corridors and rearing habitat are considered to be in good to excellent condition in most of the action area, but the Hughes Creek drainage has a partial migration barrier in lower Hughes Creek caused by private land irrigation practices (Assessment, pp. 27, B3, B5, B14).

2. Habitat Information

The Forest used focus indicators (discussed below) to establish a baseline condition for the bull trout and its habitat in the action area. That information will be summarized in this section of the Opinion.

2 The Forest has clarified that the stream miles in the text of the Assessment and in Tables 16 and 17 do not match because the tables inadvertently included streams and stream miles not within the Allotment. The stream lengths described in the text of the Assessment and this Opinion are the accurate stream lengths (Garcia 2016, pers. comm.).

Establishment of Baseline Conditions for Bull Trout

As mentioned above in the *Status of the Species* section, the survival and recovery needs of the bull trout can be described generally as cold stream temperatures, clean water quality, complex channel characteristics, and large patches of habitat that are well connected. Therefore, to determine the overall effect of a proposed action on the bull trout for purposes of a jeopardy analysis, it is logical to try and ascertain how, and to what extent, those basic needs are likely to be impacted by a proposed action. But first, a baseline condition of those habitat parameters, inclusive of conditions in the action area, needs to be described to form the context for evaluating the potential impacts of the proposed action on bull trout.

One tool that was developed to assist in describing the condition of watersheds and streams on which bull trout depends is entitled *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale* [3] (Lee et al. 1997, Appendix 9). It is commonly referred to as the "Matrix of Pathways and Indicators" and, at its most basic level, is a table which identifies the important elements or indicators of a bull trout's habitat. Using this table assists in consistent organization and assessment of current conditions and in judging how those indicators may be impacted by a proposed action (Lee et al. 1997, p. 9-6). The Forest included matrix analyses for the watersheds in the action area in Appendix B of the Assessment. These analyses are summarized in the Assessment and in Table 4 below.

Because the Matrix of Pathways and Indicators was developed to operate at several spatial scales (Lee et al. 1997, p. 9-9), the Forest selected six indicators as their "focus indicators" to address bull trout habitat conditions at the scale of the Allotment. The six selected focus indicators are spawning and incubation, water temperature, sediment, stream channel width to depth ratio, streambank condition, and condition of the Riparian Conservation Area (RCA). These indicators represent quantifiable attributes of bull trout habitat (related to its survival and recovery needs) that are most likely to reflect the complex relationships between actions, pathways for effects to the bull trout caused by these actions, and the likely effects to the fish (discussed below). Because these indicators are quantifiable, monitoring data can be collected on their status and tracked over time to determine trends. For these reasons, the Service concludes that use of these indicators is a valid method of assessing baseline conditions and the impacts of an action on the bull trout.

Using data on the above indicators, the Forest characterized the condition of the habitat for the bull trout in the occupied streams within this Allotment (Assessment, pp. 30-41). If stream-specific information was not available, then observational information or information from similar streams was used. If one or more of the focus indicators showed a habitat condition not within the range of condition considered to be appropriate to fully supporting bull trout conservation needs, the Forest presented its professional judgment regarding the most likely cause for that condition. By identifying any known specific habitat limitations, the Forest and the Service can more closely focus their analysis of the proposed action's effects on that component of the bull trout's habitat. In that way, a more precise evaluation of potential effects

3 This document was adapted from a National Marine Fisheries Service document called *Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale* (NMFS 1996).

can be made. To assist the reader, the *Effects of the Proposed Action* section below is organized by focus indicator.

Description of Baseline Conditions

Fish habitat conditions of Hughes Creek are generally good. Overall physical habitat quality, including elements of water quality, flow/hydrology, channel conditions, and structural habitat elements is considered fair to good. Mainstem Hughes Creek supports quality spawning and rearing habitat for both bull trout and anadromous fish. As described above, a partial migration barrier exists on lower Hughes Creek due to private land irrigation practices. A culvert which was a partial fish-passage barrier was removed by the Forest in 2011 and replaced with a fish-passable structure (Assessment, p. 28).

Fish habitat conditions of Hughes Creek tributaries are also generally good. Overall physical habitat quality, including the elements of water quality, flow/hydrology, channel conditions, and structural habitat elements is considered good. A fish-passage barrier associated with a road crossing exists on West Fork Hughes Creek. A culvert on Ditch Creek, which was a barrier to fish passage, was removed by the Forest in 2011 and replaced with a fish-passable structure. Hughes Creek tributaries are small high gradient streams that support rearing and spawning habitat for smaller resident fish, but spawning habitat for larger fluvial or anadromous fish is limited (Assessment, pp. 28-29).

Fish habitat conditions of Indian Creek are generally good. Overall physical habitat quality, including the elements of water quality, flow/hydrology, channel conditions, and structural habitat elements is considered good. Connectivity is excellent, with no mainstem passage barriers. Indian Creek supports quality spawning and rearing habitat for both bull trout and anadromous fish. Corral Creek, a small high gradient tributary to upper Indian Creek, provides limited spawning for bull trout and limited rearing habitat for bull trout and anadromous fish. The Forest considers the overall physical habitat quality, including the elements of water quality, flow/hydrology, channel conditions, and structural habitat elements to be fair to good for smaller cold water salmonids. There are no human-caused migration barriers, but Corral Creek is a high gradient mountain stream with limited fish habitat (Assessment, p. 29).

The Matrix of Pathways and Indicators below (Table 4) is a summary of the information contained in the Assessment (pp. B2-B23) for the watersheds that the action area falls within. Shaded rows in the table designate indicators the Forest is monitoring on the Allotment. The indicators of subpopulation size, growth and survival, and persistence and genetic integrity relate to the spawning and incubation indicator. Conditions of the watersheds are included to provide a complete description of the environmental baseline, but because the matrix describes conditions on the watershed scale, conditions at the finer scale of the action area may vary from those displayed in the matrix. Conditions of both the action area and the watersheds are considered in the narrative below.

Table 4. Matrix of Pathways and Indicators for Watersheds the Action Area Overlaps

Pathway	Indicators	Functioning Appropriately	Functioning at Risk	Functioning at Unacceptable Risk
Subpopulation Characteristics	Subpopulation Size		IC, NF	
	Growth and Survival (including incubation survival)	IC, NF		
	Life History Diversity and Isolation	IC, NF		
	Persistence and Genetic Integrity	IC, NF		
Water Quality	Temperature - spawning	IC, NF		
	Temperature - holding	IC, NF		
	Sediment	IC, NF		
	Chemical Characteristics	NF	IC	
Habitat Access	Physical Barriers	IC	NF	
Habitat Elements	Substrate Embeddedness	N/A	N/A	N/A
	LWD	IC, NF	IC, NF	
	Large Pools or Pool Frequency and Quality	IC, NF	IC, NF	
	Off-channel Habitat	IC, NF		
	Refugia	IC, NF		
Channel Condition and Dynamics	Width:Depth Ratio	IC, NF	IC, NF	
	Streambank Condition	IC, NF		
	Floodplain Connectivity	IC, NF		
Flow/Hydrology	Change in Peak/Base Flows		IC, NF	
	Increase in Drainage Networks	IC, NF		
Watershed Conditions	Road Density and Location			IC, NF
	Disturbance History		IC, NF	
	Riparian Habitat Conservation Area	IC, NF		
	Disturbance Regime	IC, NF		
Integration of Species and Habitat Conditions	Habitat Quality and Connectivity	IC, NF		

IC = Indian Creek Watershed

NF = North Fork Salmon River Watershed

Water Temperature
Water temperature data indicate that stream temperatures vary from year to year. These variations are in part influenced by winter snowpack, snowmelt/runoff, and summer air temperatures (Assessment, Appendix C Table 20, Appendix G). The stream water temperature indicator for bull trout is functioning appropriately when the maximum water temperature, as expressed by the 7-day moving average of daily maximum temperatures (7DMMAX), is below 15° C (59° F) within adult holding habitat and below 9° C (48° F) within spawning and rearing habitat. Observed water temperatures of the streams within the Allotment have generally fallen within water temperature requirements for bull trout, although some streams have had minor exceedances for brief periods (Assessment, Appendix C Table 20, Appendix G).

Sediment
Within the Allotment, sediment levels have been consistently monitored since 1993 at four core sampling monitoring sites, including two locations on Indian Creek and one location on Hughes Creek (Assessment, p. 35). Additionally, Ditch Creek has been sporadically monitored since 1995, with 4 years of data collected. One sediment sampling site on Indian Creek has been monitored 18 of the last 22 years. The other site on Indian Creek has been monitored 11 of the last 22 years. Geology of this stream's watershed is primarily granitic. Sediment levels at both sites have not exceeded the 25 percent fine sediment criteria for non-quartzite based geologies; this indicates that sediment conditions in Indian Creek are Functioning Appropriately and sediment is not a limiting factor for bull trout production (Assessment, p. 36). Hughes Creek has one sediment sampling site which has been monitored 21 of the last 22 years. In that time, sediment levels have been at or below the 20 percent fine sediment criteria for quartzite based geologies 16 of the 21 years. Based on this data, sediment conditions in Hughes Creek are considered to be Functioning Appropriately.

Stream Width to Depth Ratio
Stream width to depth ratios are considered to be Functioning Appropriately within the North Fork Salmon River and Indian Creek watersheds. Data is limited for average wetted width to maximum depth ratios on streams in the action area. There are no current data for width to depth ratios; the available data were collected between 1988 and 1990. The Forest relies on values and ranges identified within the document *Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho* (Overton et al. 1995, pp. 26-100) to establish width to depth ratio objectives specific to channel type, local geology, topography, climate, and potential vegetation (Assessment, p. 37). These values represent natural conditions in the absence of human disturbance. Width to depth ratio data was collected at a C channel reach of Hughes Creek and was within the Natural Condition database range of less than 28. Data was also collected at a B channel reach of Indian Creek in the action area. This width to depth ratio fell within the Natural Condition database range of less than 24.

The past and current effects of actions similar to the proposed action could have played a role in decreasing or increasing average wetted width to maximum depth ratio within the action area. If past or current livestock grazing were allowed to break down streambanks and significantly decrease streambank stability, an increase in average wetted width to maximum depth ratio would be expected. Based on the current streambank conditions at the three long term trend

monitoring sites (one on Hughes Creek and two on Indian Creek) showing high bank stability, we would not expect the width to depth ratios to have increased substantially.

Streambank Conditions
Streambank conditions are considered to be Functioning Appropriately within the North Fork Salmon River and Indian Creek watersheds. Streambank conditions within the action area have been monitored in association with sediment monitoring since 1994. Two sites are located on Indian Creek and one site is located on Hughes Creek. Streambank stability on all these sites is relatively high. Streambank stability was last measured on Indian Creek in 2014 and stability at both sites was over 90 percent. On Hughes Creek over the last 12 years streambank stability has been above 80 percent, but below 90 percent in five of the years and above 90 percent in seven of the years. This variability is likely due to natural flood events over the years (Assessment, p. 39).

Riparian Conservation Areas
Riparian areas are considered to be Functioning Appropriately within the North Fork Salmon River and Indian Creek watersheds, with the existing riparian vegetation being more than 50 percent similar to the potential natural community. Within the action area, the riparian areas associated with Indian Creek, lower Corral Creek, and lower Hull Creek are largely untouched by permitted livestock grazing. These areas provide adequate shade, large woody debris, habitat protection, and connectivity. The condition of riparian areas in other streams in the Allotment have been impacted by past placer mining and logging activities (Assessment, p. 40).

Three Multiple Indicator Monitoring (MIM) sites were established and subsequent monitoring has occurred on the Allotment since the early 1990s. Greenline ecological status[4] (GES) typically is the element in which interpretations of ecological status and trend will be discussed. None of the MIM sites are located on bull trout-occupied streams, but the MIM sites were selected to be representative of livestock use and stream conditions throughout the unit.

Monitoring indicates a downward trend in GES at all three MIM sites in the action area. Riparian areas in all grazing units within the action area were impacted by the 2012 Mustang Complex Wildfire, which played a significant role in the downward trend in GES at the three MIM sites.

Limiting Factors
Suitable fish habitat in the action area is limited by highly variable stream flow conditions from year to year, nutrient deficiencies in some high elevation, high gradient streams, existing fish passage barriers, and lack of streamflow in some stream reaches. Additionally, historical grazing activities may have contributed to past habitat capability limitations within the action area, but available data indicates that changes in grazing management strategies on the Allotment since the mid-1990s have greatly reduced any continuing contribution of impacts to bull trout and its habitat within the action area (Assessment, p. 30).

[4] This indicator broadly rates the present state of vegetation in a riparian area in relation to the biotic community that would become established if all successional sequences were completed without human interference, under the present environmental conditions.

IV. EFFECTS OF THE PROPOSED ACTION

A. Direct and Indirect Effects of the Proposed Action

The implementing regulations for section 7 define "effects of the action" as "the direct and indirect effects of an action on the species together with the effects of other activities that are interrelated or interdependent with that action, which will be added to the environmental baseline" (USFWS 1986, p. 19958). "Indirect effects" are caused by or result from the agency action, are later in time, but are still reasonably certain to occur (USFWS 1986, p. 19958).

1. Analytical Approach and Assumptions

In the following evaluation, the Service in part relied upon the Forest's effects analysis in their Assessment, which is based on a series of assumptions about bull trout presence and distribution in the action area, likely timing of spawning, and potential impacts to redds from livestock grazing in units on the Allotment that include bull trout-occupied streams. Because of the construct of these assumptions, the analysis is more likely to result in an overestimate, rather than underestimate, of the impacts of the proposed action on bull trout. When examining the potential impacts to a species that is listed as threatened under the Act, and there is substantial imprecision or uncertainty in some of the information, using assumptions that are more likely to overestimate, rather than underestimate, effects is a reasonably cautious and prudent approach for assessing impacts to populations of that species. Absent the consideration of the full potential of effects, detrimental impacts to the species can go unrecognized (National Research Council 1995, p.167).

The Service also relied on the published scientific literature regarding potential livestock grazing impacts to riparian/aquatic environments, particularly related to impacts occurring under various management strategies, to analyze the information presented in the Assessment and the anticipated impacts of the proposed action. The Service has reviewed the impacts to this action area due to past grazing management of the area. The Service assumes the Forest will continue to adjust livestock management to achieve resource objectives on the Allotment, as described in the proposed action.

2. Effects of the Proposed Maintenance Activities

The proposed action requires the permittee to maintain existing improvements on the Allotment as a condition of the term grazing permit. These improvements include fences and water troughs (Assessment, pp. 12, 15). The Service believes that impacts associated with maintenance activities would be infrequent, short-term, and minor, and have insignificant effects to bull trout.

Livestock on the Allotment obtain water from natural features such as streams or springs, or from troughs. The Forest indicates there are several water troughs on the Allotment (Assessment, p. 18). None of these water developments is located in occupied bull trout habitat, thus there is no potential to interfere with fish passage or to entrain bull trout.

3. General Overview of Grazing Impacts on Bull Trout

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 the bull trout, the Service developed, through extensive literature review and synthesis, a source document (Appendix A - *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. This document has informed our analysis of this proposed action. Figure 3 and Table 5 summarize the results of the evaluation presented in Appendix A.

Figure 3. Summary of effects pathways that may be triggered by grazing activities and the possible environmental results and consequences to bull trout/aquatic habitat.

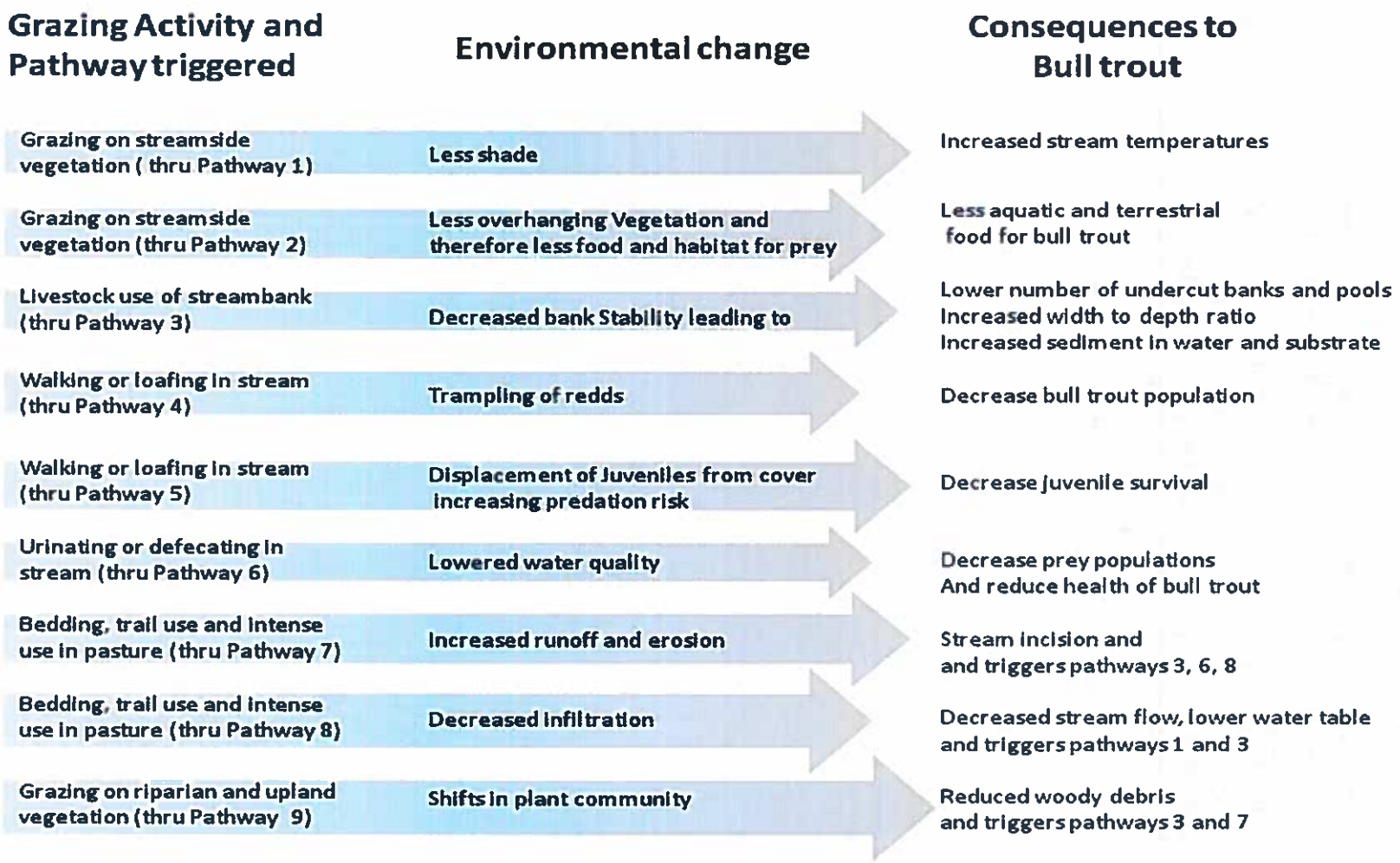


Table 5. Variables which influence the degree of impact that grazing can have on bull trout or their habitat separated by Effect Pathways (pathways are summarized in Figure 3 and described fully in Appendix A, Section 2.0).

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							
	Slope and aspect	Habitat suitability for spawning	Habitat suitability for juveniles	Amount of stream access	Vegetation type	Management considerations	Soil condition, type, and moisture content	Elevation
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					✓	✓	✓	

Level of Grazing Pressure
The level of grazing pressure on a particular area can determine the impacts on the environment and the effectiveness of variables that mitigate or enhance that impact (Appendix A, Section 3.1.4 and 3.3.6). On this Allotment, the proposed annual use indicator for stubble height is 4 to 6 inches (Assessment, p. 18). The USFS (1992, pp. 16-19) has determined that a 4 to 6 inch stubble height represents a 25 to 50 percent consumption of the plant's biomass, and this condition has been characterized as "light to medium" grazing by Clary (1999, p. 218). Holecheck et al. (2006, p. 8) reviewed 20 grazing studies and based on the categorization of the definitions within those studies, summarized 25 to 50 percent as being "light to moderate grazing". Clary (1999, p. 224) found that when those levels of grazing were applied to historically heavily grazed lands, streams narrowed and deepened, substrate embeddedness decreased, streambank stability increased, and streamside willow communities increased in both height and cover. These attributes specifically align with several of the focus indicators used below for analysis, but the Service will not repeat them in the sections below.

The Service concludes that the level of grazing proposed by the Forest is consistent with maintaining habitat in a suitable condition for fish to thrive, and may even improve areas that have been negatively impacted by past heavy grazing, based on the results reported by Clary (1999 pp. 221-225). The finding that limiting livestock utilization is an important factor in the improvement of riparian/aquatic environments is supported by studies conducted and reported on in the literature cited above and described in Appendix A (see section 3.1.4c for full discussion of this finding).

Grazing Management Techniques
Key to minimizing livestock impacts is the implementation of a grazing management program that includes techniques to distribute livestock, such as fencing, salting, off-stream water development, and riding (Laycock and Conrad 1981, p. 57). Drift fencing can alter livestock movement, deflecting livestock away from riparian areas, while exclosure fencing restricts livestock use of the area (Wyman et al. 2006, p. 32). Salting on ridges or other areas away from streams, particularly in conjunction with off-stream water development, encourages livestock use of areas that typically get little grazing (Wyman et al. 2006, pp. 26-28). Butler (2000, p. 23) and others have found riding to be effective in improving the condition of riparian areas. The finding that grazing management techniques can effectively distribute livestock away from riparian/aquatic environments is supported by studies conducted and reported on in the literature cited above and described in Appendix A.

4. Effects of the Proposed Grazing Activities on Focus Indicators

Spawning and Incubation
Bull trout typically spawn when the water temperature drops to approximately 8° to 10° C (48° to 50° F). Timing of this temperature drop depends on elevation and local conditions. The Forest assumes bull trout begin spawning within the Allotment on August 15 (Assessment, p. 32). Eggs are placed in appropriate stream substrate and remain there for 100 to 145 days, depending on water temperature. Humans, wildlife, and livestock can disturb spawning fish and trample redds or portions of redds in the stream gravel (See Appendix A, Section 2.1.3 for full discussion of redd trampling).

Because livestock would be authorized to graze the Allotment from May 23 to October 30, the Service considers spawning and incubation to be an appropriate focus indicator. Potential impacts to other life stages of bull trout from the proposed action would not occur or would have immeasurable, and therefore, insignificant effects to bull trout. As stated above, eggs remain in the stream substrate for 100 to 145 days, hatching in late winter or early spring. When eggs hatch, alevins stay in the redd continuing to develop. Fry is the life stage at which the fish begin to swim and feed. Fry remain in the stream substrates for up to 3 weeks. Livestock would not be on the Allotment at this time and thus, would not cause disturbance or trampling of alevins or fry.

Juvenile, or subadult, is a term used to describe young fish from emergent fry stage until sexual maturity. This life stage is mobile and could easily move away from disturbance, such as livestock wading in a stream. Disturbance could result in indirect effects to juveniles through increased susceptibility to predation or decreased fitness by loss of energy or feeding opportunities (Appendix A, p. 10). Grant and Noakes (1987, pp. 1393-1395) concluded that younger fish are less wary than older fish, thus taking more risks while foraging to maximize growth. Grant and Noakes (1987, pp. 1392-1393) documented smaller fish returning to foraging locations faster than larger fish, usually within about 10 minutes of the disturbance. This study suggests that while smaller fish quickly move into adjacent habitat after each disturbance, they are more likely to remain in areas with limited cover to maximize forage. Smaller fish are also less wary of disturbances and return to foraging sites faster after each disturbance with no long-term displacement. Therefore, occasional disturbance by watering or crossing livestock should have immeasurable effects on individual growth rates of smaller fish and is not expected to impact long-term survival (Assessment, p. 54). Because the proposed action incorporates measures including fencing, salting, unit rotations, and a rider required to be on the Allotment once every 2 weeks moving livestock away from streams (Assessment, p. 12) to encourage dispersal of livestock throughout a unit and limit the intensity, duration, and frequency of livestock-caused disturbance, it is likely only small numbers of livestock would be present on a given stream at any one time, leaving a substantial portion of bull trout habitat in the stream free of livestock-caused disturbance. The Service believes the disturbance is likely to cause only temporary, short-term movements from preferred habitats, resulting in an insignificant increase in predation risk.

Livestock wading in a stream could disturb deposited sediment causing it to be resuspended in the water column, resulting in increased turbidity. Although increased turbidity can have negative effects to fish (depending on the timing, concentration, and duration of exposure), Gregory and Levings (1998, pp. 283-284) concluded that juvenile salmonids were less likely to be encountered and preyed upon in turbid water. The Service expects turbidity resulting from livestock wading in the stream would neither increase nor decrease the predation risk to juvenile salmonids because increased turbidity would be of short duration and limited in extent, resulting in insignificant effects to bull trout.

Livestock, wildlife, humans, or birds may disturb adult bull trout when near enough to be perceived as a threat. The Forest fisheries biologist has observed fish drift or dart away from a disturbance, and has also observed the same fish returning in a few minutes to the same position it had occupied in the stream after the perceived threat has been removed from sight or sound

(Assessment, p. 54). Adult bull trout may be disturbed by livestock grazing adjacent to streams, crossing or walking in streams, or drinking from streams. Because the proposed action incorporates measures including fencing, salting, unit rotations, and a rider required on the Allotment once every 2 weeks, moving livestock away from streams (Assessment, p. 12) to disperse livestock throughout a unit and limit the intensity, duration, and frequency of livestock-caused disturbance (as described in the *Grazing Management Techniques* section above), it is likely only small numbers of livestock would be present on a given stream at any one time, leaving a substantial portion of bull trout habitat in the stream free of livestock-caused disturbance. The Service does not believe the disturbance would result in effects substantially different from effects experienced by fish in their natural environment, and would not be substantial enough to disrupt normal behavioral patterns. The disturbance is likely to cause short avoidance movements, would last only a few minutes after cattle leave the area, and have insignificant effects to bull trout.

The Forest determined that bull trout likely spawn in streams within the Indian Ridge and Hughes Creek Units of the Allotment (Assessment, p. 52). Based on the unit rotations and grazing periods, there would be some overlap of livestock use with bull trout spawning periods in both units every year. The Indian Ridge Unit would be grazed every year after August 15 until livestock are removed from the Allotment (based on status of annual use indicators or the Allotment off date). The Hughes Creek Unit would not be grazed after August 15, but both active trailing and unsupervised drifting of livestock would occur after August 15 every year (Assessment, p. 53). If bull trout redds and spawning fish are present, they may be exposed to livestock-related impacts. The potential for this exposure to produce redd trampling can be affected by the presence of dense vegetation and steep topographic characteristics of riparian areas (See Table 2 and Appendix A, Section 3.4.1 for a full discussion of these variables).

In the Indian Ridge Unit, bull trout spawning is known to occur in Indian Creek. The Forest believes bull trout spawning occurs in lower Corral Creek because of the documented presence of juvenile bull trout (Assessment, p. 52). Indian Creek is mapped as an allotment boundary because the topography and steep terrain make it a natural barrier to livestock movement. Each year, livestock enter the Indian Ridge Unit in the higher elevations near Tincup Springs and Grindstone Springs (Assessment, p. 11). The Forest has rarely documented livestock use anywhere near Indian Creek. Since 1999, livestock (four cows) have only once entered the riparian area of Indian Creek. The cows were removed from the area by the permittee immediately. Lower Corral Creek is a tributary to Indian Creek and is located in the same steep terrain and topography that restricts livestock movement (Assessment, pp. 52-53). Because livestock have rarely used the area near Indian Creek, and the topography and steep terrain restrict livestock movement, the Service concludes livestock are unlikely to access the streams. Therefore, effects to spawning bull trout and incubation caused by the proposed action are considered discountable.

In the Hughes Creek Unit, bull trout spawning is known to occur in Hughes Creek and North Fork Salmon River. The Forest believes bull trout spawning occurs in Salzer Creek because of the documented presence of juvenile bull trout (Assessment, p. 52). Livestock would not graze the Hughes Creek Unit when spawning bull trout and redds may be present. The unit would be grazed every other year early in the unit rotation. The Forest expects livestock to be in the unit

from approximately May 23 through mid-July (Assessment, pp. 10, 53). However, the majority of livestock on the Allotment would be actively trailed through the unit on an existing road from mid-September through October 30. Prior to mid-September, livestock begin to passively trail (drift) down to the private land in lower Hughes Creek. Neither active nor passive trailing would occur upstream of the confluence of West Fork Hughes Creek with Hughes Creek. Consequently, Salzer Creek would not be affected by livestock trailing. Livestock trailing is not expected to affect bull trout in North Fork Salmon River because livestock would be removed to private land prior to reaching the river. Hughes Creek is the only stream that livestock would have the potential to access during trailing when bull trout are spawning. Livestock are not actively trailed across Hughes Creek, but livestock trailing on the Forest road adjacent to the stream could step off the road and potentially impact spawning bull trout or redds. Each year from August 15 through October 30 there would be potential for livestock to trample bull trout redds and/or disturb spawning adult bull trout in approximately 2 miles of Hughes Creek (Assessment, p. 53).

The number of redds likely to be in individual streams where livestock and spawning overlap, and thus, could be trampled, must be estimated to inform the take analysis. Estimates in general are subject to a large number of variables. Of particular importance is that redd survey information provided by the Forest or state agencies is typically based on preferred spawning areas and therefore, densities cannot be reliably extrapolated to an entire stream length. Appendix B presents the Service's reviews of the range of difficulties in redd density estimation. Also in that appendix, we use a report with different survey methods (Sausen 2010, pp. 5-6) to arrive at two redd density values that we believe are reasonable to inform our effects analysis (Appendix B). Those values are 11.5 redds per mile for large streams or small rivers (width greater than approximately 15 feet) and 2.4 redds per mile for smaller streams (width less than approximately 15 feet). In the absence of stream-specific survey data or data from similar streams in the action area, the Service will use the above estimates.

Bull trout spawning takes place over a several month period beginning slowly – peaking – and then tapering off. Therefore, depending on which part of the period is exposed to livestock trampling, differing numbers of redds are exposed. Based on professional judgment, the Service estimates that during the early portion of the spawning period approximately 25 percent of the total number of redds are produced, by the middle (peak) portion of the spawning period 75 percent of the total are present, and the total (100 percent) occurs several weeks after the peak. Not all areas of a stream are appropriate gradient for spawning habitat and not all creeks are accessible (or even desirable) for livestock grazing (Table 5; Appendix A, Section 3.4). Additionally, salmonids have been shown to select spawning sites in proximity to cover (Witzel and McCrimmon 1983, p. 766). These variables can affect the likelihood and degree of exposure of redds to livestock.

Summary of the Scale of Impacts to Redds and Spawning Fish
The use of redds per mile values and stream miles in estimating the potential number of redds exposed to livestock allows for the generation of specific numerical values. For each stream, the value will be determined by multiplying the stream length by either 11.5 redds per mile for large streams (width greater than or 15 feet) or 2.4 redds per mile for small streams (width less than 15 feet). The Forest has presented an estimate of the length of stream segments exposed to

livestock and we have used it in the following summary. The numerical estimates below are rounded to whole numbers.

Hughes Creek (small stream) has an estimated 2 miles of suitable spawning habitat exposed to livestock after August 15 (Assessment, p. 53). That exposure occurs for up to 10 weeks annually (Assessment, p. 53). Using the above methodology, the Service estimates that the 2 miles of stream are likely to contain a maximum of 5 redds. Assuming that two spawning adults may be initiating or tending each redd, the Service expects 10 adult bull trout associated with the Hughes Creek redds.

Not all redds exposed to livestock are likely to be trampled; research on simulated redd trampling using clay pigeons as a surrogate for redds (Gregory and Gamett 2009, pp. 364-365) found a wide variation (12 to 78 percent; Appendix A, 2.1.3) in the percent of simulated redds exposed to cattle that are actually impacted (at least one broken clay pigeon). Using the ranges found by Gregory and Gamett (2009, pp. 364-365) on our estimates above yields a range of 1 to 4 redds that are likely to actually be impacted. However, as discussed earlier, this range is likely an overestimate. To date, surveys from stream segments in various Allotments on the Forest have consistently found lower redd density than estimated and none trampled (Appendix B). Gregory and Gamett (2009, pp. 364-365) also found that even given that a surrogate redd was trampled, there was variation in how much damage was done (up to 50 percent of clay pigeons broken in a simulated redd). The Service recognizes that a redd contains thousands of eggs and not all are destroyed when a redd is impacted; however, we believe that it is reasonable to use a redd as the biological unit for the discussion on effects.

The Service expects spawning adult bull trout associated with the Hughes Creek redds to be disturbed to the extent that it temporarily disrupts their spawning behavior. Because the proposed action includes supervised/active trailing of 95 percent of the livestock through the unit, livestock are expected to primarily remain on the road and livestock disturbance of adult bull trout in Hughes Creek would be limited. A limited number of livestock (7 cow/calf pairs) are expected to trail unsupervised through the unit. The Service believes that disturbance is likely to be brief, infrequent, cause only short avoidance movements, and would not be substantial enough to preclude spawning. Therefore, disturbance of spawning bull trout is expected to have insignificant effects.

Population Effects of Redd Trampling

The relationship of redd trampling to population recruitment and population persistence is complicated by many factors. Percentage of eggs killed in an impacted redd, amount of additional mortality post-impact, and compensatory young survival rates all affect population trends.

Because redds typically are larger than livestock hooves, a redd that is trampled can have both disturbed and undisturbed portions. As a result, some percentage of eggs may survive impact to a redd. Gregory and Gamett (2009, p. 364) demonstrated this using several clay pigeons to simulate redds. They found that not only was there variation in how much disturbance was done, but that it did not exceed 50 percent of the clay pigeons broken in a simulated redd. Therefore, not all eggs in a trampled redd are likely to be killed.

The amount of additional mortality and how that might drive population trajectories was explored by Peterson et al. (2010) using a matrix model for cutthroat trout. Peterson et al. (2010, pp. 959-964) found that high trampling rates (increased egg mortality) did not necessarily lead to dramatic changes in trajectory, but could reduce the ability of a population to rebound. Negative population trends caused by redd trampling were dependent on several variables including existing natural mortality, time of trampling related to egg development, and overlap of the trampling with the population (Peterson et al. 2010, pp. 960-963). Peterson et al. (2010, p. 960, 964) reported that in some cases a trampling rate of greater than 100 percent (with egg mortality of 83 percent or more) was needed to produce a negative population trend.

Another example of the relationship between egg mortality and young survival is from Lower Kananaskis Lake in Alberta, Canada, where bull trout demonstrated compensatory density dependence (Johnston et al. 2007, p. 122). This study found that having a higher number of eggs that hatch (lower egg mortality) did not result in a change to the actual number of fish that reach one year of age. Cannibalism was mentioned as a possible mechanism, but evidence for this is not clear and there could be habitat variables affecting this mechanism. Information from both this and the Peterson et al. study suggests that very high egg mortality would have little effect on some populations, but may be significant for populations with little demographic resilience.

Trout populations may be resistant to the effects of redd trampling (barring any other external, unusual, and chronic stressors) because trout exhibit a reproductive strategy best described as 'r-selected'. This strategy includes large numbers of eggs, a high mortality rate of eggs and young, little to no parental care of young, and a relatively short time to reproductive maturity. It is a strategy evolved to allow for persistence of populations in the face of unpredictable and episodic environmental stressors by allowing populations to rebound quickly and re-colonize areas once temporary stressors are absent.

Based on the above discussion, the Service concludes that the mortality to eggs from the redd trampling on this Allotment is unlikely to result in a negative population trend. This is based on the fact that only portions of one of the five streams containing bull trout spawning habitat will be exposed to potential redd trampling, many eggs will survive in a trampled redd, only a portion of the redds in the creek are likely to be trampled, and bull trout populations on the Allotment are increasing or stable, with all age classes present (Assessment, Appendix B). In addition, although only up to 4 redds are reasonably likely to be trampled, the Forest would continue to implement actions to allow improvement of bull trout habitat conditions, including using stubble height and bank alteration indicators to determine when livestock need to be moved from the unit, and the use of a rider to move livestock away from streams. Improved bull trout habitat conditions would benefit all life stages of bull trout.

Water Temperature

Bull trout are adapted to and prefer very cold water. Grazing can indirectly affect water temperature primarily through direct impacts to streamside vegetation and streambanks. Streamside vegetation is important for shading and promoting lower temperatures, while streambank condition is important for maintaining appropriate channel geometry. Development of water sources and compaction of soil can also impact water temperatures. Specific grazing

practices and local circumstances can affect the degree of that impact to temperature (See Appendix A, Section 2.1.1, 2.2.1, 2.2.2, and 2.2.4 for full discussion).

Based on information presented in the Assessment (p. 55, Appendix G), the Service concludes that observed water temperatures of most streams within the Allotment generally fall within the range to best support all phases of bull trout life history, but individual streams and stream reaches have periodically had minor exceedances of optimum temperatures for brief periods. The monitoring data does not suggest that the periodic exceedances of temperature goals are the result of livestock grazing (Assessment, p. 55). Although the condition of riparian areas at the three MIM sites has declined sharply due to the Mustang wildfire, the Assessment notes that riparian areas of many streams are dominated by dense woody vegetation (Assessment, pp. 6, 41, Appendix I). Further, the Assessment indicates that the riparian conditions are in a static to upward trend, streambanks are highly stable, and most width to depth ratios are within the natural range of variability. These factors influence stream water temperatures (Assessment, pp. 39-40, 55).

The proposed action represents light to moderate grazing, which is likely to facilitate the gradual improvement of many riparian area characteristics in the Allotment (Appendix A, Section 3.1.4c and 3.3.6c). Although livestock grazing is likely to alter some of the physical and biological elements of the riparian areas from what they would be without grazing, the intensity, duration, and frequency of potential livestock-caused impacts is limited by the rotational grazing system which ensures that livestock will not be in any one unit for the entire grazing season, but will be moved amongst the units. The conservation measures, designed in part to avoid livestock exposure to spawning areas, include the use of a rider once every 2 weeks to move livestock away from streams, salting, fencing, and fence maintenance to further limit livestock use. Additionally, adhering to annual use indicators for greenline stubble height, bank alteration, and woody browse use, described in the *Proposed Action* section above, is expected to improve habitat conditions for bull trout. Using status of these indicators (triggers) to determine when livestock need to be moved from the unit will reduce the level of grazing intensity and the duration of livestock use in the unit. Most livestock trailing will be active/supervised and utilize existing roads, thereby limiting the duration and areal extent of potential livestock impacts.

Proposed monitoring will be effective in identifying future trends of water temperature regimes, and riparian vegetative status and trend within the action area. This monitoring will be effective in identifying both the occurrence and causal mechanisms of any changed conditions which would initiate responsive modification of grazing management strategies for the Allotment under the adaptive management strategy (outlined in the Assessment, pp. 16-17).

After reviewing the information presented by the Forest in the Assessment, and background information on the variables affecting the degree of change to stream temperature (Appendix A, Section 3.1, 3.7 and 3.8), the Service concludes the impacts of the proposed action to streamside vegetation and streambanks, will be short-term, infrequent, and minor. Improved riparian conditions (streamside vegetation and streambank condition) will maintain or improve water temperature regimes because of the relationship between these conditions and water temperatures described above. Therefore, the effects to bull trout from the effect to water temperatures caused by the proposed action are considered insignificant.

Sediment

Sediment in the water column can cause negative effects to bull trout by abrading gills and even cause death if sediment concentration is great enough or over a long enough period of time. Sediment settling into the substrate also has the potential to smother eggs in the gravel or change the substrate to being unsuitable for spawning. Livestock can introduce sediment into the stream by bank shearing and by damaging the vegetation holding the bank together and also by compacting soil leading to faster water runoff and erosion (See Appendix A, Section 2.1.2 for a full discussion).

The Service, based on information presented in the Assessment (pp. 34-37), finds that sediment levels for most streams have been within the range supportive of all phases of bull trout life history. Sediment levels at all monitoring sites on the Allotment are at or near objectives. The condition of attributes that influence the likelihood of sediment introduction to the water column (streambank stability, width to depth ratio, and streambank vegetation) indicates grazing is not negatively impacting sediment levels. The Assessment indicates that streambanks are highly stable (Assessment, pp. 39-40), most width to depth ratios are appropriate for the channel type (Assessment, pp. 37-39), and streambank vegetation on many streams is dominated by dense woody vegetation (Assessment, pp. 6, 41, Appendix I).

The proposed action represents light to moderate grazing, which is likely to maintain at objective levels, or improve, streamside vegetation and streambank conditions, and to maintain width to depth ratios in the Allotment (Appendix A, Section 3.1.4c and 3.3.6c). The intensity, duration, and frequency of potential livestock-caused impacts is limited by the rotational grazing system which ensures that livestock will not be in any one unit for the entire grazing season, but will be moved amongst the units. The conservation measures, implemented as part of the Allotment's AOI, include the use of a rider once every 2 weeks to move livestock away from streams, salting, fencing, and fence maintenance to further limit livestock use. Adhering to annual use indicators for greenline stubble height, bank alteration, and woody browse use, described in the *Proposed Action* section above, is expected to improve habitat conditions for bull trout. Using status of these indicators (triggers) to determine when livestock need to be moved from the unit will reduce the level of grazing intensity and the duration of livestock use in the unit. Additionally, uplands within the Allotment, and all streams without specifically identified stubble height indicators, would be grazed at a moderate level (50 percent utilization standard). Limiting utilization will reduce potential sediment inputs to streams from the uplands and small tributary streams by ensuring vegetation is retained in the uplands and on streambanks, and by limiting the amount of time livestock are in an area, thus limiting the amount of time livestock may impact soils. The majority of livestock trailing would be active/supervised and utilize an existing road, thereby limiting the duration and areal extent of potential livestock impacts. Moreover, natural features including steep topography and dense woody riparian vegetation limit livestock access to the streams throughout much of the Allotment.

Sediment settling into the substrate has the potential to negatively affect incubating bull trout eggs. Livestock grazing would occur in the Indian Ridge Unit and livestock trailing would occur in the Hughes Creek Unit subsequent to initiation of bull trout spawning, when there would be a possibility for deposited sediment to effect incubating bull trout eggs. As described above, livestock access to streams is limited by steep terrain and dense woody riparian vegetation and

the proposed action limits the potential for sediment input to streams in the Allotment. For these reasons, sedimentation effects from the proposed action are expected to be of short duration and low in concentration, and have insignificant effects to bull trout.

Proposed monitoring will be effective in identifying future trends of sediment levels within the action area. This monitoring will be effective in identifying both the occurrence and causal mechanisms of any changed conditions which would initiate responsive modification of grazing management strategies for the Allotment under the adaptive management strategy (outlined in the Assessment, pp. 16-17).

After reviewing the information presented by the Forest in the Assessment, and background information on variables affecting the degree of change to sediment levels (Appendix A, Section 3.3), the Service concludes the impacts of the proposed action to riparian and channel conditions will be short-term, infrequent, and minor. Improved riparian conditions (streamside vegetation and streambank condition) are expected to maintain at objective levels, or reduce sediment levels, because of the relationship between these conditions and sedimentation described above. Therefore, the effects to bull trout from the effect to sediment caused by the proposed action are considered insignificant.

Width to Depth Ratio of Stream Channels

A stream's channel can be categorized using a number of variables describing the topography, gradient, and hydrology of the watershed. For different types of stream channels a range of width to depth ratios is expected if the stream is functioning appropriately for its channel type. Therefore, measuring width to depth ratios of streams is useful for assessing the condition of the stream to support healthy fish populations. Streams that have high width to depth ratios expose greater surface area for heating and the shade provided by low bank vegetation does not extend very far across the water surface. Since bull trout need cool water and are sensitive to warm water temperatures, width to depth ratios of bull trout-occupied streams are an important component of habitat quality. Livestock have the potential for increasing channel width to depth ratios by shearing off segments of the bank and reducing the vegetative community on the bank, thus making bank slough off and channel widening more likely (See Appendix A, Section 2.1.2 for a discussion of the impacts of grazing on stream channel width to depth ratios).

The Forest relied on value and ranges identified within the document *Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho* (Overton et al. 1995, pp. 26-100) to establish width to depth ratio objectives specific to channel type, local geology, topography, climate, and potential vegetation. These values represent natural conditions in the absence of human disturbance. Based on information presented in the Assessment, the Service concludes that all reported width to depth ratios in the action area are appropriate for their channel type and geology (Assessment, pp. 37-39), and fully supportive of bull trout needs related to their life history.

The Forest has limited data for stream width to depth ratios in the Allotment (Assessment, p. 37), but the Assessment reports on the condition of factors that influence width to depth ratios, such as streamside vegetation and streambank condition. The Assessment indicates that streambanks are highly stable (Assessment, pp. 39-40) and streambank vegetation on many streams is

dominated by dense woody vegetation (Assessment, pp. 6, 41, Appendix I). These data suggest impacts to riparian areas which could lead to increased width to depth ratios have not been substantial.

The proposed action is expected to maintain width to depth ratios at the resource objective level because the intensity, duration, and frequency of potential livestock-caused impacts is limited by the rotational grazing system which ensures that livestock will not be in any one unit for the entire grazing season, but will be moved amongst the units. The conservation measures, implemented as part of the Allotment's AOI, include the use of a rider once every 2 weeks to move livestock away from streams, salting, fencing, and fence maintenance to further limit livestock use. Additionally, adhering to annual use indicators for greenline stubble height, bank alteration, and woody browse use, described in the *Proposed Action* section above, is expected to improve habitat conditions for bull trout. Using status of these indicators (triggers) to determine when livestock need to be moved from the unit will reduce the level of grazing intensity and the duration of livestock use in the unit. The majority of livestock trailing would be active/supervised and utilize an existing road, thereby limiting the duration and areal extent of potential livestock impacts. Moreover, natural features including steep topography and dense woody riparian vegetation limit livestock access to the streams throughout much of the Allotment.

Proposed monitoring will be effective in identifying future trends of width to depth ratios within the action area. This monitoring will be effective in identifying both the occurrence and causal mechanisms of any changed conditions which would initiate responsive modification of grazing management strategies for the Allotment under the adaptive management strategy (outlined in the Assessment, pp. 16-17).

After reviewing the information presented by the Forest in the Assessment, and background information on the variables affecting width to depth ratios of streams in the Allotment (Appendix A, Section 3.3), the Service concludes the effects to bull trout from the effect to width to depth ratios caused by the proposed action are insignificant.

<u>Streambank Condition</u>
Streambank stability determines how easily portions of a bank can slough off into a stream when livestock walk on banks or natural high flow events move through the stream. Sloughing banks eliminate fish hiding cover under overhanging banks. Sloughing banks also contribute sediment into the channel and make the stream more likely to move out of its channel, creating higher width to depth ratios and exposing more surface area to warming. Livestock grazing has the potential to reduce streambank stability by reducing bank vegetation, which "holds" the soil via plant roots, and by directly shearing off overhanging banks (See Appendix A, Section 2.1.2 for a complete discussion).

Based on information presented in the Assessment, the Service concludes streambank condition of most streams within the Allotment are fully supportive of bull trout needs. The streambank stability objective of 90 percent stable has been met at two of the three sites monitored in conjunction with the Forest's long-term core sampling locations. Streambank stabilities have trended upward or were stable during the monitoring period of record. Streambank stabilities

have periodically been reduced in some areas of the Allotment by impacts from excessive runoff events within the watershed (e.g., well above average snowpack during the winter of 1996-1997 produced extremely high spring runoff flows).

The proposed action represents light to moderate grazing, which is likely to facilitate the gradual improvement of many riparian area characteristics in the Allotment (Appendix A, Section 3.1.4c and 3.3.6c). The duration and frequency of potential livestock-caused impacts is limited by the rotational grazing system which ensures that livestock will not be in any one unit for the entire grazing season, but will be moved amongst the units. The conservation measures, implemented as part of the Allotment's AOI, include the use of a rider once every 2 weeks to move livestock away from streams, salting, fencing, and fence maintenance to further limit livestock use. Additionally, adhering to annual use indicators for greenline stubble height, bank alteration, and woody browse use, described in the *Proposed Action* section above, is expected to improve habitat conditions for bull trout. Using status of these indicators (triggers) to determine when livestock need to be moved from the unit will reduce the level of grazing intensity and the duration of livestock use in the unit. The majority of livestock trailing would be active/supervised and utilize an existing road, thereby limiting the duration and areal extent of potential livestock impacts. Moreover, natural features including steep topography and dense woody riparian vegetation limit livestock access to the streams throughout much of the Allotment.

Proposed monitoring will be effective in identifying future trends of streambank stability within the action area. This monitoring will be effective in identifying both the occurrence and causal mechanisms of any changed conditions which would initiate responsive modification of grazing management strategies for the Allotment under the adaptive management strategy (outlined in the Assessment, pp. 16-17).

After reviewing the information presented in the Assessment, and background information on the variables affecting bank stability (Appendix A, Section 3.3), the Service concludes bank stabilities are above, or near, objective level and the proposed action is likely to maintain at objective levels, or improve stabilities. While impacts to bank stability could occur, these are expected to be localized, limited in extent, and minor. Therefore, the effects to bull trout from the effect to streambank stability caused by the proposed action are considered insignificant.

Riparian Conservation Areas

RCA is a term used to identify areas around streams or waterbodies for special management and conservation. The Forest uses a variety of information to assess whether the RCA is functioning appropriately and its trend over time. Some of this information is strongly related and even slightly redundant to several of the focus indicators discussed above. Livestock grazing can negatively impact vegetation characteristics, streambanks, and GES such that the riparian community trends lower and the quality of habitat for bull trout is reduced.

Based on information presented in the Assessment, the Service concludes the RCA condition of the creeks in the Allotment has been impacted by the Mustang Complex wildfire. GES data is available only on streams not occupied by bull trout. These data indicate a downward trend. However, the Assessment indicates that, overall, streambanks within the Allotment are highly

stable (Assessment, pp. 39-40), most width to depth ratios are appropriate for the channel type (Assessment, pp. 37-39), and streambank vegetation on many streams is dominated by dense woody vegetation (Assessment, pp. 6, 41, Appendix I).

The proposed action represents light to moderate grazing, which is likely to facilitate the gradual improvement of many riparian area characteristics in the Allotment (Appendix A, Section 3.1.4c and 3.3.6c). The duration and frequency of potential livestock-caused impacts is limited by the rotational grazing system which ensures that livestock will not be in any one unit for the entire grazing season, but will be moved amongst the units. The conservation measures, implemented as part of the Allotment's AOI, include the use of a rider once every 2 weeks to move livestock away from streams, salting, fencing, and fence maintenance to further limit livestock use. Additionally, adhering to annual use indicators for greenline stubble height, bank alteration, and woody browse use, described in the *Proposed Action* section above, is expected to improve habitat conditions for bull trout. Using status of these indicators (triggers) to determine when livestock need to be moved from the unit will reduce the level of grazing intensity and the duration of livestock use in the unit. The majority of livestock trailing would be active/supervised and utilize an existing road, thereby limiting the duration and areal extent of potential livestock impacts. Moreover, natural features including steep topography and dense woody riparian vegetation limit livestock access to the streams throughout much of the Allotment.

After reviewing the information presented by the Forest in the Assessment, and background information on the variables affecting bank stability and vegetation communities (Appendix A, Section 3.1, 3.2, 3.3), the Service concludes RCA conditions of some streams are not at objective levels, while RCA conditions on other streams likely meet objective levels. The Service anticipates the proposed action is likely to maintain at objective levels, or improve RCA conditions. While impacts to streambank vegetation could occur, these are expected to be localized, limited in extent, and minor. Therefore, the effects to bull trout from the effect to RCA condition caused by the proposed action are considered insignificant.

B. Effects of Interrelated or Interdependent Actions

The implementing regulations for section 7 define interrelated actions as those that are a part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. No interrelated or interdependent actions have been identified in this consultation.

V. 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 area considered in this Biological Opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act. No cumulative effects have been identified in this consultation.

VI. CONCLUSION

After reviewing the current status of the bull trout, the environmental baseline for the action area, the effects of the proposed action, and cumulative effects, it is the Service's biological opinion that the Forest's proposed authorization of livestock use on the Indian Ridge Allotment in Idaho is not likely to jeopardize the coterminous U.S. population of the bull trout. The Service's rationale for this determination is presented below.

The condition of riparian and aquatic habitats within most of this Allotment, as assessed through the habitat indicators, support conditions that are likely to allow for bull trout to successfully reproduce, feed, and shelter. Although data on some habitat condition indicators are lacking, the majority of bull trout habitat within the Allotment have streamside vegetation and streambank conditions (factors that influence several indicators) within the range of condition considered to be appropriate to fully support bull trout conservation needs.

The proposed level of grazing conforms to what is described in the scientific literature as "light to medium" or "light to moderate" grazing, which is likely to maintain bull trout habitat in a suitable condition, and will allow for further improvement of many riparian area characteristics in the action area (Appendix A, Section 3.1.4c and 3.3.6c). Any impacts from the proposed livestock grazing are not likely to occur evenly across the Allotment due to access, livestock preferences, and the conservation measures incorporated into the proposed action that would limit the frequency, intensity, and scale of impacts to the bull trout and its habitat. Additionally, the majority of livestock trailing would be active/supervised and utilize an existing road, thereby limiting the duration and areal extent of potential livestock impacts. To prevent negative trends, the Forest has established a process for identifying and addressing livestock impacts on the Allotment that fully considers the relevant life history needs of the bull trout (Assessment, pp. 16-17, Appendix F).

Trailing livestock with access to streams in this Allotment where bull trout are spawning and depositing eggs is expected to cause some disturbance of spawning fish and trampling of some redds. In the *Effects of the Proposed Action* section of this Opinion, the Service estimated the scale and extent of that disturbance and trampling, and determined that even redds that are trampled are not likely to be completely destroyed. The Service also finds that although the number of cattle-impacted redds may appear relatively high, the impact on the viability of the affected bull trout population is not commensurate because of the bull trout's r-selected reproductive strategy. Due to factors such as the compensatory density dependent relationship between bull trout eggs and recently hatched young, impacts to redds and eggs are a lower concern for the viability of the populations than other impacts.

For the above reasons, the Service concludes that the anticipated level of effects caused by the proposed livestock grazing to bull trout habitat, spawning adults, and redds over the term of the proposed action, taking into account past impacts in the action area, is likely to be compatible with sustaining the viability of the two affected local populations of the bull trout. Habitat quality and quantity for the bull trout on the Allotment are likely to be maintained or improved under the proposed action based on the limited accessibility of streams in the Allotment and habitat improvements that have resulted under similar grazing management.

VII. INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing 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 wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering.

Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an Incidental Take Statement. The measures described below are non-discretionary, and must be undertaken by the Forest so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply.

A. Amount or Extent of Take Anticipated

Based on the results presented in the *Effects of the Action* analysis above, the Service finds that incidental take of the bull trout is likely to occur in the form of lethal take caused by cattle trampling of up to four bull trout redds in Hughes Creek annually on the Indian Ridge Allotment.

B. Effect of the Take

In the accompanying Biological Opinion, the Service determined that this level of anticipated take is not likely to jeopardize the coterminous United States population of the bull trout.

C. Reasonable and Prudent Measures

The Service finds that compliance with the livestock management actions, as outlined in the Assessment for the proposed action, is essential to minimizing the impacts of incidental take of the bull trout on the Allotment. The Forest's commitment in the Assessment to numerous conservation measures, including the use of stubble height, bank alteration, and woody browse use indicators as triggers to move livestock from units and prevent a downward trend in habitat conditions, minimizes the impacts of take of the bull trout.

The Service also finds that the following Reasonable and Prudent Measure is necessary and appropriate to minimize the impacts of incidental take of the bull trout reasonably certain to be caused by the proposed action.

Reasonable and Prudent Measure 1 – The Forest shall report on the number or extent of bull trout redds trampled by livestock on the Allotment.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Forest must comply with the following term and condition which implements the reasonable and prudent measure described above and outlines required reporting/monitoring requirements. This term and condition is not discretionary.

Term and Condition 1 to implement Reasonable and Prudent Measure 1:

The Forest shall conduct monitoring and reporting of incidental take as follows. By March 1 of each year for the term of the proposed action, the Forest shall submit a completed form (see Appendix C) summarizing grazing results for the previous grazing year and the results of redd surveys for that year to the Team Leader of the Service's Eastern Idaho Field Office in Chubbuck, Idaho. If trampled redds are found, the Forest shall immediately notify the Service.

The Forest shall survey Hughes Creek each year for the term of the proposed action to document any impacted bull trout redds. The following survey protocol shall be followed:

- The Forest shall use a trained observer(s) to conduct a focused survey of a 1,000-meter segment. The segment surveyed should be the stream segment with the highest likelihood of having bull trout redds or one that is known to have had such redds in the past. The surveyed segment should include the best spawning habitat in the stream.

- The survey shall be conducted when the likelihood of observing bull trout redds present in the stream that have been impacted by livestock is the greatest.

- The Forest shall record the location of the survey areas, and the number of bull trout redds encountered, an estimate of the linear distance of suitable spawning habitat in the survey segment, and the number of redds impacted by grazing activities.

Changes to the above protocol can be made, as appropriate, in coordination with and the approval of the Service.

VIII. 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 action on listed species or critical habitat, to help implement recovery programs, or to develop new information on listed species.

The Service recommends monitoring all six focus indicators on all allotment units at least once every three to five years to track long-term trends. This is particularly relevant to those units that share streams or have tributaries connected to fish-bearing streams.

Given the difficulties noted above for exactly determining the number of trampled redds, should the Forest devise a more efficient monitoring program or method for monitoring take of bull trout redds, the Service will evaluate that method and consider amending this Incidental Take Statement to reflect that improvement.

The Service recommends continued monitoring for bull trout presence in streams within the Hull Creek Unit of the Allotment to support the Service's assumptions of bull trout spawning in the Allotment.

IX. REINITIATION-CLOSING STATEMENT

This concludes formal consultation on the Forest's proposal to authorize livestock grazing in the Indian Ridge Allotment in Lemhi County, Idaho. 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; (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; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

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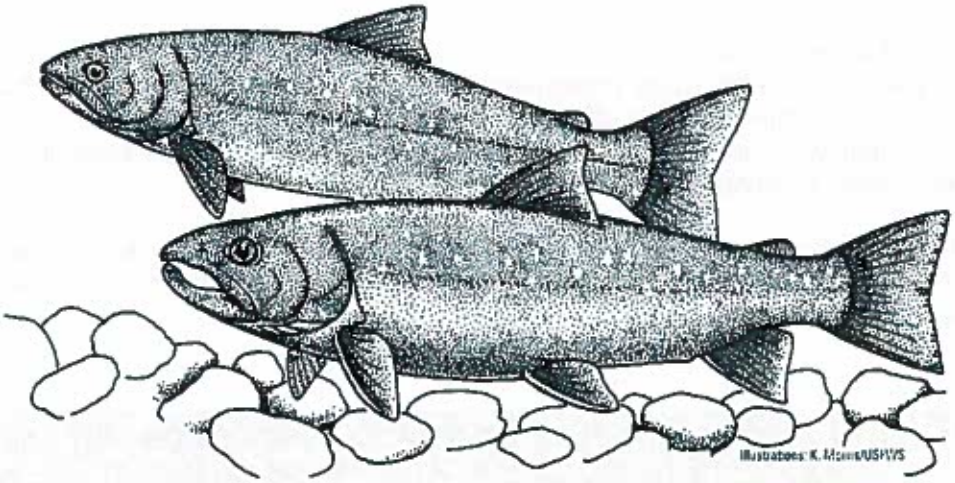
APPENDIX A

ASSESSING THE EFFECTS OF GRAZING ON BULL TROUT AND THEIR HABITAT

An alternative approach- the effects and variables influencing those effects

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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Theresa Doumitt
ATW Consulting
Ririe, Idaho
731-234-4229

Doug Laye
U.S. Fish and Wildlife Service
Eastern Idaho Field Office
Chubbuck, Idaho

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

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 1978, 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 87) 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 87). 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 148) 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 25) 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).

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 Zam 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

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 16; 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).

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.

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. 1989, 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; Miner 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 48).

"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

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 638) 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 129, 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.

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.

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 1998, 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).

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 589; 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 1967, pg 147). More nutrient-rich soils provide an additional source of nutrient input to support the aquatic food chain.

3.2.4 Management considerations/Grazing strategy

See variable discussion in section 3.1.4.

3.3 VARIABLES FOR EFFECT PATHWAY 3

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 (1995, 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 1998, 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).

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 564-565) 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 i) 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).

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 Garnett 2009, pg 364). 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

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, 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 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.

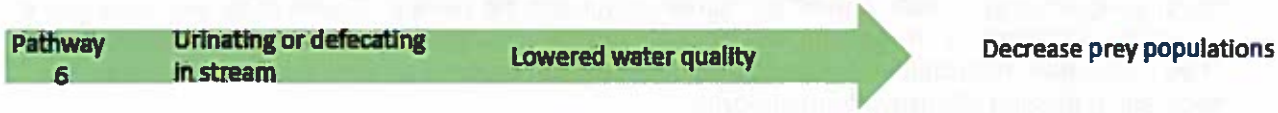
d) **Annual pasture use** – See variable discussion in section 3.1.4d, but more specifically if a pasture is being rested/deferred from grazing, then the threat of harassing juveniles is eliminated when rested or limited to the time period that the pasture is in deferred use.

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 948) 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, 329). 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 48; 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.

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).

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 48; 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.

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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APPENDIX B

ESTIMATING REDD DENSITIES FOR USE IN BIOLOGICAL OPINIONS

Estimating Redd Densities for Use in Biological Opinions
June 2010

Background

The Fish and Wildlife Service (Service) has written several biological opinions for actions of the Salmon-Challis National Forest (Forest) which anticipated bull trout redds being exposed to trampling from grazing livestock. When comprehensive redd surveys for action area streams where redds might be exposed to livestock trampling are lacking, the Service used a series of assumptions to approximate the redd numbers for those streams. In Appendix A to the Panther Creek Biological Opinion issued in October of 2007 (consultation number 1-4-07-F-0445), the Service laid out its approach for the approximation. Generally, the approximation was based on estimated bull trout densities, non-randomized redd surveys and stream lengths. In that appendix the Service also outlined the likely sources of error in the calculation. This same approach was used in several Opinions issued later including one on grazing in the Upper Hayden grazing allotment for 2009 (consultation number 14420-2007-F-0477, issued in July 2009). At the time, the Service was unaware of any better method or data to support a different, more accurate, approximation.

There is potential for large errors in the calculation because the number of redds deposited in a given section of occupied stream over a given period of time is driven by temperature of water over that period, gradient of stream, density of adult fish and amount of suitable spawning habitat and all of these conditions are variable. In turn, spawning habitat is limited to areas that have the substrate with correct gravel size, water depth and flow characteristics. The result of these variables is that the amount of suitable spawning habitat in a length of stream is generally much less (measured either in area or length) than the total area or length of the stream section. Using simplistic or sporadic fish density and redd surveys to extrapolate across the length of a stream fails to take into account those variables, and tends to substantially over-estimate the number redds or extent of the spawning habitat.

Field Observations

In those two Opinions that used the simplistic method as a part of the Incidental Take Statement, the Service required the Forest to survey segments of those streams to assess the results observed on the ground, compared to the impact anticipated by the Opinion. In addition to monitoring take from the Forest's action, this monitoring was intended to gain field information on the size of error of the Service's projected redds and redd impacts. Field surveys (in streams subject to Service redd estimates conducted in a few occupied streams on the Forest, in 2007, 2008, and 2009), have confirmed the substantial over-estimate of redd numbers using prior methodology. Below is a short description of the finding from those field surveys.

<u>Little Deep Creek</u> - In the Panther Opinion a density of 1.3 redds per 100 meters was predicted based on extrapolations from non-random redd surveys in that stream. On November 8, 2007, 1,700 meters of the stream were surveyed and 2-3 redds were observed. Extrapolated density estimate for that same length of stream segment predicted 22.1. This represents an over -

estimate at a scale of 10 fold. No trampled redds were found. Evidence of grazing was very, very light but livestock tracks were most common in areas that were most likely to be used as redd locations.

Moyer Creek - In the Panther Opinion a density of 0.04 redds per 100 meters was predicted based on extrapolations from non-random redd surveys in that stream. On September 18, 2007 (timed with livestock removal), 2,900 meters of the stream were surveyed and 0 redds were observed. Extrapolated density estimate (one redd) for that same length of stream segment predicted was an over-estimate but since no redds were found no particular error rate can be reached. However, surveyors saw very little area that was suitable for spawning – less than 100 meters of the stream surveyed. This does point to timing of grazing and redd initiation overlap as one area for error in an estimate.

Jefferson Creek - No habitat was expected in this stream (based on professional judgment about stream characteristics). On September 18, 2007, 450 meters of the stream were surveyed and 0 redds were observed. The stream lacked the width and substrate to likely support bull trout. The stream very narrow, often no more than 18 inches wide, making it likely that livestock would just step across the creek.

Moccasin Creek - In the Panther Opinion a density of 0 redds per 100 meters was predicted based on extrapolations from non-random redd surveys in streams similar to the characteristics of this stream. On September 18, 2007, 900 meters of the stream were surveyed and 0 redds were observed. No surveyed sections had substrate suitable for spawning. Part of the stream was very muddy and part was heavily armored and surrounded by spruce fir. These conditions confirm that streams do not contain spawning habitat for their entire length.

Arnett Creek -In the Panther Opinion a density of 0 redds per 100 meters was predicted based on previous non-random surveys of the stream. On October 30, 2008, 1,000 meters of the stream were surveyed and 0 redds were observed. Several bull trout were observed. Access to the stream was extremely difficult due to downed trees. It is doubtful livestock could access much of the stream. Only about 10 sites of less than 1 meter square were seen as suitable for spawning. Observations confirmed that conditions on the streams edge can reduce or eliminate access to stream (and redds).

East Fork of Hayden Creek - In the Upper Hayden Opinion a density of 7.2 redds per 100 meters was predicted based on extrapolations from non-random redd surveys in this stream. On August 26, 2009, 1,000 meters of the stream were surveyed and 0 redds were observed. Extrapolated density estimate for that same length of stream segment predicted 72 redds. Part of the reason for the difference may be that the survey was conducted at the time that livestock were expected to be off the allotment (though some were seen during the survey), but it also was at a time when few redds would be expected.

On September 16th another survey was performed along 700 meters of the best spawning habitat after all cattle had been removed. Twenty-one bull trout redds were observed (3 per 100 meters) and none appeared to have been trampled. Extrapolated density estimate would have predicted 54 redds.

Hayden Creek – In Upper Hayden Opinion a density of 6 redds per mile (0.67 redds per 100 meters) was predicted based on extrapolations from non-random redd surveys. On October 6, 2009, a survey of 1,000 meters was performed. Two bull trout redds were observed (2 redds per 1,000 meters) and neither were trampled.

The major observations from the field surveys were that - livestock tracks were not random and were often associated with spawning habitat, spawning habitat was not continuous and there were often large sections of stream unsuitable for spawning, Service estimates had as high as tenfold error potential, and many areas of streams were effectively blocked to livestock access by conditions on the stream's edge.

Recent Information

In 2010, a report was made available from the U. S. Fish and Wildlife Service Office in La Grande, Oregon on bull trout redd monitoring in the Wallowa Mountains in eastern Oregon (Sausen 2010). That report summarized the results from bull trout redd monitoring on the Lostine River, Imnaha River, Lick Creek, Bear Creek, Goat Creek and Big Sheep Creek. These surveys were done annually for 9-11 years and were performed along entire segments of the waterways that included both areas with and without spawning substrate. Average density of bull trout redds ranged between 2.4 redds per mile (Big Sheep and Lick Creeks) to 11.5 redds per mile (Imnaha River).

Based on photographs from this report (Sausen 2010, pp. 25-27) - Big Sheep Creek, Bear Creek (4.6 redds per mile) and Lick Creek are similar but trend larger in size than many of the creeks in grazing allotments on the Forest. Both resident and fluvial fish inhabited these streams and redds from both forms of bull trout were counted in the total redd counts (S. Schmidt, pers. comm., March 11, 2010).

Conclusion

Given findings from field surveys performed on the Forest, the averages presented in Sausen (2010) seems more likely to represent typical redd densities than previous methods. Lacking local redd data or surrogate data from nearby comparable streams, the Service intends to use estimates from Sausen. Those values are 11.5 redds per mile for small rivers and large streams (width greater than 15 feet), and 2.4 redds per mile for smaller streams (width less than 15 feet).

APPENDIX C

Annual Monitoring Report Form for Actions covered under the Service's Biological Opinion for Grazing on Allotments Managed by the Salmon Challis National Forest.

Please submit annually by March 1 to the Supervisor of the Service's Eastern Idaho Field Office, 4425 Burley Dr., Suite A, Chubbuck, Idaho 83202; telephone (208) 237-6975. Please include name and contact information in case additional information is needed.

1. What was the name of that stream in this allotment surveyed for impacted redds?

2. What was the date of the survey, and what were the water conditions?

3. Which stream segment was surveyed and how many redds and impacted redds were found? (Please give GPS start and stop points for segments)?

4. What was the date that livestock removed from the pasture with surveyed stream segment?

5. Did this number exceed the scale anticipated in section VII of the Biological Opinion?

6. Were there any changes to the grazing management that differed from the proposed grazing management in the Forest's Biological Assessment? If yes, what were they?

7. Were there any unexpected circumstances or events that resulted in impacts beyond those anticipated in the Forest's in the Biological Assessment or the Service's Biological Opinion? If yes, please describe.

Salmon Challis NF Official: _____

Date: _____

Contact Information: _____