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Aquatic Species Resource Report

Westside Fire Recovery

Happy Camp/Oak Knoll and Salmon/Scott River Ranger Districts
Klamath National Forest
Siskiyou County, California

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Aquatic Resources Report

Introduction

The Westside Fire Recovery (WSFR) Project Area includes about 200,000 acres (185,000 of Forest lands) that were burned in 2014 by the Beaver Fire, Happy Camp Complex and Whites Fire. The Aquatic Resources Report provides a description of the Affected Environment or Analysis Area, which includes special status aquatic species and their habitat, and the Environmental Consequences or effects of the WSFR on aquatic resources.

The Aquatic Resources Analysis Area (Analysis Area) is the 5th- and 7th-field watersheds located in the Middle Klamath River basin (see Table 2-5) that were affected by the fires and have proposed activities. The Analysis Area provides habitat for the following special status aquatic species:

Endangered:	None
Threatened: (SONCC) Coho salmon	Southern Oregon/Northern California Coast
Critical Habitat:	SONCC Coho salmon
Proposed:	None
Forest Service Sensitive aquatic species:	
Upper Klamath-Trinity (UKT) Chinook salmon, Klamath Mountains Province (KMP) steelhead, Pacific lamprey, Klamath River lamprey, Western Brook Lamprey, Southern Torrent Salamander, Foothill Yellow-Legged Frog, Cascade Frog, , and Western Pond Turtle	
Essential Fish Habitat:	SONCC Coho salmon; UKT Chinook salmon
Management Indicator Species:	Steelhead; resident rainbow trout

The Klamath National Forest (KNF) Land and Resource Management Plan (Forest Plan) (USDA-USFS 1995) contains the components, objectives, and standards and guidelines for land management projects. The Record of Decision (ROD) for the Forest Plan is the guiding document and t incorporates the Aquatic Conservation Strategy (ACS) standards and guidelines from the ROD for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl (commonly known as the Northwest Forest Plan) (USDA Forest Service and USDI Bureau of Land Management 1994). A major provision of the Forest Plan is the ACS, which includes Riparian Reserves, Key Watersheds, watershed analysis and watershed restoration to help provide quality habitat for aquatic species. Ecosystem analysis at the landscape/watershed level, which includes the watershed analysis in the ACS, is used to assess management concerns in an ecosystem approach and is an integral part of KNF Forest Plan implementation. Refer to the ID team analysis of the Project relative to attainment of ACS Objectives including the immediate (short-term) impacts, as well as long-term trends, at both the project and 5th field watershed scale.

Many of the tributary watersheds on the KNF and within the Analysis Area are designated Key Watersheds in the Forest Plan because they are in good to excellent condition, provide high quality water and are critical for the protection and recovery of salmon and steelhead.

Management direction relative to Key Watersheds emphasizes riparian and aquatic habitat protection and restoration. Riparian Reserves, as defined in the Forest Plan, receive strong protection from potential project impacts.

Existing conditions for watersheds, streams, and fisheries in the Analysis Area have been described to a fairly high level of detail in a number of other existing documents (listed below and in the Reference Section). Existing condition information for this report was also derived from post-fire field reviews.

- Klamath National Forest Land and Resource Management Plan (Klamath LRMP; USDA-USFS 1995)
- KNF Ecosystem Analyses (refer to Literature Cited Section)
- KNF Forest-wide water quality monitoring (temperature, sediment, flows) http://www.fs.usda.gov/detail/klamath/landmanagement/resourcemanagement/?cid=stelprdb5312713
- KNF WSFR Project Burned Area Emergency Response (BAER) reports (USFS 2014a-2014f)
- KNF Biological Assessments prepared for other current or past projects that potentially affected anadromous salmonids within the Analysis Area (refer to the Literature Cited Section)
- Final Recovery Plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit (NMFS 2014)

Proposed Actions and Alternatives Analyzed

Refer to the "Westside Fire Recovery Project Scoping Outcome Summary" (USFS 2014g) for a detailed description of alternatives.

Methodology

The WSFR Project Aquatic Resources analysis has two components: (1) a review of existing information, and (2) post-fire field review of proposed treatment units, Riparian Reserves and stream channels.

Existing information came from the KNF LRMP, watershed analyses conducted by the KNF, existing stream survey data and reports and other environmental analyses completed for projects within the Analysis Area. These sources provided information on watershed histories and land uses, fish distribution and habitat use within the Analysis Area and stream survey data.

To integrate assessment of upslope watershed features that generate or impact physical habitat for fish, Aquatic Resources analysts worked collaboratively with watershed and geology specialists on this Project. The watershed team collaboratively identified and reviewed sensitive watershed areas such as active landslides, active surface erosion, stream channels and Riparian Reserves in the field and developed meaningful Project Design Features (PDFs) for the protection of aquatic resources within the Analysis Area.

The interdisciplinary field review included these elements:

- **Field review of proposed salvage units, hazard tree removal areas and fuels treatment units**.

- **Field review of the most actively unstable areas in or near proposed treatment units**. The objective of this review was to look for correlations between slope failure and geology, geomorphology, and disturbance.
- **Reviews of selected stream reaches to validate and supplement existing information on channels**. These surveys were limited in geographic extent, intended only to provide a current snapshot of channel conditions since the quantitative surveys were conducted.
- Field review of Riparian Reserves with proposed treatments. The objective was to field review the condition of Riparian Reserves where they were burned or where there may be potential impacts from proposed actions.

Another component of this analysis is the application of the KNF's Cumulative Watershed Effects (CWE) model. The CWE model tracks watershed disturbance and management activities to gauge the relative risk of impairing watershed functions that can then produce secondary off-site impacts including to fish habitat and other beneficial uses.

The affected environment is described below based on the best available information. Quantitative habitat survey information available for streams within the Analysis Area reflect fish habitat prior to the 2014 fires. Thus, post-fire Burned Area Emergency Response (BAER) assessments, updated CWE analysis (updated to incorporate effects of the 2014 fires and road improvements identified in BAER assessments), post-fire analysis of acres of Riparian Reserves burned (including fire severity), and post-fire field observations by fisheries biologists and hydrologists are used herein to update pre-fire baseline conditions.

Aquatic Species

A list of Threatened, Endangered, and Candidate species was obtained online from the Arcata USFWS office website (http://www.fws.gov/arcata/specieslist/speciesreport.asp). Species considered as Forest Service Sensitive were compiled by the Forest Service Pacific Southwest Regional Office (on file KNF). These lists were used as a basis for determining which aquatic species were to be considered in this report (see Table 1). There is one aquatic species on the Sensitive species list that is not likely to occur within the project area, and therefore is not analyzed here based on the following rationale:

Western Brook Lamprey (*Lampetra richardsonii)*

Researchers conducted lamprey surveys for several years in lower, middle and upper Klamath River tributaries from 2005 through 2009; western brook lamprey were found only in McGarvey, Mynot, and Hunter creeks, and not in any tributaries upriver from these coastal streams (Goodman & Reid, personal communication). These researchers also searched fish museum collections and did not find records of any *Lampetra* species on the Klamath National Forest. Western Brook lamprey are not expected to occur in the Klamath River or tributaries within this Analysis Area (Elk Cr and upriver through Beaver Cr), therefore this species will not be analyzed as part of this project.

Fish Species

The Analysis Area provides habitat for Southern Oregon/Northern California Coasts Coho salmon (*Oncorhynchus kisutch*), listed as Threatened under the ESA, and their designated Critical Habitat. Forest Service Sensitive fish species that may occur within the Analysis Area include Upper Klamath-Trinity Rivers Chinook (*Oncorhynchus tshawytscha*), Klamath

Mountains Province Steelhead (*Oncorhynchus mykiss*), Klamath River lamprey (*Entosphenus similis*), and Pacific lamprey (*Entosphenus tridentatus*). Both steelhead and resident rainbow trout (*Oncorhynchus mykiss*) are Management Indicator Species under the KNF Forest Plan. Essential Fish Habitat for Coho and Chinook salmon occur within the Analysis Area, and is identical to the distribution of Coho salmon Critical Habitat. See project maps for the expected distribution of fish species throughout the project area.

Other Sensitive Species

Other Forest Service Sensitive aquatic species that may occur in the Analysis Area include Foothill Yellow-legged Frog (*Rana boylii*), Cascade Frog (*Rana cascadae*), Southern Torrent Salamander (*Rhyacotriton variegatus*), and Western pond turtle (*Actinemys marmorata*).

Foothill yellow legged frog and Western pond turtle are known to occur in the Klamath River, Scott River, and North Fork Salmon River. These species are assumed to occur in all relatively low gradient and low elevation slow water habitat (mostly restricted to the Klamath River and a few larger tributaries such as Beaver Cr). Cascade frogs have been observed at Wilderness lakes that comprise the headwaters of several project area streams (Elk Cr, Kelsey Cr, Canyon Cr, and South Russian Cr). Cascade frogs are assumed to occur in the project area within, or near, stream and lake habitat above 2500 feet. The KNF is mostly outside the expected distribution of Southern Torrent salamander, which occur in or very near coastal streams to the west of the KNF. It is not likely that Southern torrent salamanders occur in the project area but since presence cannot be ruled out, it is assumed that they may occur in suitable stream habitat on only the Happy Camp Ranger District (Elk Cr for this Analysis Area).

This assessment will document potential direct, indirect, and cumulative impacts to all ESA-listed and Forest Service Sensitive aquatic species. Since these aquatic species all have overlapping habitat requirements to some degree, one analysis of potential indirect and cumulative effects to aquatic habitat serves as the habitat analysis for all species discussed here. Key habitat Indicators (described below) were selected for analysis that best represent the critical important habitat components for all aquatic species analyzed.

The Klamath National Forest also uses Management Indicator Species (MIS) as management indicators to assess landscape and project-level impacts to habitat conditions (LRMP 4-39). Rationale for designation of these MIS is found in the EIS for the Klamath National Forest Land and Resource Management Plan (1995) and on the "LRMP MIS Selection Summary" located in the project file. The project MIS Report includes terrestrial and aquatic species and is included in the WSFR Project File. Rainbow trout, steelhead, and various amphibians are included as MIS for the WSFR Project.

The biological requirements of species included in this report are given in **Appendix B**.

Table 1: Summary of special status aquatic species

		Endangered	Threatened	Forest Sensitive	MIS	Critical Habitat	Essential Fish Habitat
Salmonids							
Coho Salmon (Southern Oregon/Northern California Coasts)	*Oncorhynchus kisutch*		X			X	X
Chinook Salmon (Spring/Fall runs) (Upper Klamath-Trinity Rivers)	*Oncorhynchus tshawytscha*			X			X
Steelhead Trout (Klamath Mountains Province)	*Oncorhynchus mykiss*			X	X		
Rainbow Trout	*Oncorhynchus mykiss*				X		
Lamprey							
Pacific Lamprey	*Entosphenus tridentatus*			X			
Klamath River Lamprey	*Entosphenus similis*			X			
Amphibians and Reptile							
Foothill Yellow Legged Frog	*Rana boylii*			X			
Cascade Frog	*Rana cascadae*			X			
Western Pond Turtle	*Emys marmorata*			X	X		

Analysis Indicators for Aquatic Habitat

The WSFR Project Aquatic Resources analysis uses habitat indicators from the *Analytical Process for Developing Biological Assessments for Federal Actions Affecting Fish Within the Northwest Forest Plan Area* (USDA-USDOC-USDI 2004). The Analytical Process utilizes key indicators of habitat quality (habitat indicators) and was formulated to standardize evaluations of actions and effects for conferencing/consultations under Section (§) 7(a)(2) of the ESA, focusing on salmonid fishes within the Northwest Forest Plan (NFP) area. Although the key aquatic habitat indicators apply to anadromous fish, they will also be used for other aquatic species in this report since species have over-lapping aquatic habitat requirements that are represented by the habitat indicators chosen below. The information developed through the Analytical Process generally also satisfies the information requirements for Essential Fish Habitat (EFH) consultation for Pacific salmon under the Magnuson-Stevens Fishery Conservation and Management Act and its implementing regulations (50 CFR Part 600) when the species is also listed under the ESA.

The Analytical Process involves two steps: 1) assembling and presenting the best available scientific and commercial information from a variety of sources, including watershed analysis, NEPA analysis, and other analyses used to implement land and resource management plans; and, 2) developing a Biological Assessment (BA) using analytical procedures that are based upon requirements specified in 50 CFR § 402.12(f) and described in the ESA consultation handbook (USDI and USDC 1998). The Process includes use of the “USFWS/NOAA Fisheries Table of

Population and Habitat Indicators" (the Table), which is a tool to characterize baseline habitat and populations for salmonids in the NFP Area. Habitat indicators are evaluated in the Table, and the Process allows for criteria values to be adjusted for local watershed conditions given supportive documentation. Consistent with the Matrix of Pathways and Indicators (NMFS 1996) the Table provides values and ranges of conditions to determine whether baseline conditions are *Properly Functioning*, *At Risk*, or *Not Properly Functioning*. The KNF has developed criteria for the mid-Klamath region using values from streams that are considered pristine and as supported by the data contained in the environmental impact statement for the Klamath LRMP. The Klamath tributaries matrix (KNF 2012) serves as the basis to identify relative baseline conditions, including existing conditions for the WSFR Project. This information, as well as watershed assessments, reports, and field reviews were used to formulate existing and desired conditions, and to evaluate effects of the alternatives.

A BA will be prepared for Coho salmon and this document will be the BE for Forest Service Sensitive species. These documents are prepared as part of analyzing project effects relative to the full suite of habitat indicators included in the Analytical Process: water temperature, suspended sediment-intergavel dissolved oxygen/turbidity, chemical contamination, physical barriers, substrate character and/embeddedness, large woody debris, pool frequency and quality, large pools, off-channel habitat, refugia, average wetted width/maximum depth ratio in scour pools in a reach, streambank condition, floodplain connectivity, change in peak/base flow, increase in drainage network, road density and location, disturbance history, Riparian Reserves, and disturbance regime.

The Aquatic Resources Report uses three key indicators of habitat quality selected from the Analytical Process, based on the potential for project effects and, in turn, the potential for impacts on aquatic species and their habitat: water temperature, sediment (fine sediment in substrates and substrate embeddedness) and large woody debris (Table 2). Table 2 shows these habitat indicators and their rating criteria relative to *Properly Functioning*, *At Risk*, or *Not Properly Functioning*. The full suite of habitat indicators provided in the Analytical Process are also included as part of this analysis via summary "Checklists for Documenting Environmental Baseline and Effects of Proposed Actions on Relevant Indicators" (see Appendix D). Each indicator is analyzed at the watershed scale, including the pre-project environmental baseline and effects of the proposed action.

Table 2: Measurement indicators for fisheries habitat quality (from the Klamath National Forest Matrix: Table of Population and Habitat Indicators for Use on the Klamath National Forest in the Northwest Forest Plan Area).

Properly Functioning	At Risk	Not Functioning
Water Temperature		
1st-3rd Order Streams (Instantaneous Temp. Measurement) ~20.5ºC or less	1st-3rd Order Streams (Instantaneous Temp. Measurement) >20.5 to 21.3ºC	1st-3rd Order Streams (Instantaneous Temp. Measurement) ~21.3ºC or more
4th-5th Order Streams (Maximum Weekly Maximum Temperature) ~21.4ºC or less	4th-5th Order Streams (Maximum Weekly Maximum Temperature) >21.4 to 23.1 ºC	4th-5th Order Streams (Maximum Weekly Maximum Temperature) ~23.0ºC or more
Sediment		
Substrate Character: Less than 15% fines (<2 mm) in spawning habitat (pool tail-outs, low gradient riffles, and glides) and cobble embeddedness less than 20%. Additional desired conditions, as per TMDL/NCRWB water quality compliance, include: *Pool sediment vol (V*): ≤21% *Subsurface, <0.85 mm: ≤14% *Subsurface, <6.4 mm: ≤30% Suspended Sediment/Turbidity: Water clarity returns quickly (within 3 days) following peak flows.	Substrate Character: 15% or greater fines (<2 mm) in spawning habitat (pool tail-outs, low gradient riffles, and glides) and/or cobble embeddedness is 20% or greater. Suspended Sediment/Turbidity: Water clarity slow (four to six days) to return following peak flows, moderate to high fines in substrate, moderate modeled surface erosion and mass wasting, and riparian reserves are not fully functioning.	Substrate Character: Greater than 20% fines (<2 mm) in spawning habitat (pool tail-outs, low gradient riffles, and glides) and cobble embeddedness greater than 25%. Suspended Sediment/Turbidity: Water clarity poor for long periods of time (one week or more) following peak flows. Some suspended sediments occur even at low flows or base flow. High fines in substrate, stream buffers in poor condition, high modeled surface erosion and mass wasting, and riparian reserves are in poor condition.
Large Woody Debris		
Manage for an average of 20 pieces of large wood per 1,000 ft in 3-5th order streams (LRMP Page 4-143). Large wood is defined as a minimum length of 50 feet and diameter of 24 inches on the Westside. However, site potential and channel width must be considered rather than using strict numbers. Also consider the potential for future LWD recruitment in both the short- and long-term.	Current levels are being maintained at minimum levels desired for "properly functioning", but potential sources for long-term woody debris recruitment are lacking to maintain these minimum values	Current levels are not at those desired values for "properly functioning", and potential sources of woody debris for short and/or long-term recruitment are lacking

Water Temperature

Wildfire, vegetation management and other disturbances adjacent to streams may alter forest canopy and/or sedimentation and thereby affect stream temperatures. Riparian Reserves were established within each watershed around areas that are directly coupled to streams or rivers to protect riparian function, including water temperature regulation. Riparian Reserves generally parallel the stream network but are also established to maintain hydrologic, geomorphic, and ecologic processes and as such include other areas necessary for maintaining these processes. Riparian Reserves widths are based on a site potential tree height for the project area (150'-

170'). Fish bearing streams have Riparian Reserves equal to two site potential tree heights (300'-340') on each side of the stream. Permanently flowing non-fish bearing streams have Riparian Reserves equal to one site potential tree height (150'-170') on each side of the stream. Seasonally flowing or intermittent streams have Riparian Reserves equal to one site-potential tree height (150'-170') on each side of the stream or 100' slope distance, whichever is greater. Lakes, ponds and wetlands also have designated Riparian Reserves as defined in the project design features listed in the FEIS. The width of Riparian Reserves along streams in the WSFR Project 7th field watersheds are expanded beyond the site potential tree height requirements to encompass geoterrain data that indicate locations of geologic instabilities including active landslides, toe zones of dormant landslides, and inner gorges. Riparian Reserves are managed under special standards and guidelines that prohibit and regulate forest management activities that would retard or prevent attainment of ACS objectives and are a key element designed to maintain and restore riparian structure and function and provide connectivity corridors among LSRs.

The affected environment is described below based on the best available information. Temperature data for streams within the Analysis Area was obtained prior to the 2014 fires. Pre-fire stream temperature conditions are updated herein using post-fire information and modelling conducted by the KNF including field observations, KNF CWE analysis, BAER team assessments and predictions of fire effects to sedimentation and other watershed processes, and documented impacts to Riparian Reserves (acres of Riparian Reserves burned by the 2014 fires as well as fire severity and associated effects to vegetation).

Sediment

Wildfire and vegetation management (including roads and landings) within Riparian Reserves and upslope can result in excessive concentrations of fine sediment in spawning and rearing habitats, which can reduce survival of embryos and alevins by entombing embryos and reducing flow of dissolved oxygen, decreasing interstitial hiding places, altering production of macroinvertebrates, and reducing the total volume of pools. Thus, the analysis of sediment will focus on the quality of substrates (where information is available) and the potential for project activities to deliver sediment to aquatic habitat. Bjornn and Reiser (1991) found that percent emergence of swim-up fry began to decrease when percent fine (2–6.4 millimeters [mm]) sediment exceeded 15 percent, and that embryo survival began to decrease when percentages of fine sediment exceed 10-15 percent. Natural levels of fines in spawning gravels vary with gradient and underlying geology. The KNF has developed criteria for the mid-Klamath region using values from streams that are considered pristine and as supported by the data contained in the environmental impact statement for the Klamath LRMP. The definition of "properly functioning." relative to fine sediment is given in Table 2.

Project effects to sediment supply and delivery are assessed herein at the watershed- and site-scale. The watershed-scale effects analysis relies on the WSFR Hydrology analysis and interpretation of the KNF CWE modeling and results that compare pre-fire disturbance with post-fire and post-project (WSFR Project) disturbance, including at the 5th-field and 7th-field watershed scales. The assessment of project effects to sediment supply and delivery at the site-scale relies on field review of the proposed treatment areas, an understanding and prediction of Project Element effects based on past projects and literature reviews, and discussions with the interdisciplinary team members (geologist, hydrologist, silviculturist, wildlife biologist, and fire

behavior specialist) regarding the potential for disturbance and risk to aquatic resources based on site conditions (including unit-specific slope stability, soil types, disturbance potential, and effects minimization measures that would be implemented).

The Affected Environment section provides information on baseline sediment conditions for 5th-field watersheds within the Analysis Area. Individual watershed checklists in Appendix D provide a summary of current sediment/substrate ratings within the WSFR 5th and 7th field watersheds that provide habitat for anadromous salmonids within the Analysis Area.

The affected environment is described below based on the best available information. Quantitative habitat survey information available for streams within the Analysis Area was obtained prior to the 2014 fires. Thus, pre-fire sediment conditions have been updated to incorporate ongoing stream channel monitoring conducted by the KNF to meet North Coast Water Quality Control Board Waiver requirements, post-fire Burned Area Emergency Response (BAER) assessments, and current (to incorporate effects of the 2014 fires and road improvements identified in BAER assessments) CWE modeling [Equivalent Roaded Area (ERA); Universal Soil Loss Equation (USLE); and, Mass Wasting (GEO).

Water quality monitoring conducted by the Forest Service has confirmed that streambed sediment has increased beyond the range of natural variability by at least one of the three indices in all sampled watersheds in the project area except for Whites Gulch and North Russian Creek (see Table 3 in the WSFR Hydrology Report). Sediment indicators assessed are V* (portion of pools filled with fine sediment), percent of riffle surface sediment < 2mm, percent of subsurface sediment < 6.35mm, and percent of subsurface sediment < 0.85mm.

Large Wood

Wildfire and vegetation management in Riparian Reserves and in unstable areas that feed to streams can affect large woody debris loading to streams and large wood available for future recruitment to streams. Large woody debris enters stream channels through a variety of mechanisms, including toppling of dead trees, windthrow, debris slides, mass soil movements, under cutting streambanks, and redistribution from upstream (Swanson and Lienkaemper 1978). The potential for a tree to enter a stream channel by toppling, windthrow, or undercutting is primarily a function of slope distance from the stream channel in relation to tree height and slope angle (Spence et al. 1996). Consequently, the zone of influence for large wood recruitment is defined by the particular stand characteristics and recruitment process rather than an absolute distance from the stream channel or floodplain. FEMAT (1993) concluded that the probability of wood entering the active stream channel from greater than one tree height is generally low. The Klamath LRMP and Riparian Reserve widths based on watershed analyses provide ample buffer widths to protect large wood recruitment and other important functions of Riparian Reserves (refer to widths described under water temperature above).

A major provision of the KNF LRMP is the ACS, which includes Riparian Reserves, Key Watersheds, watershed analysis and watershed restoration to help provide quality habitat for aquatic species. The WSFR Project Area includes three Key Watersheds: Elk Creek, Grider Creek and the North Fork Salmon River. The ACS allows treatment in Riparian Reserves only when it is required to attain ACS objectives (“Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuelwood cutting if required to attain Aquatic Conservation Strategy objectives”). Whether a proposed treatment in Riparian Reserves is required in order to achieve ACS objectives is an

important part of the Aquatic Resources analysis. When removal of trees (e.g. salvage, hazard trees, fuels reduction) is proposed within a Riparian Reserve, watershed analysis must show that present and future coarse woody debris needs are met and that the action would not prevent attainment of any other ACS objectives.

Quantitative stream survey information for large wood was collected prior to the 2014 fires. Post-fire, analysts quantified the extent of Riparian Reserves burned by the 2014 fires as well as fire severity and associated effects to vegetation. Thus, acres of Riparian Reserves burned in 2014, fire severity, and expected impacts to vegetation are used as a proxy to update the pre-fire baseline conditions for large wood including to update and assess the near- and long-term impacts on wood loading and recruitment potential. In addition, many of the Analysis Area streams receive large wood via debris flows. Thus, the post-fire Mass Wasting (GEO) analysis and debris flow risk is also used to update the large wood baseline.

The 2014 fires impacted the Analysis Area streams including stream temperature, sediment and large wood. Burn severity and percent of Riparian Reserves burned is provided below for each 5th-field watershed, along with the updated post-fire CWE analysis results. This information is incorporated into the Affected Environment to update the baseline for key habitat indicators.

Intensity of Effects

"Intensity" refers to the severity of effects or the degree to which an action may adversely or beneficially affect a resource. The intensity definitions used throughout this analysis are described below.

Effects to habitat Indicators are described at the site- and watershed-scale using the following terms:

- Neutral (no effect)
- Discountable (effects may occur but they are not to a level that can be meaningfully measured or detected)
- Significant (effects are detectable/are able to be measured).

Effects to aquatic species, especially ESA-listed species, are described using the following terms:

- Neutral (no effect)
- Beneficial (contemporaneous positive effects without any adverse effects to the species)
- Discountable (extremely unlikely to occur and based on best judgment, a person would not be able to meaningfully measure, detect, or evaluate insignificant effects)
- Minor (the action would result in detectable effects to an individual (or individuals) of a listed species or its critical habitat, but they would not be expected to result in substantial population fluctuations and would not be expected to have any measurable long-term effects on species, habitats, or natural processes sustaining them; minor effects equate with a *May Affect/Not Likely to Adversely Affect* determination)
- Moderate (the action would result in detectable impacts on individuals or population of a listed species, its critical habitat, or the natural processes sustaining them and key ecosystem processes may experience disruptions that may result in population or habitat condition fluctuations that would be outside the range of natural variation, but would return to natural conditions; moderate level adverse effects would equate with a "*May Affect/Likely to Adversely Affect* determination.

- Major Effect (individuals or population of a listed species, its critical habitat, or the natural processes sustaining them would be measurably affected and key ecosystem processes might be permanently altered resulting in long-term changes in population numbers and permanently modifying critical habitat; major adverse effects would equate with a "*Jeopardy/Adverse Modification of* C*ritical Habitat*" determination.

Spatial and Temporal Bounding of Analysis Area

The WSFR Project Area includes the approximately 200,000 acres burned by the Beaver Fire, Happy Camp Complex and Whites Fire. The Beaver Fire area is located north of the Klamath River near Oak Knoll, the Happy Camp Complex is south of the Klamath River between Scott Bar and Happy Camp, and the Whites Fire is upstream of Sawyers Bar, in the North Fork Salmon River basin.

The Analysis Area provides habitat for special status aquatic species (see Table 1). Biological requirements of these species is provided in Appendix B. Key indicators of habitat quality for aquatic species are described below.

The WSFR Project Aquatic Resources Analysis Area (Analysis Area) is the 5th-field subwatersheds of the Middle Klamath River and their 7th-field drainages that were affected by the fires and have proposed activities. In addition to the 5th- and 7th-field watersheds listed below, the Middle Klamath River is discussed because aquatic habitat is hydrologically linked to downstream areas.

The temporal bounding of the analysis includes effects during implementation, short-term effects expected to occur within the first year following implementation, and long-term effects (greater than one year).

Affected Environment

The Analysis Area is the following 5th-field watersheds (and their 7th-field subwatersheds or drainages) within three major burn areas that were affected by the 2014 fires and that have proposed activities:

- Beaver Creek
- Elk Creek
- French-Scott River
- Horse Creek-Klamath River
- Humbug Creek-Klamath River
- Indian Creek
- Lower Scott River
- North Fork Salmon River
- Seiad Creek-Klamath River
- South Fork Salmon
- Thompson Creek-Klamath River
- Ukonom Creek-Klamath River

The Analysis Area is on the west side of the KNF in the Klamath Mountains of northern California. The Klamath Mountains are extremely rugged with total relief in excess of 7,500 feet and hillslopes commonly steeper than 65% (Cover et al, 2010). The Klamath Mountains are also

characterized by steep ecological gradients and high vegetation, wildlife, and fish diversity, with numerous special-status species. Annual precipitation ranges from approximately 10 inches in eastern valleys to over 70 inches in the highest elevations (Cover et al, 2010). Climate is essentially Mediterranean and watershed hydrology is characterized by dry summer and fall months followed by significant winter precipitation. Morphology and function of tributaries in the Analysis Area are controlled by large floods such as those in 1997, 1974, 1964, and 1955 (Stewart and LaMarche, 1967; de la Fuente and Elder, 1998), and associated landslides and debris flows. Riparian vegetation is primarily hardwood although valley bottom mixed-conifer vegetation with large Douglas fir was historically significant (Mondry, 2004).

Middle Klamath River

Tributaries in the WSFR Project Analysis Area provide important water quality as well as spawning, rearing and thermal refugia habitat for anadromous salmonids and habitat for other aquatic species in the Klamath River basin.

Aquatic Resources

The Middle Klamath River and tributaries provides habitat for SONCC Coho salmon, UKT Chinook salmon, KMP steelhead, resident trout, lamprey and other native species. Historic use of Middle Klamath River tributaries by Coho salmon has been documented in Aikens, Bluff, Slate, Red Cap, Boise, Camp, Irving, Stanshaw, Sandy Bar, Rock, Ti, Dillon, Swillup, Ukonom, Independence Clear, Oak Flat, Elk, Little Grider, Indian, China, Thompson, Fort Goff, and Portuguese creeks (Brownell et al. 1999). Many other tributaries also likely supported natal and non-natal Coho salmon spawning and rearing historically, as evidenced by current juvenile presence in most tributaries of the Middle Klamath River (NMFS 2014).

Past human activities have influenced the numbers and distribution of anadromous salmonids and their habitat in the Klamath Basin including dams, mining, timber harvest, agriculture, water diversions and artificial propagation, and canneries. Since the early 1900s, water has been diverted from the Klamath River for the U.S. Bureau of Reclamation’s Klamath Project. This diversion has altered the historic hydrologic regime of the mainstem Klamath River, as well as reduced the total volume of water available for instream flows.

The key limiting stresses for salmonids are impaired water quality, lack of quality summer and winter rearing habitat that is protected from warm temperatures and high winter flows, accretion of sediment at creek mouths limits and access to important thermal refugia and summer rearing habitat.

Thermal refugia are one of the most important habitat types in the Middle Klamath River due to their role in rearing and migration. Water temperatures in the mainstem become warm and typically remain warm, except for stream reaches receiving significant groundwater inflow. Cool water from tributaries plays a vital role in reducing salmonid thermal stress and mortality, and cool water from smaller tributaries is as critical as larger tributaries in maintaining water quality in the Klamath River and providing thermal refugia for salmonids.

Sediment

Altered sediment supply poses a stress to salmonids. Access to tributary rearing habitat and refugia during some parts of the summer is blocked at times by alluvial barriers. Soils in this area are highly erodible, and in combination with the steep terrain, recent intense fires, and a legacy

of past timber harvest and road-building, fine sediment loading has contributed to impaired conditions throughout the Middle Klamath. Excessive fine sedimentation reduces habitat diversity, embeds spawning gravel, and reduces channel stability. Changes in the natural structure of the river and in water flow cause alluvial sills to form at many tributary confluences, which can either physically block fish or force flows subsurface, thereby limiting or eliminating access to important refugia and spawning/rearing habitat. Habitat complexity in many tributaries has been reduced by fine sediment filling of pools, off-channel ponds and wetlands. KNF biologists observed post-fire sedimentation in many of the tributaries affected by the 2014 fires, as described below.

Water Temperature

Overall, the water quality in the Klamath River is impaired and is on the 303(d) Clean Water Act list due to temperature and other constituents (Table 3). Use of mainstem habitat is most limited by water quality during the summer months (June through September) when water temperatures are high throughout the day. Juveniles must utilize tributaries and other off-channel areas where cooler water can be found.

Table 3: 303(d) Clean Water Act listed reaches of the Middle Klamath River (NCRWQCB 2008).

Waterbody	Pollutant
Middle Klamath River HA, Iron Gate Dam to Scott River Reach	Nutrients, Organic Enrichment/Low Dissolved Oxygen, Temperature
Middle Klamath River HA, Iron Gate Dam to Scott River Reach, mainstem Klamath	Microcystin
Middle Klamath River HA, Beaver Creek, Cow Creek, Deer Creek, Humgry Creek, West Fork Beaver Creek	Sediment
Middle & Lower Klamath River HAs, Scott River to Trinity River Reach	Nutrients, Organic Enrichment/Low Dissolved Oxygen, Temperature
Middle & Lower Klamath River HAs, Scott River to Trinity River Reach, mainstem Klamath River	Microcystin
Middle & Lower Klamath River HAs, China Creek, Fort Goff Creek, Grider Creek, Portuguese Creek, Thompson Creek, Walker Creek	Sediment
Salmon River HA	Temperature
Scott River HA	Sedimentation/Siltation, Temperature

Any tributary with water temperatures cooler than the mainstem Klamath River can be considered thermal refugia due to its role in maintaining water quality in the mainstem Klamath River. Intact, high quality rearing and spawning tributary habitat is vital. Habitat in Indian, Elk, Camp, Boise, Red Cap, Clear, Thompson, Dillon, Slate, and Bluff creeks provide the highest quality spawning and rearing habitat for Coho salmon and other salmonids in the Middle Klamath (Mid Klamath Restoration Partnership 2010 *In* NMFS 2014).

In general, mainstem habitat in the Klamath River is not suitable for productive summer or winter rearing, making tributary habitats highly valuable for growth and survival of Coho salmon (NMFS and USFWS 2013).

Large Wood

Although large wood and complex floodplain habitat were not dominant features of the historic mainstem Klamath River channel, degraded riparian forest conditions pose a stress for salmonids (NMFS 2014). Aerial photos show that while there are areas of disturbance, the majority of riparian areas surrounding tributaries and high quality refugia contain abundant riparian vegetation and have adequate structure and diversity. There are areas of degraded riparian condition resulting from high severity fires, mining, major floods and past timber harvests. These disturbances create localized, short term reductions in riparian vegetation that can have major impacts depending on the degree and extent of fish use of the area. Many riparian areas along the Middle Klamath remain partially barren as a result of historic placer and hydraulic mining activities that disconnected the river from its floodplain, as well as lower hillslope road construction.

The 2014 Fires

The 2014 fires impacted the Analysis Area streams including stream temperature, sediment and large wood. Baseline conditions of habitat Indicators have been updated herein using post-fire BAER Reports, field reviews of burned areas and streams, burn severity data including severity within Riparian Reserves, and post-fire CWE modeling and analysis. This information is incorporated into the Affected Environment to update the baseline for key habitat indicators.

Beaver Fire Project Area

The Beaver Fire burned approximately 43,327 acres in the following 5th-field watersheds (and their 7th -field subwatersheds listed in Table 4):

- Beaver Creek (16,303 acres burned)
- Horse Creek-Klamath River (21,244 acres burned)
- Humbug Creek-Klamath River (5,780 acres burned)

Aquatic Resources

Beaver Creek is tributary to the Klamath River and the watershed provides approximately 31 miles of critical habitat for SONCC Coho salmon, habitat for winter and summer-run KMP steelhead, EFH for spring and fall-run UKT Chinook salmon. Table 4 lists the 7-th field drainages within the Beaver Creek watershed and miles of fish habitat in each. Beaver Creek also provides habitat for Pacific lamprey and other native aquatic species. The Beaver Creek Ecosystem Analysis (USFS 1996) contains more detailed watershed information. Natural barriers exist in tributaries to Beaver Creek: anadromous salmonids cannot access many tributaries including Smokey Creek, Deer Creek and Upper West Fork Beaver Creeks. KNF Chinook spawning surveys indicate that approximately 77% of fall Chinook salmon utilize the lower five miles of Beaver Creek between the mouth and Beaver Creek campground, 22% utilize a four mile reach upstream of the campground, and 1% utilize a reach 9-15 miles upstream of the mouth (USFS 1996). Most of the stream channels in this watershed drain forested mountainous areas. At the present time, there are no runs of spring Chinook or summer steelhead in Beaver Creek.

Table 4: The Beaver Fire 7th-field watersheds, burn acres and miles of fish bearing streams

Beaver Fire 7th-field Watersheds	Beaver Fire Burned Acres	Total Miles of Anadromous Salmonid Habitat/Miles Within Analysis Area	Miles of Fish Bearing Streams/Miles Within Analysis Area
Bear Creek	0.9	1.7/0	8.3/4.2
Buckhorn Creek	3,028.9	2/0	5.8/1.3
Buckhorn Gulch-Beaver Creek	8,233.8	5.7/5.7	5.7/5.7
Collins Creek-Klamath River	2,301.2	5.6/1.9	5.6/1.9
Doggett Creek	6,317.0	1.2/0.9	4.1/3.0
Dona Creek-Klamath River	2,129.9	2.8/2.6	4.3/2.8
Dutch Creek	3,789.5	0.3/0.3	2.8/2.8
Jaynes Canyon	229.8	1.5/0	3.1/0
Kohl Creek	4,053.4	0.9/0.9	0.9/0.9
Little Humbug Creek	3.3	0/0	1.3/0
Lower West Fork Beaver Creek	1,334.3	1.9/1.7	3.6/1.7
Lumgrey Creek	1,787.1	2.0/0	4.5/0
McKinney Creek	3.6	1.6/0.1	6.4/0.1
Miller Gulch-Klamath River	3,965.4	5.0/4.7	5.0/4.7
Quigleys Cove-Klamath River	3,406.3	6.5/3.4	6.5/3.4
Soda Creek-Beaver Creek	2,715.2	4.4/2.3	6.6/2.3
Vesa Creek	27.5	0/0	1.4/0.3
Grand Total	**43,327.1**	**43.1/24.5**	**75.9/35.1**

Bear Creek, Collins Creek, Little Humbug, Lumgrey Creek, McKinney Creek, Vesa Creek have no proposed activities and will not be discussed further.

Sediment

The Beaver Creek watershed is on the 303(d) Clean Water Act list as impaired for Sediment (Table 3). Approximately 36% of the watershed is privately owned and managed. Intensive management on private lands and high road density contributes to the high pre-project risk ratios in the Beaver Creek 5th-field watershed.

Lower Beaver Creek is lower gradient and less confined than upper reaches. Pulses of sediment have overloaded the system during extreme storm events (e.g. 1997 flood) and originate from road failures and washouts. Road density in general is high in this watershed and chronic sediment delivery is a result. Road density within Riparian Reserves is also high: 4.1 miles per square mile. In addition, Long John, Grouse Creek and Hungry Creek subwatersheds all have large proportions of granitic soils combined with considerable past disturbance. Grouse Creek and Hungary Creek are recognized as heavy sediment contributors to Beaver Creek and the quality of spawning gravels has been reduced due to sedimentation from roads.

In July 2014, approximately 43,327 acres of the Beaver Creek watershed burned as a result of lightning strikes. Wildfires result in increased runoff and sediment yield commensurate with burn severity. About two thirds of the fire area had low or very low levels of soil burn severity and KNF BAER teams reported that the rate of water infiltration into the soil in these areas was not greatly affected. Dutch Creek was the most severely affected tributary: approximately 93% of this subwatershed was burned and had a large area of moderate to high soil burn intensity (see Table 5). BAER teams reported the following information: the highest changes in peak runoff potential are in the Dutch Creek, and Kohl Creek. The Kohl Creek watershed had almost half of

its acreages in the fire and is at risk for flooding and sedimentation; many of the intermittent and ephemeral channels in the affected watersheds in the Beaver fire area are full of sediment; and, a significant storm event will mobilize this sediment sending it downhill onto forest roads and downstream to perennial streams such as Beaver, Doggett and Kohl Creeks affecting water quality. Much of the moderate and high soil burn severity areas of the fire was on steep terrain in a checkerboard area of ownership with alternating sections of private land with federal land. These conditions made it very difficult to implement effective hillslope treatments. The most effective action taken post-fire to reduce increased runoff and sedimentation was stormproofing the road system. However, BAER teams observed sediment stored in intermittent and ephemeral channels post-fire. These fine sediments will flush downstream during winter storm events.

Table 5: Summary of watershed burn severity for the 2014 Beaver Fire.

Fire Area	Amount of Very Low Severity Acres (%)	Amount of Low Severity Acres (%)	Amount of Moderate Severity Acres (%)	Amount of High Severity Acres (%)	Total (Acres)
Beaver	5,131 (16%)	16,138 (50%)	9,208 (28%)	1,989 (6%)	32,466

The Beaver Creek 5th-field watershed exceeds the threshold of concern (TOC) with resulting risk ratios greater than 1.0. KNF CWE assessments model disturbances and land sensitivity. Results fall on a continuum. As disturbances increase (and recover) over time and space, at some point, the risk of initiating or contributing to existing adverse cumulative watershed impacts becomes a cause for concern. These model-specific levels are called “inference points” (or “thresholds of concern” - TOC) and are used to inform land management decisions. Ecologically, a transition exists from lower to higher risk of adverse effects to beneficial uses – from insignificant to potentially significant. From a management perspective, inference points are intended to represent the center of that transition zone. Inference points do not represent the exact point at which cumulative watershed effects will occur. Rather, they serve as “yellow flag” indicators of increasing susceptibility for significant adverse effects occurring within a watershed. The USLE model assumes 10% of mobilized hillslope sediment is delivered to stream channels during the first winter season post-disturbance, and the GEO model requires a storm event with a 10-year recurrence interval (10% chance of annual occurrence) to produce mass wasting.

Table 6: Modeled post-fire CWE, USLE and Mass Wasting (GEO) risk ratios for 5th-field watersheds within the Beaver Fire.

5th-Field Watershed Name	Area (Acres)	Pre-Fire (2012)	Post-Fire, No Action
Beaver Creek	69,610	0.7	1.0
Horse Creek-Klamath River	98,625	0.7	0.7
Humbug Creek-Klamath River	68,023	0.6	0.3

In addition to CWE modelling, the KNF is actively monitoring stream channel sediment as part of a program to meet North Coast Water Quality Control Board waiver requirements. A primary goal of this monitoring program is to determine *reference conditions* for stream sediment (Laurie and Elder, 2012). KNF watersheds were stratified in to *managed* and *reference* types (primarily at the 6th-field HUC scale), with the reference watersheds used to define desired conditions in the managed basins. A total of 20 reference streams were established, and sampling of reference stream fine sediment (filled pool volume, surface fines, subsurface fines) was used to define

thresholds (75th percentile of reference + survey error) for evaluation of conditions in managed streams (Laurie and Elder, 2012). Prior to the 2014 fires, Beaver Creek mainstem met the sediment reference conditions for all measures of fine sediment (V* and surface and subsurface sediment). The West Fork of Beaver Creek exceeded reference conditions for V* (the fraction of pool volume that is filled with fine sediment).

Decreased interception of rainfall as a result of wildfire as well as increased sediment and runoff delivered to streams, can lead to an increased debris flow probability in the affected watersheds compared to pre-fire conditions. Post-fire debris flow events can degrade or aggrade stream channels and remove riparian vegetation. BAER teams reported that the probability of aquatic habitat being damaged by debris flow is likely and there is a moderate risk of damage to the quality of habitat (for about the next 10-years).

Fire intensity and extent of area burned within Riparian Reserves is also an indicator of the potential for sedimentation to streams and adverse effects to riparian function (Table 5). Areas that burned at moderate to high intensity experienced an almost complete loss of soil cover. Where this occurred, the magnitude of impacts would be strongly influenced by the amount of area impacted and the severity of winter storms immediately following the fire and prior to re-establishment of grasses, forbes and shrubs. The duration of impacts would be likely to be intermediate between short- and long-duration as regrowth of vegetation reduces sediment source areas and high gradient channels flush stored sediments, dependent on the magnitude of winter runoff.

Post-fire, the Sediment habitat indicator in the Beaver Creek watershed is considered as “at risk” or “not properly functioning” based on modeled high risk ratios and impacts on sediment observed or documented in KNF BAER Reports. .

Water Temperatures

Tributaries and upper reaches of Beaver Creek have low summer water temperatures. Although lower reaches of the mainstem Beaver Creek are warmer and diversions exist, temperatures are far cooler than in the Middle Klamath River and are considered “Properly Functioning.” Thus, Beaver Creek provides thermal refugia for salmonids and other aquatic species. Pool habitat is lacking in Lower Beaver Creek, which limits available space for salmonid rearing.

Table 7: 2013 water temperature data for Beaver Creek (USFS 2014h).

Location	Date of Maximum MWMT	MWMT (◦C)
Beaver Creek upstream from West Fork Beaver	7/23/13	18.4
Beaver Creek 1/4 mile upstream of Klamath River	7/27/13	21.2

The percent of stream channel burned is used herein as indication of the impacts from the 2014 fires to riparian function. High burn severity areas will provide little to no shade to stream channels immediately post-fire. Moderate severity burn areas provide reduced shade. Based on field observations, an estimated 50% of the streamside vegetation was affected in moderate burn areas. Relative to stream shade, the percent of perennial streamside areas that were burned is the primary indicator of the potential effects to shade and water temperature. Approximately 3% of perennial streamside areas were burned at high severity and 14% of perennial streamside areas were burned at moderate severity. This represents an impact to riparian function in burned areas,

at the site-scale, but is not expected to affect water temperatures in Beaver Creek to a measurable extent.

Table 8: Summary of stream channel burn severity data from BAER Reports (USFS 2014a-2014f) for the 2014 Beaver Fire Area.

Stream Type	Very Low miles (%)	Low miles (%)	Moderate miles (%)	High miles (%)	Total (miles)
Intermittent	20 (15%)	66 (50%)	37 (28%)	10 (8%)	133
Perennial	12 (34%)	18 (51%)	5 (14%)	<1 (<3%)	35

Large Wood

Riparian Reserves in Beaver Creek have a high density of medium to small conifers and other vegetation. The continuity of Riparian Reserves along Beaver Creek is impacted by the main road and other disturbed sites including recovering mine sites and flood deposits. The Beaver Creek watershed has a large proportion of private industrial timberlands that are managed under the California Forest Practice Rules, which has included harvest within Riparian Reserves.

Pre-fire wood loading in Beaver Creek was determined to be "properly functioning." The 2014 fires had no effect on instream wood levels in the mainstem but will affect short-term wood loading, and large wood available for recruitment in the long-term in areas burned at moderate and high severity. Fire intensity and extent of area burned within Riparian Reserves is used herein to update the pre-fire large wood baseline. High burn severity areas along perennial streams will experience an increase in wood loading in the short-term and a reduction in large wood available for recruitment to streams in the long-term. Relative to perennial streams, the percent of streamside areas that burned at high severity in this watershed is limited (<3 percent) indicating that effects to large wood loading and recruitment will be minor. Approximately 14% of perennial streamside areas were burned at moderate severity, and an estimated 50 percent of the vegetation was burned in these areas. Thus, in the moderate severity areas, an increase in large wood loading is expected in the near term, and a reduction in large wood available for recruitment is expected over the long-term until these areas recover with conifers. Near term post-fire wood loading is considered to be "properly functioning."

The Happy Camp Complex Fire Project Area

The Happy Camp Complex Fire burned approximately 131,313 acres within the following 5th-field watersheds (and their 7th-field subwatersheds listed in Table 11):

- Lower Scott River (43,108 acres)
- Elk Creek (34,633 acres)
- Seiad Creek-Klamath River (50,897 acres)
- Thompson Creek-Klamath River (11,243 acres)

Approximately 1% of the area burned at high severity in The Happy Camp Complex and approximately 22% at moderate severity (see Table 9).

Table 9: Summary of watershed burn severity for the 2014 Happy Camp Complex

Fire Area	Amount of Very Low Severity Acres (%)	Amount of Low Severity Acres (%)	Amount of Moderate Severity Acres (%)	Amount of High Severity Acres (%)	Total (Acres)
Happy Camp Complex	12,472 (10%)	86,814 (67%)	28,182 (22%)	1,439 (1%)	128,907

The WSFR Hydrology Report (Mondry 2015) contains the WSFR Project CWE analysis, summarized herein. Table 10 summarizes the results of the CWE modeling. ERA post-fire values are relatively low for 5th-Field watersheds in the Happy Camp Complex. Ten 7th-Field watersheds in the project area exceed the TOC when 2014 fire effects were modeled against the pre-fire baseline conditions (see the WSFR Hydrology Report).

Table 10: Modeled pre- and post-fire CWE, USLE and Mass Wasting (GEO) risk ratios for 5th-field watersheds within the 2014 Happy Camp Complex.

5th-Field Watershed Name	Pre-Fire (2012)	Post-Fire, No Action
Elk Creek		
ERA	0.5	0.5
USLE	0.1	0.3
GEO	1.0	1.0
Lower Scott River		
ERA	0.1	0.5
USLE	0.1	0.5
GEO	0.3	0.6
Seiad Creek-Klamath River		
ERA	0.6	0.5
USLE	0.3	0.7
GEO	0.5	0.8
Thompson Creek-Klamath River		
ERA	0.1	0.4
USLE	0.4	0.3
GEO	0.4	0.5

Ten 7th-field subwatersheds were affected by the Happy Camp Complex and have proposed activities under the WSFR Project (see Table 11). Walker and Grider creek 6th-field subwatersheds are discussed below along with the 5th-field watersheds because they provide important habitat for anadromous salmonids and other native aquatic species, were burned in the Happy Camp Complex, and have proposed activities.

Table 11: The Happy Camp Complex 7th-field watersheds, burned acres and miles of fish bearing streams

Happy Camp Complex 7th-field Watersheds	Happy Camp Complex Burned Acres	Total Miles of Anadromous Salmonid Habitat/Miles Within Project Area	Total Miles of Fish Bearing Habitat/Miles Within the Project Area
Bear Creek	5,139.0	1.7/0	8.3/4.2
Benjamin Creek-Klamath River	249.9	8.4/0.8	8.5/0.8
Big Ferry-Swanson	2,400.7	4.9/1.8	5.4/1.9
Bishop Creek-Elk Creek	701.4	4.5/0.5	8.0/0.5

Happy Camp Complex 7th-field Watersheds	Happy Camp Complex Burned Acres	Total Miles of Anadromous Salmonid Habitat/Miles Within Project Area	Total Miles of Fish Bearing Habitat/Miles Within the Project Area
Caroline Creek-Klamath River	1,374.6	3.3/2.3	3.3/2.3
China Creek	4,298.0	1.7/1.6	3.4/3.2
Cliff Valley Creek	3,952.5	0/0	3.6/3.6
Cougar Creek-Elk Creek	3,764.5	5.6/5.6	6.3/6.2
Deep Creek-Scott River	1,951.5	4.4/3.4	4.4/3.4
Doolittle Creek	3,735.6	0/0	3.1/3.1
Franklin Gulch-Scott River	2,858.9	4.8/3.7	4.8/3.7
Fryingpan Creek-Klamath River	4,407.9	11.6/6.5	13.1/8.0
Granite Creek	221.4	0/0	11.6/0.4
Headwaters Elk Creek	2,531.6	0/0	3.0/2.8
Hoop &Devil-Elk Creek	1,937.2	4.4/3.9	4.4/3.9
Horse Creek	2,537.3	0/0	1.4/1.4
Lower East Fork Elk Creek	3,430.0	2.2/2.2	3.0/3.0
Lower Grider Creek	10,765.2	9.3/9.2	9.3/9.2
Lower Seiad Creek	2.9	2.9/0	2.9/0
McCarthy Creek-Scott River	6,112.8	5.4/4.5	5.4/4.5
Middle Creek	4,495.6	1.2/1.2	3.4/3.4
Middle Elk Creek	1,189.6	2.4/1.4	2.4/1.4
Negro Creek	11.2	0/0	0/0
North Fork Kelsey Creek	5,176.6	0.9/0.9	5.8/5.8
O'Neil Creek	2,429.2	0.9/0.9	0.9/0.9
Perkins Gulch-Indian Creek	23.6	2.2/0.2	2.2/2.0
Rainy Valley Creek	1,486.5	0/0	3.2/1.8
Rancheria Creek	4,374.5	0/0	0.5/0.5
Sambo Gulch-Klamath River	27.3	4.9/0.3	4.9/0.3
Schutts Gulch-Klamath River	2,176.2	5.2/4.0	5.2/4.0
South Fork Kelsey Creek	1,787.8	1.1/1.1	5.2/1.8
Tom Martin Creek-Klamath River	8,759.5	6.1/5.4	9.0/8.3
Tompkins Creek	9,327.2	5.2/5.2	5.2/5.2
Toms Valley Creek-Elk Creek	3,598.4	2.1/2.1	5.4/5.3
Upper Canyon Creek	127.9	0/0	2.2/0
Upper East Fork Elk Creek	3,873.3	0/0	2.3/2.3
Upper Elk Creek	3,024.6	0/0	1.5/1.5
Upper Grider Creek	8,467.5	3.0/3.0	6.1/6.1
Walker Creek	7,592.7	4.2/4.0	6.1/4.0
West Grider Creek-Klamath River	991.0	4.5/1.1	4.5/1.1
Grand Total	131,313	119/76.8	189.2/121.8

Both the Whites Fire and Happy Camp Complex burned within the Lower Scott River. The Happy Camp Complex affected tributaries to the Scott River including 34,239 acres within the Canyon Creek watershed and 9,327 acres in the Tompkins Creek watershed. The Whites Fire burned 1,542 acres within the French Creek watershed. These streams provide important habitat for anadromous salmonids and other native species. The Lower Scott River Ecosystem Analysis (USFS 2000) and the Callahan Ecosystem Analysis (USFS 1997a) contains more detailed information on watershed conditions. For the Scott River, this analysis is focused on areas

affected by the fires and that will have proposed activities: the mainstem Scott River from Kelsey Creek downstream including all tributaries on the west side of the River.

Aquatic Resources

The WSFR Project is within the Lower Scott River 5th-field watershed, which includes the mainstem from the mouth to about one mile east of Jones Beach or Isinglass Creek area, and all the subwatersheds and other land areas that drain to this section of mainstem. The Scott River provides habitat for fall-run Chinook, steelhead, Coho salmon, Pacific lamprey and other native species. Fall Chinook are usually not able to access historical spawning habitat in the upper mainstem Scott River or in the East Fork of South Fork Scott River due to low flows. Juvenile Coho salmon have been observed in the South Fork Scott River, Boulder Creek, French Creek and Sugar Creeks.

In recent times, spawning and/or redds of Coho salmon have been observed in the mainstem Scott River and its tributaries, including: East Fork Scott River, South Fork Scott River, Sugar Creek, French Creek, Miners Creek, Etna Creek, Kidder Creek, Patterson Creek, Shackleford Creek, Mill Creek, Canyon Creek, Kelsey Creek, Tompkins Creek, and Scott Bar Mill Creek (Soil Conservation Service 1972, CDFG 1974, Maurer 2005, Yokel 2007-2011, Calfish 2013 *In* NMFS 2014).

The South Fork Scott River provides approximately 4.7 miles of habitat for anadromous salmonids. KNF stream surveys document that the upper extent of Coho spawning in the South Fork Scott River appears to be limited by a natural barrier in the gorge at mile 4.7.

Tompkins Creek is a third-order perennial of the Scott River. Flowing south, it drains the western flanks of Tom Martin Peak, the south side of Lake Mountain Peak, and much of the east side of the ridge south of Lake Mountain Peak to the Tyler Meadows area. Past and present influences within the drainage include timber harvests, roads, grazing, mining, water diversion, wildfire, and flood. Coho, steelhead, and rainbow trout utilize this stream, and the upstream limits of each species (e.g., approx. three miles upstream from the mouth for SONCC Coho salmon) are restricted by gradient, discharge, stream size, and/or barriers.

O'Neil Creek is a second-order perennial tributary to the Middle Klamath and drains the ridgeline between Tom Martin Peak and Lake Mountain Peak. O'Neil Creek provides habitat for rainbow trout, and Coho and Chinook salmon in the lower reaches near or downstream of Highway 96. Due to restoration at Highway 96, SONCC Coho salmon can now ascend O'Neil Creek above the bridge crossing, but suitable habitat is limited above here by steep gradients.

Thompson, Walker and Grider creek watersheds provide spawning, rearing and holding habitat for fall and spring-run Chinook salmon, winter and summer run steelhead and Coho salmon. In addition, these streams provide habitat for Pacific lamprey and other native species. Based on stream survey data anadromous salmonids can access the lower reaches of Grider and West Grider creeks, and Walker Creek. The other smaller, steep, bedrock-dominated, stream systems found within these subwatersheds are generally more suited to resident trout populations than to anadromous species. However, these streams are critical as thermal refugia to anadromous populations because of the high quality, cool water they provide to the Middle Klamath River system.

Grider Creek is a Key watershed and a domestic water source for private landowners. There are approximately 18.4 miles of fish-bearing streams in the Grider Creek watershed. Coho salmon

are found in the lower 8.0 miles of the mainstem of Grider Creek. Critical Habitat for Coho salmon is considered to be the same as steelhead, that is, the lower 12 miles of the mainstem of Grider Creek. There are no Coho salmon or Critical Habitat in any of the tributaries to the mainstem of Grider Creek. Steelhead are found within approximately lower 12 miles of the mainstem. Fall-run Chinook salmon are found within the lower 7.5 miles of the mainstem of Grider Creek. Spring-run Chinook salmon are not known to be present in Grider Creek. There is no EFH for Coho salmon or Chinook salmon in any of the tributaries to the mainstem of Grider Creek. Resident trout occupy Rancheria, Fish, and Cliff Valley creeks.

Rancheria Creek is a third order stream that flows west draining the ridgeline south of Lake Mountain Peak to the Marble Mountain Wilderness boundary. This stream supports resident rainbow trout and steelhead in the lower reach, as there is a barrier to upstream salmonid migration about 0.5 miles upstream from the mouth.

Sediment

The Scott River is a 303(d) Clean Water Act listed reach (Sediment; Table 3). Excessive sediment loads and elevated water temperatures in the Scott River and its tributaries have resulted in degraded water quality conditions that impair anadromous fish production. Sediment yield from some Lower Scott River tributaries increased as a result of the 1997 flood and many reaches of the East Fork Scott, Moffett Creek and Shackleford Creek also suffered flood damage.

Sommerstrom (2001) measured fine sediment at many different locations on the mainstem Scott River and also on some tributaries. McNeil samples of fine sediment in the mainstem Scott showed sand size particles (<6.3 mm) to comprise more than 90% of the bed at some locations. Optimal levels of fine sediment of this size would be less than 20%. Sommerstrom (2001 noted that the principle source of fines was watersheds with granitic terrain and more specifically from road surfaces, road cuts and road fills. Following the sediment study, a French Creek Watershed Advisory Group was formed to help coordinate activities in this highly erodible Scott River sub-basin. The U.S. Forest Service, private timber landowners, ranchers, the County of Siskiyou and the Scott Valley CRMP all contributed to erosion control projects in French Creek. Studies to determine fine sediment in pools (V*) were conducted by the U.S. Forest Service in French Creek to determine the progress of restoration. The volume of fine sediment in pools decreased from approximately 30% in 1992 to nearer 10% in the following three years. The 1997 high water seemed to shift a great deal of fine sediment to reaches of the Scott River just above its convergence with the Klamath. These reaches are often the most important for spawning, particularly in drought years. However, the flows in fall of 1997 allowed fish access to reaches further upstream that had lower levels of fine sediment. Sediment yield increased in Lower Scott River tributaries on USFS lands as a result of the January 1997 storm event. The U.S. Forest Service repaired some of the flood damage to roads and other infrastructure from the 1997 storms. The most intensive area of activity for road repair in 1997 was in the Canyon Creek and Kelsey Creek watersheds. The Klamath National Forest improved drainage structures and stream crossings in these watersheds so that future flood damage is much less likely. Even during moderate flows, Moffett Creek has such high turbidity levels that it discolors the Scott River down to its convergence with the Klamath.

Altered sediment supply occurring in the Scott River imposes a medium stress to juvenile and smolt, high stress to adults, and a very high stress to the egg and fry Coho salmon life history stages (NMFS 2014). The movement of fine sediment into streams can cause substrate

embeddedness, preventing spawning and smothering eggs in redds. Additionally, excessive levels of fine sediment in pools and low gradient reaches of the Scott River and its tributaries also reduce the amount of rearing habitat available for juvenile Coho salmon (USFS 2000, NCRWQCB 2006, CDFG 2009, Cramer Fish Sciences et al. 2010 *In* NMFS 2014). While unaltered background levels of sediment were around 10 percent volumetrically, monitoring in the French Creek watershed has shown large fluctuations in the percentages of fine sediment occurring in this watershed (Sommarstrom et al. 2001). Data from the early 1990s indicate a high of approximately 32 percent fine sediment occurring in French Creek in 1992, decreasing to approximately 7.5 percent by 1994 (Power and Hilton 2003), and then reaching a dynamic level of approximately 14 percent in 2012 (Farber and Nicolls 2012). More recent monitoring indicates that there is still a large percentage of fine sediment in the channel substrate in the upper portions of French Creek, which is one of the two most productive spawning and rearing tributaries in the Scott River basin.

Tompkins Creek is considered to be “At Risk” for sediment. A 2011 survey documented elevated fines in pools and substrates relative to reference conditions (USFS 2013). Erosion of streambanks was identified as a primary source of sediment and is a result of past flooding.

The Lower Scott River 5th-field post-fire ERA risk ratios are at 0.48, well below 1.0 indicating that disturbance resulting from road, vegetation management, and wildfire is sufficiently below the watershed TOC, and interpreted to mean that effects on increased peak flow will not be significant at this scale. However, channel change would be expected along reaches that convey debris flows. The Lower Scott post-fire Mass Wasting (GEO) risk ratio is at 0.57, well below the TOC and indicates increased hillslope sediment production will not be significant at this scale.

Elk Creek is characterized by having good water quality and serves as a domestic water supply for Happy Camp. Except for broad, coarse alluvial deposits upstream of the mouth of the East Fork, little sediment is stored in stream channels. Most of the coarse sediment in stream channels is delivered by landsliding. Streams in the Elk Creek basin are high gradient, coarse bedded and erosion dominated. Channels run through steep, narrow gorges. This watershed was extensively burned in 1987 and subsequently salvage logged. The January 1, 1997 storm initiated debris torrents at the headwaters of Elk Creek and major channel changes occurred to over 80% of the channel of Elk Creek (De La Fuente 1998). Significant quantities of big wood were entrained by floodwaters and major bed aggradation also occurred.

In 2014, the Happy Camp Complex Fire burned 34,633 acres in the Elk Creek watershed. KNF BAER teams reported that many of the intermittent and ephemeral channels in the affected watersheds are full of sediment and that a significant storm event will mobilize this sediment and send it downstream to perennial streams. BAER teams predicted that the primary watershed responses are expected to include: 1) an initial flush of ash, 2) rill and gully erosion in drainages and on steep slopes within the burned area, and 3) flash floods with increase peak flows and sediment deposition. The BAER teams expected that these responses would be greatest within initial storm events. Field observations after the first larger rain event in November 2014 confirmed that there was an initial flush of sediment and ash. The disturbances will become less evident as vegetation is reestablished, providing ground cover and increasing surface roughness. Soils will also become stabilized and the infiltration capacity of the soils will improve.

The Elk Creek 5th-field ERA risk ratios are at 0.51, well below 1.0 indicating that disturbance resulting from road, vegetation management, and wildfire is sufficiently below the watershed

TOC, and interpreted to mean that effects on increased peak flow will not be significant at this scale. However, channel change would be expected along reaches that conveyed debris flows. At the 7th-field scale, Middle Elk Creek watershed exceeds the TOC based on post-fire ERA modelling. Middle Elk Creek 7th-field also exceeds the Mass Wasting (GEO) threshold of concern indicating a risk for increased hillslope sediment production.

Fire intensity and extent burned within Riparian Reserves indicator the potential sedimentation to streams and adverse effects to riparian function. Sediment impacts are likely to be minor to moderate because of the relatively low amounts (0.2-0.8% of intermittent and perennial Riparian Reserves burned at high severity. These areas experienced a nearly complete loss of soil cover. Where this occurred, the magnitude of impacts would be strongly influenced by the severity of winter storms immediately following the fire and prior to re-establishment of grasses, forbes and shrubs. The duration of impacts would be likely to be intermediate between short- and long-duration as regrowth of vegetation reduces sediment source areas and high gradient channels flush stored sediments, dependent on the magnitude of winter runoff.

Thompson, Walker and Grider creeks are high-gradient, coarse-bedded and, due to uplift of the region, erosion dominated. Channels typically run in steep, narrow gorges. Although influenced by large landslides and bedrock structure and composition, channel patterns are dendritic. Except for broad, coarse alluvial deposits in the vicinity of the mouth of Seiad and Grider Creeks, relatively little sediment is stored in stream channels. Channels are typically cut in bedrock. Most of the coarse sediment generated to stream channels is delivered by landsliding. Fine sediment is generated by surface erosion of disturbed areas, as well as landsliding. Conditions within these watersheds are influenced by various watershed disturbances in combination with a large percentage of unstable or easily eroded land types. Large portions of these watershed were impacted by wildfires in 1987 and the January, 1997 flood event, which contributed large amounts of sediment to streams, especially to Walker Creek. Large amounts of coarse sediment were deposited at the mouth of Thompson, Seiad and Walker Creeks as a result of the 1997 flood event. These deposits occur as a result of channel widening where the streams enter the broad Klamath River channel. Such deposits cause wandering of the stream channels and channel-bank erosion. Some areas have received extensive timber harvest and have high road densities. The land types of the watershed include easily eroded granitic soils and both dormant and active landslides.

In the Thompson Creek, China Creek, and upper Walker Creek basins, extensive deposits of the Dormant Landslide and Residual Soil Terrane are found. Many large, active earthflow landslides are found in this terrane. Movement of some of the landslides that produced large quantities of sediment to these streams in the Flood of 1997 is associated with roads. Extensive Granitic Terrane is found in Grider and Walker Creek basins. Some of the sandy, low cohesion soils that form on granitic rocks make road fill that is difficult to stabilize.

Refer to the KNF (1999b) Thompson/Seiad/Grider Ecosystem Analysis for more detailed information on watershed disturbance. Watershed impacts include high road densities, wildfires and past timber harvest.

From 1922-1997, this area has had a total of 1,026 fires, 67% started by lightning. Extensive areas in these watersheds have been burned in past fires including as recent as 1987, which increased susceptibility to erosion. In the twelve years since these fires, ground fuels have increased.

Road erosion in these watersheds is triggered by intense seasonal thunderstorms, however severe erosion problems associated with roads may be chronic, and generally can be traced to one or more causes (e.g. geometric design of the road, road grades, surface type, soil type, road location, steepness of terrain, inadequate drainage structures, road location, lack of maintenance, or vehicle use during wet weather conditions). In addition, numerous road failures occurred in the Rancheria Creek sub-basin which had been logged. The rain-on-snow event in January 1997 triggered over 63 landslides and 15 road failures. The lowest reaches of Grider Creek widened substantially and water temperatures increased. Walker Creek V* values exceed reference conditions. A cause of impairment has been attributed to legacy sediment sites from past management.

KNF BAER teams documented conditions in these watersheds after the 2014 fires. Fire intensities in Grider Creek were as follows: 60% low; 30% moderate and 1.2% high (9% unburned). Fire intensities in Walker Creek were as follows: 58% low; 27% moderate and 3% high (11% unburned). The Happy Camp Complex BAER Hydrologic Response Report (USDA-KNF 2014) contains more detailed information on these and other watersheds in the burn area. Post-fire, hydrologists noted that many of the intermittent and ephemeral channels in the affected watersheds in the Happy Camp Complex fire area were full of sediment. A significant storm event was expected to mobilize this sediment and send it downstream including to Tompkins, Walker, Grider, and East Fork Elk Creek.

Thompson Creek-Klamath River post-fire 5th -field watershed risk ratios are at 0.29, well below 1.0 indicating that disturbance resulting from road, vegetation management, and wildfire is sufficiently below the watershed TOC, and interpreted to mean that effects on increased peak flow will not be significant at this scale. However, channel change would be expected along reaches that conveyed debris flows. The Walker Creek 7th-field watershed exceeds the TOC based on post-fire ERA modelling. Risk ratios are at 1.03 indicating increased susceptibility for significant adverse effects. The Walker Creek 7th-field watershed post-fire Mass Wasting (GEO) risk ratio is at 1.89, exceeding the Mass Wasting (GEO) threshold of concern and indicating a risk for increased hillslope sediment production. The Lower Grider Creek 7th-field watershed risk ratio does not exceed TOC. The Lower Grider Creek 7th-field watershed post-fire Mass Wasting (GEO) risk ratio is at 1.09, exceeding the Mass Wasting (GEO) threshold of concern and indicating a risk for increased hillslope sediment production.

KNF fisheries biologists conducted spawning surveys post-fire and observed large quantities of post-fire sediment in the mainstem Grider Creek, as well as new log jams (Figure 1).

Figure 1: Post-fire sediment slug in Grider Creek 2014

Water Temperature

Anthropogenic processes that influence water temperature include changes to: stream shade, stream flow via changes in groundwater accretion, stream flow via surface water use, microclimate, and channel geometry. The primary factor affecting stream temperatures in the Scott River watershed is increased solar radiation resulting from reductions of shade provided by near-stream vegetation. Changes in groundwater accretion also impact water temperatures in Scott Valley. Diversions of surface water lead to relatively small temperature impacts in the mainstem Scott River, but have the potential to affect temperatures in smaller tributaries where the volume of water diverted is relatively large compared to the total stream flow. Microclimate alterations resulting from near-stream vegetation removal increase temperatures, where microclimates exist. Changes in channel geometry from natural conditions also negatively affect water temperatures.

Water temperatures in the Scott River can be limiting for salmonids, particularly in dry years. Flow depletion tends to contribute to temperature problems. Comprehensive temperature monitoring on the Scott and its tributaries has provided a greater understanding of how varying water years can effect temperature. The Scott River can exceed stressful conditions for salmonids in low gradient valley reaches in dry years, but remains below stressful on average in wet years. The warmest reaches of the Scott mainstem in the valley are at Highway 3 and Jones Beach. The

Lower Scott River flows in a gorge which is completely open to the full arc of the summer sun and very subject to warming. Cold water tributaries flowing from USFS lands in the Marble Mountains moderate mainstem Scott River temperatures in this reach and provide substantial refugia at their mouths. Channel scour in other Lower Scott River tributaries may also contribute to temperature increases. Loss of cold water contributions from these lower tributaries may have profound impact on ecosystem function in the Lower Scott River. Long-term trends show that periods of critically low flow have tended to increase since 1942, when flow records began to be monitored consistently on the Scott River.

Where passage is possible, juvenile fish can reach thermal refugia pools along both the mainstem Scott River and west-side tributaries, where the water temperature can be several degrees cooler than in adjacent channels. NMFS (2014) lists the following areas as thermal refugia: French Creek, Patterson Creek, Kidder Creek, Shakleford/Mill Creek, Scott River from Boulder Creek to Tompkins Creek, Canyon Creek, Kelsey Creek and Tompkins Creek.

While the mainstem Scott River stream temperatures are “not properly functioning”, French, Tomkins and Canyon creeks are all considered “Properly Functioning” relative to stream temperatures (see Table 2) and provide important thermal input and refugia to aquatic species in this watershed.

Table 12: 2013 water temperature data for Lower Scott River (USFS 2014h)

Location	Date of Maximum MWMT	Maximum Weekly Maximum Temperature ºC (MWMT)
Scott River at Sugarpine Gulch	7/26/13	26.6
Scott River downstream of Bridge Flat CG	7/27/13	23.7
Scott R downstream from Townsends GL	7/27/13	24.6
Scott River near 7F01Bridge	7/26/13	27.9
French Creek upstream of NF French Creek	7/26/13	19.7
Tompkins Creek at USFS property line Sec. 3	7/27/13	17.4
Canyon Creek (Scott) just upstream from mouth	7/27/13	16.3

The percent of streamside areas that burned in the 2014 fires is an indication of impacts to riparian function, including stream shade along perennial streams. Approximately 0.2% of perennial streamside areas burned at high severity and will provide little to no shade post-fire and until trees re-establish. Approximately 11% of perennial streamside areas burned at moderate severity and, based on field observations, experienced an estimated 50% loss of vegetation. The percent of impact to streamside areas is relatively low, and is not expected to measurable change stream temperatures.

Figure 2: 2014 Burned Riparian Reserve in Grider Creek, 2014

Table 13: Summary of stream channel burn severity data from BAER Reports (USFS 2014a-2014f) for the 2014 Happy Camp Complex

Fire Area	Stream Type	Very Low miles (%)	Low miles (%)	Moderate miles (%)	High miles (%)	Total (miles)
Happy Camp Complex	Intermittent	23 (9%)	196 (72%)	50 (18%)	2 (0.8%)	271
	Perennial	31 (13%)	188 (76%)	27 (11%)	0.4 (0.2%)	246

Peak summer temperatures have been higher than optimal for fish in the lower mainstem reaches of Elk Creek. However, habitat in Elk Creek provides some of the highest quality spawning and rearing habitat for Coho salmon in the Middle Klamath River (Mid Klamath Restoration Partnership 2010) and Elk Creek is considered thermal refugia (MKWC 2006, NCRWQCB 2010). Recent temperature monitoring data collected by the KNF (see Table 14) indicate that Elk Creek stream temperatures range from “Properly Functioning” to “At Risk.”

Table 14: 2013 water temperature data for Elk Creek (USFS 2014h)

Location	Date of Maximum MWMT	Maximum Weekly Maximum Temperature ºC (MWMT)
Elk Creek at 7C001 Bridge	7/27/13	23.0
Elk Creek upstream of mouth ~0.5 mile	7/27/13	23.2
Elk Creek upstream of Bear Creek	7/27/13	20.5
East Fork Elk Creek upstream from mouth	7/27/13	20.0

Thompson, Walker and Grider creeks are rainfall dominated. Streamflows and the maintenance of cool water during the hot dry season are sustained primarily by groundwater inputs. Large areas of dormant landslide terrain, typically composed of deep red soils, function as a sponge in storing and slowly releasing large quantities of water. Most of the subwatersheds generally have streams that flow dependably all year long, with relatively high baseflows and good water quality. Most named creeks support fish in their lower reaches before the channel gradient gets too high and upstream passage becomes restricted by waterfalls or debris jams in constricted channels.

The mouth of Grider Creek formerly produced one of the most important large, cold water refuge areas on the mainstem Klamath (Belchik and Turo, 2002), but the flood effects of the 1997 storm raised temperatures and reduced the benefit of this area as a refugia. However, Grider Creek provides critical habitat for Coho salmon and stream temperatures are rated as “Properly Functioning” relative to salmonid criteria (see Table 15).

Walker Creek suffered the worst flood damage in 1997 of any stream on the KNF and its stream channel and floodplains were scoured from headwaters to the mouth. The Walker Creek drainage has an extensive road network and there were over 45 road failures combined with 60 other active landslides in this relatively small watershed resulting from the flood. Walker Creek also had extensive areas of its watershed burned in the 1987 fires. One reach of Walker Creek went from approximately 50 feet wide to over 200 feet wide. It will be decades before this tributary recovers. It had provided a medium sized refuge area of cold water at its convergence with the Klamath according (Belchik and Turo, 2002). Walker, Grider and Thompson creeks provide important water quality to the Middle Klamath River and these tributaries may provide thermal refugia for anadromous salmonids during warm periods.

Table 15: 2013 water temperature data for Walker, Grider and Thompson creeks (USFS 2014h).

Location	Date of Maximum MWMT	Maximum Weekly Maximum Temperature ºC (MWMT)
Grider Creek near 46N66 Bridge	7/27/13	19.1
Walker Creek at ~RM 1.1	7/27/13	18.9
Thompson Creek near 18N02 Bridge	7/27/13	17.3
Thompson Creek upstream from Cedar Creek	7/30/13	15.4

Large Wood

The Happy Camp Complex burned approximately 34,633 acres within the Elk Creek watershed. Elk Creek is a tributary of the Klamath River and a “Key” watershed. Its’ confluence with the Klamath River is just downstream of the town of Happy Camp. Over 99% of the lands in the Elk Creek watershed are federal lands. The Elk Creek Ecosystem Analysis contains more detailed watershed information (USFS 1995d).

The Happy Camp Complex burned 11,243 acres in the Thompson Creek-Klamath River 5th-field watershed, 7,593 acres in the Walker Creek watershed, and 20,223 acres in the Grider Creek watershed. Walker and Grider creeks are included here because they are important 6th-field Klamath River tributaries that provide habitat for anadromous salmonids and other native species and have proposed activities. For more detailed information on these watersheds see the Thompson/Seiad/Grider Ecosystem Analysis (USFS 1999).

Riparian Reserves in the Elk Creek basin are predominately forested and comprised of conifers and hardwoods. Current levels of large woody debris are considered “at risk”. Large wood was removed from Elk Creek in the 1960’s and 1970’s to prevent damage to downstream infrastructure and floods have removed shallow-rooted vegetation such as alders, in patches immediately adjacent to the mainstem. Large wood is delivered to stream channels via debris flows in Elk Creek. The Elk Creek Mass Wasting Risk Ration is at 0.98 (Table 10), bumping up against the Mass Wasting (GEO) threshold of concern and indicating a risk for increased debris flows, which would increase large wood loading to streams as well as sedimentation. Debris slides and floodwaters from the 1997 storms contributed large wood, which subsequently added to habitat complexity in Lower Elk Creek.

The 2014 fires had no effect on instream wood levels but could increase wood loading in the short-term, and decrease large wood available for recruitment in burned areas in the long-term. Fire intensity and extent of area burned within Riparian Reserves is used here to update the large wood information collected prior to the 2014 fires. High burn severity areas along perennial streams will experience an increase in wood loading in the short-term and a reduction in large wood available for recruitment to streams in the long-term. The percent of perennial stream channels that burned at high severity is limited (<0.2 percent) indicating that effects to large wood loading and recruitment will be minor. Approximately 11% of perennial stream Riparian Reserves were burned at moderate severity in the Happy Camp Complex, and an estimated 50 percent of the vegetation was burned in these areas. Thus, in the moderate severity areas, an increase in large wood loading is expected in the near term, and a reduction in large wood available for recruitment is expected in the long-term. Collectively, these high and moderate burn severity areas will increase large wood loading in the near term and reduce recruitment sources of large wood in the long-term (within from 0.2-11% of Riparian Reserves).

The Whites Fire Project Area

The Whites Fire burned a total of 38,916 acres in the North Fork Salmon River (including its 7th-field subwatersheds listed below in Table 16). The Upper South Fork Salmon Ecosystem Analysis (USFS 1994b), Lower South Fork of the Salmon River Ecosystem Analysis (USFS 1997b), Main Salmon Ecosystem Analysis (USFS 1995b), and the North Fork Salmon Ecosystem Analysis (USFS1995c) contain more detailed watershed information. Current environmental baseline information for habitat indicators in fish-bearing 7th-field watersheds is provided in Appendix D.

Table 16: The Whites Fire 7th-field watersheds, burned acres and miles of fish bearing streams

Whites Fire 7th-field Watersheds	Whites Fire Burned Acres	Total Miles of Anadromous Salmonid Habitat/Miles Within the Analysis Area	Total Miles of Fish-Bearing Streams/Miles of Habitat Within the Analysis Area
Big Creek	104.2	1.1/0	1.1/0
Eddy Gulch	178.3	2.7/0.2	2.7/0.2
Jackass Gulch	384.3	2.5/0	2.8/0
Jessups Gulch-North Fork Salmon River	328.2	2.6/0.2	2.6/0.2
Lower North Russian Creek	4,501.2	4.6/4.6	4.7/4.7
Lower South Russian Creek	2,137.9	2.1/2.1	2.2/2.2
Music Creek	3,285.8	0	0
Robinson Gulch-North Fork Salmon River	5,038.0	4.6/4.6	4.6/4.6
Shadow Creek	693.7	1.9/0	1.9/0
Sixmile Creek	885.9		2.5/0
Specimen Creek	164.1	2.2/0	3.2/0
Sugar Creek	234.6	4.0/0	9.2/0
Taylor Creek	2,973.2	0/0	0/0
Upper French Creek	1,307.8	8.5/0	15./0.5
Upper North Russian Creek	1,346.8	1.2/1.1	1.2/1.1
Upper South Russian Creek	5,142.4	1.0/1.0	8.0/5.9
Whites Gulch	8,308.2	1.6/1.6	3.6/3.6
Yellow Dog Creek-North Fork Salmon River	5,023.1	6.0/3.5	6.1/3.5
Grand Total	**42,037.9**	**46.6/18.9**	**71.4/26.5**

Aquatic Resources

The Salmon River is a Key Watershed. The basin provides approximately 175 miles of anadromous fish habitat (Elder et al. 2002), distributed within the main stem, Wooley Creek, and North Fork and South Fork Salmon River, including for spring and fall run UKT Chinook salmon, summer and winter run KMP steelhead, and SONCC Coho salmon.

The Salmon River spring-run Chinook salmon are one of the last and largest populations in the Klamath River system (Elder et al. 2002). Spring Chinook use the mainstem Salmon River, Nordheimer Creek, and Wooley Creek (Brucker 2004 *In* NCRWQCB 2005; Barnhart 1994, USFS 1995c, West 1991) and apparently use the mainstem North Fork up to the confluence with Right Hand Fork, as well as the Little North Fork and South Russian Creek (Brucker 2004, USFS 1995c). Spring Chinook use the South Fork mainstem at least to the Little South Fork and to Shadow Creek in the East Fork of the South Fork, as well as several tributaries, particularly Knownothing Creek and Methodist Creek (Brucker 2004, Elder et al. 2002, USFS 1997c).

Fall Chinook use much of the same habitat (except for holding) as the spring Chinook, though generally do not go as far up the streams. Barnhart (1994) stated that fall Chinook use in the mainstem, North Fork, and South Fork, and Moyle (2002) indicated Wooley Creek as a spawning stream as well. Use in the North Fork occurs at least up to Russian Creek USFS (1995c), and in the South Fork up to French Creek (Barnhart 1994). Spawning occurs in Nordheimer Creek, a mainstem tributary, as well as in a number of tributaries to the South and

North forks. Brucker (2004) reports observations of late fall/winter run Chinook in the Lower Salmon River watershed below Knownothing Creek.

Steelhead are the most widely distributed of anadromous salmonids in the Salmon River system (Elder, et al 2002). Summer steelhead adults use summer holding areas with spring Chinook. Snorkel counts of summer steelhead indicate about 50% hold in the South Fork, the remainder split equally between Wooley Creek, the North Fork and the mainstem (USFS 1997b).

A comprehensive review of datasets originating from multiple agencies/entities was conducted by CDFW, with the conclusion that Coho presence in the North Fork Salmon River has been substantiated (Garwood 2012). Coho spawning surveys in the North Fork Salmon River are not conducted due to dangerous discharge conditions and poor water visibility, therefore observations of rearing juveniles during summer and fall is used to indicate Coho presence. A 2005 survey of thermal refugia in the North Fork Salmon River found Coho juveniles at the mouth of the following tributaries: Big Creek, Olsen Gulch, Jones Gulch, Little North Fork Salmon River, Shiltos Creek, and Jackass Gulch (SRRC 2005). Coho, Chinook and steelhead presence in Big Creek is expected to be limited to the mouth area only due to the small size of this drainage, low discharge, steep gradient, and lack of adequate spawning substrate. The culvert, just above the mouth of Big Creek, is considered to be a barrier to anadromous fish. Coho or Chinook surveys have not been conducted in Jackass Gulch; suitability of the system for these species is unknown. Spawning surveys were performed in 1991 and 1999, but no live fish, carcasses, or redds were found. The upstream limit of anadromy is considered to be a waterfall located ~0.2 miles above the mouth. This barrier was noted by KNF biologists in 1975, 1983, and 1988. The falls were modified in 1990 by the installation of two log and rock weirs to allow steelhead access to upstream habitat, however, the structures are no longer functioning as designed. No surveys specifically targeting Coho or Chinook salmon have been completed in the Specimen Creek drainage. This situation is largely due to difficulty of road access and/or unsafe discharge conditions when Coho would be expected to be spawning. Habitat surveys which included snorkeling to identify fish occurred in 1991, but did not observe Coho. Resident rainbow trout and presumed steelhead juveniles have been observed in the mainstem Specimen Creek to 1.5 miles up from the mouth, with resident trout present for an additional mile upstream; and both are found on Left Hand Fork to a distance of 0.75 miles up from the mouth. Fish (fry) have also been recorded as present in the King Creek tributary to a distance of ~1000 feet. Additionally, spawning surveys conducted in 1981, 1988, 1990-1996, and 1999 were positive all years, except 1993, for live steelhead and redds. Although Garwood (2012) stated Coho occupancy in Specimen Creek to be unsubstantiated, this conclusion was based from limited records. The 1995 Klamath National Forest North Fork watershed analysis did identify Specimen Creek as potentially supporting Coho (USFS 1995).

Sediment

The 2014 wildfires affected tributaries to the North Fork Salmon River that provide habitat for anadromous salmonids (Cow Creek, North Russian, South Russian and Whites Gulch) as well as tributaries that provide habitat for resident steelhead trout (Highland Creek, Hogan Creek, Johns Meadows Creek, Music Creek, Sawmill Gulch and Taylor Creek). Several other small, unnamed drainages that drain the east side of Tanners Peak towards the North Fork Salmon River between Idlewild Campground and Mule Bridge were also burned but do not have connectivity to the North Fork Salmon. Redd mapping (2011 through 2013) has documented Chinook redds

scattered throughout anadromous streams in the fire area. Although fire and its effects are a part of the natural disturbance regime in a watershed, a primary concern is the potential for excessive fine sediment, which can result in pool filling, impacts to spawning substrate, food production and thermal refugia. Several accessible tributaries to the North Fork Salmon River within the wildfire area function as thermal refugia when the mainstem North Fork Salmon River temperatures increase. The extent of damage to Riparian Reserves and the potential for impacts to stream shade is also a concern.

Post-fire BAER field reviews were focused on identifying the necessary treatments to minimize road failure and general mobilization of post-fire road-related sediment such as installation of critical dips and cleaning of culverts and cross-drains. Treatments were identified for Whites Gulch as multiple culverts were found to be partially blocked with debris, with a few completely buried such that the inlet could not be found. Post-fire mapping indicated that burn intensity along fish-bearing streams was predominantly low, or unburned. The primary exception was East Fork Whites Gulch, as well as a small segment of the North Fork Salmon River in the Hickey/Applesauce Gulch area. Additionally, the riparian area of many of the larger fishless perennial streams within the fire boundary exhibit relatively low burn severity. Field observation confirmed mapping results.

Table 17: Summary of watershed burn severity for the 2014 Whites Fire

Fire Area	Amount of Very Low Acres (%)	Amount of Low Acres (%)	Amount of Moderate Acres (%)	Amount of High Acres (%)	Total (Acres)
Whites Fire	5,612 (17%)	16,497 (49%)	10,007 (30%)	1,637 (5%)	33,753

The North Fork Salmon River post-fire 5th-field watershed risk ratio is at 0.3, well below 1 indicating that disturbance resulting from road, vegetation management, and wildfire is sufficiently below the watershed TOC, and interpreted to mean that effects on increased peak flow will not be significant at this scale. However, channel change would be expected along reaches that conveyed debris flows. The North Fork Salmon River 5th-field watershed post-fire Mass Wasting (GEO) risk ratio is at 0.73 and does exceed the Mass Wasting (GEO) threshold of concern.

Table 18: Modeled post-fire CWE, USLE and Mass Wasting (GEO) risk ratios for the Whites Fire 5th-field watershed.

5th-Field Watershed Name	Area (Acres)	Pre-Fire (2012)	Post-Fire, No Action	2014 Fire Area
ERA Risk Ratios				
North Fork Salmon River	130,545	0.2	0.3	Whites
USLE Risk Ratios				
North Fork Salmon River	130,545	0.1	0.3	Whites
GEO Risk Ratios				
North Fork Salmon River	130,545	0.5	0.7	Whites

Water Temperature

The Salmon River is impaired and is listed under the 303(d) Clean Water Act for temperature (Table 3). Water temperatures stressful to salmonids occur in the Lower Salmon River annually, but the extent and duration changes in different flow years. Cool, deep pools in the Lower

Salmon River are critical for summer holding and rearing salmonids. Spawning occurs in the mainstem Salmon River in gravels located in pool tail-outs.

Shade is lacking along the entire North Fork of the Salmon, with the exception of the upper-most reaches. Tributary temperatures are typically below lethal levels and provide thermal refugia. The Little North Fork has the largest cooling effect on the North Fork of the Salmon River due to its significant flow contribution. High water temperatures have resulted in fish kills of spring-run Chinook salmon and summer steelhead during warm low-flow drought conditions of some summer seasons, such as in 1994 and 2014. The North Fork Salmon River stream temperatures ranged from "Properly Functioning" to "Not Functioning" in 2014 relative to salmonid criteria (see Table 15).

Table 19: 2013 water temperature data for North Fork Salmon River (USFS 2014h).

Location	Date of Maximum MWMT	Maximum Weekly Maximum Temperature ºC (MWMT)
NF Salmon River upstream of Mule Bridge	7/27/13	21.9
NF Salmon River upstream of Right Hand Fork	7/27/13	19.5
NF Salmon River just upstream of Forks	7/27/13	26.2
NF Salmon R upstream of Little NF	7/30/13	25.6

The percent of stream channel burned in 2014 is an indication of the impacts to riparian function, including stream shade along perennial streams (see Table 20). Approximately 3% of streamside areas were burned at high severity and these areas will provide little to no shade to stream channels post-fire until trees re-establish. Approximately 14% of streamside areas burned at moderate severity, and these areas experienced an estimated 50% reduction in streamside vegetation. The relative percentages of reduction in vegetation along streams is low, and are not expected to measurably increase stream temperatures.

Table 20: Summary of stream channel burn severity data from BAER Reports (USFS 2014a-2014f) for the 2014 Whites Fire.

Fire Area	Stream Type	Very Low miles (%)	Low miles (%)	Moderate miles (%)	High miles (%)	Total (miles)
Whites Fire	Intermittent	18 (21%)	43 (50%)	21 (24%)	4 (5%)	86
	Perennial	16 (25%)	36 (57%)	9 (14%)	2 (3%)	63

Large Wood

Approximately 29 percent of the watershed is designated as Riparian Reserves, which includes unstable or potentially unstable lands and stream buffers. Current conditions in Riparian Reserves have been impacted by historic grazing, roads, stream crossings, and mining. Analysis of the 1944 air photos showed that at that time, most stream channels were fully vegetated with a mixture of conifer and hardwood species. The 1964 flood resulted in major changes to the stream channel in that the channel widened and long segments were scoured out. The entire length of the North Fork of the Salmon River was modified and stripped of riparian vegetation. As described above, post-2014 fire mapping indicated that burn intensity along fish-bearing streams was predominantly low, or unburned. The primary exception was East Fork Whites Gulch, as well as a small segment of the North Fork Salmon River in the Hickey/Applesauce Gulch area.

Additionally, the riparian area of many of the larger fishless perennial streams within the fire boundary exhibit relatively low burn severity. Field observation confirmed mapping results.

Recovery from debris and other scour events occur in stages and along variable timelines. Full recovery of large conifers may take 100 years or more, although initial recovery of short-lived riparian species that also provide bank stability and integrity can occur in a decade or two. In 1995 the Klamath National Forest estimated that the mainstem North Fork of the Salmon River showed 20 percent initial recovery since the 1964 flood. This may be because, in general, larger streams recover more slowly than smaller streams (the KNF also studied recovery of smaller streams) due to larger surface areas affected by scour and larger streamflows acting on this surface.

The 2014 fires had no effect on instream wood levels in the mainstem but will affect tributaries that burned relative to short-term wood loading and large wood available for recruitment in the long-term. Fire intensity and extent of area burned within Riparian Reserves is used herein as to update the large wood information collected prior to the 2014 fires. High burn severity areas along perennial streams will experience an increase in wood loading in the short-term and a reduction in large wood available for recruitment to streams in the long-term. The percent of perennial stream channels that burned in the Whites Fire at high severity is limited (3 %) indicating that effects to large wood loading and recruitment will be minor. Approximately 14% of perennial stream Riparian Reserves were burned at moderate severity in the Happy Camp Complex, and an estimated 50 percent of the vegetation was burned in these areas. Collectively, these high and moderate burn severity areas will increase large wood loading in the near term and reduce the available sources of large wood available for recruitment in the long-term.

Environmental Consequences

Alternative 1

Direct and Indirect Effects

Under the No Action Alternative, there would be no action taken to meet the purpose and need for the project and desired future conditions within the project area (see Chapter 1, Draft EIS).

The no action alternative is not a baseline condition, but rather a description of future circumstances without implementation of the WSFR Project. The no-action alternative is a continuation of the current level of management including road maintenance, hazard tree removal, dispersed recreation, mining, watershed restoration, appropriate management and fire suppression against the back-drop of ~183,127 acres of burned Forest Service lands within the Assessment Area. No direct effects would occur under the No Action Alternative since no activities would be implemented as a result of the project.

The potential for indirect effects to habitat indicators and aquatic species under the No Action Alternative is framed herein relative to the following proposed Project Elements that would occur under all of the WSFR Project action alternatives:

1) Salvage and Reforestation
2) Fuels Reduction
3) Hazard Tree Removal

Temporary Roads, Landings, Stream Crossings and Water Drafting

Legacy Site Treatments

1) Salvage and Reforestation

The no action alternative would not remove burned trees or restore forests through reforestation including in moderate and high fire intensity areas. Without salvage, site preparation and replanting, severely burned stands (such as in Walker Creek) will likely be replaced by shrubland (Skinner et al 2006 - p174) and restoration to conifer stands will take decades, or even longer. These high severity sites are lacking seed sources to reseed burned areas. Re-establishment of conifers may only occur around the edges of the fire where a good seed source is still intact (Bonnett et. al. 2005). The remaining standing dead trees would be a hazard and preclude the tending of new plantations as they would be a hazard to forest workers and increase surface fuels. Failure to remove these dead trees will fail to contribute to a timely restoration of burned stands. Without capturing the value of dead trees via timber salvage, site restoration would likely be unsafe and/or cost prohibitive. Planting without site preparation would likely result in the loss in conifer plantations before they mature given the median 5-25 year fire return interval predicted within the Analysis Area.

Sediment

Altered sediment supply poses a stress to salmonids and other aquatic species. The no action alternative could indirectly affect sediment regimes in the Analysis Area if a future wildfire occurs because there will be an increased potential for severe fire effects if fuels are not reduced and because the abundance of burned trees within the fire areas will make fire suppression difficult if not impossible in some areas.

Post-fire salvage logging adds another set of environmental effects to recently burned areas with varying effects on revegetation, soil disturbance and sediment production. Salvage logging would not occur under the No Action Alternative. Adverse impacts to sedimentation from the absence of disturbance from helicopter, cable and ground-based logging are expected to be neutral and negligible in the short- and long-term.

Water Temperature

Failing to salvage and reforest moderate to high severity stands that were burned in 2014 would have no effect on stream temperature over the next 1-5 years as post fire conditions in the analysis include reduced surface fuel loading across the landscape. Failing to salvage and reforest moderate to high severity stands in subsequent years increases the potential for a future wildfire to spread and cause adverse impacts to Riparian Reserves because it would be unsafe to fight the fire directly. However, to experience a measureable increase in temperature, relatively large contiguous segments of stream must experience significant reduction in shade canopy. Spatial patterns of high intensity fire produced by past wildfires do not exhibit this pattern. Riparian Reserves were affected in a patchy, non-contiguous spatial pattern. Many 7th-field tributaries are narrow, steep, and north-south trending; all of which suggests lower vulnerability to temperature increases. The no action alternative could indirectly affect water temperature in the Analysis Area if a future wildfire occurs because there will be an increased potential for severe fire effects if fuels are not reduced and because the abundance of burned trees within the fire areas will make fire suppression difficult if not impossible in some areas.

Large Wood

The no action alternative would forego salvage harvest and reforestation, and would have neutral effects on large wood and minor effects on aquatic species.

2) Fuels Reduction

Immediate post fire conditions in the analysis include reduced surface fuel loading across the landscape. Thus, over the next 1-5 years, if a fire occurs, there is a low potential for fire spread and fire intensity that would add to the ongoing watershed impacts to fish and their habitat from past disturbances. Fire suppression would be effective in containing new fire ignitions. Within 5-10 years, the potential for a future wildfire to spread and cause adverse impacts to watershed processes and fish habitat increases. Within moderate to high severity burn areas, enormous amounts dead trees will remain standing and some will fall, creating high fuel loads across the burned landscape. If a fire does not occur within this time, these areas will likely be covered with shrubs and dead and down snags, making the area susceptible to high severity fire. If a wildfire does occur within this time frame or after, snags will present a high hazard to fire fighters and decrease the ability for containment.

Sediment

Altered sediment supply poses a stress to salmonids. Under the no action alternative, fuels would not be reduced. If a future wildfire occurred, the loss of soil cover due to a future wildfire 5-10 years in the future would expose more soil to raindrop impact and subsequent erosion. Eroded soil moves from hillslope to stream channel via surface runoff. Based on conditions in the Analysis Area after other past fires, sediment impacts are likely to be variable with higher sedimentation coming from high intensity burned areas where there is a near complete loss of soil cover. The magnitude of impacts would be strongly influenced by the severity of winter storms in the first decade following another fire. The duration of impacts would be likely to be intermediate between short- and long-duration as regrowth of vegetation reduces sediment source areas and high gradient channels flush stored sediments, dependent on the magnitude of winter runoff. Over the next 1-5 years, if a fire occurs, there is a low potential for fire spread and fire intensity that would add to the ongoing watershed impacts to fish and their habitat including increased sedimentation to streams. Fire suppression would be effective in containing new fire ignitions. Within 5-10 years, the potential for a future wildfire to spread and cause adverse impacts to watershed processes and fish habitat including increased sedimentation to streams is high. Adverse impacts to sedimentation from failing to conduct fuels reduction under the No Action Alternative are expected to be moderate in the short-term and high in the long-term.

Water Temperature

Where stand-replacing fire intensity occurs in streamside zones, shade canopy is lost, exposing streams to increased amounts of solar radiation. To experience a measureable increase in temperature, relatively large contiguous segments of stream must experience significant reduction in shade canopy. Spatial patterns of high intensity fire produced by past wildfires do not exhibit this pattern. Riparian Reserves were affected in a patchy, non-contiguous spatial pattern. Many 7th-field tributaries are narrow, steep, and north-south trending; all of which suggests lower vulnerability to temperature increases. Adverse impacts to stream temperature from failing to conduct fuels reduction under the No Action Alternative are expected to be discountable effects water temperature and minor effects to aquatic species.

Large Wood

The no-action alternative will have no effect on large woody debris in the next 1-5 years as surface fuel loading is low from the 2014 fires and regrowth of shrubs will be limited. From 5-10 years out, and beyond, the burned areas will become more susceptible to high severity fire as snags fall, shrubs grow, fuel loading increases and the ability to contain a future fire is reduced. If a large wildfire occurs, groups of trees could be killed in Riparian Reserves. If overstory vegetation were damaged or lost, existing wood and future large wood recruitment would be reduced. However, to experience a measureable decrease in existing levels of large wood or future wood recruitment, relatively large contiguous segments of stream must experience moderate to high intensity fire. Spatial patterns of high intensity fire produced by past wildfires do not exhibit this pattern. Riparian Reserves were affected in a patchy, non-contiguous spatial pattern. Adverse impacts to water temperature and aquatic species from failing to conduct fuels reduction under the No Action Alternative are expected to be discountable.

3) Hazard Tree Removal

Hazard tree reduction would occur under the No Action Alternative, but to a lesser extent on the landscape and limited to ongoing projects already analyzed in previous projects.

Sediment

The risk of impacts to sediment are associated with tree removal from Riparian Reserves. Under the No-Action Alternative, hazard trees abatement as described for the action alternatives will not occur and will have neutral effects on sediment or aquatic species.

Water Temperature

The risk of impacts to stream temperature is associated with removal of groups of hazard trees from within Riparian Reserves along roads that parallel perennial streams or at road/stream crossings. Under the No-Action Alternative, hazard trees abatement as described for the action alternatives will not occur and will have neutral effects on water temperature or aquatic species.

Large Wood

The risk of impacts to large wood is associated with removal of groups of hazard trees from within Riparian Reserves along roads that parallel perennial streams or at road/stream crossings. Under the No-Action Alternative, hazard trees abatement as described for the action alternatives will not occur and will have neutral effects on large wood or aquatic species.

4) Temporary Roads, Landings, Stream Crossings and Water Drafting

Salvage harvest and reforestation require temporary road construction, and use of existing landings or construction of new landings, which disturbs ground cover even though these activities may occur on previously disturbed areas. Soil displacement increases as a result of these activities, and there is potential for sediment to move off-site and into stream channels, especially when these actions occur within Riparian Reserves. Soil productivity is reduced and erosion potential increases on reconstructed roads and landings in the short and long-term. The highest risk of adverse impacts is where these activities occur within Riparian Reserves. Water drafting can also directly and indirectly affect aquatic species through site disturbance.

Sediment

Altered sediment supply poses a stress to salmonids. The relative effects of soil disturbance associated with temporary road and landing construction or reconstruction vary with location, site conditions, and proximity of disturbances to stream channels. The highest potential for impacts is when roads and landings are re-opened within Riparian Reserves. These actions will not occur under this alternative, thus there will be no adverse effect on sediment or aquatic species associated with temporary roads, landings or water drafting.

Water Temperature

Salvage harvest and reforestation will not remove shade trees or occur within Riparian Reserves. These actions will not occur under the no action alternative, thus there will be no adverse effect on water temperatures or aquatic species associated with temporary roads, landings or water drafting.

Large Wood

Large wood recruitment potential can be adversely affected if temporary roads cross stream channels and require tree removal or if landings are reconstructed or expanded within Riparian Reserves and include removal of large trees. These actions will not occur under this alternative, thus there will be no adverse effect on large wood or aquatic species associated with temporary roads, landings or water drafting.

5) Legacy Sediment Site Treatments

The action alternatives all include treatments to address legacy sediment sites in the Elk Creek watershed. The roughly 148 legacy sites included for treatment to address undersized culverts, diversion potential, fill removal on abandoned roads, and aquatic organism passage would not be treated at this time with the No Action alternative. Also, road storm proofing treatments on about 33 miles of system road in the Elk Creek watershed would not be covered by this decision.

Cumulative Effects

The No Action Alternative would not add project-related incremental effects to the effects of past, present/ongoing or future projects because no management activities are proposed. However, the burned watersheds will be vulnerable to a wildfire in from 5-10 years and beyond if no action is taken, which could lead to cumulative adverse effects to fish habitat. Aquatic habitat is recovering from past disturbances and fish populations are at low levels. Thus, a severe wildfire, in combination with past, present/ongoing and future actions, could result in cumulative impacts to fish associated with increases in sediment supply, localized increases in water temperature and reduced long-term large woody debris recruitment. The magnitude of impacts is expected to be minor to moderate depending on the spatial pattern of high intensity fire. Under the No Action alternative, salvage harvest using various methods, and construction or reconstruction of roads and landings would not add to ongoing incremental effects as no action would be taken.

Alternatives 2, 3, 4 and 5

Direct Effects

The potential for direct effects to aquatic resources is associated with actions that occur in active stream channels. All action alternatives are the same with respect to the potential for direct

effects to aquatic resources because all action alternatives include water drafting and culvert upgrades as part of legacy sediment site repairs; these are the only Project Elements proposed within fish-bearing streams. Several temporary road crossings would occur within stream channels but these sites are above the range of fish and other aquatic species are not expected to be in the area as most streams involved will be dry during construction. Therefore potential impacts to aquatic habitat from temporary road actions are discussed below as indirect effects.

Water Drafting

Direct effects to Coho salmon, Forest Service Sensitive species and Management Indicator Species and their habitat can result from water drafting activities. Numerous water drafting sites will be used for the WSFR Project (see locations in Appendix A), and sites may be located within fish-bearing and non-fish-bearing streams. Water drafting sites may also overlap suitable habitat for Foothill yellow legged frogs and Western pond turtles. It is less likely that water drafting will overlap suitable habitat for Cascade frogs, but it may at sites above 2500 feet in elevation; project water drafting is even less likely to impact Southern Torrent salamanders as this species may occur only in Elk Creek and only in well-shaded waters (water drafting sites are typically along roads that have been previously disturbed and are not well-shaded).

Drafting operations can disturb holding or spawning adult fish, as well as impinge or entrain juveniles (Sicking 2003). Additionally, water drafting operations can mobilize suspended sediment to downstream aquatic habitat. Suspended sediment increases turbidity, exposing juvenile fish to gill damage and reduced oxygen uptake, and/or reduced vision and compromised feeding effectiveness. If water drafting were to occur with eggs present in adjacent redds, it is possible that deposition of suspended sediment could fill interstices of stream bottom substrate, depriving incubating eggs of dissolved oxygen and resulting in their mortality.

The timing of water drafting, and the associated direct impacts to aquatic species, usually does not coincide with spawning/reproductive timing for aquatic species. All ground disturbing activities are implemented according to Wet Weather Operations which means that during periods of wet weather ground disturbing actions, and thus water drafting needed to water roads, are not occurring. For salmonids, eggs of only resident and anadromous trout (steelhead) are incubating in redds during the summer period (generally December through July). The Chinook and Coho egg incubation period is generally October through March, during the winter period; therefore likelihood of water drafting having any effect on reproduction of Chinook or Coho salmon is low. Also, project design features eliminate any drafting site improvements within CH, such as deepening pools which could generate sediment that impacts adjacent fish habitat. Implementation of Forest Service BMPs specific to water drafting minimizes potential impacts to resident and steelhead trout, and other aquatic species that may be present, to minor or insignificant.

While screening intakes can reduce effects to fingerlings and fry, minimization of impingement requires the use of specific mesh sizes, pumping rates, and screen areas, as outlined in the *NOAA Fisheries Water Drafting Specifications* (NOAA 2001). As described in the Project description, NOAA drafting specifications will be implemented during project water drafting within Coho salmon CH (see Appendix A Maps for locations). Forest Service BMPs which require screening for aquatic species present, will be implemented at water drafting sites outside of CH. There is a very low probability of impingement given that fish will flee the area when a truck or hose is detected. It is anticipated that fish temporarily avoiding water drafting activities are not likely to

experience reduced feeding success, nor result in a significantly higher probability of exposure to prey.

The frequency of effects from water drafting is only during operations. Drafting will be done in accordance to the NOAA *Fisheries Water Drafting Specifications* (NOAA 2001) and appropriate Project PDFs (Table 2-35 in the draft EIS located on the project website) and BMPs. Numerous drafting sites have been identified for use to provide greater flexibility in choosing the best source during Project implementation. However, not all sites will be utilized. An important minimization measure is Watershed PDF-5, which requires that decisions regarding which drafting sites to use in a given area be coordinated with KNF fisheries biologists. By following these specifications and considering the mobility and likely behavioral response of aquatic species to move out of the area when a truck approaches or hose is dropped, the effects of water drafting will have minor and insignificant direct effects on aquatic habitat or aquatic species. Because Alternative 5 involves substantially less salvage harvest and site prep and plant acreage (total of almost 13,000 less acres treated in Alternative 5 as compared to Alternative 2), there will be less need for water drafting to support project implementation and therefore less potential effects to aquatic species from drafting.

Legacy sediment site repair

Legacy site repair includes upgrading stream crossings to address erosion concerns and install structures capable of withstanding 100-year storm events. The proposed legacy sites are in the Elk Creek watershed but not within anadromous salmonid habitat. PDFs and BMPs will minimize effects to other aquatic species if they are in the vicinity of culvert upgrades. Because legacy sites are not within accessible habitat, direct effects from legacy site repairs to anadromous salmonids will not occur. Methods and minimization measures for stream crossings, including for culvert installation and dewatering, were analyzed in the Facilities Maintenance and Watershed Restoration BA (USFS 2004). PDFs will be implemented to minimize direct and indirect effects to all aquatic species. Due to these measures, direct effects to aquatic species are expected to be discountable.

Other Project elements will not result in direct impacts to aquatic species as work will not occur within active stream channels.

Indirect Effects

Landscape-level changes to forested habitat occurred as a result of the 2014 wildfires. Approximately 180,000 acres of Forest Service lands burned. High fire intensity areas were characterized by total or near-total conifer crown consumption. Within areas of moderate burn intensity, some crown consumption occurred, but generally these areas are characterized by total or near-total crown scorch. The vast majority of trees in these areas have been killed by the fire or damaged beyond their ability to survive. Within areas of light burn intensity the smaller size and lower crown class conifers were burned. Without salvage, site preparation and replanting, severely burned stands will likely be replaced by shrubland (Skinner et al 2006 - p174) and restoration to conifer stands will take decades, or even longer. These high severity sites are lacking seed sources to reseed burned areas. Re-establishment of conifers may only occur around the edges of the fire where a good seed source is still intact (Bonnett et. al. 2005). The remaining standing dead trees would be a hazard and preclude the tending of new plantations as they would be a hazard to forest workers and increase surface fuels.

All action alternatives include the following five Project Elements:

- Salvage and Reforestation
- Fuels Reduction
- Hazard Tree Removal
- Temporary Roads, Landings, Stream Crossings and Water Drafting
- Legacy Sediment Site Treatments

All action alternatives are subject to the same Watershed PDFs provided in Table 2-35 in the draft EIS located on the project website, which were developed by watershed specialists to minimize impacts to soils and aquatic resources.

The action alternatives vary with respect to amount of acreage treated and temporary roads needed to access units. Acreages and miles are displayed for all alternatives in tabular form under the discussion of Alternative 2, the proposed action, so that the reader can readily compare relative differences between the alternatives.

Alternative 2, the proposed action, is discussed first and all other action alternatives (3, 4 and 5) are discussed relative to Alternative 2.

Alternative 2

Sediment

As described in the Methodology section of this Report, Project effects to sediment supply and delivery are assessed herein at the watershed- and site-scale. The watershed-scale effects analysis relies on the WSFR Hydrology analysis and interpretation of the KNF CWE modeling and results that compare pre-fire disturbance with post-fire and post-project (Alternative 2) disturbance, including at the 5th-field (see Table 22) and 7th-field watershed scales (refer to the WSFR Hydrology Report). Site-scale effects were assessed in the field and are also based on an understanding and prediction of Project Element effects based on past projects and literature reviews, and discussions with the interdisciplinary team members (geologist, hydrologist, silviculturist, wildlife biologist, and fire behavior specialist) regarding the potential for disturbance and risk to aquatic resources based on site conditions (including unit-specific slope stability, soil types, disturbance potential, and effects of minimization measures that would be implemented).

1) Salvage and Reforestation

Alternative 2, the preferred alternative, was designed to meet the purpose and need for action. Salvage harvest will occur on about 12,152 acres. Areas proposed for treatment include 1) Areas of moderate to high severity vegetation mortality; 2) Areas determined to be feasible in terms of logging systems, accessibility, and economics; and 3) Areas with more than 10 contiguous acres of medium to high severity vegetation mortality. Only standing dead trees 14 inches in diameter at breast height or greater will be considered for salvage harvest. Salvage logging will be accomplished by a combination of ground-based, skyline, and helicopter logging systems. All salvage units will be reforested with the need for site-preparation evaluated first.

Reforestation includes site-preparation, planting, and release over 7,906 acres to increase the likelihood and speed by which burned areas are reforested and will include: manual site preparation, skyline yarding, mastication, mechanical yarding and slash piling of dead trees. Treatments within Riparian Reserves may occur where existing plantations overlap and only

hand treatments (felling of dead trees less than 16 inches DBH, with lop and scatter) are proposed in these areas. Approximately 1,100 acres of Riparian Reserves will be treated with lop and scatter within site preparation and planting units. Thus, treatments will increase soil cover and sediment retention capacity, as well as improve soil productivity, reducing erosion and sedimentation.

Table 21: Acres of salvage harvest by logging system and site preparation and planting.

Logging System	Beaver Fire	Happy Camp Complex	Whites Fire	Grand Total
Alternatives 2, 3 and 4: Site Prep and Plant	1782	5470	654	7906
Alternative 2 Proposed Action				
Ground-based	632	632	23	1287
Skyline	239	4971	391	5601
Helicopter	0	4748	516	5264
Total	**871**	**10351**	**930**	**12152**
Alternative 3				
Ground-based	0	595	23	618
Skyline	0	4645	298	4943
Helicopter	0	4288	516	4804
Total	**0**	**9528**	**837**	**10365**
Alternative 4				
Ground-based	596	566	23	1185
Skyline	168	3533	382	4083
Helicopter	0	4883	516	5399
Total	**764**	**8982**	**921**	**10667**
Alternative 5				
Site Prep and Plant	1771	2093	0	3865
Ground-based	632	228	15	875
Skyline	207	872	0	1079
Helicopter	0	1535	57	1592
Total	**840**	**2635**	**72**	**3547**

Timber harvesting, including skid trails, landing and road construction, can increase the amount soil disturbance, erosion, and sediment delivery to streams. Soil disturbance and loss of cover exposes soil to raindrop impact and subsequent erosion. Eroded soil moves from hillslope to stream channel via surface runoff. In sufficient quantities, fine sediment can reduce the abundance and quality of aquatic habitat. This is an indirect effect in that sediment movement is driven by winter storms or snowmelt events that occur following disturbance and effects can occur far downstream from sites of disturbance. Salvage harvest is likely to also result in some increase in soil cover from breakage of tree tops and small limbs. All harvest units have been designed with resource protection measures that conform to LRMP guidance in meeting the Aquatic Conservation Strategy and Riparian Reserves Standards and Guidelines.

Altered sediment supply poses a stress to salmonids and other aquatic species. Access to tributary rearing habitat and refugia from the mainstem Klamath River during some parts of the summer is blocked at times by alluvial barriers resulting from sediment loads flushing out of the analysis area watersheds. Excessive fine sedimentation reduces habitat diversity, embeds

spawning gravel, and reduces channel stability. Soils in this area are highly erodible, and in combination with the steep terrain, recent fires, and a legacy of past timber harvest and road-building, fine sediment loading has contributed to impaired aquatic habitat conditions in some areas within the Analysis Area (i.e. sensitive watersheds in the Analysis Area).

Stream temperature may be altered indirectly through changes in sediment supply to streams through changes to pool depths or increases in width-to-depth ratio, which can facilitate heat exchange (Poole and Berman, 1999). In addition, fine sediment may block exchange between surface waters and intragravel flows, also contributing to warming. This discussion focuses on effects to sediment, and where those effects are determined to be significant, an impact to temperature is inferred.

The method of salvage harvest used affects the extent of watershed disturbance. Chase (2006) compared sediment production rates from sites burned at high severity and subjected to helicopter, cable or tractor logging and found that cable- and tractor-logged sites have significantly more ground disturbance than sites logged by helicopter (Chase 2006). The effect of different salvage logging methods on percent ground disturbance was studied by Klock (1975) who reported that the mean percent disturbance for tractor skidding over bare ground was 36%, 32% for cable logging without full suspension, 2.8% for cable logging with full suspension and less than 1% for helicopter. Chou et al. (1994a; 1994b) also measured disturbance after salvage logging on the 1987 Stanislaus National Forest fire and reported the mean disturbance for tractor logging was 35% versus 18% for cable-logged sites. Some studies have argued that salvage logging may reduce post-fire sediment production by breaking up soil water repellency and increasing infiltration rates by disturbing sealed soil surfaces (Bautista et al. 1996). Slash from salvage logging can increase percent cover and surface roughness, thereby reducing overland flow velocities and surface erosion (Shakesby et al. 1996; Poff 2002).

Wagenbrenner et al. (2014) found that skidder and feller-buncher plots generally had greater compaction, less soil water repellency, and slower vegetation regrowth than untreated control plots. Adding slash to skid trails increased total ground cover and reduced sediment yields by 5-50 times compared to untreated plots. Vegetative regrowth and sediment production varied widely among the study areas due to differences in rainfall and soil properties, however, susceptibility to surface runoff and erosion after high severity fire suggests that areas disturbed by ground-based salvage logging need additional mitigation.

This analysis uses the CWE model results to assess potential effects to sediment sources and delivery at the watershed-scale from Project Elements. Table 22 shows modeled results pre-FIRE, post-fire and post-project (Alternative 2). Disturbance from the 2014 fires was high in some watersheds, increasing risk ratios in the following 5th-field watersheds: Beaver Creek, Lower Scott River, Thompson Creek and North Fork Salmon. Disturbance associated with implementation of salvage harvest and all associated actions was modeled against the post-fire baseline. The proposed action did not add any incremental disturbance beyond the 2014 fires to runoff (ERA), mass wasting (GEO) or sedimentation (USLE) – at the 5th field watershed scale.

Table 22. ERA model results at the 5th-field scale comparing pre-fire conditions, no action and Alternative 2, the proposed action.

5th-Field Watershed Name	Area (Acres)	Pre-Fire (2012)	Post-Fire, No Action	Alternative2	2014 Fire Area
Beaver Creek	69,610				Beaver Fire
ERA		0.7	1.0	1.0	
USLE		1.1	1.2	1.2	
GEO		0.8	1.1	1.1	
Horse Creek-Klamath River	98,625				
ERA		0.7	0.7	0.7	
USLE		0.7	0.8	0.8	
GEO		0.7	0.9	0.9	
Humbug Creek-Klamath River	68,023				
ERA		0.6	0.3	0.3	
USLE		0.6	0.5	0.5	
GEO		0.8	0.8	0.8	
Elk Creek	60,829				Happy Camp Complex
ERA		0.5	0.5	0.5	
USLE		0.1	0.3	0.3	
GEO		1.0	1.0	1.0	
Lower Scott River	98,016				
ERA		0.1	0.5	0.6	
USLE		0.1	0.5	0.5	
GEO		0.3	0.6	0.6	
Seiad Creek-Klamath River	81,706				
ERA		0.6	0.6	0.6	
USLE		0.3	0.7	0.7	
GEO		0.5	0.8	0.8	
Thompson Creek-Klamath River	67,301				
ERA		0.1	0.4	0.4	
USLE		0.4	0.3	0.3	
GEO		0.4	0.5	0.5	
North Fork Salmon River	130,545				Whites Fire
ERA		0.2	0.3	0.3	
USLE		0.1	0.3	0.3	
GEO		0.5	0.7	0.7	

In addition to the above assessment of watershed-scale effects to Sediment at the 5th-field scale, the hydrology assessment modelled and interpreted past and predicted disturbance at the 7th-field watershed scale. The WSFR Hydrology Report (KNF 2015) includes the full CWE modelling results summarized here. Ten of the 19 7th-field watersheds showed minor incremental increases in risk ratio due to modeled effects of the proposed action. No 7th-Field watersheds that were below TOC were pushed over TOC by the proposed action. Six 7th-Field watersheds within the Happy Camp Complex had high Mass-wasting (GEO) risk ratios as a result of the 2014 fires: Middle Elk Creek, Walker Creek, Bishop Creek-Elk Creek, Caroline Creek-Klamath River, Granite Creek and O'Neil Creek. Pre-project, these watersheds are considered to be "at risk" for mass wasting, primarily due to effects of the 2014 fires. However, CWE modelling indicated that the proposed action adds only a slight incremental increase to disturbance values in these watersheds.

In addition to a review of the CWE modelling results at the 5th- and 7th-field watershed scale, this analysis reviews potential impacts to Sediment at the site scale. Relative to salvage harvest and

site preparation, the following minimization measures will be implemented: ground harvest (e.g. tractor) equipment will be limited to 35% slopes; tractors and mechanical harvesters will be excluded from all Riparian Reserves associated with stream channels, active landslides, inner gorges, and toe zones of dormant landslide deposits; no salvage logging is allowed on toe zones of landslides or active landslides; limit equipment disturbance within 20 feet on either side of swales by minimizing equipment crossings and avoiding running trails up the axis of swales, except at designated crossings; in salvage units and subsequent site preparation, skidding equipment will be restricted to slopes less than 35 percent; skid trails that connect benches in dormant landslide terrain can have minor portions of the skid trails on slopes greater than 35 percent; refueling will not take place within the Riparian Reserve; a spill containment kit will be in place where refueling and servicing take place; skid trail erosion control work will be kept current during implementation; erosion control and drainage of skid trails will be complete prior to shutting down operations due to wet weather or at project completion; use existing skid trails instead of building new skid trails unless using existing skid trails will have greater negative effects; space skid trails at least 75 feet apart; use no skid trails in areas where ground-based mechanical equipment is excluded and in unstable areas, wetlands or meadows; designation of new skid trails will be approved by a Timber Sale Administrator; erosion and sedimentation control structure will be maintained and repaired per the guidance in the Forest Service Handbook 2409.15 R5 Supplement; no full bench skid trails will be constructed; full bench skid trails have the entire skid trail cut into the hillslope; locations where skid trails intersect roads will be obliterated or effectively blocked to vehicle access; skyline corridors will be placed on the landscape as to minimize disturbance to active landslides, inner gorges and toe zones of dormant landslide deposits; all skyline and ground-based yarding will require one-end suspension in corridors and on skid trails; corridors for skyline yarding that are parallel to the stream channel will be placed outside of the Riparian Reserve; corridor may cross the stream channel with full suspension of logs within ten feet from the stream bank; where skidding occurs through areas with less than 50 percent soil cover, mulch skid trails of greater than 15 percent slope, to achieve at least 50 percent effective soil cover on skid trails. Effective soil cover could include plant litter, woody material in contact with the soil, living vegetation, and rock fragments with a diameter of ½ to 3 inches. Use of certified weed free materials including straw, wood chips, or mulch may be used where on-site material is insufficient; on cable corridors, hand waterbar and scatter slash to achieve at least 70 percent effective soil cover.

Riparian Reserves have been established along all streams to protect riparian function (PDF Watershed-3) including sediment retention capacity. Cutting of trees for salvage harvest will not occur within Riparian Reserves under all methods of removal (tractor, skyline and helicopter). The sediment retention function of Riparian Reserves will not be impacted by salvage harvest. However, the 2014 fires burned at moderate to high severity within some Riparian Reserves and these areas are considered to be “at risk” because vegetation and soil cover was impacted (Table 23). Key riparian functions, including sediment retention capacity, are assumed to be lost in Riparian Reserves that burned at high severity. Watershed specialists reviewed these areas relative to the proposed units and found that, particularly in Upper Grider Creek 7th field watershed, there is potential for adverse effects related to sediment from salvage harvest due to heavily impacted riparian areas within and downstream of project units: 520, 521, 522, 524, 525, and 528.

Table 22: Burn severity along intermittent and perennial streams in the three project fire areas. Data from 2014 BAER assessment reports. Information derived from BARC base data.

Stream Channel Burn Severity						
		Very Low miles (%)	Low miles (%)	Moderate miles (%)	High miles (%)	Total (miles)
Happy Camp Complex	Intermittent	23 (9%)	196 (72%)	50 (18%)	2 (0.8%)	271
	Perennial	31 (13%)	188 (76%)	27 (11%)	0.4 (0.2%)	246
Beaver Fire	Intermittent	20 (15%)	66 (50%)	37 (28%)	10 (8%)	133
	Perennial	12 (34%)	18 (51%)	5 (14%)	<1 (<3%)	35
Whites Fire	Intermittent	18 (21%)	43 (50%)	21 (24%)	4 (5%)	86
	Perennial	16 (25%)	36 (57%)	9 (14%)	2 (3%)	63

Salvage harvest will remove dead trees and contribute to a timely restoration of burned stands. Without capturing the value of dead trees via timber salvage, site restoration would likely be unsafe and/or cost prohibitive. Planting without site preparation would likely result in the loss of conifer plantations before they mature given the median 5-25 year fire return interval predicted within the Analysis Area.

At the watershed scale (5th- and 7th-field watersheds), the 2014 fires resulted in significant impacts to sediment in some watersheds as described above. However, Alternative 2 adds only a slight incremental increase in disturbance to the baseline disturbance conditions and will remove burned trees and include reforestation to restore these areas quicker than taking no action. Based on Watershed PDFs that will minimize effects at the site-scale, we conclude that salvage harvest and site preparation under Alternative 2 will have discountable effects on sediment regimes and minor effects on aquatic species.

2) Fuels Reduction Treatments

Alternative 2 will treat hazardous fuels on about 22,574 acres and will include the following: hand work, mechanical thinning, mastication, lop and scattering, chipping, broadcast burning, jackpot burning, and pile burning. Fuels reduction activities near streams can increase the potential for sediment-related impacts to aquatic habitat.

Mastication using low ground pressure tracked or wheeled machines with a masticator head would be used to grind slash produced from mechanical thinning and existing ground fuels. Masticated material would be left scattered in treatment areas. Secondary treatment is required to dispose of activity-generated ground fuels and existing ground fuels to significantly decrease the potential for stand-replacing fire effects. Secondary treatments would include mastication and prescribed burning, which includes burning piles of slash and underburning. The track-mounted excavator with masticator arm is restricted to slopes of 45% or less and when soil moistures are less than 18%. Therefore, insignificant amounts of rutting will occur when using this machine. In addition, the 30” track produces ground pressures of up to six psi, therefore chances of any soil compaction occurring is also insignificant. Indirect effects from mechanical and hand fuels treatments to sediment will be discountable and effects to aquatic species will be minor.

Burning under prescription can result in localized loss of protective soil cover. This effect would occur as a result of unforeseen flare-ups in fuel accumulations. Indirect effects involve the movement of sediment from areas with significantly reduced soil cover to stream channels and then downstream to be deposited in pools and riffles. Such events are expected to be few in number and limited in size by the fact that burn plans will consider retention of cover in burn

areas in conformance with LRMP guidance (PDFs, Riparian Reserve Standards and Guidelines, Best Management Practices). Should flare-ups occur, loss of soil cover would be localized and short-term as regrowth and adjacent unburned stands contribute to the rapid re-establishment of soil cover. The magnitude of this impact is virtually identical between action alternatives because the locations and amounts of underburn treatments are nearly identical. Indirect effects from burning under prescription to sediment will be discountable and effects to aquatic species will be minor.

Handpile and burning will occur in some Riparian Reserves. Handpiles will be small (<6 ft. in diameter), scattered, and away from the edge of small perennial and intermittent streams. Intact ground and canopy cover will separate burn pile areas from channels. Required Resource Protection Measures (PDFs 34, 35, 36 and 37) include that piles not be stacked one above the other, and the piles be small in size (<6 ft.). Indirect effects from handpiling and burning treatments to sediment will be discountable and effects to aquatic species will be minor.

All action alternatives include fuels reduction activities in Riparian Reserves (see Table 24) within fuels management zones, roadside hazard reduction units, WUI's and underburn units. Small diameter trees would be removed using a masticator and hand work and fuels would be piled and burned. Project design standards, BMPs and PDFs would be implemented to protect riparian and aquatic habitat. Watershed PDFs (33, 34, 35, and 36) apply to all action alternatives and have been designed to maintain stream shade, understory vegetation and riparian function during fuels treatment within Riparian Reserves, including the following measures: prescribed fire effects will mimic a low intensity backing fire, except for handpiles/windrows where higher intensity may occur to consume pile material; ignition of underburns will generally not occur in Riparian Reserves; handpile and windrows in Riparian Reserves will be placed in a checkerboard pattern whenever possible (not piled directly above another); handpiles will be less than 6 feet in diameter and will be more than 15 feet away from intermittent streams and 30 feet away from perennial streams; for underburning, handline construction in riparian vegetation shall be avoided where practical but should farther than 25 feet from the channel if necessary; handlines will be mitigated (waterbarred and covered with organic material) immediately following prescribed burning, when safe to do so; When underburning in Riparian Reserves, at least 90% of the large woody debris will not be consumed, both standing and on the ground; tractors and mechanical harvesters will be excluded from all Riparian Reserves associated with stream channels, active landslides, inner gorges, and toe zones of dormant landslide deposits; and refueling will not take place within the Riparian Reserve. A spill containment kit will be in place where refueling and servicing take place. Indirect effects from treatments within Riparian Reserves to sediment will be discountable and effects to aquatic species will be minor.

Project fuels treatments are designed to reduce the adverse effects of future wildfires, therefore, would provide some protection for future watershed condition and function, especially if/when fires occur greater than 5 years in the future.

Table 23: Acres of fuels treatment by alternative and acres within Riparian Reserves.

	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Acres of Fuels Treatment	22,887	22,887	22,887	24,100
Acres of Fuels Treatment within Riparian Reserves	6,286	6,286	6,286	6,451

3) Hazard Tree Removal

Alternative 2 includes hazard tree removal along all roads estimated at 678 miles of roads (or within 21,872 acres), including Forest Service roads, County Roads, and State Highways to provide for public and Forest worker safety and future fire suppression efforts. Both the mileage and acres of treatment proposed are a maximum; the numbers are representative of the entire length and area being evaluated for hazard tree identification and removal. All action alternatives propose the same acres for treatment, with the exception of Alternative 4. Hazard trees will be removed from Riparian Reserves. The risk of impacts to habitat indicators is associated with removal of groups of hazard trees from Riparian Reserves that parallel streams or at road/stream crossings.

Watershed PDFs (Watershed-4 and 13) will be implemented to protect Riparian Reserves from disturbance associated with hazard tree removal including the following measures: In Hazard tree units equipment will be excluded from the inner 50 feet of the non-fish bearing Riparian Reserve and one site tree for fish bearing streams; all hazard trees cut within 25 feet of a stream channel will be left on site; in fish-bearing stream reaches, all hazard trees greater than 26 inches in diameter at breast height within the first site tree (150-170 feet) will be cut and left on site unless they are above the a road parallel to the stream channel; live trees directly rooted into the banks or otherwise integral to the stability of the channel bank will not be felled unless they pose an overhead hazard and, if felled, will be left on site unless this poses a hazard on the ground per OSHA requirements; directional felling will be used to protect streambanks where hazard trees need to be mitigated for public or employee safety; refueling will not take place within Riparian Reserves and a spill containment kit will be in place where refueling and servicing take place.

Based on implementation of the Watershed PDFs for hazard tree removal that require hazard trees to be left on site in near-stream zones, and field review of hazard tree removal areas, hazard tree abatement along roadsides will have discountable effects to sediment and minor effects to aquatic species.

4) Temporary Roads, Landings, Stream Crossings and Water Drafting

Temporary roads will be constructed to access units under all action alternatives. Table 25 lists the differences between the alternatives. None of the stream crossings proposed under Alternatives 2, 3 and 5 are within fish-bearing habitat.

Table 25. Miles of temporary roads needed for the action alternatives and number of stream crossings.

	Alternatives 2 and 3	Alternative 4	Alternative 5
Miles New Temp. Road	3.6	1.2	0.8
Miles Temp Road Existing Alignment	9.9	2.7	4.0
***Miles Reopen Decomm. Roads**	9.0	0.4	3.4
Total Miles of Temporary Road Construction	22.6	4.4	8.1
# of Temp Road Stream Crossings	14	0	8
# of Temp Road Stream Crossings in fish habitat	0	0	0

Alternative 2 proposes construction of approximately 22.6 miles of temporary road segments to access harvest units: 2.8 miles in the Beaver Fire; 18.7 in the Happy Camp Complex; and 1.1 miles in the Whites Fire. The total road mileage is divided among several short segments and roads will be hydrologically restored after use.

Roads can have a major impact on sediment and the drainage network. All but 3.6 miles of the temporary roads will be placed upon existing roadbeds, which will not increase the drainage network. After use, temporary roads will be hydrologically stabilized. This includes constructing waterbars, outsloping road prisms if appropriate, and obliterating access to the road. Disturbance associated with temporary roads were accounted for in the CWE analysis. At the 5th- and 7th-field watershed scale, disturbance from Alternative 2 including roads and harvest, will only add slight or insignificant levels of disturbance to the baseline conditions that include the 2014 fires. At the watershed scale, because temporary roads will be hydrologically stabilized and closed post-project, and because there will be no net increase in road density or drainage network after the project is complete, and based on implementation of Watershed PDFs (20, 21 and 25) temporary roads will have discountable effects to sediment and minor effects to aquatic species.

Figure 3: Decommissioned road and crossing in Cliff Valley Creek proposed for re-opening.

Project design features, BMPs and Watershed PDFs will be implemented to avoid unstable areas and minimize potential adverse effects to sediment from roads and at stream crossings *during project implementation* including the following: Fill materials generated from road treatments will be reincorporated back into subgrade to the extent possible; all excess fill materials will be spoiled outside Riparian Reserves; all project-related temporary structures, materials and debris will be removed from riparian areas and stream channels prior to winter shutdown; activities which require culvert replacement or removal will occur during the least critical periods for water and aquatic resources: when streams are dry or during low-water conditions; and in compliance with spawning and breeding season restrictions; upgrades or improvements to stream

crossings will be built to Forest Plan standards; new temporary roads or landings will not be constructed in Riparian Reserve associated with stream channels, on toe zones of landslides, active landslides or inner gorges. Exceptions for this project design feature for alternatives 2, 3, and 5: Landings # DZ03, DZ10, DZ23, L043, L044, and L090.

Watershed PDFs will be implemented *post-project* to effectively minimize the adverse effects to sediment from roads *until vegetative recovery can occur,* including the following: following harvest activities, maintain at least 50 percent slash on temporary roads and block them after the harvest season (prior to the first winter after use); new temporary roads will be sub-soiled; all temporary roads will have the takeoffs from system roads obliterated or blocked to avoid unauthorized use; hydrologic stabilizations which may also include removal of culverts and fills at stream crossings, out-sloping of road surfaces and/or obliteration of temporary road segments; erosion and sedimentation control structure will be maintained and repaired per the guidance in the Forest Service Handbook 2409.15 R5 Supplement.

Even with implementation of BMPs and PDFs, watershed specialists were concerned about temporary road construction effects to sediment supply and delivery. Temporary roads (re-opened and new) that are hydrologically linked via stream crossings were of greatest concern, as were log landings (re-opened and new) in RRs, and unstable areas crossed by roads. These features were analyzed by watershed specialists on a site-specific basis using GIS data and field surveys.

Temporary road actions on existing roadbeds include near stream road work and fourteen stream crossings (4 perennial and 10 intermittent streams) that are above the range of fish in the following drainages: Doggett Creek, Buckhorn-Beaver Creek, Grider Creek, O'Neil Creek, Kuntz Creek, China Creek, and Caroline Creek-Klamath River. Field surveys determined that if reopened roads, crossings, and landing sites were current actively eroding or at risk for erosion they are "legacy sediment sites" that need to be hydrologically stabilized to current specifications if used for the project. Several existing road beds proposed for use as temporary roads have crossings on non-fish bearing tributaries of Doggett, Beaver and Grider creeks that were determined to be legacy sites. For example, the temporary road bed in Doggett Creek proposed for use has numerous intermittent channels captured by the old road bed, and these will be fixed through implementation of the Project. Across the landscape, the analysis assumed that existing legacy sites and erosion concerns on reopened infrastructure would be restored after the project, as a result of compliance with current law, regulation and policy (specifically the Clean Water Act). Therefore long term beneficial effects in terms of reduced erosion, and/or risk of erosion, are expected at several sites where legacy sediment sources will be addressed (Doggett Creek, Beaver Creek and Grider Creek, in addition to the legacy site treatment proposed for Elk Creek). Project temporary road actions in O'Neil and Kuntz drainages would also result in long term benefits to sediment reduction as current road drainage problems would be addressed with use by the project. Temporary stream (perennial and intermittent) crossings would likely have short duration effects to sediment production limited to the first winter after use. Due to implementation of effects minimization measures (BMPs and PDFs) effects are expected to be site-scale and limited to the immediate area downstream of work.

Alternative 2 proposes to temporarily re-open segments of decommissioned road in the following drainages: Caroline Cr-Klamath River, China Creek, Upper and Lower Grider Creeks, Cliff Valley Creek, and Upper Elk Creek. These actions involve stream crossings on non-fish bearing reaches of Gard Creek, China Creek, Lower Grider Creek, and Cliff Valley Creek. Only one

site, within Lower Grider Creek drainage, has a legacy sediment site that will be improved with use in the project. All other decommissioned roads proposed for use have been appropriately decommissioned (from 10-15 years ago); with crossings pulled and road prisms outsloped these roadbeds are fading back into the hillslope to varying degrees. Therefore, there is no potential long term benefit involved in opening and using these roads for the project (no legacy sediment sites to address). Short term site level effects related to sediment delivery to streams as a result of disturbance, especially at crossings, would be expected during and post project during storms for several years. Non fish-bearing reaches of China, Grider, and Cliff Valley creeks are likely to experience these relatively minor negative short term effects over approximately 1.25 miles.

Scale and intensity of temporary road effects could increase to moderate in the case of the long road segment traversing multiple mid- or upper-slope channel crossings in Caroline Creek-Klamath River drainage (46N62). This drainage experienced a debris flow in the 1997 flood event that affected road stream crossings, the largest of which is the Gard Creek crossing which involves a perennial and an intermittent channel. There is also an active landslide below the road, west of Gard Creek that is narrowing the roadbed. Temporary re-opening of the road will require the reinstallation of stream crossings and widening the road on an active landslide. The effects of this work were incorporated into the geology risk analysis for Caroline Creek-Klamath River drainage. At the site scale the probability of re-activating the landslide by temporarily widening the road is moderate. Where the roadbed is narrowed due to road-fill related landslides, proposed re-construction of this segment could add weight to the head of the landslide which could cause it to re-activate if a landslide producing storm should occur before vegetation is re-established.

Alternative 2 incudes use of existing landings, where available, and construction of new landings. A maximum of 85 existing landings and 247 new landings are proposed under Alternative 2 within the three burn areas. Landing size will be commensurate with operational safety. Helicopter landings will be up to two acres in size. Skyline landings will use roads where ever possible. New skyline landings off the road system and ground-based landings will average one acre in size but will not be larger than 1.5 acres in size. Both new and existing landings will be hydrologically stabilized after use.

As existing landings are opened and new landings constructed, the potential risk of adverse effects to habitat indicators increases, in particular when landings are in or near Riparian Reserves. Watershed PDFs will be implemented under all action alternatives to minimize impacts to sediment including the following: new landings will not be constructed in any Riparian Reserve associated with stream channels, on toe zones of landslides, active landslides or inner gorges (exceptions to this project design feature for Alternative 2: Landing # DZ03, DZ10, DZ23, L043, L044, and L090); existing landings will be used to the extent possible; existing landings in stream-course Riparian Reserves will not be expanded towards stream channels or where mature trees or vegetation that provides shade to streams would need to be removed; existing landings in Riparian Reserves will be shaped and treated for erosion control at the end of each season of use, and hydrologically restored at project completion (including subsoiling and covering with slash/mulch as needed); reused landings in Riparian Reserves will have site specific erosion control measures to reduce risk of sediment delivery into streams; refueling will not take place within the Riparian Reserve; a spill containment kit will be in place where refueling and servicing take place; at project conclusion, landings will configured for long-term drainage and stability by reestablishing natural runoff patterns; all landings will be covered with at least 50 percent effective soil cover; use of certified weed free materials

including straw, wood chips, or mulch may be used where on-site material is insufficient; identified (selected) landings will be subsoiled, then covered with at least 50 percent effective soil cover.

Alternative 2 includes construction of the following new landings within Riparian Reserves: Landings # DZ03, DZ10, DZ23, L043, L044, and L090. Variables that provided for field-surveyed log landings to be approved for use include if they were on stable landforms and slope positions, were in the outer zone of the Riparian Reserve, or were separated from critical habitat channels by existing, stable road segments. Landings were not approved for use if they would require removal of mature vegetation or significant earthwork or fill. Although the CWE modelling indicates that the proposed action will not add incremental increases to disturbance at the 5th-field watershed scale, and only a slight incremental increase in some watersheds at the 7th-field scale, landings constructed within Riparian Reserves has a high risk of impacts to sediment supply and delivery at the site-scale.

Water drafting (locations are shown on maps in Appendix A) can result in indirect effects through short term and localized increases in turbidity when substrates are disturbed as the water hose is set into and pulled from the water. Watershed PDFs (37 and 38) will be implemented to minimize effects of water drafting on sediment and aquatic species including the following: draft water only at designated water drafting sites; when drafting from waters designated as Coho salmon Critical Habitat, implement NOAA Fisheries Water Drafting Specifications (2001) and implement Forest Service Best Management Practices. Existing water drafting sites will be used to avoid new streamside disturbance associated with construction of drafting sites. Turbidity, that may result during water hose sets and removals, will be localized, limited to pre-designated sites (see Appendix A) and fish will likely flee these areas once they sense a water truck approaching. A measurable increase in turbidity is not expected beyond the immediate drafting area. This conclusion is based on field observations that indicate turbidity is quickly diluted to background water clarity conditions. Thus, water drafting will result in discountable effects to sediment and minor effects to aquatic species.

5) Legacy Sediment Site Treatments

Legacy site treatments are considered connected actions under all of the action alternatives, and the same sites will be treated under all action alternatives. These restoration sites are existing legacy sediment sites that were identified and will be scheduled for treatment in compliance with the Clean Water Act as a condition of the North Coast Regional Water Quality Control Board waiver of waste discharge requirements (Order No. R1-2010-0029). The portion of Elk Creek within the project area contains about 148 legacy sites. Most of the legacy sites are located on or adjacent to the Forest transportation system. The other legacy sites are located on existing landings or roadbeds (historic roads, abandoned temporary roads, or decommissioned roads). Legacy site treatments will include the following:

- Culvert upgrades (about 45 sites) – replace culverts to accommodate the 100-year peak flow;
- Diversion prevention (about 51 sites, 17 include culvert upgrade) – construct armored rolling dips to prevent streams from diverting down roadways should the culvert plug or fail;
- Aquatic organism passage (three sites)– replace existing stream crossing with bottomless arch culvert to improve or restore aquatic organism passage

- Retaining wall (about 7 sites) – construct Hilfiker wall, rock buttress, reinforced embankment, or equivalent. where road prism has slumped or failed;
- Fill reduction (about 16 sites) –remove excess fill materials from the top of stream crossings to reduce the amount of fill available for discharge should the culvert plug or fail; add riprap to armor fill slopes.
- Fill removal (about 27 sites) - remove all fill materials from stream channels, swales, road shoulders and sliver fills; these treatments would occur on closed NFTS roads and existing roadbeds
- Repair/maintain existing infrastructure (about 16 sites)– clean culvert inlets, ditches, etc., repair damaged culvert inlets, shorten "shotgun" culvert outlets, place riprap below culvert outlets to reduce hill slope erosion, remove cut slope slide materials

In addition, road storm-proofing treatments between individual sites will occur on about 33 miles of Forest system roads (15N02, 15N75, 16N05, 16N39 and 45N19). Treatments between legacy sites may include the following: where possible reconstruct road prism to an out sloped configuration, otherwise reduce inboard ditch length by adding additional relief culverts or dips; reduce road prism width; remove berms; place rip-rap below outlets of ditch relief culverts; recondition road subgrade and travel surface - apply crushed aggregate; add rolling dips where needed to control road surface runoff; stabilize road prism slumps with retaining walls or rock buttresses.

The potential for indirect effects is highest for culvert upgrades or passage projects that are within active stream channels. The culvert projects will likely generate some turbidity. Culvert upgrade work has been programmatically analyzed in the Klamath National Forest Facility Maintenance and Watershed Restoration BA (USFS 2004). Turbidity from these types of projects was determined to have an insignificant, temporary impact where actions occurred less than 300 feet from areas occupied by fish; and where in-channel actions were greater than 300 feet from fish, no effect was expected. In the long-term, turbidity levels will return to pre-construction conditions as the site settles/stabilizes. None of these sites are within habitat accessible to anadromous salmonids. PDFs (20 and 24) will be implemented for all projects to minimize impacts to sediment and aquatic species. Legacy site repair will result in discountable and short-term effects to sediment, minor effects to aquatic species, and measurable long-term beneficial effects to both sediment and aquatic species through reducing sediment sources and improving passage in the Elk Creek watershed.

Water Temperature

Maintaining or restoring stream shade as a way to control water temperature is important. Ambient air temperature over the stream also drives maximum water temperature, and shade is third in influence following relative humidity (Bartholow et al 1989, Essig 1999). Thus, the width of Riparian Reserves, not just the shade canopy is key to maintaining micro-climate conditions. FEMAT (1993) called for protection of two site potential tree heights or to the edge of the inner gorge. Spence et al. (1996) note that the absolute minimum buffer width for maintaining cool air flow over the stream is one site potential tree height. All of the action alternatives include Riparian Reserve widths of one site potential tree height along fish-bearing streams. Riparian Reserves are protected from salvage harvest, but some vegetation management will occur within Riparian Reserves (Table 26) where they cross fuels treatment areas and hazard

tree removal areas. Watershed PDFs (e.g. 13, 15 and 16) will be implemented to maintain riparian function in treated areas, including existing stream shade.

Water drafting can directly affect stream temperature if stream flow is measurably reduced and for more than a brief duration. Effects of water drafting are discussed above under direct effects. Changes in sedimentation rates or supply can also indirectly affect stream temperatures if there are increases in sediment inputs to streams. Effects to Sediment are discussed above under the Sediment Indicator. In addition, Poole and Berman (1999) noted that large wood jams can contribute to stream cooling by forcing more stream flow into shallow ground water, which is called the hyporheic zone. The water drops slightly in temperature before emerging downstream. Temperature effects associated with large wood are discussed below under the Large Wood Indicator below.

1) Salvage Harvest and Reforestation

Under all action alternatives, Riparian Reserves have been established along all perennial streams and tributaries to protect riparian function (see PDFs Watershed-3) including stream shade. Risks to sediment supply and delivery are discussed above under the Sediment Indicator. Cutting of trees for salvage harvest will not occur within Riparian Reserves and for all methods of removal (tractor, skyline and helicopter). The acres of salvage harvest are shown above in Table 26 and indicate the amount of Riparian Reserves that fall within harvest units, but harvest will not occur within Riparian Reserve. Acres of Riparian Reserves within units are shown because those with Riparian Reserves have a higher risk of increasing sediment inputs to drainages, and subsequently affecting stream temperatures. This risk is discussed above under the Sediment Indicator. Skyline yarding corridors will not alter stream shade as they will not be installed over perennial streams. On other drainages, existing skyline yarding corridors will be reused when possible except where a less ground disturbing option is available. Watershed-32 requires that corridors be outside of Riparian Reserves if one is needed parallel to a stream channel, thereby protecting standing trees along streams. Existing skyline yarding corridors be reused when possible except where a less ground disturbing option is available. Because salvage harvest will not remove trees within Riparian Reserves, salvage harvest will have discountable effects on Temperature and minor effects on aquatic species.

Table 26. Acres of Riparian Reserves included within or near WSFR treatment units.

Treatment Type	Alt 2 Acres with Riparian Reserves	Alt 3 Acres with Riparian Reserves	Alt 4 Acres with Riparian Reserves	Alt 5 Acres with Riparian Reserves
Fuels	6286	6286	6286	6451
Salvage Harvest	2695	2294	2380	767
Hazard Tree Abatement	5684	5684	5458	5684

Reforestation includes site-preparation, planting, and release over 7,906 acres to increase the likelihood and speed by which burned areas are reforested. Reforestation includes manual site preparation, skyline yarding, mastication, mechanical yarding and slash piling of dead trees. Treatments within Riparian Reserves is limited to locations where moderate or high severity burned plantations overlap Riparian Reserves and only hand treatments are allowed. Site preparation and planting activities are proposed within salvage units and otherwise mostly within plantations that burned at high or moderate severity. All action alternatives include hand treatments within Riparian Reserves that are within site preparation and planting units unless

safety of forest workers prohibits use of these treatments. These treatments target plantations that were heavily burned during recent fires and are within units where ground-disturbing actions are proposed. The hand treatment is designed to provide near-term soil cover in these areas where the natural buffering capacity of the Riparian Reserves has been temporarily lost. The treatment is likely to reduce short term erosion/stream sedimentation at the site level, and help promote and encourage natural regeneration and soil recovery in the Riparian Reserve. Releasing over-crowded trees will result in long-term benefits to areas treated because the remaining trees will grow to a larger size quicker.

2) Fuels Reduction

Table 24 above shows the extent of fuels treatments that will occur within Riparian Reserves.

Watershed PDFs (33, 34, 35, and 36) apply to all action alternatives and have been designed to maintain stream shade, understory vegetation and riparian function during fuels treatment within Riparian Reserves. For example, within Riparian Reserves, prescribed fire effects will mimic a low intensity backing fire, except for handpiles/windrows where higher intensity may occur to consume pile material. There is no material difference between the action alternatives with respect to fuels treatments and applicable PDFs. Due to the Watershed PDFs that will implemented, and because shade canopy will not be affected by fuels treatment activities, fuels reduction actions will have discountable effects on water temperature and minor effects on aquatic species.

3) Hazard Tree Removal

Under Alternative 2, hazard trees will be removed from roadside areas as described above under the Sediment Indicator, including within Riparian Reserves. The risk for effects to stream temperatures are where there are groups of hazard trees standing together along roads that parallel or cross perennial streams. Removal of individual hazard trees that are not grouped will have no measurable effect on stream temperature. Based on field reviews and mapped hazard tree areas, removal of groups of hazard trees within Riparian Reserves along perennial stream channels will not occur to an extent that could measurably reduce existing shade canopy. Many of the trees proposed for removal are burned. The groups of hazard trees that will be removed are along short stretches of fishless intermittent or ephemeral channels. There is no difference between action alternatives relative to the extent of hazard tree reduction, and the same PDFs will be applied across all alternatives. Removal of hazard trees under Alternative 2 along roadsides will have discountable effects on temperature and minor effects on aquatic species.

4) Temporary Roads, Landings, Stream Crossings and Water Drafting

Approximately 22.6 miles of temporary roads with 14 stream crossings will be constructed within the three major burn areas to access harvest units (see Table 25). These temporary road actions include fourteen stream crossings (4 perennial and 10 intermittent streams) that are above the range of fish in the following drainages: Doggett Creek, Buckhorn-Beaver Creek, Grider Creek, O'Neil Creek, Kuntz Creek, China Creek, and Caroline Creek-Klamath River. Approximately 9.9 miles of the proposed temporary roads will be on existing old road alignments and 9.0 miles on decommissioned roads that will be re-opened. Approximately 3.6 miles of the proposed temporary roads will create new alignments on the landscape.

Temporary roads can affect stream temperature through increased sedimentation (discussed above under the Sediment Indicator) or through alteration of stream shade associated with stream

crossing construction. Most of Alternatives 2 stream crossings will be on existing old road alignments. However, vegetation that has regrown into existing old crossings or vegetation on new alignments will be disturbed or removed. At the watershed scale, because none of the stream crossings are within fish-bearing habitat, and most are on intermittent streams, and because Watershed PDFs will be implemented to minimize impacts, Alternative 2 will have discountable effects on water temperature and minor effects to aquatic species. At the site-scale, temporary stream crossings would likely have short duration effects to sediment during in channel work and in the first winter after use. Based on implementation of BMPS and PDFs, effects of individual crossings are expected to be site-scale, limited to the immediate downstream channel reach. The intensity of effects would be low at individual crossings. These temporary crossings will be removed before the first rainy season after use. Therefore the excess material will be removed before debris flow events are likely making the increase in risk small. In some cases, project temporary road actions are proposed on road beds and crossings that were not properly hydrologically stabilized (or decommissioned) and are existing sediment sources. Where these sites are actively eroding, or at risk for erosion, they were classified as legacy sediment sites and will be stabilized and improved as a result of the proposed action. Therefore long term beneficial effects in terms of reduced erosion, and/or risk of erosion, are expected at several sites where legacy sediment sources will be addressed (Doggett Creek, Beaver Creek and Grider Creek, in addition to the legacy site treatment proposed for Elk Creek).

Landings located within Riparian Reserves represent one of the greatest risk to stream temperature and aquatic species because landings disturb vegetation in close proximity to stream channels. Landing use and construction and potential effects to sediment are discussed above under the Sediment Indicator Alternative 2 has the highest risk of affecting stream temperature relative to landings because new landings are proposed within Riparian Reserves (Landings # DZ03, DZ10, DZ23, L043, L044, and L090). As existing landings are opened and new landings constructed, the potential risk of adverse effects to habitat indicators increases, in particular when landings are in or near Riparian Reserves. Watershed PDFs will be implemented under all action alternatives to minimize impacts to stream temperature including the following: existing landings will be used to the extent possible; existing landings in stream-course Riparian Reserves will not be expanded towards stream channels or where trees greater than 25” diameter at breast height would need to be removed. Because removal of shade trees is prohibited during landing use and construction, landings will have discountable effects on stream temperature and minor effects on aquatic species. There is one new landing in RR (L072), in Whites Gulch, that remains in alternatives 2, 3, and 5 but has not been approved as an exception to PDF Watershed-5. Watershed specialists have concerns about potential long term impacts to shade (Whites Gulch is an important thermal refugia for salmonids in NF Salmon River) and large wood recruitment, due to the close proximity of the landing location to a perennial stream and the potential need to remove mature green trees to allow for use in the project. Logging system specialists are working to find alternate locations for this helicopter landing to determine the best method to facilitate helicopter logging in this area while protecting shade over streams and the vulnerable post fire condition in this area.

Water drafting will result in minor, short-term and localized decreases in flow in smaller streams. However, NOAA specifications (2001) don’t allow drafting volumes to exceed 10% of stream flow within fish-bearing streams, and BMPs also limit drafting rates at all sites. Due to PDFs that have been designed to minimize drops in stream flow and changes to water temperatures associated with water drafting (PDF 18), the requirement to adhere to NOAA’s (2001) water

drafting specifications and KNF BMPs, the action alternatives will have discountable effects on water temperature and minor effects on aquatic species.

5) Legacy Sediment Site Treatments

The potential for indirect effects to stream temperature is highest for culvert upgrades or passage projects that are within active stream channels. None of the culverts are within habitat accessible to anadromous salmonids. The culvert projects will likely disturb streamside vegetation in localized areas where culverts are located, and to a limited extent on each side of roads. This work will occur on existing road alignments, where vegetation has been previously disturbed. Culvert upgrade work has been programmatically analyzed in the Klamath National Forest Facility Maintenance and Watershed Restoration BA (USFS 2004). Disturbance to streamside vegetation will be minimized at each site and these projects are expected to have discountable effects on stream temperature and minor effects on aquatic species. Legacy site repair will result in long-term beneficial effects to aquatic species through reducing sediment sources and restoring passage for aquatic species and watershed products in the Elk Creek watershed.

Large Wood

Figure 4: Large wood jam comprised of burned trees in Grider Creek, 2014.

Landscape-level changes to forested habitat occurred as a result of the 2014 wildfires. High fire intensity areas were characterized by total or near-total conifer crown consumption, resulting in impacts to large wood recruitment potential where this occurred along perennial streams. Within

areas of moderate burn intensity, some crown consumption occurred, but generally these areas are characterized by total or near-total crown scorch. The vast majority of trees in these areas have been killed by the fire or damaged beyond their ability to survive. Thus, the 2014 fires will likely result in increased large wood loading to streams in some areas over the next 20 years or so. After burned trees fall and are recruited to stream channels, there will be a reduction in large wood available for recruitment from burned areas until Riparian Reserves recover and conifers regenerate. These processes of recruitment and regrowth will occur at varying rates across the landscape, and burned areas will manifest large wood at different rates than adjacent unburned stands. Thus, a mosaic of different conditions are expected. Within areas of light burn intensity the smaller size and lower crown class conifers were burned. Without salvage, site preparation and replanting, severely burned stands will likely be replaced by shrubland (Skinner et al 2006 - p174) and restoration to conifer stands will take decades, or even longer. High severity sites are lacking seed sources to reseed burned areas. Re-establishment of conifers may only occur around the edges of the fire where a good seed source is still intact (Bonnett et. al. 2005).

Large trees in streams play a dominant role in forming pools, metering sediment, trapping spawning gravels and creating a more complex stream environment. In general, the larger the size of the wood, the greater its stability in the stream channel. Heavier pieces require higher flows for mobilization and longer pieces are more likely to be caught by the stream bank and its vegetation (Spence et al., 1996). Large wood is important for forming pools in lower order streams as well (Kelly et al., 1995; Bisson et al., 1987) and pieces that span the channel can create dam pools or form complex jams which make excellent cover for aquatic species. Much of the large wood entering stream channels does so through landslides and debris torrents during large storm events. The wood component of debris torrents forms log jams, which may retain sediment for several years, thereby protecting lower reaches of the stream from sediment impacts. Poole and Berman (2000) note that large wood jams can also force stream flows underground and that this connection with the hyporheic zone can help cool stream temperatures. In intensively logged areas, debris torrents may lack large wood, so the torrents may have very long run-out distances and damage a far greater length of stream habitat (Pacific Watershed Associates, 1998). Large wood in headwater areas may also prevent headward erosion of gullies and stream channels (Kelly et al., 1995).

The risk of altering large wood loading and recruitment potential is associated with actions that occur within the near-stream zone in Riparian Reserves. Protection zone distances of at least one site potential tree height are needed to protect large wood sources (FEMAT, 1993; Spence et al. 1996). All action alternatives include Riparian Reserves of two site potential tree heights along fish-bearing streams and one site potential tree height along non-fish bearing streams, which will protect riparian function (see PDFs Watershed-3) including large wood. Most proposed actions will avoid these areas, however, the following Project Elements will occur within Riparian Reserves and have the potential to alter large wood loading or recruitment: fuels reduction, hazard tree abatement, temporary road construction, landings and stream crossings.

1) Salvage Harvest and Reforestation

Cutting of trees for salvage harvest will not occur within Riparian Reserves and for all methods of removal (tractor, skyline and helicopter). Large wood recruitment areas within Riparian Reserves will be maintained under all action alternatives.

Skyline yarding corridors will not reduce large wood recruitment potential as existing corridors will be used where possible and where they are needed parallel to stream channels they will be placed outside of Riparian Reserves. All of the action alternatives have the same Watershed PDFs that will be implemented to protect large wood within Riparian Reserves, thus the effects of all alternatives are the same. Because salvage harvest will not remove trees eligible for recruitment or large wood in stream channels, salvage harvest and reforestation under Alternative 2 will have discountable effects on existing large wood and recruitment potential and minor effects on aquatic species.

Reforestation includes site-preparation, planting, and release over 7,906 acres to increase the likelihood and speed by which burned areas are reforested. Reforestation includes manual site preparation, skyline yarding, mastication, mechanical yarding and slash piling of dead trees. Treatments within Riparian Reserves is limited to locations where existing plantations overlap Riparian Reserves and only hand treatments are allowed. Watershed PDF-11 limits removal of trees to those that are less than 8” in diameter, and only hand work is allowed within Riparian Reserves. Based on these effects minimization measures, site preparation and reforestation is expected to have discountable effects on Large Wood and minor effects on aquatic species. Releasing over-crowded trees will result in long-term benefits to areas treated because the remaining trees will grow to a larger size quicker.

2) Fuels Treatment

Fuels reduction activities within Riparian Reserves could reduce the number of trees and snags available for recruitment to streams. Fuels reduction through thinning small diameter trees in Riparian Reserves will occur in the proposed roadside treatments and FRZs. Thinning will improve the growth rate of larger trees left on site, thereby improving long-term large wood recruitment potential. Short-term, direct effects to large wood recruitment associated with removal of small diameter trees will be insignificant because small trees are not of desirable size for recruitment to streams. Further, overstocked conditions prevent or retard the small diameter trees targeted for removal from reaching desired size for recruitment to streams. The action alternatives include standards to protect existing coarse wood on the ground within Riparian Reserves. Prescribed fire in Riparian Reserves will not consume greater than 10% of current coarse woody debris in a given Riparian Reserve. Riparian Reserve are included within prescribed burn units. Some small localized flare-ups could occur in pockets where fuel accumulations are high but overall, prescribed fire actions are designed to minimize effects on large wood and aquatic species. Fuels reduction under Alternative 2 will have discountable effects on large wood and minor effects on aquatic species.

3) Hazard Tree Removal

Hazard trees will be removed from roadside areas, including within Riparian Reserves. The risk of effects to large wood loading and recruitment are associated with removal of large, or key pieces in the near-stream zone along perennial streams. Watershed PDFs will be implemented to minimize effects on large wood loading and recruitment, in particular the following: all hazard trees cut within 25 feet of a stream channel will be left on site; in fish-bearing stream reaches, all trees greater than 26 inches in diameter at breast height within the first site tree (150-170 feet) will be cut and left on site unless they are above the a road parallel to the stream channel; live trees directly rooted into the banks or otherwise integral to the stability of the channel bank will not be felled unless they pose an overhead hazard and, if felled, will be left on site unless this

poses a hazard on the ground per OSHA requirements; directional felling will be used to protect streambanks where hazard trees need to be mitigated for public or employee safety. Because Watershed PDFs will be implemented to protect large wood and retain felled trees in near-stream zones, hazard tree removal along roadsides under Alternative 2 will have discountable effects to large wood and minor effects to aquatic species.

4) Roads, Landings, Stream Crossings and Water Drafting

Temporary roads will be constructed to access units under all action alternatives. Table 25 above lists the differences in extent of new temporary roads for each action alternative.

Temporary roads can affect large wood loading if trees are removed along streams when stream crossings are installed. Alternatives 2 includes stream crossing construction. All of these crossing sites have been previously disturbed as they are on existing old road alignments. Most of the crossings were reviewed in the field and only have early seral stage riparian or grass vegetation. Because none of the stream crossings are within fish-bearing habitat, and most are on intermittent streams, and because Watershed PDFs will be implemented to minimize impacts, Alternatives 2 will have discountable effects on large wood loading and recruitment and minor effects to aquatic species.

Landings located within Riparian Reserves represent one of the greatest risk to large wood recruitment potential and aquatic species because use of existing landings or construction of new landings disturb vegetation in close proximity to stream channels. Alternative 2 allows use of existing landings within Riparian Reserves and construction of new landings within Riparian Reserves (Landings # DZ03, DZ10, DZ23, L043, L044, and L090. Landings will result in discountable effects to large wood and minor effects to aquatic species because removal of large trees in near-stream recruitment zones is prohibited and the extent of new landings is limited. Especially in context of the post-fire condition that consists of millions of snags on the landscape and elevated chance of debris flows and large wood recruitment, the project is not likely to have any meaningful negative effect to large wood in streams.

Water drafting will have discountable effects on large wood and aquatic species as existing drafting sites will be used and no trees will be removed.

5) Legacy Sediment Site Treatments

The potential for indirect effects to large wood is highest for culvert upgrades or passage projects that are within perennial stream channels. None of the culverts are within habitat accessible to anadromous salmonids. The culvert projects will likely disturb streamside vegetation in localized areas where culverts are located, and to a limited extent on each side of roads. This work will occur on existing road alignments, where vegetation has been previously disturbed. Late seral vegetation is not expected to be removed for legacy site repair. Culvert upgrade work has been programmatically analyzed in the Klamath National Forest Facility Maintenance and Watershed Restoration BA (USFS 2004). Disturbance to streamside vegetation will be minimized at each site and these projects are expected to have neutral effects on large wood loading or recruitment and minor effects on aquatic species. Legacy site repair will result in long-term beneficial effects to aquatic species through reducing sediment sources and restoring passage for aquatic species and watershed products in the Elk Creek watershed.

Alternative 3

Alternative 3 is responsive to wildlife habitat concerns and differs from Alternative 2 as follows: retain 20% of snags in salvage harvest units; retain more of the largest trees on the land scape; salvage harvest would occur only in units greater than 20 acres in size; salvage harvest would be limited in areas with talus habitat; salvage harvest would be limited in areas of moderate and high ranked northern spotted owl cores; no salvage harvest in Beaver Fire area; and retain largest downed logs to meet 7 tons per acre in the salvage and site prep units.

1) Salvage Harvest and Reforestation

Reforestation actions, and potential effects, are the same across Alternatives 2, 3, and 4. Alternative 3 eliminates salvage harvest in the Beaver Fire area (871 acres in Alt 2), and reduces salvage acreage in Happy Camp Fire area by almost 1000 acres (in Walker Cr, and Caroline Cr-Klamath River drainages). Therefore, any impacts to Beaver Creek associated with salvage harvest are eliminated under this alternative and there would be a slight reduction in harvest-related impacts in Walker Creek.

2) Fuels Reduction

Fuels reduction actions, and potential effects, are the same across Alternatives 2, 3, and 4.

3) Hazard Tree Removal

Hazard tree actions, and potential effects, are the same across Alternatives 2, 3, and 5.

4) Roads, Landings, Stream Crossings and Water Drafting

Roads, landings, and water drafting actions, and potential effects, are the same across Alternatives 2, 3, and 5.

5) Legacy Sediment Site Treatments

Legacy sediment site treatment, and potential effects, are the same across all action alternatives.

Alternative 4

Alternative 4 was designed by watershed specialists to minimize impacts to sensitive watersheds and adds further protections for Riparian Reserves, and is different from Alternative 2 as follows: no use of non-system existing road beds for temporary access (includes previously decommissioned roads); use of non-system temp roads will be limited to segments that are ridgetop and not hydrologically connected to the drainage network (no stream crossings or roads adjacent to streams); in Key Watersheds, any new temp roads will be less than 250 feet in length, on ridgetops and not hydrologically connected to the drainage network (no stream crossings or roads adjacent to streams); no use of maintenance level 1 roads if major reconstruction and/or stream crossings reconstruction is needed; no new landings in Riparian Reserves (the exceptions granted for Alt. 2 are not exceptions under Alt. 4). The effects of Alternative 4 from all Project Elements, with the exception of roads, landings and stream crossings, are the same as those described for Alternative 2. In contrast to Alternative 2, Alternative 4 would have discountable effects to habitat indicators and aquatic species at both the watershed- and site-scale.

1) Salvage Harvest and Reforestation

Reforestation actions, and potential effects, are the same across Alternatives 2, 3, and 4. Alternative 4 reduces salvage harvest acreage by approximately 1500 acres across the project

area so there would be a reduction in the watershed-scale discountable effects described for Alternative 2. Due to elimination of temporary road actions, alternative 4 substantially reduces salvage acreage in Upper Grider Creek drainage, where 2014 fire effects to stream channels were severe; therefore the risk of project related sediment inputs are reduced. Alternative 4 also provides increased protection for soils within Riparian Reserves within "at risk" watersheds by requiring lop and scatter in Riparian Reserves within harvest units, where safety of forest workers allows. While all action alternatives include lop and scatter within about 1,000 acres of Riparian Reserves within site preparation units, Alternative 4 provide additional soil cover benefits by including lop and scatter within approximately 1,500 acres additional treatments within burned Riparian Reserves (including outside of site preparation units) to restore soil cover and improve the sediment retention capacity of these areas, which is critical given the effects of the 2014 fires. Thus, this action will provide short and long term beneficial effects to sediment, aquatic habitat and aquatic species.

2) Fuels Reduction

Fuels reduction actions, and potential effects, are the same across all action alternatives.

3) Hazard Tree Removal

Alternative 4 reduces the extent of hazard tree removal by not including treatment on Maintenance Level 1 roads that will not be used by the project. This reduces the total acreage potentially affected by hazard tree removal by about 1,000 acres. Therefore, the discountable effects described for alternative 2 are slightly reduced in this alternative in the following drainages: Lower West Fork Beaver, Dutch Creek, Middle Creek, Deep Creek, and Horse Creek.

4) Roads, Landings, Stream Crossings and Water Drafting

Alternative 4 is notably different than the other action alternatives with respect to construction and use of temporary roads and stream crossings as it limits these actions in "at risk" watersheds to only include ridgetop sections of road no longer than 250 feet, and precludes stream crossing construction. At the site-scale, Alternative 4 eliminates the short-term adverse effects to sediment from roads (described above under Alternative 2). However, in some cases, temporary road actions are proposed on road beds and crossings that were not properly hydrologically stabilized (or decommissioned) in the past and are legacy sediment sources. Where these sites are actively eroding, or at risk for erosion, they were determined to be legacy sediment sites and would be stabilized and improved as a result of road and crossing work proposed under the other action alternatives. Therefore, Alternative 4 will not result in long term beneficial effects as described under the other action alternatives relative to reducing erosion (sites in Doggett, Beaver, and Lower Grider drainages).

New landing construction in RRs is also eliminated under this alternative, so exceptions granted under Alternative 2 do not apply with Alternative 4 and the site-scale adverse effects of new landings in Riparian Reserves are eliminated. Because Alternative 4 eliminates the effects of roads and stream crossings in "at risk" watersheds and new landings are not allowed within Riparian Reserves, effects are reduced at both the site- and watershed-scales. Alternative 4 is different than all other action alternatives in that it would have discountable effects on habitat indicators and minor effects on aquatic species at both the site-scale and watershed-scale.

The effects of water drafting are the same as under Alternative 2.

5) Legacy Sediment Site Treatments

Legacy sediment site treatment, and potential effects, are the same across all action alternatives.

Alternative 5

Alternative 5 is the same as Alternative 2, the proposed action, with the exception that salvage harvest is only proposed within management areas considered as matrix lands and about 1,000 more acres of fuels treatment would occur. Compared to the proposed action, alternative 5 removes salvage harvest and site preparation, planting, and release from within Special Habitat (MA 5), Special Interested Areas (MA 7), Cultural Areas (MA 8), Backcountry Areas (MA 9), Retention Visual Quality Objective (MA 11), and Winter Range (MA 14).

1) Salvage Harvest and Reforestation

Alternative 5 eliminates salvage harvest in areas designated as Late Successional Reserve in the Forest Plan. Salvage and reforestation acreages are reduced by approximately 8000 acres in the Happy Camp Fire area and 900 acres in Whites Fire area. Acres of units that have Riparian Reserves within or near them is significantly reduced (see Table 24; 767 acres of Riparian Reserves are within or near salvage units). Thus, Alternative 5 reduces the potential discountable effects to Riparian Reserves resulting from salvage harvest (described for Alternative 2). This alternative also removes site preparation and planting on approximately 3300 acres in the Happy Camp Fire area and 650 acres within the Whites Fire. The beneficial effect of site preparation and planting in burned areas will be foregone.

2) Fuels Reduction

Alternative 5 includes about 1000 more acres of fuels treatment in the Beaver Fire area. Effects are expected to be similar as described for Alternative 2: fuels reduction will have discountable effects on habitat indicators and minor effects on aquatic species.

3) Hazard Tree Removal

Hazard tree actions, and potential effects, are the same across Alternatives 2, 3, and 5.

4) Roads, Landings, Stream Crossings and Water Drafting

Because this alternative involves substantially less salvage, and site preparation and planting acreage, landings and road actions are also reduced, potentially sizeable site-level effects of temporary road crossings and landings are reduced with this alternative, but not eliminated. Site level negative short term effects to aquatic habitat are expected in the following streams: Doggett Creek, Beaver Creek, Kuntz Creek, Whites Gulch, Gard Creek, and Caroline Creek; negative effects described for alternative 2 are avoided in Grider Creek, O'Neil Creek, and China Creek.

The extent of water drafting needed to support implementation of this alternative would also be reduced, but effects are expected to be similar as those described under Alternative 2.

5) Legacy Sediment Site Treatments

Legacy sediment site treatment, and potential effects, are the same across all action alternatives.

Cumulative Effects

Cumulative effects includes both ESA Cumulative Effects and NEPA Cumulative Effects. All interrelated and interconnected actions were included in the action alternatives and considered for effects analysis.

ESA Cumulative Effects

The ESA defines cumulative effects in 50 C.F.R. 402.02 as "those effects of future State or private activities, not involving Federal Activities that are reasonably certain to occur within the Action Area of the Federal action subject to consultation."

The KNF uses standardized CWE models (Equivalent Roaded Area, Universal Soil Loss Equation, Mass Wasting) to assess effects of past, present, and reasonably foreseeable activities. The WSFR Hydrology Report affected environment analysis includes the following projects within the Analysis Area: Eddy Late Successional Reserve, Elk Thin, Fish Meadows, Glassups Timber Sale, Happy Camp Fire Protection Phase 2, Johnny O'Neil Late Successional Reserve Habitat Restoration and Fuels Reduction, Lake Mountain Foxtail Pine, Lower Scott Roads, North Fork Roads Storm-proofing, Oak Flat Thin, Singleton, Thom Seider Vegetation Management and Fuels Reduction, Two Bit Vegetation Management projects, work done under the Burned Area Emergency Response, grazing allotments, Timber Harvest Plans since 2005, and private land salvage (under Emergency Timber Harvest Plans). These are on-going activities and the CWE model includes them in the "current" portion of the results.

The CWE models reflect that there will be no increase in disturbance at the 5th-field watershed scale, and minimal increase at the 7th field watershed scale. Therefore cumulative impacts from adding the effects of the proposed action to present and reasonably foreseeable future actions are insignificant.

The site level analysis conducted by watershed specialists found that site-scale, short term negative effects to sediment may occur due to construction of temporary roads and stream crossings. Thus, ongoing and future actions in these drainages where site level effects are expected were reviewed and include grazing, private timber harvest (green and salvage timber harvest plans), and two Forest Service vegetation projects (Thom Seider and Eddy LSR projects). Additive effects related to sediment delivery to streams are likely only as a result of private timber harvest, particularly in Doggett Creek. These effects to habitat are likely restricted to within the first year post project and, although it will contribute to elevated sediment inputs to the Klamath River, it is not expected to appreciably reduce the current quality of fish habitat in Doggett Creek. Addressing the legacy sediment site on existing road bed, reducing fuels, and accelerating reforestation on NFS lands in this highly disturbed watershed are considered benefits of alternative 2.

Future Federal actions that have not already been consulted on will be analyzed through separate Section 7 consultations.

NEPA Cumulative Effects

Current and future foreseeable actions considered for analysis within the twenty-nine 6th field watersheds that intersect the WSFR Project boundary are provided in Appendix F. The activities listed in F-1 were accounted for in the project CWE analysis and interpretation. The KNF uses standardized CWE models (Equivalent Roaded Area, Universal Soil Loss Equation, Mass Wasting) to assess effects of past, present, and reasonably foreseeable activities. In addition other current actions, models were updated to incorporate effects of the 2014 fires and road improvements identified in BAER assessments. The modelling provides the fundamental assessment of post-fire existing conditions, as well as an initial assessment of the project *No Action* alternative. Subsequently, effects of project *action alternative*s were modeled based on

proposed actions. These model results reflect that there will be minimal cumulative impact from adding the effects of alternative 2 to the past, present and reasonable foreseeable future actions.

The site level analysis found that short term negative effects to aquatic habitat may occur in several stream reaches due to the project. Ongoing and future actions in these drainages where site level effects are expected include grazing, private timber harvest (green and salvage timber harvest plans), and two Forest Service vegetation projects (Thom Seider and Eddy LSR projects). Additive effects related to sediment delivery to streams are likely only as a result of private timber harvest, particularly in Doggett Creek. These effects to habitat are likely restricted to within the first year post project and, although it will contribute to elevated sediment inputs to the Klamath River, it is not expected to appreciably reduce the current quality of fish habitat in Doggett Creek. Addressing the legacy sediment site on existing road bed, reducing fuels, and accelerating reforestation on NFS lands in this highly disturbed watershed are considered benefits of alternative 2.

Summary of Effects

Potential direct effects to aquatic resources from all of the action alternatives are associated with water drafting and stream crossing work. Direct effects of these actions were determined to be discountable due to implementation of effects minimization measures. Indirect effects to aquatic resources are primarily associated with temporary road and stream crossing construction within “at risk” watersheds, and locating landings within Riparian Reserves. These higher risk actions are proposed under all action alternatives, with the exception of Alternative 4. Alternative 4 addresses watershed concerns by limiting temporary road construction in “at risk” watersheds to short segments on ridgetops that are not hydrologically connected to the drainage network, precludes stream crossing installations within “at risk” watersheds, prohibits new landings within Riparian Reserves and still allows salvage harvest, reforestation and fuels reduction.

The use of resource protection measures/BMPs, and in particular the Watershed PDFs, minimizes direct and indirect effects to habitat indicators (Sediment, Water Temperature and Large Wood) under all action alternatives. However, Alternative 4 includes additional protections for aquatic resources in “at risk” watersheds. In addition to the limitations on roads, stream crossings and landings as described above, Alternative 4 addresses site-scale sedimentation concerns by requiring lop and scatter within Riparian Reserves within salvage harvest units to restore ground cover in burned areas that are vulnerable to erosion. These measures are important given the degraded conditions on the landscape as a result of the 2014 wildfires.

The CWE models indicates the severity of effects to watershed disturbance that was associated with the 2014 wildfires. At the watershed scale, the action alternatives add no incremental increase at the 5th-field watershed scale and only a slight incremental increase at the 7th-field watershed scale in some watersheds, an increase that is determined to be discountable or insignificant (effects may occur but they are not expected to be to a level that can be meaningfully measured or detected). At the site-scale, all of the action alternatives except alternative 4 pose a risk to the watersheds identified as being “at risk” post-fire. The risks are site-scale and are associated with temporary roads, stream crossings and landings within Riparian Reserves. Implementation of all of the action alternatives will allow for a quicker recovery of conifer stands in these burned watersheds. Alternative 4 most fully minimizes

impacts at the site and watershed-scale and would have discountable effects to habitat indicators in “at risk” watersheds at both scales.

Relative to aquatic species, alternatives 2, 3, and 5 involve short term negative effects to habitat at the site scale (due to temporary road actions and landings) for the following special status aquatic species: resident trout and tailed frog (MIS); foothill yellow-legged frog, Cascade frog, and western pond turtle (Forest Service Sensitive). Habitat for Coho Salmon (Threatened), Chinook salmon, steelhead, Pacific lamprey, and Klamath River lamprey (Forest Service Sensitive) may also be negatively affected with alternatives 2, 3, and 5. These impacts are expected in large part due to the vulnerable post fire condition of project area watersheds and streams where project disturbance would occur. With alternative 4 these site level impacts to aquatic habitat are avoided, and also site level benefits are lost for a few sites where project hydrologic stabilization of existing road beds and crossings (after use in the project) would benefit/protect water quality long term. All action alternatives include hand lop-and-scatter treatments in heavily burned plantation Riparian Reserves, where safe, which will provide benefits; only alternative 4 adds this beneficial treatment to Riparian Reserves in salvage units which may provide meaningful benefit to downstream habitat in the drainages it occurs. All alternatives include legacy sediment site treatment, including aquatic organism passage improvement, in Elk Creek watershed.

In summary, Fisheries Biologists have reached the following determinations for the action alternatives:

Table 24: Summary of findings for the action alternatives with regard to Threatened/Endangered species, Sensitive species, and Management Indicator Species.

Species	Special Status	[1]Determination
Fish		
Coho Salmon (and CH)		
Alternative 2	Federally Threatened	TBD
Alternative 3		
Alternative 4		
Alternative 5		
Chinook Salmon (Spring/Fall runs)		
(Upper Klamath-Trinity Rivers)		
Alternative 2	FSS	MANL
Alternative 3		MANL
Alternative 4		MANL
Alternative 5		MANL
Steelhead Trout		
(Klamath Mountains Province)		
Alternative 2	FSS, MIS	MANL
Alternative 3		MANL
Alternative 4		MANL
Alternative 5		MANL
Rainbow Trout	MIS	MANL
Pacific Lamprey	FSS	MANL
Klamath River Lamprey	FSS	MANL
Other Habitat		
Essential Fish Habitat (Coho/Chinook)		
Alternative 2		No Effect
Alternative 3		No Effect
Alternative 4		No Effect
Alternative 5		No Effect

[1]Federally Listed Species
NE - Will not affect the species or its Critical Habitat
NLAA - May affect, not likely to adversely affect the species or its Critical Habitat
LAA - May affect, likely to adversely affect the species or its Critical Habitat
Forest Sensitive Species (FSS) / Management Indicator Species (MIS)
NE - No effect to the species (FSS and MIS)
MANL - May affect individuals, but is not likely to lead to a trend towards listing (FSS); and/or
May affect individuals, but is not likely to lead to a decreasing population trend (MIS)
MALT - May affect individuals, and is likely to result in a trend towards listing (FSS); and/or
May affect individuals, and is likely to lead to a decreasing population trend (MIS)

Table 25: Summary of comparison of effects of alternatives for aquatic resource analysis indicators

Indicator	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Temperature	Discountable	Discountable	Discountable	Discountable
Sediment				
Site-Scale	Site-scale Adverse Effects	Site-scale Adverse Effects	Discountable	Minor Negative
Watershed Scale	Discountable	Discountable	Discountable	Discountable
Large Wood	Discountable	Discountable	Discountable	Discountable

Compliance with law, regulation, policy, and the Forest Plan

Refer to Aquatic Conservation Strategy analysis that was developed together in an interdisciplinary fashion with the project watershed specialists. The Forest Plan consistency checklist reflects how the project meets specific standards and guidelines from the Forest Plan. Interagency consultation under ESA section 7 is currently in progress with National Marine Fisheries Service, and will also include consultation under the Magnuson-Stevens Fishery Conservation and Management Act.

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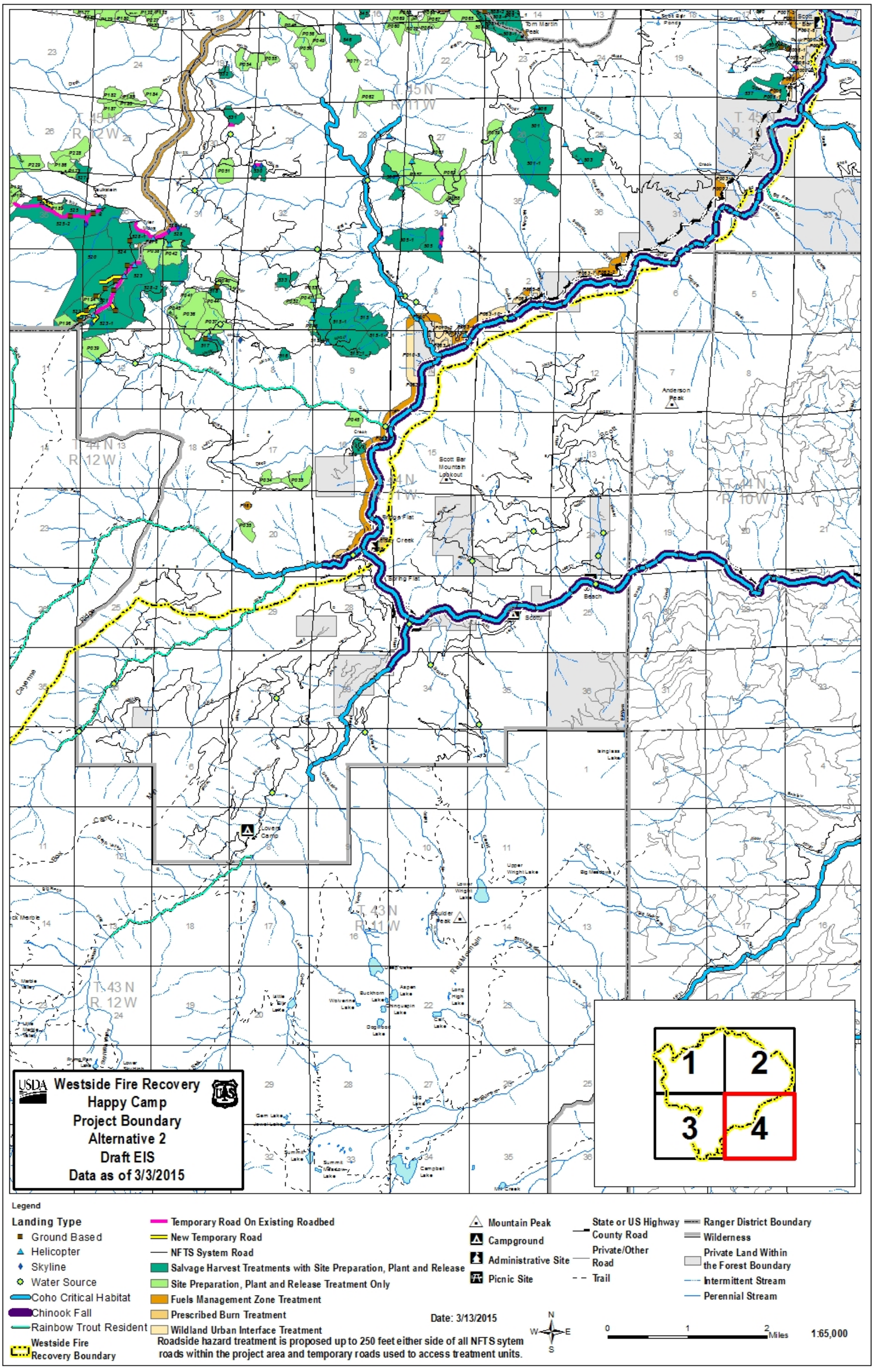
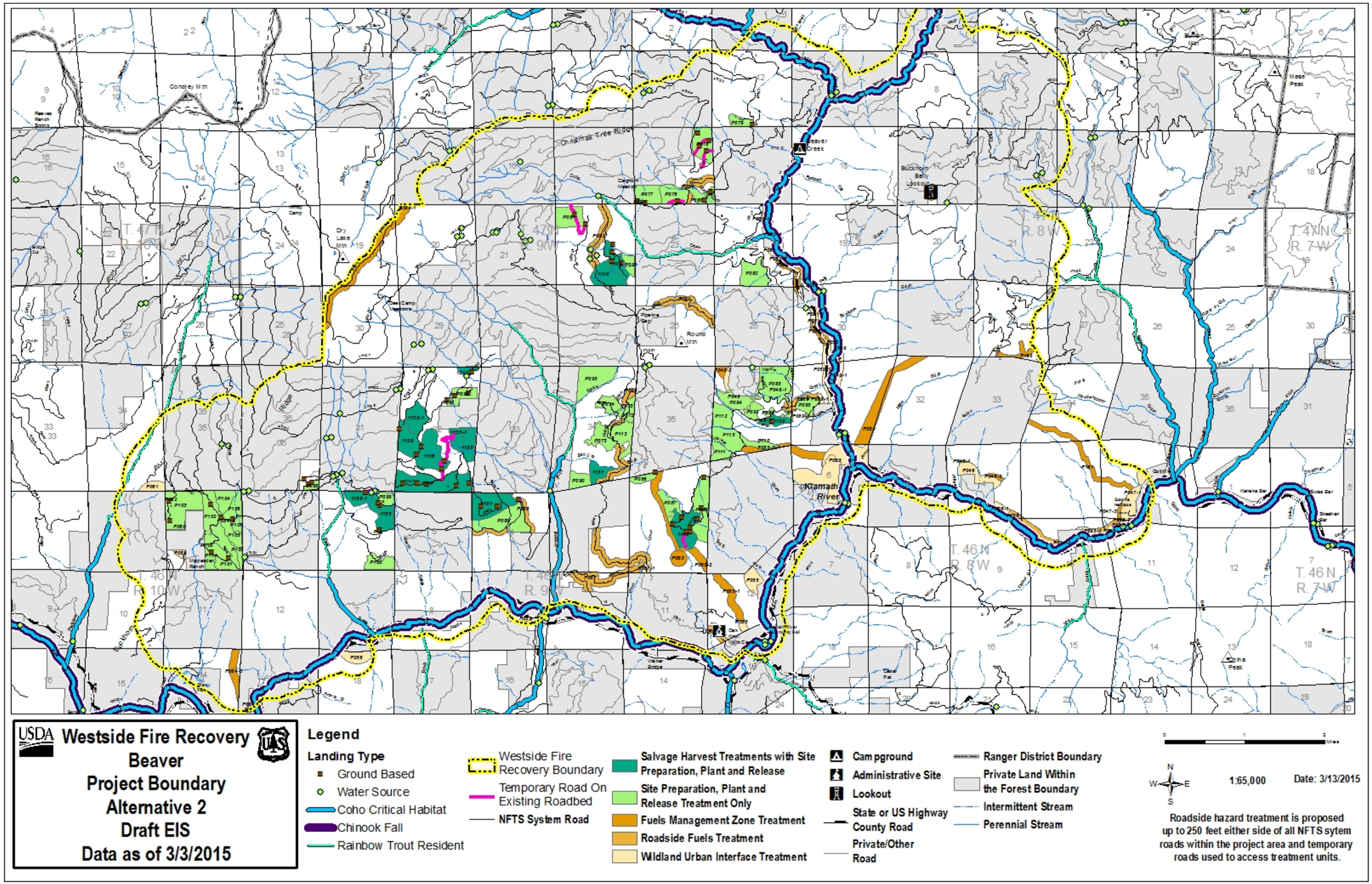
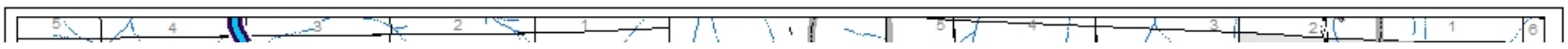
Appendix A: Project Maps




Westside Fire Recovery
Beaver
Project Boundary
Alternative 2
Draft EIS
Data as of 3/3/2015
Legend
Landing Type
Ground Based
Water Source
Coho Critical Habitat
Chinook Fall
Rainbow Trout Resident
Westside Fire Recovery Boundary
Temporary Road On Existing Roadbed
NFTS System Road
Salvage Harvest Treatments with Site Preparation, Plant and Release
Site Preparation, Plant and Release Treatment Only
Fuels Management Zone Treatment
Roadside Fuels Treatment
Wildland Urban Interface Treatment
Campground
Administrative Site
Lookout
State or US Highway
County Road
Private/Other Road
Ranger District Boundary
Private Land Within the Forest Boundary
Intermittent Stream
Perennial Stream
1:65,000
Date: 3/13/2015
Roadside hazard treatment is proposed up to 250 feet either side of all NFTS sytem roads within the project area and temporary roads used to access treatment units.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Appendix B: Life History and Biological Requirements of Aquatic Species

Fish Species

Coho Salmon *(Oncorhynchus kisutch)*

General life history information and biological requirements of Southern Oregon/Northern California Coastal (SONCC) Coho salmon have been described in various documents (Hassler 1987; Sandercock 1991; Weitkamp, et al. 1995) as well as NOAA-Fisheries' final rule listing SONCC Coho salmon (May 6, 1997; 62 FR 24588).

Coho salmon enter the mainstem of the Klamath River for spawning typically in their third year, primarily between September and December, with a peak in October (NFMS 2007). Over most of this interval, mainstem flows below Iron Gate Dam often are high (ca. 2500-3000 cfs: NMFS 2001). Thus, standard methods for observing and counting spawning fish are not easily applied, and the size of the spawning population is unknown. Approximations put the entire ESU at about 10,000 spawning Coho salmon of non-hatchery origin per year (Weitkamp, et al. 1995), of which only a small portion is associated with the Klamath Basin, where several important tributary runs have been reduced to a handful of individuals (NMFS 2001, 2007). Although a minor amount of spawning and growth may occur in the mainstem, the mainstem serves adults primarily as a migration route (NFMS 2007).

Spawning occurs from November to January (Hassler 1987) in the tributaries to the Klamath River, but occasionally as late as February or March (Weitkamp, et al. 1995). Coho salmon eggs incubate for 35-50 days between November and March. Successful incubation depends on several factors including dissolved oxygen levels, temperature, substrate size, amount of fine sediment, and water velocity. Fry start emerging from the gravel two to three weeks after hatching and move into shallow areas with vegetative or other cover. As fry grow larger, they disperse up or downstream. In summer, Coho salmon fry prefer pools or other slower velocity areas such as alcoves, with woody debris or overhanging vegetation. Juvenile Coho salmon over-winter in slow water habitat with cover as well. Juveniles may rear in fresh water for up to 15 months then migrate to the ocean as smolts from March to June (Weitkamp, et al. 1995). Coho salmon adults typically spend two years in the ocean before returning to their natal streams to spawn as three-year olds.

Available historical and most recent published Coho salmon abundance information are summarized in the NOAA-Fisheries coast-wide status review (Weitkamp, et al. 1995). The rivers and tributaries in the California portion of this ESU were estimated to have average recent runs of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as native fish occurring in tributaries having little history of supplementation with non-native fish. However, limited information exists regarding Coho salmon abundance in the Klamath River basin. What information exists [CDFW unpublished data; U.S. Fish and Wildlife Service (USFWS) unpublished data] suggests adult populations are small to nonexistent in most years. The decline of SONCC Coho salmon across the ESU is not the result of one single factor, but rather a number of natural and anthropogenic factors that include dam construction, instream flow alterations; land use activities coupled with large flood events, fish harvest and hatchery effects.

Chinook Salmon *(Oncorhynchus tshawytcha)*

The following information was excerpted or summarized from NMFS status review of Chinook salmon (Meyers, *et al.* 1998). Chinook salmon mature between 2 and 6+ years of age (Meyers, *et al.* 1998). Fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991). Incubation temperature for eggs is 5.0 to 14.4°C, with below 13.0°C preferred for optimal development in most stocks (McCullough 1999). Emerging fry generally do not develop normally above 12.8°C (McCullough 1999). Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. Once feeding, the optimal growth range for juveniles is 10.0 to 15.6°C, with fingerlings preferring to hold at 12 to 14°C (McCullough 1999). In preparation for their entry into a saline environment, juvenile salmon undergo physiological transformations known as smoltification that adapt them for their transition to salt water. For Chinook salmon, the recommended maximum temperature to maintain migratory response and seaward adaptation is 12.0°C; and at temperatures greater than 13.0°C, some physiological processes of smolting may be delayed, and, in extreme cases, reversed (McCullough 1999). Chinook salmon spend between one and four years in the ocean before returning to their natal streams to spawn (Meyers, *et al*. 1998). Chinook salmon addressed in this document exhibit an ocean-type life history, and smolts out-migrate predominantly as subyearlings, generally during April through July. Chinook salmon spend between 2 and 5 years in the ocean (Healey 1991), before returning to freshwater to spawn. Some Chinook salmon return from the ocean to spawn one or more years before full-sized adults return.

The UKT ESU includes fall- and spring-run Chinook salmon in the Klamath and Trinity River Basin upstream of the confluence of the Klamath and Trinity rivers. Historically, spring-run Chinook salmon were probably the predominate run. This ESU still retains several distinct spring-run populations, albeit at much reduced abundance levels. Fish from this ESU exhibit an ocean-type life history; however genetically and physically, these fish are quite distinct from coastal and Central Valley Chinook salmon ESUs. Genetic analysis indicated that this ESU form a unique group that is quite distinctive compared to neighboring ESUs. The majority of spring- and fall-run fish emigrate to the marine environment primarily as subyearlings, but have a significant proportion of yearling smolts. Recoveries of coded wire tags indicate that both runs have a coastal distribution off the California and Oregon coasts. The 2011 fall-run Chinook salmon run into the Klamath River system, as compiled by CDFW, was estimated to be 188,845 fish (103,005 adult and 85,840 grilse) (CDFW 2012). This is 154% of the 1978-2011 mean run total of 122,510 fish. Of the 110,554 basin-wide natural spawners (i.e., not of hatchery origin), 5,493 were from the Salmon River and 5,515 from the Scott River. The Klamath River run in 2013 was projected to be above recent historical average (KRTT 2013).

Steelhead *(Oncorhynchus mykiss)*

Biologically, steelhead can be divided into two basic run-types, based on the state of sexual maturity at the time of river entry and duration of spawning migration (Moyle 2002). The stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns shortly after river

entry (August 9, 1996, 61 FR 41542; Barnhart 1986). South of Cape Blanco, Oregon, summer steelhead are known to occur in the Rogue, Smith, Klamath, Trinity, Mad, and Eel rivers, and in Redwood Creek (Busby, *et al.* 1996).

Winter steelhead in California enter fresh water after rivers rise in response to fall/winter rains, typically from December through March, with a peak in January and February, with spawning soon after reaching the breeding grounds (Moyle 2002). In contrast, summer steelhead enter systems as flows taper off in the spring, then spawn the following winter (Moyle 2002). Steelhead require a minimum depth of 0.18 m and a maximum velocity of 2.44 m/s for active upstream migration (Smith 1973). Spawning and initial rearing of juvenile steelhead generally take place in small, moderate-gradient (generally 3-5%) tributary streams (Nickelson, *et al*. 1992). A minimum depth of 0.18 m, water velocity of 0.30-0.91 m/s, and clean substrate 0.6-10.2 cm (Nickelson, *et al*. 1992) are required for spawning. Steelhead spawn in 3.9-9.4°C water (Bell 1991). Depending on water temperature, steelhead eggs may incubate for 1.5 to 4 months (August 9, 1996, 61 FR 41542) before hatching, generally between February and June (Bell 1991). After two to three weeks, in late spring, and following yolk sac absorption, alevins emerge from the gravel and begin actively feeding. After emerging from the gravel, fry usually inhabit shallow water along banks of perennial streams. Fry occupy stream margins (Nickelson, *et al*. 1992). Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson, *et al*. 1992). Steelhead prefer water temperatures ranging from 12-15°C (Reeves *et al*. 1987). Juveniles live in freshwater from one to four years (usually two years in the California ESUs), then smolt and migrate to the ocean in March and April (Barnhart 1986). Winter steelhead populations generally smolt after two years in fresh water (Busby, *et al*. 1996).

The KMP steelhead ESU occurs in coastal river basins between the Elk River in Oregon and the Klamath River in California, inclusive. The KMP steelhead ESU contains populations of both winter and summer steelhead. The Rogue and Klamath River basins are distinctive in that they are two of the few basins producing “half-pounder” steelhead. In 2001, NOAA-Fisheries reconsidered the status of KMP steelhead under the ESA (66 FR 17845, April 4, 2001) and determined that KMP steelhead do not warrant listing as threatened or endangered at this time.

In California, the largest proportions of naturally spawning hatchery fish are believed to occur in the Trinity River, where estimates from 1990s range from 20-70 percent hatchery. These estimates apply to fall-run fish. Because the hatchery program in the Trinity River basin propagates mostly fall-run fish, natural spawners in this basin that return at other times are believed to be predominantly of natural origin. Counts at Willow Creek weir provide an estimate of about 2000 natural origin fall-run spawners per year. The Willow Creek weir samples steelhead only over a period of about 3 months during the fall run and thus provides no information about other runs in the basin. CDFW biologists estimated natural escapement in the California portion of the ESU to be approximately 30,000-50,000 adults per year.

Rainbow Trout *(Oncorhynchus mykiss)*

Rainbow trout are native to Pacific slope drainages from the Kuskokwim River in Alaska to Baja California, Mexico (Moyle 2002). However their distribution has expanded significantly,

including previously fishless streams and lakes, due to introductions. Rainbow trout is a MISin on the Klamath National Forest.

Rainbow trout inhabit a wide variety of habitats. However, stream dwelling rainbows tend to prefer waters with a higher percentage of riffles than pools. Optimal habitat conditions include temperatures between 15 and 18°C, slightly alkaline water (pH 7-8), and oxygen concentrations close to saturation. Temperatures above 28°C are known to be lethal to rainbow trout; and for large fish, lethal temperatures may be around 23-25°C. In summer, where water temperatures begin to approach the upper range of tolerance, trout will seek cooler microhabitats (Moyle 2002).

Adult forage and dispersal patterns appear to vary with local conditions, environmental factors, and the presence of other fish species (Meehan and Bjornn 1991, Moyle 2002). Rainbow trout are typically diurnal, opportunistic feeders. They are carnivores that feed in a rover-predator style. The majority of their diet consists of aquatic insects, although they will eat crayfish, grasshoppers, winged bugs, worms, salamanders, and other fish (including other trout). They occasionally feed on benthic invertebrates when the benthic food supply is great and/or when there is increased competition for prey form the water column (Behnke 2002).

Rainbow trout usually spawn between the ages of 2 to 4 years old. Age of first spawn can vary greatly depending on size and genetics (Behnke 2002). Female fecundity ranges from 1,200-3,200 eggs per kilogram of body weight (Behnke 2002). Rainbow trout spawning behavior typically begins during the spring but can begin as early as in December and varies due to temperature and water flow conditions. Temperatures of 3-6°C often initiate spawning behavior, although actual spawning does not usually occur until temperatures reach 6-9°C (Behnke 2002). In lakes, this often means moving from the lake into their natal stream. If the lake is not stream-fed, rainbow trout will move into near-shore shallow waters (Moyle and Cech 2000). In rivers, rainbow trout will migrate from feeding areas into smaller, cool-water tributaries (Moyle and Cech 2000). Both rainbow and steelhead trout are iteroparous, meaning that they can spawn more than once throughout their lifetime.

Critical Habitat and Essential Fish Habitat for Anadromous Salmonids

Designated Critical Habitat (CH) for Coho salmon encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive (May 5, 1999, 64 FR 24049). The area described in the final rule represented the current freshwater and estuarine range of Coho salmon. Land ownership patterns within the Coho salmon ESU analyzed in this document and spanning southern Oregon and northern California are 53% private lands; 36% Federal lands; 10% State and local lands; and 1% Tribal lands. The Forest Service manages about 1,680,000 acres (90.6%) of land within the Forest boundaries and about 200,000 acres (9.4%) of land are within the Forest boundaries but in other ownership (LRMP, Page 3-12). Essential Fish Habitat (EFH) is considered for both Coho and Chinook salmon, with consultation occurring under 305 (b) (4) (A) of the Magnuson-Stevens Fishery Conservation and Management Act. The definition of Coho/Chinook EFH components and extent is described by Amendment 14 (Appendix A, pages 12-35 [adopted year 2000]) of the 1978 Pacific Fisheries Management Council Salmon Fisheries Management Plan.

Conclusions regarding CH and EFH occurrence are based on field review of habitat suitability, professional judgment, District fish survey records, and California Department of Fish and Wildlife (CDFW) information. In general, the KNF Coho Presence (GIS) layer defines CH, and

Coho or Chinook distribution (whichever is of maximal extent) defines EFH. As appropriate, the California state information in Calfish.org may also be utilized. Where information on Coho or Chinook is lacking (e.g., no/few surveys have been completed), else it is the professional judgment of the Fish Biologist that neither KNF nor Calfish.org range maps fully capture CH/EFH extent, the KNF Steelhead Trout Distribution (GIS) layer may be used as a proxy for maximum range of anadromous fishes. This dataset is recognized as a conservative approach for assessment of effects to anadromous fish habitat because Coho and Chinook salmon may not occupy the same waters as steelhead due to differences in jumping abilities. The maximum jumping height (under ideal conditions) for adult Coho is 2.2 meters; Chinook salmon is 2.4 meters; and steelhead is 3.4 meters (Meehan 1991). Therefore, steelhead trout can access more habitat than Coho or Chinook salmon (i.e., steelhead trout can make a 3-meter jump to migrate up a stream, but Coho and Chinook salmon cannot.). Additionally, differences in spawn timing may also affect actual distribution. As an example, steelhead spawn in the spring, encountering higher discharge conditions than Chinook, which spawn in the fall. In consequence, Chinook may be denied access to streams, or segments thereof, due to the presence of low-water barriers that are passible to steelhead during spring flows. In all cases, field review and site-specific surveys may refine the location of CH or EFH.

Appendix A Maps shows the distribution of CH and EFH the Action Area and Analysis Area. This map is based on fish distribution with site-specific changes made per professional fisheries biologist knowledge, stream surveys, or CDFW data.

Lamprey

Pacific Lamprey *(Entosphenus tridentate)*

Pacific lamprey are found in north Pacific coast streams from Japan, through Alaska, and down the North America continent coast, potentially as far as southern California or Baja California (USFWS 2012; Moyle 2002). This species has many derivative forms, including anadromous (the most common), resident, and landlocked; and the relationship between *E. tridentata* and its multiple forms, as well as similar species, is not fully resolved (Moyle 2002). Pacific lamprey is a Sensitive species for the Klamath National Forest.

Pacific lamprey are usually anadromous, with two distinct parts of their complex life cycle. Following is a generalized life cycle description, as summarized from Moyle (2002), Close, *et al*. (2010), and USFWS (2012). After hatching in freshwater in the late spring and early summer, larvae (ammocoetes) leave the nest and passively drift until suitable substrate – sand/silt – is encountered. Once a site is colonized, the blind larvae filter feed upon detritus for an extended period of time. Length of in-stream residence is uncertain, an individual may retain a larval form between three to seven years, with four to six years typical. Time to metamorphosis is dependent upon how long it takes to grow to a particular size. At 14-16 centimeter total length, larvae begin metamorphosis to the ocean-going adult form. Metamorphosis occurs over multiple months, and requires physiological changes from sessile filter-feeder to active predator, including changes in sensory system (such as growing eyes), digestive system, and tolerance to sea water. Downstream migration appears correlated with high flow events of winter and spring. Adults spend up to four years in the ocean where feeding is by parasitism: an individual latches to its prey (usually fish, but sometimes marine mammals), rasps a hole through the skin, extracts body fluids and flesh, and finally drops off once full. Upmigration from the ocean occurs from winter

through early summer, although lamprey may hold in a river up to a year before the final migration into spawning streams. Once the spawning migration starts, lamprey stop eating. Pacific lamprey do not appear to home to a natal stream, instead following the smell of pheromones produced by ammocoetes to find suitable spawning habitat. In late spring through early summer, nests are constructed, and while some adults may survive to return to the ocean, most die soon after spawning.

Specifics of the general Pacific lamprey life cycle as applied to the Klamath River system, much less its individual tributaries, are largely uncertain. Initial movement of spawners from the ocean into the river may occur at any time of the year, but is primarily late winter and into spring (Larson and Belchik 1998, Close, *et al*. 2010). Additionally, there is evidence of at least two distinct runs: a spring run that spawns shortly after entering freshwater, and a fall run that holds over and spawns the following spring (Anglin 1994). Downstream emigration of lamprey occurs year-round, with final outmigration to saltwater of transformed adults in late fall through spring (Anglin 1994; Close, *et al*. 2010). Other particulars, such as details about the ammocoete stage and spawning specifics (i.e., months, locations) for the various Klamath River tributaries, are unknown.

Habitat for Pacific lamprey ammocoetes is very important due to the long in-stream residence. Sands and silts are the preferred habitat of larvae, with larger substrate sizes utilized by larger (older) individuals (Sugiyama and Goto 2002; Stone and Barndt 2005). Finer particles are endemic of lower velocity environments such as stream margins, backwaters, eddies, and pools. Although ammocoetes are often considered to be sedentary, they will actively seek new habitat if a particular site becomes unsuitable (Moyle 2002; USFWS 2010). Most important is that the stream velocity has to be fast enough to allow filter feeding, yet sufficiently slow to retain the preferred sediments (Torgensen and Close 2004). For poorly known reasons, distribution of lamprey larvae in a stream tends to be patchy – not all suitable habitats are utilized – but it may be a function of microhabitat, variation between stream reaches, and seasonal movement to take advantage of different habitat (Sugiyama and Goto 2002; Torgensen and Close 2004). Optimal temperature requirements for ammocoetes, as well as other water quality parameters, needs further study. However, it is known that eggs will successfully hatch from 10° to 22°C, with highest survival 10° to 18°C; and that local spawning peaks are likely tied with water temperatures most advantageous for embryo development (Meeuwig, *et al*. 2005).

Pacific lamprey spawning habitat is very similar to that required by salmonids. Redds are generally built in gravel and cobble substrates, with moderate velocity flowing water. Of the 125 Pacific lamprey nests surveyed in the Smith River, Oregon, most were observed in low gradient riffles, pool tailouts and lateral scour pools (Gunckel, *et al*. 2009). Most of these nests were associated with cover, including gravel and cobble substrates, vegetation and woody debris. Likewise, most nests observed in Cedar Creek, Washington, were observed in pool-tail outs, low gradient riffles and runs (Stone 2006). Upstream extent of spawning Pacific lamprey is often considered synonymous with salmonid anadromy, although there are indications that this assumption may not always be true – under natural conditions, lamprey may be able to pass traditional barriers to upmigrating steelhead and salmon, such as waterfalls (USFWS 2012). Research is on-going on this topic. Until consensus is reached within the scientific community, it is appropriate to continue to utilize salmonid range of anadromy as Pacific lamprey extent.

Pacific lamprey numbers in the Klamath River appear to be decreasing. While there is no estimate of the current population, oral history taken from tribal fishers indicates a long-term

decline in adult catch (Larson and Belchik 1998; USFWS 2012). Additionally, a downward trend is suggested for outmigrating juveniles caught in rotary screw traps in the Klamath River basin between 1997 and 2004 (USFWS 2004).

Klamath River Lamprey *(Entosphenus similis*)

Klamath River lamprey are found throughout the Klamath River, includings its tributaries (Moyle 2002). This species of lamprey is non-migratory and can be found in both rivers and lakes (Moyle 2002). Klamath River lamprey is a KNF Sensitive Species. Information on life History and biological requirements is lacking, but is presumed to be roughly similar to Pacific lamprey with the exception of anadromy: Klamath River lamprey are not anadromous. Also unlike Pacific lamprey, Klamath River lamprey feed on salmonids, suckers and cyprinids in the freshwater environment.

Other Aquatic Species

Cascade Frog *(Rana cascadae*)

The Cascade frog is a medium sized frog; olive to olive-brown with sharply defined dark splotches on the back. It is a montane species found in the Olympic Peninsula, Washington, and in the Cascade Range of Oregon, Washington, and northern California (Stebbins 2003). It appears that populations are declining throughout the range. Reasons for this decline are not well understood, but locally populations have been affected by predation from introduced trout in mountain lakes.

Historically this frog was abundant throughout its range. Although northern populations appear to be stable, many of the historical localities in the southern portion of this frog's range are either declining or have disappeared (Fellers and Drost 1993). Some Oregon populations appear to be declining, but the frog remains well distributed in Oregon (Fellers et al. 2007). Populations on Region 5 lands appear stable in the Klamath-Siskiyou area, but populations in the Lassen area have declined significantly from historic numbers and are likely functionally if not physically extinct (Fellers et al. 2007).

All life stages of this species are dependent upon water. Habitat for this species includes open montane meadows, marshes, ponds, small bodies of water, ephemeral pools, potholes without vegetation, and along small creeks (Stebbins 2003). They are typically found at elevations above 2500 feet (Corkran and Thoms, 1996) and are closely restricted to water (Stebbins 2003). Calm ponds with warm shallow areas are preferred for breeding, but adults can be found upwards of 100m from their breeding pond in adjacent waterways (Hammerson and Pearl 2004). Adult frogs stay close to water, but can be found upland during high humidity.

Cascade frogs have been observed at Wilderness lakes that comprise the headwaters of several project area streams (Elk Cr, Kelsey Cr, Canyon Cr, and South Russian Cr). This species is assumed to occur in the project area within, or near, stream and lake habitat above 2500 feet.

Foothill Yellow-legged Frog *(Rana boylii*)

Known distributions of the foothill yellow-legged frog range through most Pacific drainages west of the Sierra/Cascade Crest from the Santiam River, Oregon to the San Gabriel Drainage in southern California. They are typically found at elevations below 1800 feet (Corkran and Thoms,

1996). Current distribution and abundance of this species has been reduced in the southern portion of its range but still occurs in significant numbers in some coastal drainages. Listed as a California Species of Special Concern, the foothill yellow-legged frog is at risk due to various anthropogenic and environmental threats throughout their range. Among some of the larger rivers in California, predation from introduced bullfrogs has been implicated as a cause of their decline. Increased sediment loads in breeding streams have a potential to reduce survival of eggs.

Breeding occurs in the spring, where adults congregate in habitats consisting of shallow, slow flowing water with pebble and cobble substrate, preferably with shaded riffles and pools. This species is also known to utilize moderately vegetated backwaters, isolated pools, and slow moving rivers with mud substrates in a variety of habitats, including valley-foothill hardwood, valley-foothill hardwood-conifer, valley-foothill riparian, ponderosa pine, mixed conifer, coastal scrub, mixed chaparral, and wet meadow types (Stebbins 2003).

Surveys for the foothill yellow-legged frog have not been conducted in the project area although there are recorded observations of this species along Beaver Creek, the Klamath River, the Scott River, and the North Fork Salmon River. Foothill yellow-legged frogs prefer shallow, slow moving streams with gravel or rocky substrate. The majority of in-stream environments within the project area are not suitable for the foothill yellow-legged frog as the streams are characterized by steeper gradients and/or fast currents (and the vast majority of treatment units are above 1800 feet elevation).

Western Pond Turtle *(Emys marmorata*)

Western pond turtles are a highly aquatic species that can be found in ponds, lakes, streams, rivers, marshes, and irrigation ditches that have a muddy or rocky bottom and abundant vegetation (Stebbins 2003). They feed on aquatic plants, insects, worms, fish, and carrion.

Turtles favor areas with offshore basking sites including floating logs, snags, protruding rocks, emergent vegetation and overhanging tree boughs, but also will utilize steep and/or vegetated shores. Hatchlings additionally require shallow, eutrophic, warm areas which are typically at the margins of natural waterways (Buskirk 2002). Terrestrial habitats are less well understood. In southern California animals spend only one to two months in terrestrial habitats while animals in the northern portions of the range can be terrestrial for up to eight months (Lovich and Meyer 2002). Animals have been documented to overwinter under litter or buried in soil in areas with dense understories consisting of vegetation such as blackberry, poison oak and stinging nettle which reduces the likelihood of predation (Davis 1998).

Western pond turtles use terrestrial habitat for nesting and sometimes for overwintering. Females lay their eggs in soil and have been recorded nesting up to 300’ from water (Holland 1991). Holland (1991) reported that individuals moved an average of 600’ from water to their overwintering sites.

Southern Torrent Salamander (*Rhyacotriton variegatus*)

The southern torrent salamander is found in the coastal mountain ranges on the Pacific Coast of North America. Specifically, it ranges from Mendocino County, California north to northwestern Oregon. The historical range of this species is not well known, but it is thought to have had a historical patchy distribution in headwaters and tributaries (Hammerson 2004).

Southern torrent salamanders can be found in habitats at or below approximately 4800 feet (Welsh and Lind 1996).

The primary habitat for southern torrent salamanders is well-shaded permanent streams and springs in redwood, Douglas fir, mixed conifer, montane riparian and hardwood-conifers (Marangio 2005). Southern torrent salamanders are not directly tied to old growth forest, but the specific microhabitat required is more likely to occur in these undisturbed areas (Diller and Wallace 1996). Adults will utilize upland moist habitat in riparian and forested areas during the wet season (Welsh and Lind 1996). These salamanders are typically found in cold, well-shaded waters, within the splash-zone or on moss-covered rocks near water (Marangio 2005).

The KNF is mostly outside the expected distribution of this species, which is coastal streams to the west. It is not likely that this species occurs on the KNF, however since presence cannot be ruled out it is assumed southern torrent salamanders may occur in suitable habitat on only the Happy Camp Ranger District.

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Appendix C: KNF Tributaries Table of Pathways and Indicators

Table C- 1: Klamath National Forest Tributaries Table of Pathways and Indicators.

Pathways	*Indicators*	*Properly Functioning*	*At Risk*	*Not Properly Functioning*
Habitat: Non Watershed Condition Indicators				
Water Quality:	Temperature [(1)]			
	1st - 3rd Order Streams [instantaneous]	69 F degrees (~ 20.5 C) or less	> 69 to 70.5 degrees F	70.5 F degrees (~ 21.3 C) or more
	4th-5th Order Streams [Maximum Weekly Maximum Temperature]	70.5 F degrees (~ 21.4 C) or less	> 70.5 to 73.5 degrees F	73.5 F degrees (~ 23.0 C) or more
	Suspended Sediment/Turbidity	Little to no quantitative turbidity data exists for streams on the Klamath National Forest. Use the following criteria to infer condition of turbidity Indicator: (1) professional judgment from years of direct observation of tributary streams; (2) amount of fines in substrate from stream survey data, (3) CWE modeled level of watershed surface erosion and mass wasting, and (4) condition of stream buffer RR and channel (particularly if there has been recent debris flows that altered the channel). Professional judgment of turbidity is based on observations of water clarity after peak flows in tributaries to the mainstems of the Klamath, Scott, and Salmon Rivers that have watersheds with varying degrees of disturbance from nearly pristine to highly disturbed. Properly Functioning: Water clarity returns quickly (within three days) following peak flows.	Water clarity slow (four to six days) to return following peak flows, moderate to high fines in substrate, moderate modeled surface erosion and mass wasting, and riparian reserves are not fully functioning.	Water clarity poor for long periods of time (one week or more) following peak flows. Some suspended sediments occur even at low flows or base flow. High fines in substrate, stream buffers in poor condition, high modeled surface erosion and mass wasting, and riparian reserves are in poor condition.
	Chemical/Nutrient Contamination [(2)]	Scott, Salmon, and Klamath River mainstems: Low levels of contamination from agriculture, industrial, and other sources; no excess nutrients. No CWA	Scott, Salmon, and Klamath River mainstems: Moderate levels of contamination from agriculture, industrial, and other sources; some excess	Scott, Salmon, and Klamath Rivers: mainstems: High levels of contamination from agriculture, industrial, and other sources; high levels of nutrients. One or

Pathways	Indicators	Properly Functioning	At Risk	Not Properly Functioning
		303d designated reaches. Scott, Salmon, and Klamath River tributaries: None or low levels of chemical and/or nutrient contamination from agriculture, industrial, and other sources; no excess nutrients.	nutrients. One or more CWA 303d designated reaches Scott, Salmon, and Klamath River tributaries: Moderate levels of contamination from agriculture, industrial, and other sources and/or moderate excess nutrients.	more CWA 303d designated reaches Scott, Salmon, and Klamath River tributaries: High levels of contamination from agriculture, industrial, and other sources and/or moderate to high excess nutrients.
Habitat Access:	Physical Barriers (AP)	Any man-made barriers present in watershed allow upstream and downstream passage at all flows.	One or more human -made barriers present in watershed do not allow upstream and/or downstream passage at base/low flows.	Human-made barriers present in watershed do not allow upstream and/or downstream passage at a range of flows for at least one life history stage.
Habitat Elements:	Substrate character (3)	Use stream survey data for determining substrate character. In addition, use USLE and GEO models to determine functioning level of Indicator and potential effects of sediment delivery to streams that may affect anadromous fish and their habitat. Can also infer substrate character functioning level from other factors such as high road density and hydrologic connection, recent large intense wildfires, and recent (last 20 years) altered channel.		
		Less than 15% fines (<2 mm) in spawning habitat (pool tail-outs, low gradient riffles, and glides) and cobble embeddedness less than 20%. Additional desired conditions, as per TMDL/NCRWB water quality compliance, include: *Pool sediment vol (V*): ≤21% *Subsurface, <0.85 mm: ≤14% *Subsurface, <6.4 mm: ≤30%	15% or greater fines (<2 mm) in spawning habitat (pool tail-outs, low gradient riffles, and glides) and/or cobble embeddedness is 20% or greater.	Greater than 20% fines (<2 mm) in spawning habitat (pool tail-outs, low gradient riffles, and glides) and cobble embeddedness greater than 25%.
	Large Woody Debris (4)	See KNF LRMP EIS Chapter 3, text and tables on Pages 68-69. For stream reaches on the Westside of the Forest, manage for an average of 20 pieces of large wood per 1,000 ft in 3-5th order streams (LRMP Page 4-143). Large wood is defined as a minimum length of 50 feet and diameter of 24 inches on the Westside. However, site potential and channel width must be considered rather than using strict numbers. Also consider the potential for future LWD recruitment in both the short- and long-term.	Current levels are being maintained at minimum levels desired for "properly functioning" but potential sources for long term woody debris recruitment are lacking to maintain these minimum values.	Current levels are not at those desired levels for "properly functioning" and potential sources of woody debris for short and/or long term recruitment are lacking.
	Pool Quality and Frequency (5)	At least one primary pool every three to seven bankfull channel widths. In 1st through 3rd order streams, a primary pool must have a maximum depth of two feet or greater. In 4th and 5th order streams, a primary pool must have a maximum depth of three feet or greater. In 6th order and	At least one pool every three to seven bankfull channel widths. At least half of the pools are primary pools. At least half the pools have a maximum depth of at least 24 inches (1st- 3rd order streams) or 36 inches (4th order and greater).	There is less than one pool every three to seven bankfull channel widths and/or less than half the pools have maximum depth of at least 24 inches (1st-3rd order streams) or 36 inches (4th order and greater).

Pathways	*Indicators*	*Properly Functioning*	*At Risk*	*Not Properly Functioning*
		larger streams, a primary pool must have a maximum depth of four feet or greater.		
	Off-Channel Habitat	Fish have unrestricted access to off-channel habitats (such as oxbows, off-channel ponds, backwaters, and areas of low flow velocity and cover) in unconstrained reaches during high flows and flooding events in winter. And these off-channel areas are relatively undisturbed by dikes, levees, dredge tailings, roads, excavations, fills, flow diversions, development, vegetation clearing, wood removal, poor water quality, etc.	Fish access to off-channel habitats, and the quantity and quality of off-channel habitats, in unconstrained reaches, is diminished due to dikes, levees, dredge tailings, roads, excavations, fills, flow diversions, development, vegetation clearing, wood removal, poor water quality, etc.	Fish access to off-channel habitats in unconstrained reaches is severely restricted or impossible due to dikes, levees, dredge tailings, roads, excavations, fills, flow diversions, development, etc., and/or the quality of the off-channel habitats is poor due to vegetation clearing, wood removal, poor water quality, and the other factors listed above. .
Habitat Elements:	Refugia (important remnant habitat for sensitive aquatic species)	Critical habitats necessary for successful completion of all anadromous salmonid life history phases (spawning, incubation, emergence, freshwater rearing, and migration) are functioning, accessible, and well-distributed. Critical summer refugia in Klamath Mountain streams include: (1) thermal refugia and (2) anadromous stream reaches with intact riparian reserves, cool clean water, pools that are not filled-in or partially filled-in with excess sediment, adequate stream flows, and good water quality. Critical winter habitat for anadromous salmonids includes side channels, off-channel habitats, and floodplain habitats.	Not all critical habitats necessary for successful completion of all anadromous salmonid life history phases are functioning and/or accessible for salmonids and/or well-distributed. Habitat quality and/or accessibility is diminished due to dikes, levees, dredge tailings, other fills, roads, excavations, flow diversions, development, vegetation clearing, wood removal, poor water quality, etc.	Many of the critical habitats necessary for successful completion of all anadromous salmonid life history phases are not functioning and/or not accessible for salmonids, and are thus are poorly distributed across the stream network and not providing adequate biological connectivity.
Channel Condition and Dynamics:	Width/Depth Ratio [6]	Width-to-Depth ratio < 12 on all reaches that could otherwise best be described as 'A', 'G', and 'E' channel types. Width-to-Depth ratio > 12 on all reaches that could otherwise best be described as 'B', 'F', and 'C' channel types. No braided streams formed due to excessive sediment loads. Lacking data, width-to-depth ratio should be evaluated considering the following factors: (1) recent (last 20 years) history of debris flows that have scoured channel and resulted in aggradation or degradation of the stream bed, (2) recent history of mass wasting that delivered large volumes of sediment to the stream	More than 10% of the reaches are outside of the ranges given for Width/Depth ratios for the channel types specified in "Properly Functioning" block. Braiding has occurred in some alluvial reaches as a result of excessive aggradation due to high sediment loads. For at-risk, stream crossing density is moderate to high, there have been some mass wasting events caused by management actions, pool frequency and quality is at-risk, modeled mass wasting and surface erosion is moderate to high, and there is inadequate LWD.	More than 25% of the reaches are outside of the ranges given for Width/Depth ratios for the channel types specified in "Properly Functioning" block. Braiding has occurred in many alluvial reaches as a result of excessive aggradation due to high sediment loads. For not properly functioning, stream crossing density is high, there have been some large mass wasting events caused by management actions, pool frequency and quality is poor, modeled mass wasting and surface erosion is moderate to high, and there is inadequate LWD.

Pathways	*Indicators*	*Properly Functioning*	*At Risk*	*Not Properly Functioning*
		that may have filled in pools, (3) pool frequency and depth information from stream surveys, (4) watershed disturbance as estimated with CWE modeling for mass wasting (GEO) and peak flows (ERA/TOC), and (5) frequency of large woody debris in the stream channel. For properly functioning, stream crossing density is low, there have been few mass wasting events caused by management actions, there are numerous deep pools, modeled mass wasting and surface erosion is low, and there is adequate LWD. If there is no or little management disturbance legacy in a watershed, then width-to-depth ratio is assumed to be properly functioning.		
	Streambank Condition (AP)	> 80% of any stream reach has ≥ 90% stability. Most watersheds have no bank stability surveys data so the level of streambank stability should be evaluated by considering: (1) density of road-stream crossings per stream or stream reach, (2) amount of inner gorge road, (3) other clearing and/or compaction directly adjacent to the stream, (4) artificial banks created by pushing up berms, and (5) recent (since 1996) channel altering debris flows. For properly functioning: Stream crossing density is low to moderate, there is little to no inner gorge road, there is no or only minor disturbance next to the stream channel, there are few or no berms, dikes, or levees constraining the channel, and/or there has been no or minor channel alteration/filling due to debris flows/landslides related to past management actions.	50-80% of any stream reach has ≥ 90% stability. For at-risk: Stream crossing density is moderate to high, there is some inner gorge road, there is some disturbance next to the stream channel, there are some berms, dikes, or levees constraining the channel, and/or there has been some channel alteration/filling due to debris flows/landslides related to past management actions.	< 50% of any stream reach has ≥90% stability For not properly functioning: Stream crossing density is high, there is over a mile of inner gorge road, there is significant disturbance next to the stream channel, berms, dikes, or levees constrain over a mile of channel; and/or there has been significant channel alteration/filling due to debris flows/landslides related to past management actions.
	Floodplain Connectivity (AP)	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation, and succession.	Reduced linkage of wetland, floodplains, and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession.	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain, and riparian areas; wetland area drastically reduced and riparian vegetation/succession altered significantly.
Flow /	Change in	Properly functioning watersheds for peak	Watersheds at-risk for change in peak	Watersheds not properly functioning or

Pathways	*Indicators*	*Properly Functioning*	*At Risk*	*Not Properly Functioning*
Hydrology:	Peak/Base Flows [7]	flow have low modeled ERA/TOC, low road density, few large clearings in the rain-snow transition zone, and vegetation close to reference condition. Properly functioning watersheds for base flow have low modeled ERA/TOC, low road density and hydrologic connectivity, and vegetation close to reference condition.	flow have moderately high to high modeled ERA/TOC, moderate to high road density, and/or some large recent clearings in the rain-snow transition zone. Watersheds at-risk for change in base flow have denser vegetation compared to reference conditions, several water diversions, and moderate density of roads that have hydrologic connectivity.	change in peak flow have high modeled ERA/TOC, high road density, and may have large recent clearings in the rain-snow transition zone. Watersheds not properly functioning for change in base flow have much denser vegetation compared to reference conditions, numerous or large water diversions, and high density of roads that have hydrologic connectivity.
	Increase in Drainage Network (AP)	Zero or minimum increases in active channel length correlated with human caused disturbance (e.g., trails, ditches, compaction, impervious surface, etc). The primary cause of drainage network increase in Klamath Mountain watersheds is hydrologic connectivity between the road system and the stream network.	Low to Moderate increases in active channel length correlated with human caused disturbance (e.g., trails ditches, compaction, impervious surface, etc).	Greater than moderate increase in active channel length correlated with human caused disturbance (e.g., trails ditches, compaction, impervious surface, etc).
Watershed Condition <u>Indicators</u>				
Watershed Conditions:	Road Density and Location (AP)	Less than 2 miles per square mile.	Two to three miles per square mile.	Over 3 miles per square mile.
	Riparian Reserves – NW Forest Plan (AP) [8]	The riparian reserve system provides adequate shade, large woody debris recruitment, and habitat protection and connectivity in all subwatersheds, and buffers or includes known refugia for sensitive aquatic species (> 80% intact), and/or for grazing impacts; percent similarity of riparian vegetation to the potential natural community/composition > 50%.	Moderate loss of connectivity or function (shade, LWD recruitment, etc) of riparian reserve system, or incomplete protection of habitat and refugia for sensitive aquatic species (approx. 70-80% intact), and/or for grazing impacts; percent similarity of riparian vegetation to the potential natural community/composition 25-50% or better. Some past stand-replacement timber harvest or intense fire in RR, moderate road and landing density in RR, minor to moderate level of mining in RR, vegetation/fuels moderately departed from historic fuels conditions, species diversity and vegetation structure in stream buffers moderately altered from reference condition due to fire suppression and past timber harvest, and moderate modeled CWE values.	Riparian reserve system is fragmented, poorly connected, or provides inadequate protection of habitat and refugia for sensitive aquatic species (approx. less than 70% intact), and/or for grazing impacts; percent similarity of riparian vegetation to the potential natural community/composition is 25% or less. Extensive past stand-replacement timber harvest or intense fire in RR, high road and landing density in RR, moderate to high intensity of mining in RR, vegetation/fuels greatly departed from historic fuels conditions, species diversity and vegetation structure in stream buffers significantly altered from reference condition due to fire suppression and past timber harvest, and high modeled CWE values.
	Disturbance History/Regime	Frequency, duration, and magnitude of stochastic disturbance events are close to reference condition. The following factors should be considered in rating the	In at-risk watersheds, frequency, duration, and magnitude of stochastic disturbance events are moderately departed from reference condition. At-risk watersheds	In not properly functioning watersheds, frequency, duration, and magnitude of stochastic disturbance event is significantly departed from reference

Pathways	*Indicators*	*Properly Functioning*	*At Risk*	*Not Properly Functioning*
		Watershed Disturbance/Regime indicators: (1) overall watershed disturbance as determined through CWE modeling, (2) road density and location, (3) current impacts from past stand-replacing forestry, mining, and intense fires, (4) departure from historic fire regime, (5) departure from historic vegetation structure and composition, and (6) character of development on private property. For properly functioning, a watershed should have low CWE and road density (all models under "1" threshold), few impacts from past stand-replacement forestry or intense fire, are not significantly departed from historic vegetation/fuels condition and fire regime, and/or have low disturbance on private property.	have moderate to high CWE and road density (one or two models over "1" threshold), some significant impacts from past stand-replacement forestry or intense fire, are moderately departed from historic vegetation/fuels condition and fire regime, and/or have moderate disturbance on private property.	condition. Not properly functioning watersheds have high CWE and road density (all models over "1" threshold), significant impacts from past stand-replacement forestry or intense fire, are significantly departed from historic vegetation/fuels condition and fire regime, and/or have significant disturbance on private properties.
Summary Integration of all species and habitat indicators effects	How do the effects to indicators affect each fish species and their habitat? Describe by species and by 7th and 5th field watersheds. See AP guidance. In addition to the narrative summary, use Summary Table in Tables required for BA/BE.			

Footnotes to Table Above: Table of Population and Habitat Indicators for use on the Klamath National Forest in the Northwest Forest Plan Area, as adjusted from Appendix A in the Analytical Process.

1. (Temperature) Proper Functioning criteria for 4th -5th Order streams is derived from temperature monitoring near the mouth of streams of relatively undisturbed watersheds (Clear, Dillon, and Wooley Creeks). –Maximum Weekly Maximum Temperatures (MWMT) as high as 70.5 degrees F have been recorded on these streams (EA Engineering, 1998 Salmon River and Dillon Creek Watershed Fish Habitat and Channel Type Analysis, Appendix 2). At-Risk criteria for 4th/5th order streams is derived from monitoring in streams that support populations of anadromous fish, although temperatures in this range (70.5 to 73.5 degrees F) are considered sub-optimal. The Not Properly Functioning criterion is sustained temperatures above 73.5 degrees F - that causes cessation of growth and approach lethal temperatures for salmon and steelhead. Properly Functioning criteria for 1st - 3rd order streams is derived from Desired Future Conditions (DFC) values given in the LRMP EIS p 3-68. At Risk and Not Properly Functioning criteria for 1st – 3rd order streams are assigned on a temperature continuum with values given for 4th/5th order streams, with the maximum instantaneous temperature of At Risk 1st - 3rd order streams coinciding with the minimum MWMT of 4th/5th order At Risk streams. [Stream Order according to Strahler (1957).]
2. (Chemical/Nutrient Contamination) For projects within the river corridors of the mainstem Scott, Salmon, and Klamath Rivers the criteria is unchanged from AP Table. For tributaries to the Scott, Salmon, and Klamath Rivers use the criteria from the AP table. Although these tributaries have CWA 303d designation, Klamath National Forest tributaries are typically properly functioning for dissolved oxygen, nutrients, and microcystin, and because temperature and sediment is assessed in the Temperature and Substrate Character Indicators. Chemical contamination and nutrients should be assessed for Scott, Salmon, and Klamath River tributaries.
3. (Substrate Character) Use recent stream survey data where available. Properly Functioning criteria for % fines in gravel is from the LRMP EIS p 3-68. Additional Forest-wide desired conditions for sediment (pool sediment, subsurface sediment) are described by Laurie and Elder (2012) in relation to monitoring for TMDL and NCRWB water quality standards. When location-specific information is unavailable, use the following as best appropriate: use USLE and GEO models to determine functioning level of Indicator and potential effects of sediment delivery to streams that may affect anadromous fish and their habitat, infer substrate character functioning level from other factors such as high road density and degree of hydrologic connection, recent large intense wildfires, and recent (last 20 years) debris flows that altered channels, and lastly use professional judgment to describe existing conditions and to estimate effects based upon model output interpretation, research results, or other information. The KNF CWE modeling procedure describes the risk (probability) of project-caused sediment production (see 2004 CWE process paper, by Elder and Reichert, in fisheries sufficiency guides). For existing condition and effects of the action:

   Properly Functioning: USLE and GEO values are less than 1.0

   At Risk: USLE and GEO values are between 1.0-1.20

   Not Properly Functioning: USLE and GEO values are greater than 1.20
4. (Large Woody Debris) See KNF LRMP EIS Chapter 3, text and tables on Pages 68-69. For stream reaches on the Westside of the Forest, manage for an average of 20 pieces of large wood per 1,000 ft in 3-5th order streams (LRMP Page 4-143). Large wood is defined as a minimum length of 50 feet and diameter of 24 inches on the Westside. However, site potential and channel

width must be considered rather than using strict numbers. Also consider the potential for future LWD recruitment in both the short- and long-term.

Criteria for length of LWD for larger streams may be based on average bankfull channel width of the reach: in streams larger than 3rd order a piece of woody debris may qualify as large woody debris in a stream reach if its length is 1.5 times the average bankfull channel width, or if it has a rootwad attached and its length is 1¼ times the average bankfull channel width. Stable pieces of woody debris remain stationary during normal to high flows. Channel width and depth largely determines whether large woody debris recruited into a stream reach will be stable, and largely determines the average size of wood retained in streams (Bilby and Ward 1989, 1991; Robison and Beschta 1990). As channels become wider and deeper, the average size of a stable piece of wood increases. Pieces shorter than bankfull width and with a diameter less than bankfull depth are more likely to be transported out of a reach by streamflow (Bilby 1984, Braudrick et al. 1997). Length of woody debris appears to be most important to its stability where stream discharge is sufficient to float large diameter stems (Bilby 1985, Swanson and others 1984). Branches and/or rootwads, if still attached, add to the stability of woody debris. Therefore, criteria for length of LWD for larger streams may be based on average bankfull channel width of the reach: in streams larger than 3rd order a piece of woody debris may qualify as large woody debris in a stream reach if its length is 1.5 times the average bankfull channel width, or if it has a rootwad attached and its length is 1¼ times the average bankfull channel width.

5. (Pool Quality and Frequency) A measurable pool is an area of channel which (1) shows clear signs that the pool was created by scour at high flows and/or that the pool is the result of the channel being dammed at the downstream end; (2) has a significant residual depth - the deepest part of the pool must be at least twice as deep as the water flowing out of the pool at the riffle crest; (3) has an essentially flat water surface during low flow - water surface slope <0.05 percent; and (4) includes most of the channel - it must include the thalweg and occupy at least half of the width of the low-flow channel. “Primary” pools are defined by their maximum depth in relationship to size or stream order. As the order or size of the stream increases the required minimum depth for a primary pool increases. In 1st through 3rd order streams, a primary pool must have a minimum depth of two feet or greater. In 4th and 5th order streams, a primary pool must have a minimum depth of three feet. In 6th order and larger streams, a primary pool must have a minimum depth of four feet.

6. (Width/Depth Ratio) The Width-to-Depth ratio for various channel types is based on delineative criteria of Rosgen (1996). Properly Functioning means that Width-to-Depth ratio falls within expected channel type as determined by the other four delineative factors (entrenchment, sinuosity, slope, and substrate). Aggradation on alluvial flats causing braiding is well known phenomenon that often accompanies changes in Width-to-Depth ratio as watershed condition deteriorates. Stream width is a function of streamflow occurrence and magnitude, size and type of transported sediment, and the bed and bank materials of the channel (Rosgen 1996). Channel widths generally increase with flow volume downstream. Channel widths can be modified by changes in riparian vegetation, landslides particularly debris flows, changes in streamflow regimes, and changes in sediment supply. The AP Table indicates that confined or entrenched channel types (such as A, G, and E types) are Properly Functioning when Width-to-Depth ratios are <12, and wider channel types (such as B, C, and F types) are Properly Functioning when Width-to-Depth ratios are >12. To meet the Properly Functioning criteria channels must also have no or minimal braiding due to excessive sediment.

7. (Peak/Base Flows) In most cases, sufficient hydrograph data is not available to determine comparative changes in peak flows as suggested in the AP. Infer changes in **peak flows** when no

hydrograph data is available by considering the following factors: (1) CWE runoff model (ERA/TOC) outputs, (2) road density and the degree of hydrologic connectivity between the road system and the stream network, and (3) number, size, and vintage of openings in the forest canopy resulting from past stand-replacement forestry in the snow-rain transition zone where increased openings can result in elevated runoff from rain-on-snow events. The potential for decreased **base flows** in the Project HUC7 watersheds should be evaluated by considering the following factors: (1) increased/decreased evapotranspiration due to denser/sparser vegetation than reference condition that has resulted from stand-replacement forestry and/or fire suppression, (2) number and size of water diversions, and (3) degree of hydrologic connectivity between the road system and the stream network (watersheds with high road density likely have reduced base flows due to impervious surfaces and groundwater interception in road cuts).

8. (Riparian Reserves) The following factors should be considered in determining the condition of stream buffer (hydrologic) RR: (1) amount and age of past stand-replacement forestry or intense fire in stream buffers, (2) road and landing density in stream buffers, (3) mining in stream buffers, (4) departure from historic fire regime, (5) condition of riparian vegetation for providing shade, large woody debris, sediment-filtering, and nutrient cycling, and (6) the amount of overall disturbance in the watershed particularly as estimated by the peak flow (ERA) and mass wasting (GEO) models. The following two factors should be considered in determining the condition of geologic RR: (1) amount and age of past stand-replacement timber harvest and/or recent intense wildfire on geologic RR and (2) road and landing density on geologic RR.

Appendix D: Checklist for Documenting Environmental Baseline and Effects Of Proposed Action(s) on Relevant Indicators

PROJECT AND SITE #:

Westside Fire Recovery, Buckhorn-Beaver 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Buckhorn-Beaver 7th - field watershed			**EFFECTS OF THE ACTION(S)** Buckhorn-Beaver 7th - field watershed		
	PROPERLY FUNCT	**AT RISK**	**NOT PROP FUNCT**	**RESTORE**	**MAINTAIN**	**DEGRADE**
Water Quality Temperature		**TEMP**				
Sediment - Turbidity			**SS89 KNF GIS PO PJ**			
Chemical Contamination	**ND/PO/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character			**SS89 SED PO KNF GIS**			
Large Woody Debris			**ND/PJ**			
Pool Frequency/Quality			**SS89 KNF GIS**			
Off-channel Habitat		**PO PJ**				
Refugia		**TEMP SS89 / PJ**				
Channel Cond & Dyn Width/Depth Ratio			**KNF GIS PO PJ**			
Streambank Condition			**KNF GIS PO PJ**			
Floodplain Condition		**PO PJ**				
Flow /Hydrology Change in Peak/Base Flow			**KNF-GIS RSS**			
Drainage Network Increase			**KNF GIS RSS**			
Watershed Condition Road Density/Location			**KNF-GIS**			
Disturbance History/Regime			**KNF GIS**			
Riparian Reserves			**KNF GIS**			

TEMP = Last five years of temperature monitoring near the mouth of Beaver Creek; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory (KNF 2003); **SS89** = 1989 KNF stream survey of mainstem Beaver Creek from mouth to WF Beaver Ck; **SED =** 2011 sediment assessment survey; **RSS** = 1999 KNF Road Sediment Source Inventory and Risk Assessment; **ND** = No Data; **PO** = Personal Observation; **PJ** = Professional Judgment; **NA** = Not Applicable; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline completed by Jon Grunbaum on February 11, 2015.**

The **Buckhorn-Beaver** 7th-field watershed is a 8,265 acre composite watershed that includes about five miles of lower mainstem Beaver Creek from the mouth upstream to WF Beaver Creek. Mainstem Beaver Creek is a 5th-order stream (Strahler, 1957) within the Buckhorn-Beaver watershed. Mainstem Beaver Creek supports steelhead and resident rainbow trout, coho and Chinook salmon. Within the Buckhorn-Beaver 7th-field watershed there is (are): one 3rd-order tributary to mainstem Beaver Creek named Buckhorn Gulch; three named 2nd-order tributaries (Fish Gulch, Marble Gulch, and Myrtle Gulch); one unnamed 2nd-order tributary; two named 1st-order tributaries (Ragged Creek and Polly Gulch); over 15 unnamed 1st-order tributaries; and several zero-order draws. These tributaries have very low summer flows or are intermittent. None of the tributaries to mainstem Beaver Creek within the Buckhorn-Beaver HUC14 are fish-bearing. The last stream surveys of mainstem Beaver Creek within the Buckhorn-Beaver watershed were in 1989 and 1991. There are no stream surveys for any of the tributaries to mainstem Beaver Creek in this composite watershed. The Buckhorn-Beaver watershed is 60% National Forest land and the rest is private industrial timberland and smaller private home/small ranch parcels.

Buckhorn-Beaver 7th-Field Watershed Environmental Baseline:

Temperature: Summer water temperature was monitored near the mouth for most years from 1997 to 2014 – monitoring results for the last five years is given in the table below. In the five year period of record the maximum instantaneous water temperature ranged from 18.0°C to 23.2°C; the maximum weekly average temperature (MWAT) ranged from 15.7 °C to 19.6°C; and the maximum weekly maximum temperature ranged from 17.7°C to 22.4°C. Water temperature in mainstem Beaver Creek was within the properly functioning range from 2010 to 2013 (and in previous years of record) but was in the At-Risk range in 2014. Near record low base flows in summer 2014 may have been a primary factor in high water temperatures and large diurnal temperature variation. It is likely that the rate and magnitude of stream heating and cooling will increase due the 2014 Beaver Fire because: (1) the wildfire burned large swaths of riparian vegetation that had provided shade to stream channels, (2) pools are likely to infill or partially infill with excess sediment which will increase surface area to volume ratio, and (3) the wildfire is likely to significantly increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. **At-Risk**.

Recent Water Temperature Monitoring Results for Mainstem Beaver Creek Near Mouth

Start	End	Max Daily Max Temp C	Max Average Daily Temp C	Max Diurnal Variation Temp C	Maximum Weekly Average Temp C (MWAT)	Maximum Weekly Maximum Temp C (MWMT)
10/8/2009	10/26/2010	19.5	17.1	5.2	16.9	18.9
6/10/2011	10/5/2011	18.0	15.9	4.3	15.7	17.7
6/15/2012	11/1/2012	20.3	18.0	4.7	17.4	19.6
6/11/2013	10/31/2013	21.7	19.1	5.1	18.5	20.7
6/3/2014	9/23/2014	23.2	20.3	6.3	19.6	22.4

Sediment - Turbidity: In the 1989 stream survey of mainstem Beaver Creek within the Buckhorn-Beaver composite watershed the percent fines in pebble counts was 11% and embeddedness was 21%. From annual snorkel fish census surveys through the years it is well documented that mainstem Beaver Creek is turbid with fine suspended sediment even after long periods of low flow – underwater visibility is low with a range of about five or six feet during the

most optimal conditions. The Beaver Creek 5th-field watershed has a high level of disturbance from roads and past logging (particularly the private timberlands).

Post 2014 Beaver Fire water quality and sediment conditions in lower mainstem Beaver Creek and lower West Fork Beaver Creek were observed and photographed in the winter after several light to moderate precipitation events: the observations and photographs revealed that (1) turbidity was very high during and long- after precipitation events and (2) large quantities of fine sediment had been delivered to the mainstem which had partially smothered the pre-Fire streambed and salmonid spawning gravels. The 2014 Fire increased the actual rate of surface erosion as well as the modeled rate of surface erosion to well over threshold (USLE = 1.28). Increase in the frequency, magnitude and duration of turbidity due to increased surface erosion due to the 2014 Beaver Fire is likely last for a few years to a decade or more until vegetation gets re-established and ground cover is largely recovered in burned areas. Modeled mass-wasting is over threshold (GEO = 1.16). The rate of mass wasting that can cause bouts of acute turbidity will likely be increased for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots. **Not Properly Functioning**.

Chemical Contamination: No data. There are no known sources of chemical contamination on National Forest land within the Buckhorn-Beaver watershed. Properly Functioning.

Habitat Access

Physical Barriers: An inventory of fish/aquatic organism barriers related to roads was completed in 2003 for the Buckhorn-Beaver area (on National Forest lands/roads) and no barriers to fish or aquatic organisms were found. Properly Functioning.

Habitat Elements

Substrate: In the 1989 stream survey of mainstem Beaver Creek within the Buckhorn-Beaver composite watershed: percent fines (11%) and embeddedness (21%) were elevated but within the properly functioning range. From recent annual snorkel fish census surveys it is known that mainstem Beaver Creek still has a large percentage of fines in the channel substrate. **At-Risk.**

Large Woody Debris: There is no reliable quantitative information on LWD and potential for future LWD recruitment to the stream. Qualitatively, there is very little effective LWD in the channel and little potential for future LWD recruitment (personal observation made during numerous salmon/steelhead census surveys of mainstem Beaver Creek). In the late 1980s and early 1990s hundreds of log structures were cabled into the Beaver Creek stream channel to enhance fish habitat and because LWD levels were determined to be very low. Many of these structures have since washed away during peak flows and new recruitment has not replenished the channel.

Existing down LWD and standing large green trees or snags are likely reduced in the stream channel and stream buffer of the mainstem due to easy access and disturbance in stream buffers at: (1) numerous upslope stream crossings (throughout the Beaver HUC10 watershed), (2) numerous valley bottom roads (including unauthorized and ghost roads on the valley floor), (3) the campground (streamside on the mainstem), (4) on private property (about half of the land adjacent to mainstem Beaver Creek is private), and (5) on industrial timberlands (nearly half of this HUC14 and the Beaver Creek HUC10 is industrial timberland). Past timber harvest and

associated road construction has reduced the number of large upslope conifers that could be delivered to a stream channel via falling or landsliding.

Based on these factors, it is my professional opinion that the LWD indicator is **Not Properly Functioning**.

Pool Frequency and Quality: There were 26 pools in the 6.2 miles of mainstem Beaver Creek within the Buckhorn-Beaver composite watershed that was surveyed in 1989 with an average maximum pool depth of 3.6 feet. Assuming the average bankfull width was 36 feet there was one pool every 35 bankfull widths, however, the frequency of deep pools (over three feet maximum depth) would be less. Pools in this composite watershed were likely partially filled with excessive sediment - modeled surface erosion risk and mass wasting risk were At-Risk at the 5th-field watershed scale. Pool filling from excessive sedimentation is expected to increase over the next ten years or more due to elevated erosion and increased mass wasting associated with the 2014 Beaver Fire that burned large swaths of forest at moderate to high intensity. Modeled surface erosion and mass wasting risk are over threshold (USLE = 1.28; GEO = 1.16). Sedimentation into Beaver Creek has already significantly increased due to the 2014 Beaver Fire.

Beaver were nearly extirpated in Beaver Creek and other streams in Northern California (Lanman et.al. 2013). Aquatic habitat in Beaver Creek was likely much different before fur trapping and European settlement due to beaver activity. Beaver Creek likely had numerous beaver dams which created pools and prime habitat for salmonids. Pool frequency and quality was likely much higher before trapping and settlement. There are still some beaver left in Beaver Creek but the population is slow to rebound probably because of continued trapping but also because streamside disturbance, lack of in-stream key pieces of LWD, and lack of large recruit-able streamside trees greatly diminishes beaver habitat suitability. **Not Properly Functioning**.

Off-Channel Habitat: Much of the channel of mainstem Beaver Creek is constrained with little potential for floodplain and off-channel habitat development. Most of the unconstrained reaches are on private land where the floodplain is cut-off and the potential for off-channel habitat is restricted by existing roads, berms, and current human activities. There are a few areas where there is functioning off-channel habitat. **At-Risk**.

Refugia: Cold water and cover are the primary elements of fish refugia in this watershed. The water temperature is cool and usually within suitable to optimum range for anadromous salmonids. Water temperature was in the properly functioning range for every year of record except 2014 when it was in the at-risk range. There is little specific quantitative information on cover, however, from stream survey data it is known that cover in the form of deep pools is lacking. LWD levels are low (see LWD indicator above). **At-Risk**.

CHANNEL CONDITION AND DYNAMICS

Width to Depth Ratio: (same discussion as the Pool Frequency/Quality indicator above). **Not Properly Functioning**

Stream Bank Condition: Streambanks are degraded at: (1) numerous stream crossings, (2) where roads and berms are constructed within the stream buffer and inner gorge, (3) adjacent to mainstem Beaver Creek where residences have cleared, compacted, or otherwise modified the streambank, and (4) at the campground where the streambank is a berm and where large conifers on the streambank are removed as hazard trees before they have a chance to be recruited to the

stream by streamside residents. The 2014 Beaver Fire burned 1,454 acres of vegetation in stream buffer RRs (52% of the total stream buffer in the composite watershed) at moderate to high intensity. **Not Properly Functioning**.

Floodplain Connectivity: Much of the channel of mainstem Beaver Creek is constrained with little potential for floodplain and off-channel habitat development. Most of the unconstrained reaches are on private land where the floodplain is cut-off and the potential for off-channel habitat is restricted by existing roads, berms, and current human activities. There are a few areas where there is functioning off-channel habitat. **At-Risk**.

FLOW/HYDROLOGY

Change in Peak/Base flow: Road density is high and 21% of the road system is hydrologically connected to the stream network in the Beaver-Buckhorn HUC14. Peak flows in mainstem Beaver Creek within the Buckhorn-Beaver composite watershed is determined at the 5th-field watershed scale of Beaver Creek because all water drains though this lowest subwatershed. Road density and hydrologic connectivity is high in most of the HUC14s upstream of the Beaver-Buckhorn HUC14 as well. Modeled runoff risk is slightly over threshold at the in the Buckhorn-Beaver HUC14 (ERA/TOC = 1.01) and in the entire Beaver Creek HUC10 (USLE = 1.01). There are several water diversions from lower Beaver Creek – at least one of them takes a significant volume of water out of the summer base flow. The exact volume is unknown, but it is likely that several cfs are diverted from lower Beaver Creek during summer low-flow periods. **Not Properly Functioning**.

Increase in Drainage Network: Road density is high and 21% of the road system is hydrologically connected to the stream network in the Beaver-Buckhorn HUC14. **Not Properly Functioning**

WATERSHED CONDITION

Road Density/Location: Road density is high at 3.9 miles of road per square mile of watershed. There is a valley bottom and/or inner gorge road on at least on one side of mainstem Beaver Creek for most of its' length through this HUC14 watershed. **Not Properly Functioning**.

Disturbance History/Regime: Road density is high and 21% of the road system is hydrologically connected to the stream network. There has been extensive stand-replacement forestry in this composite watershed - particularly on private timberland (some areas of private timberland were and are being salvaged after the 2014 Beaver Fire). Ground disturbance and compaction is at fairly high levels streamside and on the valley floor due to: (1) roads and berms constructed within the stream buffer and inner gorge, (2) existence and maintenance of residences and grounds, and (3) existence and maintenance of the campground.

Another major stressor that is adversely affecting watershed processes now, and that will continue to affect watershed processes/conditions and set the stage for future disturbance regimes in the next decades or longer, was the 2014 Beaver Fire that burned large swaths of forest at moderate and high intensity in upslope and riparian areas. The 2014 Beaver Fire burned 1,454 acres of vegetation in stream buffer RRs (52% of the total stream buffer in the composite watershed) at moderate to high intensity. This much moderate and high intensity fire in hydrologic RRs, coupled with a high-density road system, is expected to significantly: (1) decrease hydrologic retention, (2) decrease the sediment filtering and nutrient spiraling function of riparian vegetation compromising the potential of hydrologic RRs to buffer the stream from

upslope ground disturbances and landslides, and (3) increase streamside landsliding. The 2014 Fire caused 25% or greater basal area mortality on 635 acres of unstable ground RR as follows: 4 acres of active landslide; 157 acres of toe-zone; and 534 acres of inner gorge. [note: most or all of the 534 acres of inner gorge are within hydrologic RR so these acres should not be double-counted]. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the risk, rate, and adverse cumulative effects of excess sediment delivery, transport, and deposition in stream channels.

CWEs are over threshold in all three CWE model runs as follows: (USLE = 1.28; GEO = 1.16; ERA/TOC = 1.10). **Not Properly Functioning**.

Riparian Reserves: Stream buffer RRs are degraded at: (1) numerous upslope stream crossings, (2) numerous valley bottom and/or inner gorge roads (including unauthorized and ghost roads), (3) the campground (streamside on the mainstem), (4) on private property (about half of the land adjacent to mainstem Beaver Creek is private), and (5) on industrial timberlands (nearly half of this HUC14 and the Beaver Creek HUC10 is industrial timberland). In addition, the 2014 Beaver Fire burned 1,454 acres of vegetation in stream buffer RRs (52% of the total stream buffer in the composite watershed) at moderate to high intensity. This much moderate and high intensity fire in hydrologic RRs, coupled with a high-density road system, is expected to significantly: (1) decrease hydrologic retention, (2) decrease the sediment filtering and nutrient spiraling function of riparian vegetation compromising the potential of hydrologic RRs to buffer the stream from upslope ground disturbances and landslides, and (3) increase streamside landsliding. The 2014 Fire caused 25% or greater basal area mortality on 635 acres of unstable ground RR as follows: 4 acres of active landslide; 157 acres of toe-zone; and 534 acres of inner gorge. [note: most or all of the 534 acres of inner gorge are within hydrologic RR so these acres should not be double-counted]. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the risk, rate, and adverse cumulative effects of excess sediment delivery, transport, and deposition in stream channels. **Not Properly Functioning**.

PROJECT AND SITE #

Westside Fire Recovery, China Creek 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** China Creek 7th Field Watershed			**EFFECTS OF THE ACTION(S)** China Creek 7th Field Watershed		
	PROPERLY FUNCT	AT RISK	NOT PROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	**TEMP**					
Sediment-Turbidity		**SS98 SED KNF GIS**				
Chemical Contamination	**ND/PO/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character		**SS98 SED KNF GIS**				
Large Woody Debris		**SS98**				
Pool Frequency/Quality		**SS98 Flood**				
Off-channel Habitat		**PO/PJ**				
Refugia	**TEMP**	**SS98 PO/PJ**				
Channel Cond & Dyn Width-to-Depth Ratio		**SS98 Flood PO/PJ**				
Streambank Condition		**SS98 Flood PO/PJ**				
Floodplain Condition		**PO/PJ**				
Flow /Hydrology Change in Peak/Base Flow		**KNF GIS RSS**				
Drainage Network Increase		**KNF GIS RSS**				
Watershed Cond. Road Density/Location			**KNF GIS**			
Disturbance History/Regime		**KNF GIS RSS**				
Riparian Reserves		**KNF GIS RSS**				

TEMP = Water temperature monitoring of mainstem Elk Creek upstream of Bear Creek confluence from 2010 to 2014; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory; **ND** = No Data; **PJ** = Professional Judgment; **PO** = Personal observation based on 20+ years observing; **NA** = Not Applicable; **SED =** 2011 KNF Sediment Assessment Survey (KNF 2013); **Flood** = 1997 Flood Assessment (KNF 1998); **SS98** = 1998 KNF (contracted) stream survey of mainstem China Creek; **RSS =** KNF Road Sediment Source Inventory and Risk Assessment (USDA 2012); **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015);
Environmental Baseline and Checklist last updated by Jon Grunbaum on March 3, 2015.

The **Klamath/China Creek** 7th-field (HUC14) watershed is a true watershed with an area of 6,189 acres. Approximately 9% of the watershed is private property and the rest in National Forest. Mainstem China Creek is the primary stream in the watershed and is a 3rd-order (Strahler 1957) stream. South Fork China Creek, Three Biscuit Gulch, and Wolf Creek are the only named tributaries to China Creek. South Fork China Creek provides habitat for rainbow trout but the other tributaries to China Creek are not fish-bearing. Mainstem China Creek and South Fork China Creek combined provide approximately 3.4 miles of habitat for resident rainbow trout. Mainstem China Creek provides approximately 1.8 miles of habitat for steelhead trout; 0.8 mile of habitat for Coho salmon; and 0.5 miles for Chinook salmon. The last stream survey of mainstem China Creek was in 1998.

Klamath-China Creek 7th-field watershed Environmental Baseline Elements:

Water Temperature: Summer water temperature in mainstem China Creek about 0.8 mile upstream of the mouth was monitored from 2010 to 2014 – see table below for a summary of monitoring results. In this five year period of record the maximum instantaneous water temperature ranged from 17.6°C to 20.3°C; the maximum weekly average temperature (MWAT) ranged from 15.7°C to 18.4°C; and the maximum weekly maximum temperature ranged from 17.1°C to 19.6°C. Near record low base flows may have been a primary factor in the much higher than average water temperatures in 2014. It is possible that rate and magnitude of stream heating and cooling will slightly increase due the 2014 Happy Camp Complex Fire because: (1) the wildfire burned areas of riparian vegetation that had provided stream shade and thermal buffering to stream channels, (2) pools may partially infill with excess sediment which will increase surface area to volume ratio, and (3) the wildfire may increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. The condition of the water temperature indicator is just barely in the **Properly Functioning** range in 2014.

Recent Water Temperature Monitoring Results for mainstem China Creek at RM 0.8

Start	End	Max Daily Max Temp C	Max Average Daily Temp C	Max Diurnal Variation Temp C	Maximum Weekly Average Temp C (MWAT)	Maximum Weekly Maximum Temp C (MWMT)
6/6/2010	10/11/2010	19.0	17.5	3.8	17.0	18.6
6/10/2011	10/13/2011	17.6	16.1	3.5	15.7	17.1
6/8/2012	10/9/2012	18.3	17.2	3.6	16.6	17.8
5/18/2013	10/1/2013	19.7	18.5	3.6	17.7	18.9
5/28/2014	10/1/2014	20.3	19.0	3.8	18.4	19.6

Sediment - Turbidity: See discussion for Substrate Character indicator below **At-Risk.**

Chemical Contamination: No significant source of chemical contamination is known to exist. **Properly Functioning.**

HABITAT ACCESS

Physical Barriers: No barriers to fish passage are known to exist. **Properly Functioning**.

Substrate Character: The results of 2011 intensive monitoring and evaluation of sediment in mainstem China Creek that included the metrics: percent surface fines < 2mm, percent sub-surface sediment < 0.85mm, percent sub-surface sedient < 6.38mm, and percent residual pool

volume filled with fine sediment (V*), is shown in the table below. Substrate quality was evaluated by comparing the four sediment indicators in mainstem China Creek (a managed watershed) to the 85th percentile value of the four indicators for pooled reference streams that have minor to negligble management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams may have impaired sediment regime. In 2011 three of the four sediment indices exceeded reference values.

Average surface fines, average sub-surface fines, and average volume of fine sediment filling pools (V*) from the 2011 China Creek response reach (china1) compared to KNF Stream Sediment Monitoring reference conditions (85th percentile). (china1) metrics over reference values are bolded.

Sediment Index	2011 China1 reach average %	Reference Condition (%)
Surface Fines < 2mm	**8.6**	6.4
Sub-surface fines < 0.85mm	**23.2**	16.2
Sub-surface fines < 6.38mm	**47.4**	46.1
Fraction of pools filled with fine sediment < 2mm (V star)	0.088	0.108

Average percent surface fines observed during the 1998 stream survey of China Creek were as follows: 8.9% on riffles; 12.8% on pool tail-outs; and 12.3% in runs. This survey was conducted the summer after the 1997 New Years Flood which caused numerous debris flows that delivered a large pulse of sediment into the mainstem.

The 2014 Happy Camp Complex Fire increased the rate of erosion and sediment delivery to China Creek. The frequency, magnitude and duration of turbidity and fine sediment delivery due to surface erosion is likely to be elevated for a few years until vegetation gets re-established and ground cover is largely recovered in burned areas. The volume of fine and coarse sediment delivery to streams due to mass wasting is likely to increase for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots.

Modeled surface erosion risk (USLE = 0.75); modeled mass wasting risk (GEO = 0.75); and modeled runoff risk (ERA/TOC = 0.84) are moderately to highly elevated due to roads, past wildfires, and past vegetation management; in that order. **At-Risk**.

Large Woody Debris: Course Woody Material (CWM) was tallied in the lower three miles of China Creek during the 1998 stream survey. The majority of CWM was in the 4- to 18-inch diameter class and were less than 36 feet in length. Several dozen pieces occurrred in the 24-inch diameter class but were less than 50 feet in length. Eighteen pieces of CWM were over 24-inches in diameter and over 50 feet in length, or an average of 6 pieces of LWD per mile. There is a high density of stream crossings where green trees, snags and LWD can be accessed, and past timber harvest and road building/mainteance has reduced the amount of LWD that could be transported to the stream channel via trees falling or landsliding. The was a moderate to large number of green trees adjacent to lower China Creek that were large enough to provide large woody debris should they fall into China Creek. **At-Risk**.

Pool Frequency and Quality: In the 1998 stream survey of China Creek there were 81 pools in the lower three miles of China Creek that ranged in maximum depth from 1.2 to 5.8 feet, with a

mean maximum depth of 2.4 feet. Seventeen pools had a maximum depth of three feet or greater. There was one pool every 9.7 bankfull channel widths (assuming bankfull width was 20 feet). There was one deep pool approximately every 47 bankfull widths. Pools may be reduced in number and/or depth due to low levels of in-channel LWD and/or excess sediment (from high levels of watershed disturbance) in-filling pools. **At-Risk**.

Off-Channel Habitat: Generally not applicable in the China Creek watershed where most channels are Rosgen A-, and B-Channel types that are too constrained and entrenched to have floodplains that allow off-channel habitat development. There is a few tenths of a mile of slightly unconstrained channel in the lower mainstem reach that could be flooded and become off-channel habitat, however, the County road crossing just upstream from this reach may be preventing floodplain interaction. **At-Risk**.

Refugia: Cold water and cover are the primary elements of fish refugia in this watershed. China Creek water temperatures are believed to remain cool and within the suitable range for anadromous salmonids throughout the year. In the 1998 stream survey there was good cover provided by CWM and large boulders but deep pools were sparse. The one unconstrained reach that could provide winter refugia may not be functioning due to way the channel is constricted at the County Road stream crossing. **At-Risk**.

CHANNEL CONDITION AND DYNAMICS

Width-to-Depth Ratio: There were 11 landslides and 32 major road failures in the China Creek drainage during the 1997 flood event resulting in numerous debris flows that altered about 24% of the channels in the China Creek watershed. The Width-to-depth ratio was appreciably altered by the 1997 Flood, and that the channel of China Creek is shallower and wider as a result. Flood-altered channels are recovering but probably slowly due to high levels of watershed disturbance. **At-Risk**.

Streambank Condition: About 24% of the channels in the China Creek watershed were altered in the 1997 Flood and areas of streambank were reset, however, vegetation on streambanks has largely recovered. Invasive blackberries have taken over some of the streambanks adjacent to the lower 0.5 mile of mainstem. There is a high density of stream crossings. **At-Risk**.

Floodplain Connectivity: Generally not applicable in the China Creek watershed where most channels are Rosgen A-, and B-Channel types that are too constrained and entrenched to have floodplains that allow off-channel habitat development. There is a few tenths of a mile of slightly unconstrained channel in the lower mainstem reach that could be flooded and become off-channel habitat, however, the County road crossing just upstream from this reach may be preventing floodplain interaction. **At-Risk**.

FLOW/HYDROLOGY

Change in Peak/Base Flow: Road and stream crossing density is very high and 5% of the road system is hydrologically-connected to the stream network. Peak flows are likely being affected (increased) by increased drainage network due to roads. Runoff will be increased from areas that burned at moderate to high intensity in the 2014 Fire. Modeled runoff risk is highly elevated (ERA/TOC = 0.84) but still under threshold. **At-Risk.**

Increase in Drainage Network: Road and stream crossing density is very high and 5% of the road system is hydrologically-connected to the stream network. In the short term (10 years)

runoff will be increased from areas that burned at moderate to high intensity in the 2014 Fire which will increase effective drainage density. **At-Risk.**

WATERSHED CONDITION

Road Density/Location: Road density is very high with 5.6 miles of road per square mile of watershed, and there is over a mile of valley bottom road. **Not Properly Functioning.**

Disturbance History/Regime: Watershed disturbance is high primarily due to the very high density road system and the high density of stream crossings. Many of the streams in the watershed have multiple stream crossings stacked on them.

There has been considerable past stand-replacement forestry but none within the last 25 years on National Forest land. The current effect of past stand-replacement forestry on watershed processes is likely small.

The 2014 Happy Camp Complex Fire burned 502 acres or 8.1% of the watershed at moderate to high severity including 100 acres of stream buffer RR and 36 acres of geologic RRs (some of the hydrologic and geologic RRs are the same acres).

Approximately 9% of the watershed is private property that has residences, roads, and clearings but no other major ground disturbing or industrial grade disturbances are known to occur there.

Modeled surface erosion risk (USLE = 0.75); modeled mass wasting risk (GEO = 0.75); and modeled runoff risk (ERA/TOC = 0.84) are moderately to highly elevated due to roads, past wildfires, and past vegetation management; in that order. **At-Risk**.

Riparian Reserves: There has been past timber harvest/salvage and road building in areas that would now qualify as riparian reserve, although none of this disturbance has been recent (within the last 25 years) and recovery is taking place. There are numerous stream crossings and roads within stream buffers (hydrologic RR). There is high road density and many road segments are constructed on unstable ground (geologic RR).

The 2014 Fire burned 100 acres of stream buffer RRs at moderate to high intensity, which is 7% of the total stream buffer in the HUC14 watershed. This much moderate and high intensity fire in hydrologic RRs, coupled with a high-density road system, is expected to: (1) decrease hydrologic retention time, (2) decrease the sediment filtering and nutrient spiraling function of riparian vegetation thereby compromising the potential of hydrologic RRs to buffer the stream from upslope ground disturbances and landslides, and (3) increase streamside landsliding. The 2014 Fire caused 25% or greater basal area mortality on 36 acres of unstable ground RR as follows: 2 acres of active landslide and 34 acres of inner gorge. [note: most or all of the 36 acres of inner gorge are within hydrologic RR]. This much moderate and high intensity fire on geologic RRs is expected to slightly increase the risk, rate, and adverse cumulative effects of excess sediment delivery, transport, and deposition in stream channels. **At-Risk**.

PROJECT AND SITE #

Westside Fire Recovery, Cougar Creek 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** CougarCk-ElkCk 7th Field watershed			**EFFECTS OF THE ACTION(S)** CougarCk-ElkCk 7th Field watershed		
	PROPERLY FUNCT	AT RISK	NOT ROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature		**TEMP**				
Sediment-Turbidity		**KNF GIS PO**				
Chemical Contamination		**ND/PO/PJ**				
Habitat Access Physical Barrier		**FPI**				
Habitat Elements Substrate Character		**SS2006 SED KNF GIS PO/PJ**				
Large Woody Debris		**SS2006 PO**				
Pool Frequency/Quality		**SS2006 PO**				
Off-channel Habitat	**NA**					
Refugia		**TEMP SS2006 PO**				
Channel Cond & Dyn Width-to-Depth Ratio		**Flood PO**				
Streambank Condition		**Flood PO/PJ**				
Floodplain Condition	**NA**					
Flow /Hydrology Change in Peak/Base Flow		**KNF GIS RSS**				
Drainage Network Increase			**KNF GIS RSS**			
Watershed Cond. Road Density/Location			**KNF GIS RSS**			
Disturbance History/Regime		**KNF GIS Flood RSS PJ**				
Riparian Reserves		**KNF GIS Flood RSS PJ**				

TEMP = Last five years of temperature monitoring at RM 4.5 of mainstem Elk Creek; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory (KNF 2003); **SS06** = 2006 KNF stream survey of mainstem Elk Ck; **Flood** = KNF flood analysis of the 1997 New Years Flood **SED =** 2011 sediment assessment survey (USFS 2014); **RSS** = KNF Road Sediment Source Inventory and Risk Assessment (USFS 2012); **ND** = No Data; **PO** = Personal Observation; **PJ** = Professional Judgment; **NA** = Not Applicable; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline completed by Jon Grunbaum on February 25, 2015.**

The Cougar Creek-Elk Creek 7th-field watershed is a composite watershed with an area of 6,918 acres. Mainstem Elk Creek is a fourth-order stream (Strahler 1957) and the principle stream in the composite watershed. Main tributaries to mainstem Elk Creek in this composite watershed include Cougar, Malone, and Twins Creeks. The (approximate) 4.7 miles of mainstem Elk Creek within the Cougar-Malone watershed provides habitat for winter- and summer-run steelhead, spring- and summer-run Chinook salmon, coho salmon, and rainbow trout. Cougar Creek has 1.3 miles of habitat for resident rainbow and steelhead trout and a few hundred feet of coho habitat. Twins Creek has 0.3 miles of resident rainbow trout habitat. Malone Creek is non fish-bearing. None of the other tributaries to mainstem Elk Creek in this composite watershed are known to support fish populations. The last stream survey of mainstem Elk Creek was summer 2006.

Cougar Creek-Elk Creek 7th-Field (HUC14) Watershed Environmental Baseline Elements:

WATER QUALITY

Water Temperature: There has been no consistent water temperature monitoring within the Cougar Creek-Elk Creek HUC14, however, summer (and some winter) water temperature of mainstem Elk Creek was monitored 0.2 miles downstream of the Cougar Creek-Elk Creek HUC14 every year since 1990 (no data for 1996). The 1997 flood greatly altered the mainstem channel of Elk Creek – resulting in widening and shallowing of the channel, and loss of streamside vegetation. Much of mainstem Elk and several tributaries to mainstem Elk Creek experienced large debris flows that scoured and altered their channels and ripped out riparian vegetation. Excess sediment from numerous natural debris torrents, and from over 200 road failures, resulted in excessive bedload which overwhelmed and altered the channel of mainstem Elk Creek. The loss of riparian vegetation and narrowing/widening of the stream channel increased the range and magnitude of daily heating and cooling – as described in the assessment: *The Flood of 1997- Klamath National* Forest (USDA KNF, November 1998). Riparian and channel recovery was still taking place when the 2014 Fire hit. Before the 1997 Flood: from 1990 to 1995, the 7-day maximum water maximum temperature (MWMT) 18.7 ^{o}C to 21.8 ^{o}C, with six-year average of 20.8^{o}C. After the 1997 Flood: from 1997 to 2004, the MWMT ranged from 20.1 ^{o}C to 23.7 ^{o}C, with eight-year average of 22.9^{o}C. Since then, the 2008 Panther Fire burned riparian vegetation and increased water temperatures in tributary watersheds upstream from the Cougar Creek-Elk Creek HUC14. As shown in the table below, in the last five years of monitoring, the maximum instantaneous water temperature ranged from 20.2^{o}C to 24.8 ^{o}C; the maximum weekly average temperature (MWAT) ranged from 17.5 ^{o}C to 21.1^{o}C; and the MWMT ranged from 19.6 ^{o}C to 23.8^{o}C, with a five-year average of 21.8 ^{o}C. High water temperatures in Klamath River tributaries, including Elk Creek, in summer 2014 was likely the result of record or near record low streamflows. **At-Risk**.

Recent Water Temperature Monitoring Results for Mainstem Elk Creek at RM 4.5							
Start	**End**	**Max Daily Average Temp C**	**Max Daily Max Temp C**	**Min Daily Min Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp (MWMT)**
7/1/2010	10/21/2010	19.7	22	8.3	5.3	19.0	21.4
7/14/2011	10/11/2011	17.8	20.2	5.3	4.9	17.5	19.6
6/22/2012	10/23/2012	19.5	22.0	7.4	5.2	18.8	21.0
6/8/2013	11/3/2013	21.5	24.4	5.9	6.2	20.5	23.0
5/28/2014	9/24/2014	21.8	24.8	10.3	6	21.1	23.8

Sediment - Turbidity: Turbidity was noticeably high during and after peak flows for several years following the 1997 Flood. The 2008 Panther Fire significantly elevated the magnitude and duration of turbidity in mainstem Elk Creek (personal observation). The increase in turbidity from the 2008 Panther Fire was generally subsiding when the 2014 Fire hit. The 2014 Fire again significantly elevated the magnitude and duration of turbidity in mainstem Elk Creek during peak runoff events (personal observation). Chronic turbidity is likely to remain elevated for several more years until vegetation and duff recovers ground cover again. Acute fire-related turbidity in mainstem Elk Creek is expected to be elevated for up to ten years or longer because the rate of mass wasting/debris flows is expected to increase in the Cougar Creek-Elk Creek HUC14 for this period of time as well as in many of the HUC14s that drain into the Cougar Creek-Elk Creek HUC14. Modeled surface erosion is moderately elevated (USLE = 0.50); modeled wasting is moderately elevated (GEO = 0.64); and modeled runoff risk is slightly elevated (ERA/TOC = 0.39). **At-Risk.**

Chemical Contamination: No significant source of chemical contamination is known to exist on National Forest lands. An auto wrecking yard on private property is *suspected* of minimally contaminating surface and ground water with petroleum products and other automotive pollutants but tests have not been conducted. **At-Risk.**

HABITAT ACCESS

Physical Barriers: Two road related barriers to fish passage are known to exist from the KNF 2003 Fish Passage Inventory (sites #180 and #183). These two barriers likely exclude steelhead from a few tenths of a mile of suitable habitat in Twins and Malone Creeks, however, there is little to no suitable salmon habitat in these streams. **At-Risk**.

HABITAT ELEMENTS

Substrate Character: Substrate character was determined from a 2006 stream survey, 2011 intensive sediment monitoring and evaluation in the mainstem 0.2 miles downstream of the HUC14 boundary, existing watershed disturbance levels as described under the *Disturbance History/Regime Indicator* below; and personal observation. During the 2006 stream survey: (1) surface fines in pebble counts averaged 6.9%; (2) surface fines in pool tail-outs averaged 8.1%, and (3) embeddedness averaged 26.4%. The values of surface fines were within desired range for properly functioning streams but embeddedness slightly exceeded desired range.

The results of 2011 intensive monitoring and evaluation of sediment in mainstem Elk Creek that included the metrics: percent surface fines < 2mm, percent sub-surface sediment < 0.85mm, percent sub-surface sedient < 6.38mm, and percent residual pool volume filled with fine

sediment (V*), is shown in the table below. Substrate quality impairment was evaluated in mainstem Elk Creek by comparing the four sediment indicators in Elk Creek (a managed watershed) to the 85th percentile value of four indicators for reference streams that have negligible management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams are considered impaired. In the 2011 sediment monitoring, two of the four sediment indices (surface fines < 2mm and subsurface fines < 0.85mm) in Elk Creek were determined to very slightly exceed reference watershed values as shown in the table below.

Average surface fines, average sub-surface fines, and average volume of fine sediment filling pools (V*) from the 2011 Elk Creek response reach (elk2) compared to KNF Stream Sediment Monitoring reference conditions (@85 percentile). Elk2 metrics over threshold values are bolded.

Sediment Index	Elk2 reach average (%)	Reference Condition (%)
Surface Fines < 2mm	**6.7**	6.4
Sub-surface fines < 0.85mm	**18.9**	16.2
Sub-surface fines < 6.38mm	36.6	46.1
Fraction of pools filled with fine sediment < 2mm (V star)	0.05	0.11

The area of streambed covered by sand and the volume of sandbars in mainsten Elk Creek has been noticeably increasing since the 2008 Panther Fire and rapidly increasing after the 2014 Happy Camp Complex Fire (personal observation from frequent fish/stream surveys and/or kayak trips down mainstem Elk Creek over the last 20 years – made by myself and FS River Ranger David Payne). Fines are increasing in volume and decreasing residual pool volume. Fines are infiltrating or covering spawning areas. Surface erosion and chronic sedimentation into streams is likely to be elevated for several years until vegetation and duff recovers ground cover in areas that burned at moderate-to-high intensity. The rate of mass wasting and debris flows is expected to increase for up to ten years or longer until ground cover increases and the roots of recovering vegetation regain the capacity to bind soil in areas that burned at moderate-to-high intensity. Modeled surface erosion is moderately elevated (USLE = 0.50); modeled wasting is moderately elevated (GEO = 0.64); and modeled runoff risk is slightly elevated (ERA/TOC = 0.39). **At-Risk.**

Large Woody Debris: During the 2006 stream survey of mainstem Elk Creek within the Cougar Creek-Elk Creek HUC14 composite watershed (total of 4.9 miles surveyed) there was only one piece of Key LWD, several logs jams composed of woody debris smaller than Key LWD, a fish habitat enhancement structure composed of LWD smaller than Key LWD, and five logs that were cut up that may have qualified to be Key LWD before being cut. A total of 135 standing trees large enough to qualify as LWD were counted during the stream survey, which is an average of 27.5 per mile. There has been little management on National Forest land on the North side of mainstem Elk Creek in this composite watershed that would reduce LWD or potential recruitment of LWD, however, LWD and potential future LWD recruitment is reduced within the stream buffer on several private parcels on the north banks of Elk Creek. LWD delivery, and development of future potential LWD recruits on the south side of mainstem Elk Creek is diminished due to the Elk Creek County/Forest Service road which is constructed in the inner gorge or on lower slopes within the RR stream buffer of Elk Creek, and several other creek access roads/mining camps in the stream buffer RR. The County/Forest Service road intercepts logs that may otherwise be delivered to mainstem Elk Creek and reduces potential for growth of

trees that could become LWD in the future. Creek accesses provide public access to standing and down trees in the stream buffer RR of mainstem Elk Creek.

Based on: (1) the lack of sufficient LWD within the stream channel of mainstem Elk Creek, and (2) the poor to fair number of potential recruit trees observed in the stream buffer RRs of mainstem Elk Creek - it is my professional opinion that the LWD indicator is **At-Risk**.

Pool Frequency/Quality: Many pools in mainstem Elk Creek were filled in with excessive sediment during the 1997 flood event. The flood filled in half the pools so that they were no longer classified as pools in the 1997 stream survey versus the 1989 stream survey. The remaining half of pools that existed prior to the 1997 flood were greatly reduced in depth. Pool frequency in the 1998 stream survey of mainstem Elk Creek was one pool every 9.4 bankfull channel widths. Deep pool (three feet deep or greater) frequency in the 1998 stream survey of mainstem Elk Creek was one deep pool every 24 bankfull channel widths. Streamflows since the 1997 Flood have moved much of the excessive sediment out of the system and excavated pools but recovery is likely incomplete. In the 2006 stream survey, there were 49 pools with an average depth of 5.6 feet, and 47 of the pools were deep pools (greater than 3 feet deep). In the 2006 stream survey there was one deep pool every nine bankfull channel widths. In my professional opinion, pool frequency/quality is still not quite fully recovered fully. The area of streambed covered by sand and the volume of sandbars in mainstem Elk Creek has been noticeably increasing since the 2008 Panther Fire and rapidly increasing after the 2014 Happy Camp Complex Fire (personal observation from frequent fish/stream surveys and/or kayak trips down mainstem Elk Creek over the last 20 years – made by myself and FS River Ranger David Payne). Fines are increasing in volume and decreasing residual pool volume. **At-Risk**.

Off-Channel Habitat: Generally NA to the Rosgen C-, G-, and F-Channel types in mainstem Elk Creek between the confluences of East Fork Elk Creek and Doolittle Creek. However, there is one large braid with pools that can serve as critical high-water refugia for juvenile coho salmon – the braid is on Private land but has not been modified in a way that degrades its' value as winter refugia. **NA**.

Refugia: Cold water and cover are the primary elements of fish refugia in this watershed. Water temperature is still slightly high due to channel-widening and loss of vegetation during the 1997 Flood, and from loss of stream-shading vegetation in the 2008 Panther Fire and 2014 Happy Camp Complex fire. LWD is below desired condition in mainstem Elk Creek due to past and current human disturbance in the stream buffer (roads; private property). There are frequent deep pools that provide good cover. **At-Risk**.

CHANNEL CONDITION AND DYNAMICS

Width to Depth Ratio: Depositional reaches were scoured and/or overwhelmed with sediment from the 1997 Flood. Pools were lost or partially filled with sediment. The stream channel was widened and/or shallowed in many locations, and/or entrenched under a deep lens of sediment after the flood resided. Mainstem Elk Creek has been getting deeper and narrower since the 1997 Flood but channel recovery (channel deepening and narrowing) is still incomplete. Constrained reaches are largely recovered. Recovery of the few unconstrained reaches is progressing well but alder trees are still small and have limited ability to stabilize the streambanks. Excess fine sediment is being delivered to mainstem Elk Creek as a result of the 2008 and 2014 wildfires. Sandbars are beginning to diminish residual pool volume which is slightly increasing the channel width-to-depth ratio. **At-Risk**.

Stream Bank Condition: Much of the streambanks of mainstem Elk Creek were scoured and eroded during the 1997 Flood event, however, many reaches are constrained transport reaches with bedrock banks that showed little to no disturbance from the flood. Recovery of the few unconstrained reaches is progressing well but alder trees are still small and have limited ability to stabilize the streambanks. **At-Risk**.

Floodplain Connectivity: Generally NA to the Rosgen C-, G-, and F-Channel types in mainstem Elk Creek between the confluences of East Fork Elk Creek and Doolittle Creek. However, there is one "floodplain" with a large high-water braid with pools that can serve as critical high-water refugia for juvenile coho salmon – the floodplain is on Private land but has not been modified in a way that degrades its' value as winter refugia. **NA.**

FLOW/HYDROLOGY

Change in Peak/Base flow: Road density is high at 4.1 miles of road per square mile of watershed and 33% of the road system is hydrologically connected to the stream network. Modeled runoff risk is slightly elevated (ERA/TOC = 0.39) due to past timber harvest/salvage and road building. **At-Risk**.

Increase in Drainage Network: Road density is high at 4.1 miles of road per square mile of watershed and 33% of the road system is hydrologically connected to the stream network. **Not Properly Functioning**.

WATERSHED CONDITION

Road Density/Location: Road density is high at 4.1 miles of road per square mile of watershed. There are many miles of valley bottom road adjacent to mainstem Elk Creek and Cougar Creek – several miles are within inner gorge. **Not Properly Functioning**.

Disturbance History/Regime: The entire length of the stream channel of mainstem Elk Creek was altered by debris flows from road failures and/or natural landslides during the 1997 Flood, and is still recovering. Several roads have been decommissioned or storm proofed since the 1997 Flood but the (non-decommissioned) road density is still high at 4.1 miles per square mile and 33% of the road system is still hydrologically connected to the stream network. There are many miles of road within the stream buffer including several miles of inner gorge road. Roads are likely increasing peak flows, elevating sediment delivery to stream channels, and diminishing the potential for LWD to be left in channels and the potential for new LWD to grow and be recruited into channels.

The 1987 Fire burned the SE quarter of the watershed. The 2007 Titus-Wingate Fire caused minor disturbance when 83 acres burned including two acres that burned at moderate intensity within stream buffer RRs. The 2014 Happy Camp Complex fire burned 100 acres of stream buffer RR at moderate-to-high severity which is about 6% of the hydrologic RRs in the HUC14. The 2014 Happy Camp Complex fire burned 56 acres of geologic RR at moderate-to-high intensity which is about 9% of the geologic RRs in the HUC14 – 55 acres of that was in inner gorge (which is both hydrologic and geologic RR). From a watershed perspective, the 2014 Fire in the Cougar Creek-Elk Creek HUC14 was generally a beneficial disturbance since it cleaned up excess dead and live fuels, did some natural thinning, and had minimal torching into the crowns of large live trees. However, this disturbance is likely to elevate peak flows and increase sediment delivery in the short-term. **At-Risk**.

Riparian Reserves: The 1997 flood greatly altered the mainstem channel of Elk Creek, and some of the tributaries to the mainstem – resulting in widening and shallowing of the channel, and loss of streamside vegetation. Excess sediment from numerous natural debris torrents, and from over 200 road failures, resulted in excessive bedload which overwhelmed and altered the channel of mainstem Elk Creek and removed or buried riparian vegetation. Recovery is taking place as riparian vegetation grows back and the channel deepens and narrows, but recovery is incomplete. The 2014 Happy Camp Complex fire burned 56 acres of geologic RR at moderate-to-high intensity which is about 9% of the geologic RRs in the HUC14 – 55 acres of that was in inner gorge (which is both hydrologic and geologic RR). There are many miles of road within the stream buffer including several miles of inner gorge road. **At-Risk**.

PROJECT AND SITE #

Westside Fire Recovery, Horse Creek 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Horse Creek 7th Field Watershed			**EFFECTS OF THE ACTION(S)** Horse Creek 7th Field Watershed		
	PROPERLY FUNCT	AT RISK	NOT PROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	**TEMP**					
Sediment - Turbidity		**KNF GIS RSS ND/PO/PJ**				
Chemical Contamination	**PJ/ND**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character		**KNF GIS RSS ND/PO/PJ**				
Large Woody Debris	**ND/PO/PJ**					
Pool Frequency/Quality		**ND/PJ Flood**				
Off-channel Habitat	**NA**					
Refugia	**TEMP**	**PO/PJ**				
Channel Cond & Dyn Width-to-Depth Ratio		**ND/PJ Flood**				
Streambank Condition		**KNF GIS**				
Floodplain Condition	**NA**					
Flow /Hydrology Change in Peak/Base Flow		**KNF GIS RSS PO/PJ**				
Drainage Network Increase		**KNF GIS RSS**				
Watershed Cond. Road Density/Location			**KNF GIS**			
Disturbance History/Regime		**KNF GIS Flood RSS**				
Riparian Reserves		**KNF GIS RSS**				

TEMP = 2004 Karuk DNR Horse Creek water temperature monitoring in KNF database; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory; **ND** = No Data; **PJ** = Professional Judgment; **PO** = Personal observation based on 20+ years observing; **NA** = Not Applicable; **Flood** = 1997 Flood Assessment (KNF 1998); **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **RSS =** KNF Road Sediment Source Inventory and Risk Assessment (USDA 2012); **Environmental Baseline and Checklist last updated by Jon Grunbaum on March 4, 2015.**

The (Little) Horse Creek 7th field watershed (HUC14) is a true watershed of 2,537 acres. Approximately 2% of the watershed is private property and the rest in National Forest. Horse Creek is a 3rd-order stream (Strahler 1957) and the primary stream in the watershed. Horse Creek is known to provide about 1.4 miles of habitat for resident rainbow trout, a few tenths of a mile of habitat for Coho salmon and winter steelhead trout. (Little) Horse Creek is not known to support Chinook salmon or summer-run steelhead. There are several zero and 1st-order tributaries to mainstem Horse Creek but none are named and none are fish-bearing. There are no

recent surveys of (Little) Horse Creek other than presence/absence surveys to determine fish distribution.

(Little) Horse Creek 7th-Field watershed Environmental Baseline Elements:

Water Quality

Water temperature: Water temperature in lower Horse Creek stayed below 66°F from July 10 through to the end of September, 2004 (Karuk Tribe Temperature monitoring record in KNF temperature database). **Properly Functioning**.

Sediment-Turbidity: No Data. Turbidity likely slightly elevated due to high road density and moderate to high watershed disturbance. The 2014 Happy Camp Complex that burned 15% of the stream buffer RR s in the watershed and 45 acres within inner gorge will increase the duration and magnitude of turbidity associated with peak flows for the short term until vegetation and ground cover recover. **At-Risk.**

Chemical Contamination: No significant source of chemical contamination is known to exist. **Properly Functioning.**

Habitat Access

Physical Barriers: The are no barriers to fish passage in the Horse Creek watershed. P**properly Functioning.**

Habitat Elements

Substrate Character: No data. Rate of sediment delivery and fines in substrate likely elevated due to high road density and moderate to high levels of watershed disturbance (USLE = 0.86; GEO = 0.76). The 2014 Happy Camp Complex that burned 15% of the stream buffer RR s in the watershed and 45 acres within inner gorge will increase sediment delivery rate for the short term until vegetation and ground cover recover. **At-Risk**.

Large Woody Debris: The in-channel quantity of LWD and the number of large conifers that could recruit into a stream channel is likely near site potential in and adjacent to most channels because there is not much access to the stream buffer (i.e. there is not much private property or valley bottom road, there is a low density of stream crossings, and not much stand-replacement forestry has occurred adjacent to perennial streams). **Properly Functioning**.

Pool Frequency and Quality: Much of the mainstem of Horse Creek was altered during the 1997 Flood and pools were likely lost or diminished due to aggradation and/or channel scour. Recovery from the flood (the scouring of sediment out of pools in this instance) is likely occurring. **At-Risk**.

Off-channel Habitat: Not applicable in the Horse Creek watershed where channels are Rosgen A-, and B-channel types that are too constrained and entrenched to have floodplains that allow off-channel habitat development. There is no off-channel habitat. **NA**.

Refugia: Coho salmon and other salmonids use the lower few tenths of a mile of Horse Creek for summer thermal refugia nearly every year. Cold clear water and cover are the primary element of refugia. Water temperature is believed to be suitable to optimum for Coho salmon and other salmonids but cover is lacking. Each summer, the local watershed council ensures

passage into the creek from the Klamath River and installs branch bundles for fish cover. **At-Risk**.

Channel Conditions and Dynamics

Width-to-Depth Ratio: No data. The Rosgen A- and B-channel types of the Fort Goff watershed are generally not susceptible to channel type change unless a major debris flow has scours and/or aggrades the channel. Much of the stream channel of (Little) Horse Creek was altered during the 1997 Flood. Recovery of the altered channel is probably proceeding slowly because sediment delivery rate is still elevated above threshold (GEO = 1.01). **At-Risk**.

Streambank Condition: Much of the mainstem of Horse Creek was altered during the 1997 Flood and pools were likely lost or diminished due to aggradation and/or channel scour. Recovery from the flood (the scouring of sediment out of pools in this instance) is likely occurring. **At-Risk**.

Floodplain Connectivity: Not applicable in the Horse Creek watershed where channels are Rosgen A-, and B-channel types that are too constrained and entrenched to have floodplains. There are no floodplains. **NA**

Flow/Hydrology

Change in Peak/Base Flow: Peak flows may be slightly increased because road density is high and 12% of the road system is hydrologically connected to the stream network. Road-related increase in peak flow will continue until the road system is disconnected from the stream network through storm proofing and/or decommissioning. In addition, peak flows may be increased in the short term due to decreased hydrologic retention capacity on the 22% of the watershed that burned at moderate to high severity. Increase in peak flows related to the 2014 Fire will diminish as vegetation and ground cover recovers. Modeled runoff risk is moderately high (ERA/TOC = 0.70). The residences at the mouth of Horse Creek have domestic water rights that reduce base flow. **At-Risk.**

Drainage Net Increase: The drainage density is slightly increased due to high road density coupled with 12% hydrologic connectivity between the road system and the stream network. **At-Risk**.

Watershed Conditions

Road Density/Location: Road density is high at 4.8 miles of road per square mile of watershed and 12% of the road system is hydrologically connected to the stream network. There is about a half-mile of valley bottom road within the watershed. **Not Properly Functioning**.

Disturbance History/Regime: There is moderate to high disturbance from the high density road system. There has been no recent (last 25 years) stand-replacement forestry so there is very little disturbance of watershed processes still present from past vegetation management projects. The 2014 Happy Camp Complex Fire burned 567 acres (22% of the HUC14) at moderate to high intensity and the rest not burned or low intensity. This mix of unburned, low intensity burn, and moderate to high intensity burn is likely not too far outside the range of historical natural variability for wildfires in the western Klamath Mountains. Past fire suppression and stand-replacement forestry over the last 80 years or so may have contributed to higher percentage of moderate to high severity burn than would have occurred if fires had not been suppressed since the early 1900s, and stand-replacement forestry had not occurred.

There are two residences and a residential lot adjacent to the lower .3 mile of mainstem Horse Creek which have minor localized impact on the riparian zone and channel.

Modeled surface erosion risk (USLE = 0.86) is moderately high; modeled mass wasting risk (GEO = 0.76) is moderately high; and modeled runoff risk (ERA/TOC = 0.70) is moderately high primarily due to high road density with the 2014 Fire a distant second source of disturbance. Disturbance from past vegetation management is negligible (at least in the CWE models). **At-Risk**.

Riparian Reserves: Although road density is high the density of stream crossings and roads within stream buffer RRs is relatively low. The stream buffer is modified at the mouth of Horse Creek due to the County Road and clearings, compacted areas, and structures on three private parcels, however, streambanks and a narrow buffer are largely undisturbed. The 2014 Happy Camp Complex burned 15% of the stream buffer in the HUC14 at moderate to high severity; and burned at moderate to high severity on 2 acres of active landslide and on 45 acres of inner gorge (which is 12% of the geologic RRs in the watershed). **At-Risk**.

PROJECT AND SITE #

Westside Fire Recovery, Hoop & Devil 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Hoop & Devil 7th Field watershed			**EFFECTS OF THE ACTION(S)** Hoop & Devil 7th Field watershed		
	PROPERLY FUNCT	AT RISK	NOT ROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature		**TEMP**				
Sediment-Turbidity		**PO KNF CWE**				
Chemical Contamination	**ND/PO/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate		**SED KNF CWE PO**				
LWD		**SS06 PO**				
Pool Frequency/Quality	**SS06 PO**					
Off-channel Habitat	**NA**					
Refugia		**TEMP SS06 PO PJ**				
Channel Cond & Dyn W/D Ratio		**SS06 Flood PO PJ**				
Streambank Condition		**Flood PO PJ**				
Floodplain Condition	**NA**					
Flow /Hydrology Peak/Base Flow		**KNF GIS RSS**				
Drainage Network Increase		**KNF GIS RSS**				
Watershed Cond. Road Density/Location			**KNF GIS RSS**			
Disturbance History/Regime		**KNF GIS Flood RSS**				
Riparian Reserves		**KNF GIS Flood PO PJ**				

TEMP = Water temperature monitoring at RM 4.5 of mainstem Elk Creek from 1990 to 2014; **SS06** = 2006 KNF stream survey of mainstem Elk Creek from mouth to EF Elk Confluence (3.8 miles); **RSS =** 1999 KNF Road Sediment Source Inventory and Risk Assessment; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory; Flood = KNF analysis of the 1997 New Years Flood; ND = No Data; PJ = Professional Judgment; **PO** = Personal Observation based on 20+ years observing; NA = Not Applicable; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline and Checklist completed by Jon Grunbaum on February 9, 2015.**

The Hoop and Devil 7th-field watershed is a composite watershed with an area of 3,070 acres. The Hoop&Devil composite watershed is 92% National Forest land, and 8% private land. The private land is mostly residential with low ground disturbance, however, one upslope large parcel has a several-acre auto wrecking yard complete with hundreds of old cars and noxious weeds; one streamside several acre parcel is the intake facility and water treatment plant for the town of Happy Camp; and one large (10-20 acres) streamside parcel is a commercial campground. Mainstem Elk Creek is a fourth-order stream (Strahler 1957) and the principle stream in the composite watershed. The channel and riparian vegetation along the lower 0.7 mile of Elk Creek mainstem is moderately impacted by the water treatment plant, the campground, private residences, roads and a bridge, and an off-road ATV play area at the mouth. The (approximate) 4.3 miles of mainstem Elk Creek within the Hoop&Devil watershed provide habitat for winter- and summer-run steelhead, spring- and summer-run Chinook salmon, and winter coho salmon. There is one 2nd-order tributary, several 1st-order tributaries, and several intermittent and ephemeral tributaries to mainstem Elk Creek within the Hoop&Devil composite watershed but none are named and none are fish-bearing. The last stream survey of mainstem Elk Creek was summer 2006. Channel sediment metrics were assessed in 2009 and 2013 but those metrics are no longer valid for describing current condition because excess sediment has already been delivered to the channel as a result of the 2014 Fire. Channel sediment metrics in mainstem Elk Creek were assessed in 2011.

Hoop & Devil 7th-Field Watershed Environmental Baseline Elements:

WATER QUALITY

Water Temperature: Summer (and some winter) water temperature of mainstem Elk Creek was monitored within the Hoop&Devil 7th-field watershed at approximately RM 4.5 nearly every year since 1990 (no data for 1996). The 1997 flood greatly altered the mainstem channel of Elk Creek – resulting in widening and shallowing of the channel, and loss of streamside vegetation. Much of mainstem Elk and several tributaries to mainstem Elk Creek experienced large debris flows that scoured and altered their channels and ripped out riparian vegetation. Excess sediment from numerous natural debris torrents, and from over 200 road failures, resulted in excessive bedload which overwhelmed and altered the channel of mainstem Elk Creek. The loss of riparian vegetation and narrowing/widening of the stream channel increased the range and magnitude of daily heating and cooling – as described in the assessment: *The Flood of 1997-Klamath National* Forest (USDA KNF, November 1998). Riparian and channel recovery was still taking place when the 2014 Fire hit. Before the 1997 Flood: from 1990 to 1995, the 7-day maximum water maximum temperature (MWMT) 18.7 ^{o}C to 21.8 ^{o}C, with six-year average of 20.8^{o}C. After the 1997 Flood: from 1997 to 2004, the MWMT ranged from 20.1 ^{o}C to 23.7 ^{o}C, with eight-year average of 22.9^{o}C. Since then, the 2008 Panther Fire burned riparian vegetation and increased water temperatures in tributary watersheds upstream from the Hoop-n-Devil watershed. High water temperatures in Klamath River tributaries including Elk Creek in summer 2014 was likely the result of record or near record low streamflows. As shown in the table below, in the last five years of monitoring, the maximum instantaneous water temperature ranged from 20.2^{o}C to 24.8 ^{o}C; the maximum weekly average temperature (MWAT) ranged from 17.5 ^{o}C to 21.1^{o}C; and the MWMT ranged from 19.6 ^{o}C to 23.8^{o}C, with a five-year average of 21.8 ^{o}C. **At-Risk**.

Recent Water Temperature Monitoring Results for Mainstem Elk Creek at RM 4.5							
Start	**End**	**Max Daily Average Temp C**	**Max Daily Max Temp C**	**Min Daily Min Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp (MWMT)**
7/1/2010	10/21/2010	19.7	22	8.3	5.3	19.0	21.4
7/14/2011	10/11/2011	17.8	20.2	5.3	4.9	17.5	19.6
6/22/2012	10/23/2012	19.5	22.0	7.4	5.2	18.8	21.0
6/8/2013	11/3/2013	21.5	24.4	5.9	6.2	20.5	23.0
5/28/2014	9/24/2014	21.8	24.8	10.3	6	21.1	23.8

Turbidity: The 2008 Panther Fire significantly elevated the magnitude and duration of turbidity in mainstem Elk Creek (personal observation). This increase in turbidity was generally subsiding when the 2014 Fire hit. The 2014 Fire again significantly elevated the magnitude and duration of turbidity in mainstem Elk Creek during peak runoff events (personal observation). Chronic turbidity is likely to remain elevated for several more years until vegetation and duff recovers ground cover again. Acute fire-related turbidity in mainstem Elk Creek is expected to be elevated for up to ten years or longer because mass wasting/debris flows are expected to significantly increase in the Hoop'n'Devil HUC14 watershed for this period of time as well as in many of the HUC14 watersheds upstream of the Hoop'n'Devil HUC14. Modeled surface erosion is moderately elevated (USLE = 0.63) in the Hoop'n'Devil HUC14 and moderately to highly elevated in the three East Fork Elk Creek HUC14s that drain into the Hoop'n'Devil HUC14. Modeled wasting is moderately elevated (GEO = 0.60) in the Hoop'n'Devil HUC14 and moderate to way-over threshold in most of the HUC14s that drain into the Hoop'n'Devil HUC14. **At-Risk**.

Chemical Contamination: No significant source of chemical contamination is known to exist other than an auto wrecking yard on private property (which is not known to be point source of water contamination). **Properly Functioning**.

HABITAT ACCESS

Physical Barriers: No barriers to fish passage were found in the KNF Fish Passage Inventory (KNF 2003). **Properly Functioning**.

HABITAT ELEMENTS

Substrate Character: Substrate character was determined from a 2006 stream survey, 2011 intensive sediment monitoring and evaluation, existing watershed disturbance levels as described under the *Disturbance History/Regime Indicator* below; and personal observation. During the 2006 stream survey: (1) surface fines in pebble counts averaged 6.9%; (2) surface fines in pool tail-outs averaged 8.1%, and (3) embeddedness averaged 26.4%. The values of surface fines were within desired range for properly functioning streams but embeddedness slightly exceeded desired range.

The results of 2011 intensive monitoring and evaluation of sediment in mainstem Elk Creek that included the metrics: V*, percent surface fines < 2mm, percent sub-surface sediment < 0.6.35mm, and percent sub-surface sedient < 0.85mm. Substrate quality impairment was

evaluated in mainstem Elk Creek by comparing the four sediment indicators in Elk Creek (a managed watershed) to the 85th percentile value of four indicators for reference streams that have negligible management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams are considered impaired. In the 2011 sediment monitoring, two of the four sediment indices (surface fines < 2mm and subsurface fines < 0.85mm) in Elk Creek were determined to very slightly exceed reference watershed values as shown in he table below.

Average surface, sub-surface and volume of fine sediment filling pools (v-star) from the 2011 Elk Creek response reach (elk2) compared to KNF Stream Sediment Monitoring reference conditions (@85 percentile). Elk2 metrics over threshold values are bolded.

Sediment Index	Elk2 reach average (%)	Reference Condition (%)	Reference Condition ratio
Surface Fines < 2mm	**6.7**	**6.4**	**1.05**
Sub-surface fines < 0.85mm	**18.9**	**16.2**	**1.17**
Sub-surface fines < 6.38mm	36.6	46.1	0.79
Fraction of pools filled with fine sediment < 2mm (V star)	0.05	0.11	0.45

The area of streambed covered by sand, and the size of sandbars, in mainsten Elk Creek has been noticeably increasing since the 2008 Panther Fire and more recently the 2014 Happy Camp Complex (personal observation from frequent fish/stream surveys and kayak trips down mainstem Elk Creek over the last 20 years). Surface erosion and chronic sedimentation into streams is likely to be elevated for several years until vegetation and duff recovers ground cover in areas that burned at moderate-to-high intensity. The rate of mass wasting and debris flows is expected to increase for up to ten years or longer until ground cover increases and the roots of recovering vegetation regain the capacity to bind soil in areas that burned at moderate-to-high intensity. Modeled surface erosion is moderately elevated (USLE = 0.63) in the Hoop'n'Devil HUC14 and moderately to highly elevated in the three East Fork Elk Creek HUC14s that drain into the Hoop'n'Devil HUC14. Modeled wasting is moderately elevated (GEO = 0.60) in the Hoop'n'Devil HUC14 and moderately to way-over threshold in most of the HUC14s that drain into the Hoop'n'Devil HUC14. **At-Risk.**

Large Woody Debris: During the 2006 stream survey of mainstem Elk Creek within the Hoop&Devil composite watershed there were only four pieces of LWD in 3.8 miles of mainstem that was surveyed. However, the potential for future LWD recruitment is near site potential between RM 0.7 and RM 3; and many large trees along this reach did fall into mainstem Elk Creek during heavy snowfall in winter 2012-13. The potential for future LWD recruitment and for recruited LWD to be left in the stream is greatly diminished along the lower 0.7 mile of Elk Creek mainstem due to the existence of the Happy Camp community water treatment plant, a campground, private residences, roads and a bridge, and an off-road ATV play area in the stream buffer. The potential for future LWD recruitment and for recruited LWD to be left in the stream is greatly diminished from RM 3.8 to RM 4.3 of Elk Creek mainstem due to private residences, roads, and a bridge in the stream buffer. The potential for future LWD recruitment and for recruited LWD to be left in the stream buffers of tributaries to mainstem Elk Creek is moderate to high because most tributary watersheds have low disturbance in the stream buffers. **At-Risk**.

Pool Frequency/Quality: In the 2006 stream survey of mainstem Elk Creek there was one deep (over three feet maximum depth) pool every 5.6 bankfull widths with an average maximum depth of 6.6 feet. Maximum pool depth ranged from 3.5 to 13.9 feet. Excessive fines that are being delivered to mainstem Elk Creek as a result of the 2008 Panther Fire and 2014 Happy

Camp Complex fire has increased the size of sandbars in pools but has only slightly decreased residual pool depth and volume (as of last personal observation made in middle of January 2015). **Properly Functioning**.

Off-Channel Habitat: Generally NA to the Rosgen C-, G-, and F-Channel types in mainstem Elk Creek. Off-channel habitats are not characteristic of these channel types. **NA**

Refugia: Cold water and cover are the primary elements of fish refugia in this watershed. Water temperature is still slightly high due to channel-widening and loss of vegetation during the 1997 Flood, and from loss of stream-shading vegetation in the 2008 Panther Fire and 2014 Happy Camp Complex fire. LWD is below desired condition in the top 0.6 mile and lower 0.7 mile of mainstem Elk Creek due to past and current human disturbance in the stream buffer (roads; private property). There are frequent deep pools that provide good cover. **At-Risk**.

CHANNEL CONDITION AND DYNAMICS

Width to Depth Ratio: Mainstem Elk Creek was scoured and/or overwhelmed with excess sediment delivered to the channel from the 1997 Flood. Pools were completely or partially filled with sediment. Constrained gorge reaches of mainstem Elk Creek were least altered by the flood and first to be able to transport out the excessive sediment. Most of the channel of mainstem Elk Creek within the Hoop&Devil composite watershed is tightly constrained gorge and excessive sediment from the 1997 Flood has largely been transported out based on based on the 2006 pool frequency/quality data and personal observation. Recovery of the few unconstrained reaches is progressing well but alder trees are still small and have limited ability to stabilize the streambanks. **At-Risk**.

Stream Bank Condition: Much of the streambank of mainstem Elk Creek was scoured and eroded during the 1997 Flood event, however, most of the reaches are constrained sediment transport reaches with bedrock banks that sustained little to no disturbance from the flood. Streamside vegetation was largely ripped out and the streambanks were altered in the few unconstrained reaches. Recovery of vegetation and streambanks in unconstrained reaches is well underway and most streamside alder trees are still small having only sprouted or germinated in 1998 and have limited ability to stabilize the streambank. **At-Risk**.

Floodplain Connectivity: Generally NA to the Rosgen C-, G-, and F-Channel types in mainstem Elk Creek. Floodplains are not characteristic of these channel types. **NA**.

FLOW/HYDROLOGY

Change in Peak/Base flow: Modeled runoff risk is slightly elevated (ERA/TOC = 0.39) primarily due to roads, past wildfires, vegetation management, and fire lines (in that order). Road density is high but only 10% of the road system is hydrologically-connected to the stream network. The fire lines are mostly not hydrologically-connected. Increased peak flows due to all these factors combined is likely minor. Base flows are reduced in summer due to riparian water rights and municipal water diversion from mainstem Elk Creek. Municipal demand can divert as much as 1.5 million gallons of water per day – this water is diverted at about RM 0.6. **At-Risk**.

Increase in Drainage Network: Road density is high but only about 10% of the road system is hydrologically-connected to the stream network. **Properly Functioning**.

WATERSHED CONDITION

Road Density/Location: Road density is high at 3.4 miles of road per square mile of watershed. There are several hundred meters of valley bottom road. There is over a mile of (County) road constructed within the inner gorge of lower mainstem Elk Creek but this road is paved, full-bench in bedrock and has not had few stability problems over at least the last 20 years. **Not Properly Functioning**.

Disturbance History/Regime: Watershed disturbance in the Hoop&Devil composite watershed is moderately high, primarily from high road density but also from the 1987 Fire (which burned the SE quarter of the watershed) and the 2014 Happy Camp Complex fire and from past harvest/salvage: modeled surface erosion risk is moderately high (USLE = 0.63), modeled mass wasting risk is moderately elevated (GEO = 0.60, and modeled runoff risk is slightly elevated (ERA/TOC = 0.39). The entire length of the stream channel of mainstem Elk Creek was altered by debris flows from road failures and/or natural landslides during the 1997 Flood, and is still recovering. The 1997 Flood triggered hundreds of road failures in the Elk Creek watershed that caused many debris flows and intensified mainstem channel alteration from natural debris flows that were occurring. There was only one major road damage site within the Hoop&Devil composite watershed resulting the 1997 Flood. The 2014 Happy Camp Complex fire burned 653 acres of stream buffer RR but only 27 acres burned at moderate-to-high severity. The 2014 Happy Camp Complex fire burned only 13 acres of geologic RR at moderate-to-high intensity. From a watershed perspective, the 2014 Fire in the Hoop&Devil HUC14 was generally a beneficial disturbance since it cleaned up excess dead and live fuels, did some natural thinning, and had minimal torching into the crowns of large live trees. **At-Risk**.

Riparian Reserve: The stream buffer RR of mainstem Elk Creek is largely intact between RM 0.7 and RM 3.8 because there are no roads or development along this section of mainstem. The stream buffer of mainstem Elk Creek is significantly impacted along the lower 0.7 mile of Elk Creek mainstem due to the existence of the Happy Camp community water treatment plant, a campground, private residences, roads and a bridge, and an off-road ATV play area in the stream buffer. The stream buffer of mainstem Elk Creek is slightly impacted from RM 3.8 to RM 4.3 due to private residences, roads, and a bridge in the stream buffer. Upslope road density is high but the density of stream crossings is moderate. The 2014 Happy Camp Complex fire burned 653 acres of stream buffer RR but only 27 acres burned at moderate-to-high severity. The 2014 Happy Camp Complex fire burned only 13 acres of geologic RR at moderate-to-high intensity. **At-Risk**.

PROJECT AND SITE #

Westside Fire Recovery, Lower East Fork Elk Creek 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** LowerEastForkElkCreek HUC14			**EFFECTS OF THE ACTION(S)** LowerEastForkElkCreek HUC14		
	PROPERLY FUNCT	AT RISK	NOT ROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature		**TEMP**				
Sediment-Turbidity		**SED KNF GIS PJ**				
Chemical Contamination	**ND/PO/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character		**SED KNF CWE PJ**				
Large Woody Debris		**SS90 PO PJ**				
Pool Frequency/Quality	**SS90 PO**					
Off-channel Habitat	**NA**					
Refugia		**TEMP SS90 PO PJ**				
Channel Cond & Dyn Width-to-Depth Ratio		**SS90 PO PJ**				
Streambank Condition		**PO PJ**				
Floodplain Condition	**NA**					
Flow /Hydrology Change in Peak/Base Flow		**KNF GIS RSS**				
Drainage Network Increase		**KNF GIS RSS**				
Watershed Cond. Road Density/Location			**KNF GIS RSS PO**			
Disturbance History/Regime		**KNF GIS RSS**				
Riparian Reserves		**KNF GIS**				

TEMP = Water temperature monitoring at RM 4.5 of mainstem Elk Creek from 1990 to 2014; **SS90** = 1990 KNF stream survey of mainstem East Fork Elk Creek; **SED =** 2011 sediment assessment survey; **RSS =** 1999 KNF Road Sediment Source Inventory and Risk Assessment; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory; ND = No Data; PJ = Professional Judgment; **PO** = Personal Observation based on 20+ years observing; NA = Not Applicable; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline and Checklist last updated by Jon Grunbaum on February 27, 2015.**

Lower East Fork Elk Creek is a 7th-field (HUC14) composite watershed of 3,430 acres that includes the lower three miles of mainstem EF Elk Creek which is a 3rd-order stream (Strahler 1957) and several zero- to second-order (Strahler 1957) tributaries to the mainstem. In summer 2014 juvenile Coho salmon were documented in the lower 0.18 mile of East Fork Elk Creek below a suspected barrier. The KNF GIS fish distribution layer shows Coho range extending up to 0.5 miles but documentation is poor. Chinook salmon were observed in the lower 0.15 miles of EF Elk Creek during the 1990 stream survey. Mainstem EF Elk supports resident rainbow and steelhead trout for the entire reach within this composite watershed. Little Elk Creek is the largest (3rd-order) and only named tributary to EF Elk Creek within this HUC14 and supports resident rainbow trout in the lower few tenths of a mile (and maybe steelhead but no adult steelhead have been documented). None of the other tributaries to mainstem EF Elk Creek within this HUC14 are fish-bearing. The last survey of mainstem East Fork Elk Creek was in 1990.

Lower East Fork Elk 7th Field (HUC14) Watershed Environmental Baseline Elements:

WATER QUALITY

Water Temperature: Summer water temperature in mainstem EF Elk Creek was monitored near the mouth of the creek from 2010 to 2014 – see table below for a summary of monitoring results. In this five year period of record the maximum instantaneous water temperature ranged from 18.1°C to 22.1°C; the maximum weekly average temperature (MWAT) ranged from 16.0 °C to 19.0°C; and the maximum weekly maximum temperature ranged from 17.6°C to 21.2°C. Water temperature in mainstem EF Elk Creek was within the properly functioning range from 2010 to 2012 but was in the at-risk range in 2013 and 2014. Near record low base flows may have been a primary factor in the much higher than average water temperatures and large diurnal temperature variation in 2014. It is likely that the rate and magnitude of stream heating and cooling will increase due the 2014 Happy Camp Complex Fire because: (1) the wildfire burned large swaths of riparian vegetation that had provided shade and thermal buffering to stream channels, (2) pools are likely to infill or partially infill with excess sediment which will increase surface area to volume ratio, and (3) the wildfire is likely to significantly increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. **At-Risk**.

Recent Water Temperature Monitoring Results for East Fork Elk Creek Near Mouth						
Start	**End**	**Max Daily Max Temp C**	**Max Average Daily Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp C (MWMT)**
7/1/2010	10/10/2010	19.5	17.8	4.2	17.3	18.9
6/11/2011	10/4/2011	18.1	16.5	3.9	16.0	17.6
6/8/2012	10/23/2012	19.3	17.8	4.1	17.1	18.5
6/7/2013	9/29/2013	21.0	19.1	4.4	18.3	20.0
5/28/2014	9/24/2014	22.1	19.9	5.1	19.0	21.2

Sediment – Turbidity: The 2014 Happy Camp Complex Fire burned 200 acres of stream buffer hydrologic RR (20% of the total stream buffer RR in the HUC14) at moderate to high intensity – half of which was within inner gorge geologic RR. In addition, the 2014 Fire burned four acres of active landslide geologic RR at moderate to high intensity. The magnitude and duration of turbidity in East Fork Elk Creek has increased significantly since the 2014 Fire (personal observation). Surface erosion and chronic sedimentation into streams is likely to be elevated for several years until vegetation and duff recovers ground cover in areas that burned at moderate-to-high intensity. The rate of mass wasting and debris flows is expected to increase in moderate to high severity burned areas for up to ten years or longer until ground cover recovers and the roots of regenerating vegetation regain the capacity to bind soil. Therefore, the magnitude and duration of turbidity during and after peak flow events is likely to remain significantly elevated for at least more several years. Modeled surface erosion risk is high (USLE = 0.88); and modeled mass wasting risk is moderately elevated (GEO = 0.48). Modeled disturbance in the two HUC14s that drain into Lower East Fork Elk Creek mainstem is about the same as in Lower East Fork Elk Creek HUC14.

Chemical/Nutrient Contamination: No chemical or nutrient contamination is known to exist.

HABITAT ACCESS

Physical Barriers: There are no man-made barriers restricting or preventing salmon migration. The road-stream crossing over Little Elk Creek may be a barrier to rainbow/steelhead trout but there is only a few tenths of a mile of suitable habitat.

HABITAT ELEMENTS

Substrate Character: The results of 2011 intensive monitoring and evaluation of sediment in mainstem East Fork Elk Creek that included the metrics: percent surface fines < 2mm, percent sub-surface sediment < 0.85mm, percent sub-surface sedient < 6.38mm, and percent residual pool volume filled with fine sediment (V*), are shown in the table below. Substrate quality impairment was evaluated by comparing the four sediment indicators in East Fork Elk Creek (a managed watershed) to the 85th percentile value of four indicators for reference streams that have negligble management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams *may* have impaired watershed function. In the 2011 sediment monitoring, one of the four sediment indices (surface fines < 2mm) in East Fork Elk Creek was determined to slightly exceed reference watershed values as shown in the table below.

Average surface fines, average sub-surface fines, and average volume of fine sediment filling pools (V*) from the 2011 East Fork Elk Creek response reach (efelk1) compared to KNF Stream Sediment Monitoring reference conditions (@85 percentile). East Fork Elk Creek metrics exceeding 85th percentile reference values are bolded.

Sediment Index	efelk1 reach average (%)	Reference Condition (%)
Surface Fines < 2mm	**9.0**	6.4
Sub-surface fines < 0.85mm	15.2	16.2
Sub-surface fines < 6.38mm	45.6	46.1
Fraction of pools filled with fine sediment < 2mm (V star)	0.065	0.11

The 2014 Happy Camp Complex Fire burned 200 acres of stream buffer hydrologic RR (20% of the total stream buffer RR in the HUC14) at moderate to high intensity – half of which was within inner gorge geologic RR. In addition, the 2014 Fire burned four acres of active landslide

geologic RR at moderate to high intensity. Surface erosion and chronic sedimentation into streams is likely to be elevated for several years until vegetation and duff recovers ground cover in areas that burned at moderate-to-high intensity. The rate of mass wasting and debris flows is expected to increase in moderate to high severity burned areas for up to ten years or longer until ground cover recovers and the roots of regenerating vegetation regain the capacity to bind soil. Modeled surface erosion risk is high (USLE = 0.88); and modeled mass wasting risk is moderately elevated (GEO = 0.48). Modeled disturbance in the two HUC14s that drain into Lower East Fork Elk Creek mainstem is about the same as in Lower East Fork Elk Creek HUC14. **At-Risk.**

Large Woody Debris: During the 1990 stream survey there was only five pieces of LWD per mile. The availablity of LWD to be recruited to the stream channel has been significantly reduced in all HUC14s of East Fork Indian Creek due to past wildfires, and extensive road building (and maintenance) and stand-replacement timber harvest. **At-Risk**.

Pool Frequency/Quality: Pool frequency was one pool every 19 bankfull channel widths during the 1990 stream survey. **At-Risk**.

Off-Channel Habitat: NA to most of the stream channels in the East Fork Elk Creek HUC14 which are Rosgen A-, B-, and G-channel types. Off-channel habitat is not characteristic of these constrained and entrenched channel types. **NA**.

Refugia: Cold water and cover are the primary elements of refugia that East Fork Elk Creek could potentially provide. Water temperature in EF Elk Creek is at or near properly functioning condition and still optimal to suitable for salmonids. There is likely insufficient cover in the form of LWD and deep pools. **At-Risk.**

CHANNEL CONDITION AND DYNAMICS

Width to Depth Ratio: Based on low pool frequency (lack of deep spots) it is assumed that width-to-depth ratio is increased. **At-Risk**.

Streambank Condition: Prior to the 2014 Happy Camp Complex Fire streambanks were in relatively undisturbed condition except: (1) at stream crossing of which there is a low density and (2) in Little Elk Creek where a road impacts the streambank at several locations. A few tenths of a mile of streambanks along Little Elk Creek was destroyed or degraded during the 2014 Fire when fire crews attempted to reconstruct the lower section of the road to gain access to manage the fire. The 2014 Happy Camp Complex Fire burned 200 acres of stream buffer hydrologic RR (20% of the total stream buffer RR in the HUC14) at moderate to high intensity – half of which was within inner gorge geologic RR. **At-Risk.**

Floodplain Connectivity: NA to most of the stream channels in the East Fork Elk Creek HUC14 which are Rosgen A-, B-, and G-channel types. There is negligible potential for floodplain in these constrained and entrenched channel types. **NA**.

FLOW/HYDROLOGY

Change in Peak/Base Flow: Road density is high and 15% of the road system is hydrologically-connected to the stream network. Modeled runoff risk is moderately elevated (ERA/TOC = 0.41) primarily due to past wildfires and roads. 2014 fire lines are mostly not hydrologically-connected. **At-Risk**.

Drainage Network Increase: Road density is high and 15% of the road system is hydrologically-connected to the stream network. 2014 fire lines are mostly not hydrologically-connected. **At-Risk**.

Road Density and Location: Road density is high at 4.0 miles road per square mile watershed and 15% of the road system is hydrologically connected to the stream network. There is a valley-bottom road in the stream buffer RR that runs the entire length of the mainstem (about three miles). There is a road all the way up the gut of Little Elk Creek that is within the stream buffer RRs and directly impacts that channel in some places. The lower 1000 feet or so of this road was re-opened during the 2014 Fire and much sediment was pushed into the creek. **Not Properly Functioning**.

Disturbance History/Regime: The primary disturbances currently adversely affecting watershed processes are: (1) the high density road system with 15% hydrologic connectivity and with a large percentage of the road length within hydrologic and/or geologic RRs and (2) the 2014 Happy Camp Complex Fire that burned 200 acres of stream buffer hydrologic RR (20% of the total stream buffer RR in the HUC14) at moderate to high intensity (half of which was within inner gorge geologic RR), and that burned four acres of vegetation at moderate to high intensity on four acres of active landslide. Surface erosion and chronic sedimentation into streams is likely to be elevated for several years until vegetation and duff recovers ground cover in areas that burned at moderate-to-high intensity. The rate of mass wasting and debris flows is expected to increase in moderate to high severity burned areas for up to ten years or longer until ground cover recovers and the roots of regenerating vegetation regain the capacity to bind soil. Modeled surface erosion risk is high (USLE = 0.88); modeled mass wasting risk is moderately elevated (GEO = 0.48); and modeled runoff risk is moderate (ERA/TOC = 0.41). The 2014 Fire helped restore the fire regime by reducing the Fire Return Interval Departure (FRID). **At-Risk**.

Riparian Reserves: The primary disturbances currently adversely affecting the condition of riparian reserves are: (1) the high density road system with a large percentage of the road length within hydrologic and/or geologic RRs and (2) the 2014 Happy Camp Complex Fire that burned 200 acres of stream buffer hydrologic RR (20% of the total stream buffer RR in the HUC14) at moderate to high intensity (half of which was within inner gorge geologic RR), and that burned four acres of vegetation at moderate to high intensity on four acres of active landslide. **At-Risk**.

PROJECT AND SITE #

Westside Fire Recovery, Lower Grider Creek 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Lower Grider Creek 7th -field watershed PROP FUNCT	AT RISK	NOT PROP FUNCT	**EFFECTS OF THE ACTION(S)** Lower Grider Creek 7th -field watershed RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature		TEMP				
Sediment-Turbidity			SS1998 2014Recon			
Chemical Contamination	ND/PJ					
Habitat Access Physical Barrier	FPI					
Habitat Elements Substrate			SS1998 2014Recon			
LWD		SS1998 2014 Recon PJ				
Pool Frequency/Quality		SS1998				
Off-channel Habitat		KNF GIS PJ				
Refugia		TEMP PJ				
Channel Cond & Dyn Width/Depth Ratio		2014Recon				
Streambank Condition		Flood 2014 Fire				
Floodplain Condition		PJ				
Flow /Hydrology Peak/Base Flow		KNF-GIS RSS				
Drainage Network Increase		KNF-GIS RSS				
Watershed Condition Road Density/Location		KNF-GIS Flood				
Disturbance History/Regime			KNF-GIS Flood 2014 Fire			
Riparian Reserves			KNF-GIS Flood 2014 Fire			

ND = No Data; **NA** = Not Applicable; **PJ** = Professional Judgment; **2014 Recon** = Observations/photos of channel, riparian, LWD recruitment, and substrate condition made in Fall 2014; **TEMP** = USFS Water temperature monitoring data from 2010 to 2014; **FPI** = Fish Passage Inventory (KNF, 2003); RSS **=** 1999 KNF Road Sediment Source Inventory and Risk Assessment; **SS1998** = 1998 KNF stream survey of mainstem Grider Creek; **Flood** = 1997 KNF Flood Assessment **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline completed by Jon Grunbaum on February 9, 2015.**

The Lower Grider Creek 7th-field watershed is a composite watershed of 10,768 acres of which approximately 95% is National Forest land. The lower mainstem of Grider Creek is a 4th-order (Strahler 1957) stream and is the primary stream in the composite watershed. Approximately eight miles of lower mainstem Grider Creek is within the composite watershed. There are

numerous un-named zero-order draws and first-order tributaries to lower mainstem Grider Creek, and three named 2nd-order tributaries: Salt Creek, No Mans Creek, and Bark Shanty Creek. Mainstem Grider Creek within the lower Grider Creek HUC 7 composite watershed provides habitat for rainbow/steelhead trout along its' entire length, and provides habitat for Coho and Chinook salmon in the lower seven miles. Salt Creek supports salmon and steelhead/rainbow trout in the lower few hundred feet of stream that flows out on the floodplain of mainstem Grider Creek, but No Mans and Bark Shanty Creeks are not fish-bearing. The most current quantitative and qualitative stream survey of mainstem Grider Creek was in summer 1998. Channel sediment metrics were assessed in 2009 and 2013 but those metrics are no longer valid for describing current condition because excess sediment has already been delivered to the channel as a result of the 2014 Fire.

Lower Grider Creek 7th-Field Watershed Environmental Baseline Elements:

Water Quality:

Temperature: Summer water temperature was monitored 1.60 miles above the mouth (at the Forest Service property boundary) most years from 1996 to 2014 – monitoring results for the last five years is given in the table below. In the five year period of record the maximum instantaneous water temperature ranged from 17.4 ^{o}C to 20.4 ^{o}C; the maximum weekly average temperature (MWAT) ranged from 15.2 ^{o}C to 17.7^{o}C; and the maximum weekly maximum temperature ranged from 17.1 ^{o}C to 19.6^{o}C. Although water temperature in mainstem Grider Creek has been within the properly functioning range in the last five years it is likely that the rate and magnitude of stream heating and cooling will significantly increase due the 2014 Fire because: (1) the wildfire burned large swaths of riparian vegetation that had provided shade to stream channels, (2) pools are likely to infill or partially infill with excess sediment, and (3) the wildfire is likely to significantly increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. **At-Risk**.

Recent Water Temperature Monitoring Results for Mainstem Grider Creek at RM 1.6							
Start	**End**	**Daily Average Temp C**	**Daily Max Temp C**	**Daily Min Temp C**	**Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp (MWMT)**
7/2/2010	10/25/2010	17.2	19.4	8.0	4.6	16.6	18.9
6/9/2011	10/11/2011	15.5	17.4	14.0	4.1	15.2	17.1
6/7/2012	10/10/2012	16.8	18.5	7.7	4.1	16.3	18.0
5/17/2013	10/1/2013	18.0	19.8	7.2	4.0	17.3	19.1
5/23/2014	9/24/2014	18.3	20.4	9.0	4.5	17.7	19.6

Sediment/Turbidity: Fines and embeddedness were slightly elevated during the 1998 stream survey. The 2014 Happy Camp Complex Fire burned large areas of the Grider watershed at high to moderate intensity which has greatly increased sediment delivery into Grider Creek stream channels. Post 2014 Fire water quality and sediment conditions in lower mainstem Grider Creek were observed and photographed in the fall after several light to moderate precipitation events: the observations and photographs revealed that (1) turbidity was very high during and long- after precipitation events and (2) large quantities of fine sediment and silt had been delivered to

mainstem Grider Creek which had partially filled in pools and has partially smothered the pre-Fire streambed and salmonid spawning gravels. The frequency, magnitude and duration of turbidity is likely to be significantly elevated for at least the next the next few years until vegetation gets re-established and ground cover increases, and excess fines are winnowed out of the system. Risk of landslides that can cause bouts of acute turbidity will likely be increased for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots. Modeled surface erosion is moderately elevated to over threshold in the four Grider HUC14 subwatersheds. Modeled mass-wasting is over threshold in the Lower Grider HUC14 watershed. **Not Properly Functioning**.

Chemical Contamination: No significant source of chemical contamination is known to exist on National Forest land in the Grider Creek watershed. **Properly Functioning.**

Habitat Access

Physical Barriers: Fish passage barriers were inventoried on the Westside of the KNF (USDA, 2003) – no fish passage barriers at road-stream crossings were found in the Lower Grider Creek composite watershed. **Properly Functioning**.

Habitat Elements

Substrate: During the 1998 stream survey there was 12% fines in pool tail-outs and embeddedness was 30%, and fines composed 45% of surface substrate in pebble counts. Post-2014 Fire water quality and sediment conditions in lower mainstem Grider Creek were observed and photographed in the fall after several light to moderate precipitation events: the observations and photographs revealed large quantities (excess) of fine sediment and silt had been delivered to mainstem Grider Creek which had partially filled in pools and smothered the pre-Fire streambed and salmonid spawning gravels. Excess sediment delivery to lower mainstem Grider Creek from the 2014 Fire is expected to persist for up to ten years or longer until vegetation and ground cover recovers and until trees start growing large enough for their roots to provide soil cohesion. Modeled surface erosion is moderately elevated to over threshold in the four Grider HUC14 subwatersheds. Modeled mass-wasting is over threshold in the Lower Grider HUC14 watershed. **Not Properly Functioning**.

Large Woody Debris: There were very few pieces of LWD in the active channel during the 1998 stream survey - after the floods and debris flows of the 1997 New Years Flood. Additional wood has recruited into the stream since 1998 and LWD levels have improved on National Forest land. Recruitment potential for future LWD is near site potential above the Grider Creek campground because there are few roads and little access to timber along the upper reaches of mainstem Grider Creek. Recruitment potential for future LWD is low downstream of the 46N66 Bridge because there is easy creek access from private properties and the potential for growing large conifers that would be allowed to fall into Grider Creek from the broad privately-owned valley floor is low. Upstream of the 46N66 Bridge, the 2014 Fire killed and damaged many trees in the riparian zone that has greatly increased large woody debris loading into mainstem Grider Creek so that LWD loading is high side upstream of the 46N66 Bridge. The LWD indicator is **At-Risk** because downstream of the 46N66 Bridge on private property there is little LWD in the channel and few potential recruitment trees adjacent to the channel.

Pool Frequency and Quality: In the last stream survey of Grider Creek in 1998 there was one pool every about every 13 bankfull channel widths, and one deep pool every 82 bankfull channel widths. In 1998 the average maximum pool depth was 1.2 meters. This related to a rating of "Not Properly Functioning". However, it is my professional opinion that the mainstem of Grider Creek had largely recovered before the 2014 Fire hit (based on annual visits to the creek for salmon and steelhead surveying since 1996; and based on the fact there had been no major disturbances in the watershed since 1997). Currently, excess sediment from severely and moderately burned forest is being delivered to mainstem Grider Creek and this elevated sediment delivery rate is expected to continue or increase over the several years. Pools are partially filling with sediment now and that trend is likely to increase over the next several years or longer. Pools are likely to decrease in frequency, depth, area, and volume over the next several years or longer. **At-Risk**.

Off-channel Habitat: Not applicable in the Rosgen A-, B-, and G-Channel types of most of mainstem Grider Creek upstream of the 46N66 bridge. There off-channel habitat and unhindered potential for off-channel habitat development upstream of the 46N66 bridge in a few stream reaches where the valley floor is wide enough to allow off-channel habitat development. Below the 46N66 bridge (private land; lower 1.6 miles of mainstem Grider Creek) there is a broad valley floor (actually a large alluvial fan) that could support significant off-channel habitat but much of the creek through this area has been channelized to keep the creek from flooding, braiding or meandering onto grazing lands or other developed property, and to keep the creek in the right alignment for the existing bridge near the mouth. Therefore, it is unlikely that the lower 1.6 mile of Grider Creek, where there is significant potential for off-channel habitat, will be allowed to develop off-channel habitat in the foreseeable future. **At-Risk**.

Refugia: Cool water and cover are the primary elements of fish refugia in this watershed. Water temperature was within the suitable to optimum range for salmonid growth and survival prior to the 2014 Fire. Water temperature is likely to significantly increase due to the 2014 Fire and may drop into the non-suitable or less than optimal range. Cover provided by LWD and channel complexity is near site potential in mainstem Grider Creek upstream of the campground (because there has been nearly no roads or harvest within the riparian zone). Cover complexity is below site potential downstream of the campground (lower two miles of mainstem) due to manual removal of woody debris from the riparian zone by campers, road/campground maintenance crews and private property owners, and due to channelization on private lands. **At-Risk**.

Width/Depth Ratio: The New Years Flood of 1997 and associated debris flows altered the channel of Rancheria Creek (tributary to mainstem Grider Creek) and the mainstem of Grider Creek from Rancheria Creek to the mouth: over 50% of stream channels in the Lower Grider Creek HUC14 watershed were altered. The altered channel/streambank/riparian zone is still recovering. Upstream of the 46N66 bridge, stream channel width-to-depth ratio was largely recovered by the time the 2014 Fire hit. The pre-2014 Fire recovery trajectory of the lower two miles of mainstem Grider Creek downstream from the 46N66 bridge has been slower and limited due to channelization, grazing, and other activities on that private property. The 2014 Fire is already starting to increase the width-to-depth ratio of pools in mainstem Grider Creek due to infilling with excessive fine sediment (silt, sand, gravels) generated by increased surface runoff and erosion and small debris flows from large swaths of forest that burned at moderate to high intensity. Although not observed yet, the 2014 Fire is likely to trigger excessive sediment to be

delivered to stream channels for a decade or more because the rate of landsliding is expected to increase in large swaths of forested areas that burned at moderate to high intensity. Increased runoff and landsliding from burned areas is likely to increase the frequency of channel-altering debris flows. Excessive sediment delivery and increased channel-altering debris flows are likely to persist for up to ten years or longer. **At-Risk**.

Streambank Condition: The New Years Flood of 1997 and associated debris flows altered the channel of Rancheria Creek (tributary to mainstem Grider Creek) and the mainstem of Grider Creek from Rancheria Creek to the mouth: over 50% of stream channels in the Lower Grider Creek HUC14 watershed were altered. The altered channel/streambank/riparian zone is still recovering. Upstream of the 46N66 bridge, streambanks were largely recovered by the time the 2014 Fire hit although many of the streamside alders are still young having sprouted after the 1997 Flood. The pre-2014 Fire recovery trajectory of the streambank adjacent to the lower two miles of mainstem Grider Creek downstream from the 46N66 bridge has been slower and limited due to channelization, grazing, and other activities on that private property. **At-Risk**.

Floodplain Connectivity: Not applicable in the Rosgen A-, B-, and G-Channel types of most of mainstem Grider Creek upstream of the 46N66 bridge. There off-channel habitat and unhindered potential for off-channel habitat development upstream of the 46N66 bridge in a few stream reaches where the valley floor is wide enough to allow off-channel habitat development. Below the 46N66 bridge (private land; lower 1.6 miles of mainstem Grider Creek) there is a broad valley floor (actually a large alluvial fan) that could support significant off-channel habitat but much of the creek through this area has been channelized to keep the creek from flooding, braiding or meandering onto grazing lands or other developed property, and to keep the creek in the right alignment for the existing bridge near the mouth. Therefore, it is likely that the lower 1.6 mile of Grider Creek, where there is significant potential for floodplain connectivity, will not be allowed to flood if the property owners can prevent it from occurring. **At-Risk**.

Flow/Hydrology

Change in Peak/Base Flow: Road density is low to moderate and only 18% of the road system is not hydrologically-connected to the stream network. Drainage net increase due to roads is low. The 2014 Fire that burned large swaths of forested ground at moderate to high intensity is expected to increase surface runoff and peak flows during runoff periods, and expected to slightly elevate base flows due to less evapotranspiration. Modeled runoff risk is high but still below threshold (ERA/TOC = 0.88). Lower in the watershed, base flows may be adversely affected by water diversions. The Grider Ranch alone has a large capacity intake. It is unknown how much water is actually drafted out of Grider Creek. **At-Risk**.

Drainage Net Increase: There is minor potential for significant drainage net increase due to roads because: (1) road density is low, (2) a 1999 road sediment source survey conducted by the KNF determined that only 18% of the road system was hydrologically-connected to the stream network, (3) only 11% of hydrologically-connected road has not been storm proofed, and (4) other than the two miles of valley bottom road, much of the road system is on upper slopes or ridges with not much drainage area or other roads upslope of them. Overland flow will increase on large swaths of previously forested ground that was burned at moderate to high intensity during the 2014 Fire and is likely to increase drainage network density. **At-Risk.**

Watershed Conditions

Road Density/Location: Road density is low to moderate at 1.6 miles road per square mile watershed (slightly higher if all roads on private lands were included). Several roads with the highest watershed risk were decommissioned or storm proofed in 2002 and 2003. There is valley bottom road in the lower two miles of the Grider Creek valley. **At-Risk.**

Disturbance History/Regime: Watershed risk and adverse watershed effects due to roads is low because road density is low, roads with the highest watershed risk have been decommissioned or storm proofed, and drainage network increase due to roads is minor. The New Year Flood of 1997 and associated debris flows altered over 50% of all stream channels in the Lower Grider Creek watershed. Approximately seven miles of lower mainstem Grider Creek was altered by a massive debris flow that originated several miles up the mainstem of Rancheria Creek. There were 28 landslides and nine major road failures in the Lower Grider Creek composite watershed during the flood; some of the landslides and debris flows appeared to be related to road drainage failure or road-stream crossing failure (including the massive debris flow that originated up Rancheria Creek). Stream channels, streambanks, and riparian vegetation were still recovering from the flood when the 2014 Fire hit.

Currently, the major disturbance event that is affecting watershed processes now and that will continue to affect watershed conditions in the next ten years or more was the 2014 Fire that burned large swaths of forest at moderate and high intensity in upslope and riparian areas. Prior to the 2014 Fire, fire regimes had been significantly altered due to fire suppression with the Fire Return Interval Departure (FRID) severely departed from the pre-fire-suppression regime. The severely departed FRID was likely a significant factor in the large size and high severity of the 2014 Fire in the Grider Creek watershed. Dead fuel loading is now very high in many of the fire-suppressed stands that burned at moderate to high intensity in 2014. The 2014 Fire helped restore the fire regime in some areas but more cycles of fire (either prescribed fire or managed unplanned ignitions) will be needed in the near future to clean up fire-killed vegetation and restore a fire regime that benefits ecosystems – and to avoid a truly catastrophic fire decades from now across large swaths of landscape where dense fire-suppressed stands of trees were killed in the 2014 Fire.

Fire severity exceeding 25% basal area mortality can significantly increase the risk of landsliding on unstable ground. The 2014 Fire caused 25% or greater basal area mortality on 3,587 acres (or 33% of the total watershed area!) of unstable ground geologic RR as follows: 39 acres on active landslide; 1,081 acres within inner gorge; and 2,467 acres on highly dissected granitic terrain. Post-2014 Fire modeled cumulative watershed effects for the Lower Grider Creek HUC14 watershed are moderately elevated to over threshold with most of the disturbance attributed to the 2014 Fire: (USLE = 0.74; GEO = 1.09; ERA/TOC = 70). The GEO model for mass wasting is over-threshold. **Not Properly Functioning.**

Riparian Reserves: The New Years Flood of 1997 and associated debris flows severely scoured the channel of mainstem Grider Creek and removed much of the riparian vegetation - over 50% of stream channel in the Lower Grider Creek watershed was altered, including much of the mainstem of Grider Creek from Rancheria Creek down. The altered channel/streambank/riparian zone was still recovering when the 2014 Fire hit. Upstream of the campground the channel and streambanks were well on the way to recovery before the 2014 Fire but riparian vegetation was still recovering from the loss of streamside large alders. The post-flood recovery trajectory of

stream channels and riparian vegetation was slower and less clear in the lower 2.0 miles of the Grider Creek watershed below the campground because: (1) most of the broad valley floor adjacent to Lower Grider Creek is private land with various levels of disturbance in stream buffer and upslope areas from grazing, roads, and other activities which limits the development of mature riparian vegetation in some places and times and (2) two miles of road and one campground is within hydrologic riparian reserve.

Currently, the major factor affecting condition of hydrologic RRs was the 2014 Fire which burned 3,418 acres of hydrologic RRs at moderate to high intensity, which is 47% of all hydrologic RR in the HUC14 watershed. This much moderate and high intensity fire in hydrologic RRs is expected to significantly decrease the nutrient spiraling and sediment buffering function of stream course RRs and will significantly compromise the potential of hydrologic RRs to buffer the stream from upslope ground disturbances and landslides. The 2014 Fire caused 25% or greater basal area mortality on 3,587 acres (or 33% of the total watershed area!) of unstable ground geologic RR. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the rate and risk of landsliding. **Not Properly Functioning**.

PROJECT AND SITE #

Westside Fire Recovery, Lower Horse Creek 7th Field Watershed Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Lower Horse Ck 7th Field watershed			**EFFECTS OF THE ACTION(S)** Lower Horse Ck 7th Field watershed		
	PROP FUNCT	AT RISK	NOT PROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	TEMP					
Sediment-Turbidity			SED RSS SS2002 KNF GIS PO PJ			
Chemical/Nutrient Contamination		PO PJ				
Habitat Access Physical Barriers	FPI					
Habitat Elements Substrate			SED RSS SS2002 KNF GIS PO PJ			
Large Woody Debris			SS2002 PO PJ			
Pool Frequency/Quality			SS2002 SED PO PJ			
Off-channel Habitat			Horse WA PO PJ			
Refugia	TEMP	PO PJ				
Channel Cond & Dyn Width/Depth Ratio			SS2002 SED PO PJ			
Streambank Condition			Horse WA PJ			
Floodplain Condition			Horse WA PO PJ			
Flow /Hydrology Change in Peak/Base Flow			KNF GIS RSS			
Drainage Network Increase			KNF GIS RSS			
Watershed Cond. Road Density/Location			KNF GIS PO PJ			
Disturbance History/Regime			SED RSS KNF GIS Horse WA			
Riparian Reserves			RSS KNF GIS Horse WA			

TEMP = Last five years of temperature monitoring of mainstem Horse Creek at RM 2.4; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory (KNF 2003); **SS2002 =** KNF stream survey of the upper 1.15 miles of mainstem Horse Creek within the Lower Horse Creek HUC14; **SED =** 2010/2013 sediment assessment survey (USFS 2014); **RSS** = Road Sediment Source Inventory and Risk Assessment (KNF 2012); **Horse WA** = Horse Creek Watershed Analysis (KNF 2002); **ND** = No Data; **PO** = Personal Observation; **PJ** = Professional Judgment; **NA** = Not Applicable; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline completed by Jon Grunbaum on February 17, 2015.**

The Lower Horse Creek 7th-field (HUC14) watershed is a composite watershed of 7,983 acres. Approximately 74% of the HUC14 is National Forest and the rest is private residential and ranching property, and industrial timberland. Approximately 6.2 miles of mainstem Horse Creek is within this composite watershed: from the mouth upstream to the confluence with Salt Gulch. Lower mainstem Horse Creek is a 4th-order (Strahler 1957) stream in this composite watershed. Measuring from the mouth: the entire 6.2 miles of mainstem Horse Creek provides habitat for coho salmon, winter steelhead trout, and resident rainbow trout; and the lower five miles provides habitat for Chinook salmon. There are five 2nd-order tributaries to mainstem Horse Creek in this HUC14 named: Crawfish Gulch, Fish Gulch, Hamburg Gulch, Maple Gulch, and Robinson Gulch. Robinson Gulch provides a few tenths of a mile of habitat for winter steelhead/rainbow trout. Fish Gulch provides a few tenths of a mile of habitat for winter steelhead/rainbow trout and coho salmon. Maple Gulch and all other un-named tributaries to lower mainstem Horse Creek are not fish-bearing. There are also several zero- and first-order tributaries to mainstem Horse Creek in the composite watershed that are not named and not fish-bearing, and often not running with surface flow in summer. Buckhorn and Middle Creeks are major tributaries to lower mainstem Horse Creek but are their own HUC14 true watersheds (that support steelhead/rainbow trout and possibly Coho salmon (the land is private and has not been surveyed by FS). The most current comprehensive stream survey in the Lower Horse Creek HUC14 watershed was conducted in 2002 and surveyed the upper 1.15 mile section of mainstem Horse Creek that is on National Forest land. An earlier stream survey of the entire mainstem of Horse Creek and some tributaries was conducted in 1989-90 as reported in the Horse Creek Watershed Analysis (KNF 2002). Streambed sediment and stream shading was monitored in 2010 and 2013. Water temperature of mainstem Horse Creek within the Horse Creek HUC14 was monitored for five years between 2010 and 2013. Summer streamflow volume is measured annually a short distance upstream from the mainstems' confluence with the Klamath River.

Lower Horse Creek 7th-Field Watershed Environmental Baseline Elements:

Water Quality:

Temperature: Summer water temperature was monitored in mainstem Horse Creek at RM 2.4 from 2010 to 2014 and those monitoring results are given in the table below. In the five year period of record the maximum instantaneous water temperature ranged from 15.1°C to 18.2°C; the maximum weekly average temperature (MWAT) ranged from 14.8°C to 16.7°C; and the maximum weekly maximum temperature ranged from 15.8°C to 17.7°C. **Properly Functioning**.

Recent Water Temperature Monitoring Results for Mainstem Horse Creek at RM 2.4						
Start	**End**	**Max Daily Max Temp C**	**Max Average Daily Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp C (MWMT)**
7/8/2010	10/25/2010	17.1	16.1	3.5	15.8	16.8
6/9/2011	10/14/2011	15.1	16.1	3.9	14.8	15.8
6/16/2012	10/31/2012	17.0	16.2	3.8	15.7	16.6
6/6/2013	10/31/2013	18.2	17.1	3.3	16.5	17.6
5/29/2014	10/1/2014	18.2	17.2	3.3	16.7	17.7

Sediment –Turbidity: Turbidity discussion included with Substrate Character indicator discussion - see below. **At-Risk**.

Chemical/Nutrient Contamination: No significant source of chemical contamination is known to exist in Horse Creek. Range cattle utilizing allotments throughout the watershed and intensive grazing in the lower Horse Creek Valley contributes an unknown amount of nutrients to Horse Creek streams and the Klamath River. The Horse Creek Ecosystem Analysis states that EPA thresholds are not exceeded using existing stocking rates coupled with data from a study conducted in Oregon. The Ecosystem analysis goes on to state that "there is the possibility of a significant effect on the aquatic resources, however the true affects are unknown because nutrient loading of the aquatic environment has not been investigated on the Klamath National Forest." **At-Risk**.

Habitat Access

Physical Barriers: There are no high or medium priority fish passage barriers in the Horse Creek watershed. There is only one remaining low-priority fish barrier on National Forest lands in the Horse Creek watershed – this is a barrier to resident fish but not salmon or steelhead. Push-up dams created by private landowners annually or semi-annually by use of heavy equipment often prevents or makes fish passage difficult in lower mainstem Horse Creek. **At-Risk**.

Habitat Elements

Substrate Character and **Sediment-Turbidity:** It is theorized that turbidity and rate of sediment delivery to mainstem Horse Creek is significantly elevated over pre-European settlement conditions or reference conditions. This theory is based on the following results and observations:

(1) Road density is high and about 15% of the road system is hydrologically connected to the stream network.
(2) Road density is high to very high in all the HUC14 watersheds that drain into the Lower Horse HUC14 watershed. Road density is high at the scale of the Horse Creek HUC12 true watershed.
(3) There are few pools in the lower mainstem and existing pools are generally very shallow. Poor pool frequency and quality was documented during the 1989 and 2002 stream surveys and is observed each year during annual salmon spawning surveys. It is suspected that excessive sediment from extensive watershed disturbance throughout the HUC12 is being delivered to mainstem Horse Creek and that the excess sediment is

filling pools in the lower gradient reaches. [The dearth of LWD and restricted channel sinuosity, and lack of beaver, in the lower mainstem channel are also major contributing factors for low pool frequency and quality].

(4) Results of intensive sediment monitoring (see discussion and results below) suggests that excessive sediment is being delivered to lower mainstem Horse Creek and that this excessive sediment is impacting sediment condition and in-filling pools.

(5) Modeled CWEs are moderately high in the Lower Horse Creek HUC14: (USLE = 0.54; GEO = 0.59; ERA/TOC = 0.79). Modeled CWEs are moderately high or high in all the HUC14 watersheds that drain into the Lower Horse HUC14 watershed.

The results of 2010 and 2013 intensive monitoring and evaluation of sediment in mainstem Horse Creek that included the metrics: percent surface fines < 2mm, percent sub-surface sediment < 0.85mm, percent sub-surface sedient < 6.38mm, and percent residual pool volume filled with fine sediment (V*), is shown in the table below. Substrate quality impairment was evaluated in mainstem Horse Creek by comparing the four sediment indicators in mainstem Horse Creek (a managed watershed) to the 85th percentile value of four indicators for reference streams that have minor to negligble management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams are considered impaired. In 2010 and 2013 three of the four sediment indices exceeded reference values.

Average surface fines, average sub-surface fines, and average volume of fine sediment filling pools (V*) from the 2010 and 2013 Horse Creek response reach (horse1) compared to KNF Stream Sediment Monitoring reference conditions (85th percentile). [horse1] metrics over threshold values are bolded.

Sediment Index	2010 horse1 reach average %	2013 horse1 reach average %	Reference Condition (%)
Surface Fines < 2mm	4.3	**11**	6.4
Sub-surface fines < 0.85mm	**20**	**16.4**	16.2
Sub-surface fines < 6.38mm	**46.6**	45.2	46.1
Fraction of pools filled with fine sediment < 2mm (V star)	**0.237**	**0.220**	0.108

Based on the preceding discussion, it is my professional opinion that the functioning condition of the Sediment-Turbidity indicator is **At-Risk**; and the functioning condition of the Substrate Character indicator is **Not Properly Functioning.**

Large Woody Debris: The 1989-90 stream surveys showed there was a lack of LWD along most of mainstem Horse Creek (Horse Creek WA). In the last stream survey of lower mainstem Horse Creek in July 2002, there was zero pieces of LWD in the 1.2 mile section of stream that was surveyed, however, there were over 57 trees growing adjacent to that reach that were big enough to qualify as LWD: this survey was on National Forest lands at the upper end of the Lower Horse Creek HUC14 mainstem segment. From personal observations made during recent annual fish censuses: (1) there are very few pieces of in-channel LWD in the lower five mile segment of mainstem Horse Creek; (2) there are very few large conifers or conifers at all in the riparian zone on the east side of the mainstem to provide for future LWD recruitment, and (3) there is little potential for growing large conifers on the east side of the mainstem because the riparian buffer is narrow and confined by a berm and road. **Not Properly Functioning**.

Pool Frequency and Quality: Pool frequency was very low during the 1989-90 stream survey (Horse Creek WA). In the last stream survey of lower mainstem Horse Creek, in July 2002, there were only two pools in the 1.15 miles of stream that was surveyed: this survey was on National Forest land at the upper end of the segment of lower mainstem Horse Creek that is within the Lower Horse Creek HUC14 watershed. From personal observations made during recent annual fish censuses: pool frequency is low and pools are generally very shallow in the lower five mile segment of mainstem Horse Creek. Factors suspected for low pool frequency and depth are: (1) pool in-filling due to excessive sediment delivery from excessive watershed disturbance, (2) dearth of in-channel LWD to create lateral scour and plunge pools, and (3) restricted channel sinuosity due to berm diminishes potential for meander scour/point bar formation. It is likely that beaver were plentiful in Northern California streams including Horse Creek prior to fur trapping and settlement (Lanman et.al. 2013). If so, aquatic and riparian habitat in the broad lower Horse Creek valley was probably profoundly different than today with numerous beaver dams creating pools and prime habitat for salmonids. Beaver are nearly extirpated in Horse Creek and beaver habitat is severely degraded or lost due to berms, roads, and conversion to pasture. **Not Properly Functioning**.

Off-channel Habitat: Before channelization, the lower four miles of mainstem Horse Creek was unconstrained as it flowed through its' broad very gently sloping valley - so that the stream could interact with its' floodplain and off-channel habitats could develop. Currently, lower mainstem Horse Creek is tightly constrained to the west hillside by a berm to protect ranch land and roads; therefore, there is little potential for off-channel habitat development along this section. A small unconstrained mainstem reach just upstream from Fish Gulch is partially impacted by a stream crossing. Other unconstrained channel areas along the mainstem are not significantly restricted due to human disturbance. There are no unconstrained reaches in the tributaries to lower mainstem Horse Creek (*within the Lower Horse Creek HUC14* watershed). **Not Properly Functioning**.

Refugia: Cool water and cover in lower mainstem Horse Creek are the primary elements of fish refugia in this HUC 14 composite watershed. Water temperature is within optimum to suitable range for salmonids, however, there is very little cover or quality cover due to near lack of pools, lack of deep pools, and dearth of LWD. Prior to near extirpation of beaver and severe degradation of beaver habitat, beaver likely constructed numerous dams that would have provided excellent habitat for salmonids. **At-Risk**.

Width-to-Depth Ratio: There are very few pools in lower mainstem Horse Creek within this HUC14 which suggests that sediment delivery rate in the Horse Creek watershed is excessive and beyond the ability of the stream to transport it. Excessive sediment delivery beyond the capability of the Horse Creek to transport the sediment is likely because the Lower Horse Creek HUC 14 and most of the HUC14s that drain into lower Horse Creek have moderate to high levels of watershed disturbance. It is likely that W/D ratio of the mainstem is increased due to channel shallowing from the sediment infilling.

The lower several miles of mainstem Horse Creek is prevented from moving laterally due to a berm, therefore, potential for channel recovery/restoration is very low. The berm transformed lower mainstem Horse Creek from an unconstrained flood-prone channel to constrained channel with a narrow riparian stream buffer. Restricted channel sinuosity due to berm diminishes potential for meander scour/point bar formation that likely existed before the channel was constrained. **Not Properly Functioning.**

Streambank Condition: Streambanks adjacent to lower mainstem Horse Creek are likely quite different than they were prior to when the channel was constrained against the west hillside via a berm. Streambanks are altered or in a disturbed state at several locations adjacent to the mainstem where the main road is constructed within inner gorge which has subsequently required rip-rapping of the streambank to stabilize/buttress some sections of road. Streambanks are altered at road-stream crossings which are numerous throughout the HUC14. **Not Properly Functioning**.

Floodplain Connectivity: Historically, lower mainstem Horse Creek was unconstrained as it flowed through a (relatively) wide flat valley, and high flows could spill out onto a wide floodplain. Today, lower mainstem Horse Creek is tightly constrained by a berm and is disconnected from its' floodplain. **Not Properly Functioning**.

Flow/Hydrology

Changes in Peak/Base Flow: Road density is high in the Lower Horse Creek HUC 14 composite watershed and about 15% of the road system is hydrologically connected to the stream network. In addition, road density is high in the HUC14s that drain into the Lower Horse Creek HUC14. Modeled ERA/TOC is moderately high (ERA/TOC = 0.79) in the Lower Horse Creek HUC14; and is high in the Buckhorn HUC14 watershed, and well over threshold in the Middle Creek and Middle Horse HUC14 watersheds, that drain into the Lower Horse Creek HUC 14 watershed. Therefore, peak flows are likely significantly elevated in lower mainstem Horse Creek. Numerous large diversions from mainstem Horse Creek diminish base flows (Horse Creek WA, KNF 2002) which can reduce carrying capacity for salmonids. Excessive water diversion in late summer 2014 severely diminished base flow in the lowest reaches of Horse Creek threatening the survival of juvenile salmonids including coho salmon (personal observation): the California Department of Fish and Wildlife had to intervene to reduce diversion and restore adequate flow to the creek for the fish. **Not Properly Functioning**.

Drainage Net Increase: Road density is high and 21% of the road system is hydrologically connected to the stream network. **Not Properly Functioning**.

Watershed Conditions

Road Density/Location: The road density is high at 3.8 miles of road per square mile of watershed. There is valley bottom road adjacent to the entire length of mainstem lower Horse Creek on the east side of the channel, including over two miles of inner gorge road (the highest risk sections have been recently storm proofed). **Not Properly Functioning.**

Disturbance History/Regime: Road density is high and 15% of the road system is hydrologically connected to the stream network. There has been extensive stand-replacement forestry in this composite watershed - particularly on private timberland. Ground disturbance, compaction, and removal of riparian vegetation is prevalent streamside and on the valley floor due to: (1) roads and berms constructed within the stream buffer and inner gorge, (2) construction and maintenance of residences and ranches, and (3) grazing and pasture maintenance.

The most significant and longest-lasting degradation of aquatic and riparian habitats and ecosystems in the Lower Horse Creek HUC14 resulted from industrial mining. In the late 1930s much of the Horse Creek valley floor from the confluence with the Klamath River up to Fish Gulch was industrially dredged. The mining proponent had the foresight to remove and store

much of the topsoil before the valley was over-turned with the house-sized dredge. After dredging, Horse Creek was tightly and permanently confined against the west hillside with a berm so that the stream could no longer interact with its' floodplain and so the pastures that were created with the saved topsoil would be protected. Currently, aquatic and riparian ecosystems are kept in an altered and largely un-recovered condition by the berm, berm and road maintenance and reconstruction, land clearing, and occasional use of heavy equipment in the stream buffer and channel (on private land). Constraining mainstem Horse Creek has significantly reduced the quantity and quality of aquatic and riparian habitats and the potential for recovery towards pre-European settlement conditions.

The fire return interval departure (FRID) and vegetative attributes in the Horse Creek watershed and surrounding landscape are moderately to significantly departed from historical range due to fire suppression which has successfully interrupted fire cycles in many areas of the watershed. Increasing fire return intervals can result in moderate to dramatic changes to one or more of the following: fire size, intensity and severity and landscape patterns. Stand-replacement forestry in the watershed is also likely to have altered the fire regime.

Modeled CWEs are moderately high in the Lower Horse Creek HUC14: (USLE = 0.54; GEO = 0.59; ERA/TOC = 0.79).

Based on the above discussion, it is my professional opinion that the condition of the watershed Disturbance History/Regime indicator is **Not Properly Functioning**.

Riparian Reserves: Road density and stream crossing density is high, and cumulatively, there are many miles road on the valley floor, within stream buffer RRs, and within inner gorge. Much of the stream buffer of lower mainstem Horse Creek is altered by berm construction and inner gorge road on the east side of the stream. The lower two miles of the Horse Creek valley was converted from an unconstrained stream with a wide riparian zone to pasture protected by a berm to keep the stream tightly constrained against the west hillside. As a result there is reduced stream shading, reduced sediment buffering and nutrient cycling, reduced potential to grow large conifers, reduced large wood recruitment, and significant overall loss of habitat for aquatic and riparian species. Range cattle that utilize allotments throughout the watershed impact riparian vegetation and trample streambanks. **Not Properly Functioning**.

Table of Pathway and Indicators for 7th Field Watershed: Westside Fire Recovery Project: Lower North Russian / Upper North Russian (for North Russian Creek) 7th Field Checklists

DIAGNOSTIC OR PATHWAY and INDICATOR	Environmental Baseline				
	PROPERLY FUNCTIONING	FUNCTIONING - AT RISK	NOT PROP. FUNCT.	RESTORE	MAINTAIN
Habitat Quality Temperature	WQ 2012; WA 1995; Temps-NRussian				
Suspended Sediment - Intergravel DO/Turbidity[1]	PO-Fire, CWE 2015; Sed 2013				
Chemical Contamination/ Nutrients	PJ				
Habitat Access Physical Barriers	PJ; CDFW 2015; FishPass 2001				
Habitat Elements Substrate Character and Embeddedness[1]	CWE 2015; Sed 2013; NRussian 2004				
Large Woody Debris			NRussian 2004; WA 1995		
Pool Frequency and Quality			NRussian 2004; WA 1995		
Large Pools					
Off-channel Habitat	PJ				
Refugia	PJ				
Channel Cond & Dyn Average Wetted Width/Maximum Depth		PJ; NRussian 2004			
Streambank Condition	ND - likely Properly Functioning (PJ)				
Floodplain Connectivity	PJ				
Flow/Hydrology Change in Peak/Base Flows[1]	PJ; CWE 2015; Coho 2014 (long-term)	PJ, BAER (short-term)			
Increase in Drainage Network		PJ			
Watershed Conditions Road Density & Location		SRSS 2002; GIS			
Disturbance History & Regime	PJ; CWE 2015				
Riparian Reserves - Northwest Forest Plan		PJ; Coho 2014; WA 1995			
Species and Habitat: Summary/Integration of all Species and Habitat Indicators		X			
	For the Salmon River drainage, long-term trends for most anadromous species/runs are unclear (Quiñones 2011). The exceptions include spring Chinook (increasing) and summer steelhead (decreasing), but these trends also show a signal of hatchery influence (Quiñones 2011). See Life History section for additional information.				

Table of Pathway and Indicators for 7th Field Watershed: Lower South Russian / Upper South Russin (for South Russian Creek)

DIAGNOSTIC OR PATHWAY and INDICATOR	Environmental Baseline			Effects of the Action		
	PROPERLY FUNCTIONING	FUNCTIONING - AT RISK	NOT PROP. FUNCT.	RESTORE	MAINTAIN	DEGRADE
HABITAT:						
Habitat Quality Temperature	WQ 2012; WA 1995; Temps-SRussian					
Suspended Sediment - Intergravel DO/Turbidity[1]	PJ, CWE 2015; Sed 2013 (long-term)	PO-Fire (short-term)				
Chemical Contamination/ Nutrients	PJ					
Habitat Access Physical Barriers[2]		PJ; CDFW 2015; FishPass 2001; SRussian1980				
Habitat Elements Substrate Character and Embeddedness[1]	CWE 2015; Sed 2013 (long-term)	PO-Fire (short-term)				
Large Woody Debris			WA 1995			
Pool Frequency and Quality		PJ; SRussian 1994				
Large Pools						
Off-channel Habitat	PJ					
Refugia	PJ					
Channel Cond & Dyn Average Wetted Width/Maximum Depth		PJ; SRussian 1994				
Streambank Condition	ND - likely Functioning-At-Risk (PJ)					
Floodplain Connectivity	PJ					
Flow/Hydrology Change in Peak/Base Flows[1]	PJ; CWE 2015; Coho 2014 (long-term)	PJ, BAER (short-term)				
Increase in Drainage Network		PJ				
Watershed Conditions Road Density & Location[3]	GIS (Upper S. Rus)		SRSS 2002; WA 1995; GIS (Lower S. Rus.)			
Disturbance History & Regime	PJ; CWE 2015 (Upper S. Rus.)	PJ; Coho 2014; WA 1995 (Lower S. Rus.)				
Riparian Reserves - Northwest Forest Plan		PO-Fire; PJ; BAER; Coho 2014; WA 1995				
SPECIES AND HABITAT:						
Species and Habitat: Summary/Integration of all Species and Habitat Indicators		X				
	For the Salmon River drainage, long-term trends for most anadromous species/runs are unclear (Quiñones 2011). The exceptions include spring Chinook (increasing) and summer steelhead (decreasing), but these trends also show a signal of hatchery influence (Quiñones 2011). See Life History section for additional information.			See Env. Conseq. and Table 11 for a Indicator effects summary. The Env. Conseq. section also describes effects to fish and their habitat. Project will not cause adverse effects.		

[1]Short-term, post-fire degradation in current condition may occur for several Indicators - turbidity, substrate character, change in peak/base flows. These Indicators are expected to return to more typical and expected condition within a season or two. Other fire-affected Indicators, such as Riparian Reserves, will take longer to recover, and the new "current condition" will likely persist for many years.

[2]Although various databases do not identify any passage barriers, a potential barrier is present on private property downstream of Music Creek in the form of an historic dam atop a bedrock fall/chute which used to divert water to a small hydropower plant (Pers. Obs. - M. Meneks; SRussian 1980). Degree of passage restriction unknown.

[3]Focus is on Lower South Russian watershed as Wilderness dominates Upper South Russian; and most Project activities will be occurring in association with the former 7th-field HUC. This watershed also identified as having concerns due to disturbance at least in part from roads.

Table of Pathway and Indicators for 7th Field Watershed: Whites Gulch (for Whites Gulch)

DIAGNOSTIC OR PATHWAY and INDICATOR	Environmental Baseline			Effects of the Action		
	PROPERLY FUNCTIONING	FUNCTIONING - AT RISK	NOT PROP. FUNCT.	RESTORE	MAINTAIN	DEGRADE
HABITAT:						
Habitat Quality Temperature	WQ 2012; WA 1995; Temps-Whites					
Suspended Sediment - Intergravel DO/Turbidity[1]	PJ, CWE 2015; Sed 2013; Whites 2006 (long-term)	PO-Fire (short-term)				
Chemical Contamination/ Nutrients	PJ					
Habitat Access Physical Barriers[2]	PJ, CDFW 2015; Siskiyou 2002; FishPass 2001					
Habitat Elements Substrate Character and Embeddedness[1]	CWE 2015; Sed 2013; Eddy 2006	PO-Fire (short-term)				
Large Woody Debris			Whites 2006; WA 1995			
Pool Frequency and Quality	Whites 2006					
Large Pools						
Off-channel Habitat	N/A - Not present					
Refugia	PJ					
Channel Cond & Dyn Average Wetted Width/Maximum Depth		PJ, Whites 2006				
Streambank Condition		PJ				
Floodplain Connectivity	PJ					
Flow/Hydrology Change in Peak/Base Flows[1]	PJ; CWE 2015; Coho 2014 (long-term)	PJ, BAER (short-term)				
Increase in Drainage Network		PJ				
Watershed Conditions Road Density & Location		SRSS 2002; GIS				
Disturbance History & Regime		PJ; Coho 2014; WA 1995				
Riparian Reserves - Northwest Forest Plan		PO-Fire; PJ; BAER; Coho 2014; WA 1995				
SPECIES AND HABITAT:						
Species and Habitat: Summary/Integration of all Species and Habitat Indicators		X				
	For the Salmon River drainage, long-term trends for most anadromous species/runs are unclear (Quiñones 2011). The exceptions include spring Chinook (increasing) and summer steelhead (decreasing), but these trends also show a signal of hatchery influence (Quiñones 2011). See Life History section for additional information.			See Env. Conseq. for a Indicator effects summary. The Env. Conseq. section also describes effects to fish and their habitat. Project will not cause adverse effects.		

[1]Short-term, post-fire degradation in current condition may occur for several Indicators - turbidity, substrate character, change in peak/base flows. These Indicators are expected to return to more typical and expected condition within a season or two. Other fire-affected Indicators, such as Riparian Reserves, will take longer to recover, and the new "current condition" will likely persist for many years.

[2]Barriers in identified in anadromous reach have been remediated. Some partial (culvert) barriers to resident fish may be present WF Whites Gulch.

Table of Pathway and Indicators for 5th Field Watershed: North Fork Salmon River (for NF Salmon River)

DIAGNOSTIC OR PATHWAY and INDICATOR	Environmental Baseline			Effects of the Action		
	PROPERLY FUNCTIONING	FUNCTIONING - AT RISK	NOT PROP. FUNCT.	RESTORE	MAINTAIN	DEGRADE
HABITAT:						
Habitat Quality Temperature		Coho 2014; SRCA 1998; WA 1995				
Suspended Sediment - Intergravel DO/Turbidity	CWE 2015; WA 1995					
Chemical Contamination/ Nutrients	CA-EPA					
Habitat Access Physical Barriers	CDFW 2015; Coho 2014; Siskiyou 2002; FishPass 2001					
Habitat Elements Substrate Character and Embeddedness		SRCA 1998; WA 1995				
Large Woody Debris			Coho 2014; SRCA 1998; WA 1995			
Pool Frequency and Quality		SRCA 1998; WA 1995				
Large Pools						
Off-channel Habitat		PJ; Coho 2014				
Refugia	PJ					
Channel Cond & Dyn Average Wetted Width/Maximum Depth	PJ; CWE 2015					
Streambank Condition	ND - likely Properly Functioning (PJ)					
Floodplain Connectivity	PJ, Coho 2014					
Flow/Hydrology Change in Peak/Base Flows	PJ; CWE 2015; Coho 2014					
Increase in Drainage Network	PJ; CWE 2015					
Watershed Conditions Road Density & Location	CWE 2015; SRSS 2002					
Disturbance History & Regime	PJ; CWE 2015; WA 1995					
Riparian Reserves - Northwest Forest Plan		PJ; Coho 2014; WA 1995				
SPECIES AND HABITAT:						
Species and Habitat: Summary/Integration of all Species and Habitat Indicators		X				
	For the Salmon River drainage, long-term trends for most anadromous species/runs are unclear (Quiñones 2011). The exceptions include spring Chinook (increasing) and summer steelhead (decreasing), but these trends also show a signal of hatchery influence (Quiñones 2011). See Life History section for additional information.			See Env. Conseq. for a Indicator effects summary. The Env. Conseq. section also describes effects to fish and their habitat. Project will not cause adverse effects.		

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PROJECT AND SITE #

Westside Fire Recovery, Lower West Fork Beaver Creek 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Lower WF Beaver Ck 7th field			**EFFECTS OF THE ACTION(S)** Lower WF Beaver Ck 7th field		
	PROP FUNCT	AT RISK	NOT PROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	TEMP					
Sediment-Turbidity		SED KNF GIS Beaver WA				
Chemical Contamination	ND/PJ					
Habitat Access Physical Barriers	FPI					
Habitat Elements Substrate Character			SED KNF GIS Beaver WA			
Large Woody Debris			Beaver WA RSS PO PJ			
Pool Frequency/Quality		SED KNF GIS Flood				
Off-channel Habitat	NA					
Refugia	TEMP	PO PJ				
Channel Cond & Dyn Width-to-Depth Ratio		SED KNF GIS Flood				
Streambank Condition		KNF GIS RSS				
Floodplain Condition	NA					
Flow /Hydrology Change in Peak/Base Flow			KNF GIS RSS			
Drainage Network Increase			KNF GIS RSS			
Watershed Cond. Road Density/Location			KNF GIS RSS			
Disturbance History/Regime			KNF GIS RSS Flood			
Riparian Reserves		KNF GIS RSS				

TEMP = Last five years of temperature monitoring of mainstem WF Beaver Creek at RM 0.8; **FPI** = Fish Passage Inventory (KNF, 2003); **Beaver WA** = 1996 Beaver Creek Ecosystem (Watershed) Analysis; **SS89** = 1989 KNF stream survey of the lower 2.5 miles of WF Beaver Creek; **SED =** 2010/2013 sediment assessment survey (USFS 2014); **Flood** = 1997 KNF Flood Assessment; **RSS** = Road Sediment Source Inventory and Risk Assessment (KNF 2012); **NA** = Not Applicable; **PO** = Personal Observation; **PJ** = Professional Judgment; **ND** = No Data; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline completed by Jon Grunbaum on February 17, 2015**.

The Lower WF Beaver Creek 7th-field (HUC14) watershed is a composite watershed of 4,044 acres. Approximately 44% of the area is National Forest and the rest is primarily private

industrial timberland. About 3.3 miles of lower mainstem WF Beaver Creek flows through the Lower WF Beaver HUC14 composite watershed. Lower mainstem WF Beaver Creek is a 4th-order (Strahler 1957) stream and the primary stream in the composite watershed. The entire 3.3 miles of Lower WF Beaver Creek provides habitat for rainbow/steelhead trout. Lower mainstem WF Beaver Creek provides about 1.7 miles of habitat for Chinook and Coho salmon. There is one 3rd-order tributary to Lower WF Beaver Creek named Bear Creek but this drainage is its' own 7th-field watershed. The Lower WF Beaver Creek 7th-field composite watershed has one 2nd-order tributary to Lower WF Beaver Creek named Little Soda Creek, and has numerous unnamed 1st-order tributaries and zero-order draws or intermittent streams. None of the tributaries to Lower WF Beaver Creek within the Lower WF Beaver Creek HUC14 is fish-bearing. The last stream survey of Lower WF Beaver Creek was in 1989.

Lower WF Beaver Creek 7th-Field watershed Environmental Baseline Elements:

Water Quality:

Temperature: Summer water temperature was monitored in mainstem WF Beaver Creek at RM 0.8 from 2010 to 2014 and those monitoring results are given in the table below. In the five year period of record the maximum instantaneous water temperature ranged from 15.2°C to 18.9°C; the maximum weekly average temperature (MWAT) ranged from 14.0°C to 16.9°C; and the maximum weekly maximum temperature ranged from 15.0°C to 18.5°C. **Properly Functioning**.

Recent Water Temperature Monitoring Results for Mainstem WF Beaver Creek at RM 0.8						
Start	**End**	**Max Daily Max Temp C**	**Max Average Daily Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp C (MWMT)**
6/28/2010	10/2/2010	15.2	16.7	4.2	15.0	16.3
6/23/2011	10/2/2011	15.3	14.2	4.7	14.0	15.0
6/16/2012	10/31/2012	17.2	16.1	4.1	15.6	16.8
6/11/2013	10/15/2013	18.3	16.8	3.9	16.1	17.5
6/3/2014	10/6/2014	18.9	17.4	4.2	16.9	18.5

Sediment/Turbidity: See discussion for the Substrate Condition indicator below. **At-Risk.**

Chemical Contamination: No significant source of chemical contamination is known to exist in streams in the Lower WF Beaver HUC 7 watershed. **Properly Functioning.**

Habitat Access

Physical Barriers: A fish passage inventory was completed in 2001 (KNF, 2003). No fish passage barriers were found in the Lower WF Beaver HUC 7 composite watershed. **Properly Functioning**.

Habitat Elements

Substrate Character and **Sediment-Turbidity:** It is theorized that turbidity and rate of sediment delivery to mainstem WF Beaver Creek is significantly elevated over pre-European settlement conditions or reference conditions. This theory is based on the following results and observations:

(1) Road density is very high and about 22% of the road system is hydrologically connected

to the stream network.

(2) Results of intensive sediment monitoring (see discussion and results below) suggests that excessive sediment is being delivered to mainstem WF Beaver Creek and that this excessive sediment is impacting sediment condition and in-filling pools.

(3) Modeled surface erosion risk (USLE = 1.65) and runoff risk is (ERA/TOC = 1.31) are well over threshold, and modeled mass wasting is at threshold (GEO = 1.05).

(4) Excess fines were already being delivered to mainstem WF Beaver Creek after just light to moderate rains on the 2014 Beaver Fire burned areas (personal observation and photos, January 2015). The frequency, magnitude and duration of turbidity is likely to be significantly elevated for at least the next the next few years until vegetation gets re-established in burned areas and ground cover increases, and excess fines are winnowed out of the system.

The results of 2009 and 2013 intensive monitoring and evaluation of sediment in mainstem WF Beaver Creek that included the metrics: percent surface fines < 2mm, percent sub-surface sediment < 0.85mm, percent sub-surface sedient < 6.38mm, and percent residual pool volume filled with fine sediment (V*), are shown in the table below. Substrate quality impairment was evaluated in mainstem by comparing the four sediment indicators in WF Beaver Creek (a managed watershed) to the 85th percentile value of four indicators for reference streams that have minor to negligble management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams may be impaired. In 2009 and 2013 two of the four sediment indices exceeded reference values.

Average surface fines, average sub-surface fines, and average volume of fine sediment filling pools (V*) from the 2009 and 2013 West Fork Beaver Creek response reach (wfbea1) compared to KNF Stream Sediment Monitoring reference conditions (85th percentile). [wfbea1] metrics over threshold values are bolded.

Sediment Index	2009 horse1 reach average %	2013 horse1 reach average %	Reference Condition (%)
Surface Fines < 2mm	3.1	6.1	6.4
Sub-surface fines < 0.85mm	**16.9**	**20.3**	16.2
Sub-surface fines < 6.38mm	45.5	45.5	46.1
Fraction of pools filled with fine sediment < 2mm (V star)	**0.143**	**0.124**	0.108

Based on the preceding discussion, it is my professional opinion that the functioning condition of the Sediment-Turbidity indicator is **At-Risk**; and the functioning condition of the Substrate Character indicator is **Not Properly Functioning.**

Large Woody Debris: Current LWD levels are likely low in WF Beaver Creek streams because: (1) there was extensive upslope stand-replacement timber harvest that has not recovered long enough to provide LWD-sized trees for recruitment, (2) there is a very high density of road-stream crossings where vegetation is kept cleared, where large hazard trees are felled, and where people have access to and remove standing trees and LWD, (3) the inner gorge road on the north bank of mainstem WF Beaver Creek is a major factor in limiting the amount of LWD that can grow, fall into, or be left in the mainstem, and (4) fish habitat surveys have identified a lack of LWD in Beaver Creek watershed streams (1996 Beaver WA). **Not Properly Functioning**.

Pool Frequency and Quality: The 1997 New Year Flood triggered 19 major road failures, activated or caused five landslides, and altered three miles of stream channel or about 20% of the stream channels in the Lower WF Beaver Creek composite watershed. In addition, there were numerous major road failures and landslides in the HUC14 watersheds upstream of Lower WF Beaver Creek that likely delivered excess sediment to the lower mainstem. There were few pools during a stream survey in 1989-90 (Horse WA) suggesting that pools may have been partially or completely filled in with excessive sediment. The 1996 Beaver Creek Watershed Analysis stated that all surveyed streams [in the Beaver Creek watershed] are severely lacking pools; probably a result of excessive sediment inputs. Altered channels appear to be recovering but likely very slowly due to continuing high CWEs from the road system. Width-to-depth ratio may still be slightly increased, and pool depth might still be slightly decreased, compared to reference conditions. Results of 2009 and 2013 sediment monitoring suggest that excess sediment is still being delivered to mainstem WF Beaver Creek. **At-Risk**.

Off-channel Habitat: Not applicable in the Rosgen A-, B-, C-, and G-channel types of lower WF Beaver Creek and tributaries. Off-Channel habitat development is not characteristic of these channel types. **NA**

Refugia: Cool water and cover are the primary elements of fish refugia in this watershed. Summer water temperature is within the optimum to suitable range for salmonids but fish cover is inadequate due to low frequency of deep pools and deficiency of LWD. **At-Risk**.

Width-to-Depth Ratio: See discussion for Pool Frequency and Quality indicator above. **At-Risk**.

Streambank Condition: The 1997 Flood altered about 20% of the channels in the Lower WF Beaver Creek watershed and recovery is still taking place. Road-stream crossing density is extremely high and there is disturbance of the streambank at each stream crossing from clearing vegetation, grading, compacting, and removing hazard trees. The numerous disturbances could be cumulative particularly when there are multiple stream crossings on the same streams as there are on several tributaries to lower WF Beaver Creek. The entire length of lower WF Beaver Creek mainstem has a road constructed within the inner gorge (NFTS 47N01) on the north side of the stream. Segments of that road prism actually comprise the streambank where rip-rapping has been placed to prevent the road from washing out. The riparian zone on the south side of mainstem WF Beaver Creek is relatively undisturbed. About 336 acres of stream course RR burned in the 2014 Beaver Fire but only eight acres burned at moderate to high severity. **At-Risk**.

Floodplain Connectivity: Not applicable in the Rosgen A-, B-, C-, and G-channel types of Lower WF Beaver Creek and tributaries. Floodplains are not characteristic of these channel types. **NA**

Flow/Hydrology

Change in Peak and Base Flow: Road density is very high, stream crossing density is extremely high, and there has been little maintenance or storm proofing on these roads except for repairing major road failures after the 1997 Flood, therefore, potential for hydrologic connectivity of the road system to the stream network is high. The main road running up Lower WF Beaver Creek is constructed within a tight inner gorge and there is no way that this road can

be hydrologically disconnected from the stream network. Modeled runoff risk is ratio is well over threshold (ERA/TOC = 1.31). **Not Properly Functioning**.

Increase in Drainage Network: Road density is very high at 5.9 miles of road per square mile of watershed and 22% of the road system is hydrologically connected to the stream network. **Not Properly Functioning**.

Watershed Conditions

Road Density/Location: Road density is very high at 5.9 miles of road per square mile of watershed and 22% of the road system is hydrologically connected to the stream network. Road-stream crossing density is extremely high (about half the tributaries to Lower WF Beaver Creek have three or more road-stream crossings). The entire length of WF Beaver Creek Road (NFTS Road 47N01) is constructed within stream buffer RRs and much of the road prism is near the streambank within a tight inner gorge. The inner gorge road is rip-rapped in several locations to prevent the road from washing out. The inner gorge road on the north bank precludes development of riparian vegetation and delivery of LWD to the channel from that side of the stream. **Not Properly Functioning**.

Disturbance History/Regime:

The 1997 New Year Flood triggered 15 major road failures, activated or caused nine landslides, and altered three miles of stream channel or about 20% of the stream channels in the Lower WF Beaver Creek composite watershed. The channel is still recovering but likely very slowly due to continuing high CWEs from the road system.

The largest disturbance factor in the Lower WF Beaver Creek watershed is by far the high density and poorly located road system. Past stand-replacement forestry is a distant second source of watershed disturbance and 2014 Beaver Fire effects is a lagging third source of disturbance.

Modeled surface erosion risk is not properly functioning (USLE = 1.65) and is well over threshold, modeled mass wasting risk is just at threshold (GEO = 1.05), and runoff risk is at-risk (ERA/TOC = 1.31) and at threshold. **Not Properly Functioning**.

Riparian Reserves: The 1997 Flood altered about 20% of the channels in the Lower WF Beaver Creek HUC14 watershed adversely affecting streambanks and removing riparian vegetation. Riparian vegetation is largely recovered from the flood.

Road-stream crossing density is extremely high and there is disturbance of the streambank and stream buffer at each stream crossing from clearing vegetation, grading, compacting, and removing hazard trees – the numerous disturbances add up to a significant impact especially when there are multiple stream crossings on the same streams as there are on several tributaries to lower WF Beaver Creek. The entire length of WF Beaver Creek Road (NFTS Road 47N01) is constructed within stream buffer RRs and much of the road prism is near the streambank within a tight inner gorge. This inner gorge road precludes development of riparian vegetation on that side of the creek, destabilizes the inner gorge, and chronically and acutely (during storms) delivers sediment directly into WF Beaver Creek. There are also short road segments that are located on toe zone in the HUC14. There has been past (over 15 years ago) stand-replacement timber harvest and road building on National Forest lands that would now be protected within

stream buffer RRs or geologic RRs, and there has been past and current timber harvest on private lands in riparian and upslope areas that would be considered stream buffer RR or geologic RR if the land was National Forest.

The 2014 Fire caused 25% or greater basal area mortality on only five acres of unstable ground RR and eight acres of hydrologic RR. **At-Risk**.

PROJECT AND SITE #

Westside Fire Recovery, Middle Elk Creek 7th Field Watershed Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** Middle Elk 7th Field Watershed			**EFFECTS OF THE ACTION(S)** Middle Elk 7th Field Watershed		
	PROPERLY FUNCT	AT RISK	NOT ROP FUNCT	RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	**TEMP**					
Sediment-Turbidity	**SED KNF GIS PO/ PJ**					
Chemical Contamination	**ND/PO/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character	**SED KNF GIS PO/ PJ**					
Large Woody Debris	**PO / PJ**					
Pool Frequency/Quality	**PO/ PJ**					
Off-channel Habitat	**NA**					
Refugia	**TEMP PO / PJ**					
Channel Cond & Dyn Width-to-Depth Ratio	**KNF GIS PO/ PJ**					
Streambank Condition		**KNF GIS PO / PJ**				
Floodplain Condition	**NA**					
Flow /Hydrology Change in Peak/Base Flow			**KNF GIS**			
Drainage Network Increase		**KNF GIS PJ**				
Watershed Cond. Road Density/Location	**KNF GIS RSS**					
Disturbance History/Regime		**KNF GIS PO / PJ**				
Riparian Reserves			**KNF GIS PO / PJ**			

TEMP = Water temperature monitoring of mainstem Elk Creek upstream of Bear Creek confluence from 2010 to 2014; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory; **ND** = No Data; **PJ** = Professional Judgment; **PO** = Personal Observation based on 20+ years observing; NA = Not Applicable; **SED =** 2009 and 2012 KNF Sediment Assessment Survey; **RSS =** KNF Road Sediment Source Inventory and Risk Assessment (USDA 2012); **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015); **Environmental Baseline and Checklist last updated by Jon Grunbaum on March 2, 2015.**

The Middle Elk 7th-field watershed (HUC14) is a composite watershed with an area of 2,727 acres. The composite watershed is 100% National Forest land, and a small fraction of the composite watershed is within the Marble Mountain Wilderness. Mainstem Elk Creek is a

fourth-order stream (Strahler 1957) and the principle stream in the composite watershed. There are two 2nd-order, several 1st-order, and several intermittent and emphemeral tributaries to mainstem Elk Creek in the composite watershed but none are named and none are fish-bearing. The (approximate) 2.4 miles of mainstem Elk Creek within the Middle Elk composite watershed provides habitat for winter steelhead and resident rainbow trout, and is suspected coho salmon habitat, although few coho have been seen as high as Bear Creek (which is just downstream from the Middle Elk watershed boundary) in annual surveys conducted over the last 20 years. A few summer steelhead and spring Chinook have been seen in mainstem Elk Creek in the Middle Elk composite watershed in surveys over the past 20 years. Fall Chinook generally do not spawn or rear as far upstream as the Middle Elk composite watershed. The last survey of mainstem Elk Creek within the Middle Elk composite watershed was summer 1997 but this survey is no longer current because the 1997 Flood altered the channel of mainstem Elk Creek. Lower mainstem Elk Creek just downstream of the Middle Elk composite watershed was surveyed in 1997/98 and 2006. The 1997/98 stream survey of mainstem Elk Creek is no longer valid because the channel and aquatic habitats have greatly recovered from the 1997 Flood (but the survey is useful for demonstrating recovery). In developing the Environmental Baseline for the Middle Elk composite watershed, the 2006 stream survey of lower mainstem Elk Creek just downstream from the Middle Elk composite watershed was used as surrogate for estimating aquatic habitat conditions in mainstem Elk Creek within the Middle Elk composite watershed.

Middle Elk 7th-Field (HUC14) Watershed Environmental Baseline Elements:

WATER QUALITY

Water temperature: Summer water temperature in mainstem Elk Creek within the Middle Elk Creek HUC14 just upstream of the Bear Creek confluence was monitored from 2010 to 2014 – see table below for a summary of monitoring results. In this five year period of record the maximum instantaneous water temperature ranged from 18.1°C to 22.2°C; the maximum weekly average temperature (MWAT) ranged from 15.3 °C to 18.3°C; and the maximum weekly maximum temperature ranged from 17.8°C to 21.4°C. Near record low base flows may have been a primary factor in the much higher than average water temperatures and large diurnal temperature variation in 2014. It is likely that the rate and magnitude of stream heating and cooling will increase due the 2014 Happy Camp Complex Fire because: (1) the wildfire burned large swaths of riparian vegetation that had provided shade and thermal buffering to stream channels, (2) pools are likely to infill or partially infill with excess sediment which will increase surface area to volume ratio, and (3) the wildfire is likely to significantly increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. The condition of the water temperature indicator is just barely in the **Properly Functioning** range.

Recent Water Temperature Monitoring Results for mainstem Elk Creek Upstream of Bear Creek Confluence						
Start	**End**	**Max Daily Max Temp C**	**Max Average Daily Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp C (MWMT)**
7/7/2010	10/1/2010	19.7	17.2	5.0	16.5	19.1
6/10/2011	10/5/2011	18.1	15.5	5.0	15.3	17.8
6/7/2012	9/27/2012	20.1	17.1	5.3	16.6	19.3
6/5/2013	9/29/2013	21.6	18.6	5.7	17.7	20.5
5/23/2014	9/30/2014	22.2	19.0	6.2	18.3	21.4

Sediment - Turbidity: See discussion for Substrate Character indicator below At-Risk.

Chemical Contamination: No significant source of chemical contamination is known to exist. Properly Functioning.

HABITAT ACCESS

Physical Barriers: There are no roads or stream crossings. No barriers to fish or aquatic organism passage are known to exist. **Properly Functioning**.

HABITAT ELEMENTS

Substrate Character: The results of 2009 and 2012 intensive monitoring and evaluation of sediment in mainstem Elk Creek in the Middle Elk HUC14 that included the metrics: percent surface fines < 2mm, percent sub-surface sediment < 0.85mm, percent sub-surface sedient < 6.38mm, and percent residual pool volume filled with fine sediment (V*), is shown in the table below. Substrate quality in the Middle Elk HUC14 was evaluated by comparing the four sediment indicators in mainstem Elk Creek to the 85th percentile value of the four indicators for pooled reference streams that have minor to negligble management-related watershed disturbance. Watersheds exceeding the 85% percentile of reference streams may have impaired sediment regime. In 2009 three of the four sediment indices exceeded reference values; and in 2012 two of the four sediment indices exceeded reference values.

Average surface fines, average sub-surface fines, and average volume of fine sediment filling pools (V*) from the 2009 and 2012 Elk Creek response reach (elk4) compared to KNF Stream Sediment Monitoring reference conditions (85th percentile). (elk4) metrics over reference values are bolded.

Sediment Index	2009 Elk4 reach average %	2012 Elk4 reach average %	Reference Condition (%)
Surface Fines < 2mm	4.2	3.8	6.4
Sub-surface fines < 0.85mm	**20.8**	**17.7**	16.2
Sub-surface fines < 6.38mm	**61.6**	**56.2**	46.1
Fraction of pools filled with fine sediment < 2mm (V star)	**0.121**	0.043	0.108

The Elk4 site monitors a HUC12 reference watershed : the 2007 Elk Fire and 2008 Panther Fire likely contributed to the sediment indices being over reference values in this reference watershed – particularly the 2008 Panther Fire that severely burned much of this HUC14 resulting in debris flows in most of the tributaries that was delivered to mainstem Elk Creek.

The 1987 Fire, the 2007 Elk Fire, the 2008 Panther Fire, and the 2014 Happy Camp Complex Fire have likely significantly increased the rate of erosion and sediment delivery to streams. The frequency, magnitude and duration of turbidity and fine sediment delivery due to surface erosion is likely to be elevated for a few years until vegetation gets re-established and ground cover is largely recovered in burned areas. The volume of fine and coarse sediment delivery to streams due to mass wasting is likely to be excessive for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots.

No recent surveys or observations have been made of mainstem channel condition in the Middle Elk HUC14 since the 2014 Fire, however, sand is notably decreasing the volume of pools in the lower mainstem (personal observation of myself and River Ranger David Payne in February 2015) and I suspect that excess sand is accumulating in the mainstem within the Middle Elk HUC14 as well.

Modeled surface erosion risk is low (USLE = 0.12) because ground cover has largely recovered from the 2008 Panther Fire that was far more severe and widespread that the 2014 Fire that largely burned at low severity. Modeled mass wasting is way over threshold (GEO = 2.85); and modeled runoff risk is well over threshold (ERA/TOC = 1.40). Therefore, sediment delivery rate to mainstem Elk Creek is likely to remain excessive for at least the short-term (10 years). A**t-Risk**.

Large Woody Debris: The only past and current management actions that could affect the growth of large streamside trees, the recruitment of large trees into the stream channel, and the residence time of LWD in channels within the Middle Elk HUC14 is: (1) construction and maintenance of a foot-trail on one side of the creek and (2) fire suppression actions. Neither of these actions independently or combined has been of great enough magnitude to significantly affect the process of LWD recruitment and retention. Therefore, the condition of the large woody debris indicator is **Properly Functioning**. Much LWD is being recruited to the stream channel due to the 2008 Panther Fire that killed a lot of streamside conifers that are now falling.

Pool Frequency/Quality: Past and current management actions that could affect the Pool Frequency/Quality and Width-to Depth Ratio indicators are: (1) construction and maintenance of a foot-trail on one side of the creek and (2) fire suppression actions. These types of actions could affect pool frequency/quality and width-to depth ratio by cutting down large streamside trees and/or bucking up LWD that is lying in the channel so that the scour, sediment sorting, and cover functions of LWD is diminished. However, neither of these actions independently or combined has been of great enough magnitude to significantly affect the process of LWD recruitment and retention. **Properly Functioning**. However, increased erosion from the 2008 Panther Fire that burned large areas of the Middle Elk HUC14 at moderate to high severity has increased sediment delivery to the mainstem and may be reducing pool volume. Increase in sedimentation of mainstem Elk Creek has also increased due to the 2014 Happy Camp Complex fire that burned 512 acres of stream buffer RR at moderate to high intensity in the Middle Elk HUC14 and in contributing HUC14s. Therefore, the pool frequency/quality and width-to depth ratio indicators could become at-risk in the near future. No recent surveys or observations have been made of channel condition in the Middle Elk HUC14 since the 2014 Fire, however, sand is notably decreasing the volume of pools in the lower mainstem (personal observation of myself and River Ranger David Payne in February 2015) and is likely decreasing the volume of pools and the quality of spawning gravels in the Middle Elk HUC14.

Off-Channel Habitat: There is no potential for development of off-channel habitats in the Rosgen A-, B-, and G-channel types of mainstem Elk Creek or the A- and B-channel types of Middle Elk HUC14 tributaries. Off-channel habitat development is not characteristic of these channel types. **NA**.

Refugia: Cold water and cover are the primary elements of fish refugia in this watershed. Water temperature is Properly Functioning in Middle Elk Creek and there is good cover provided by boulders and LWD (that is actively recruiting to the channel due to the 2008 Panther Fire that killed large trees along extensive segments of the mainstem). **Properly Functioning**.

CHANNEL CONDITION AND DYNAMICS

Width to Depth Ratio: See discussion for Pool Frequency/Quality indicator above. **Properly Functioning**.

Streambank Condition: Much of the streambank of mainstem Elk Creek was scoured during the 1997 Flood, however, many reaches are constrained transport reaches with bedrock banks that changed little during the flood. High water and debris flows during the flood did remove riparian vegetation (mainly alder and willow) in places which is re-growing. The channel alteration from the flood is considered natural since there was negligible management disturbance in or upstream from the Middle Elk HUC14 prior to the flood. Recovery of flood-altered channels was progressing well until the 2008 Panther Fire hit which burned large swaths of stream buffer RR along the mainstem and tributaries at moderate to high severity – which later resulted in debris flows down most of the tributaries which altered those tributary channels and streambanks. The 2014 Happy Camp Complex burned 8% of the stream buffer RRs at moderate to high intensity. So, vegetation on streambanks is in early stages of recovery along miles of stream. Construction and maintenance of a trail on one side of the mainstem causes minor isolated streambank disturbances at stream crossings. **At-Risk**.

Floodplain Connectivity: Floodplain is not characteristic of the constrained Rosgen A-, B-, and G-channel types in the Middle Elk HUC14 composite watershed. There are no floodplains. **NA**.

FLOW/HYDROLOGY

Change in Peak/Base Flow: There is no road, landings, stand-replacement forestry or other significant management disturbance in the Middle Elk HUC14 or any of the HUC14s upstream of Middle Elk. It could be argued that fire suppression was a management action that contributed to the large area of moderate to high severity burn that occurred in the 2008 Panther Fire and 2014 Happy Camp Complex Fire. Modeled runoff risk is way over threshold (ERA/TOC = 1.40) due almost entirely to the 2008 and 2014 fires. **Not Properly Functioning**.

Increase in Drainage Network: There is negligible road mileage so there is negligible potential for road-related hydrologic connectivity that could increase drainage network. There is a trail system in the composite watershed but this disturbance to too minor to have any significant effect on the extent of drainage network. Overland flow and the extent of the drainage network will be increased in watershed areas that burned at moderate to high intensity until vegetation and ground cover is well on the way to recovery. **At-Risk**.

WATERSHED CONDITION

Road Density/Location: Road density is extremely low (0.05 mile per square mile of watershed) within the Middle Elk composite watershed, and there are no valley bottom roads. **Properly Functioning**.

Disturbance History/Regime: There is little road (0.05 mile) in the composite watershed and there has been minor past timber harvest and salvage.

The 1997 New Year Flood altered about half the channels in the composite watershed, including the entire length of mainstem Elk Creek, and many tributaries on the south side of the watershed that drain the 1987 Fire area. The debris torrents that altered mainstem Elk Creek in the Middle Elk Creek composite watershed appeared to derive from natural sources such as landslides originating on un-managed ground in wilderness upstream from the Middle Elk Creek composite watershed and from sensitive ground (granitic plutons) within the Middle Elk Creek composite watershed where the 1987 Fires burned at moderate to high intensity. Therefore, much of the 1997 channel alteration of mainstem Elk Creek within the Middle Elk composite watershed was within the range of natural variability. Stream channels that were altered in the 1997 Flood are mostly recovered; vegetation on streambanks is still recovering.

Existing disturbance affecting watershed function is almost entirely from wildfires in 1987, 2007, 2008, and 2014 – particularly the 2008 Panther Fire that burned much of the Middle Elk HUC14 at moderate to high severity resulting in debris flows that altered most of the tributary channels and that delivered large volumes of sediment to mainstem Elk Creek. It could be argued (but not proven) that fire suppression was a primary factor that contributed to the large areas of moderate to high severity burn that is outside of the range of natural variability. Modeled surface erosion risk is low (USLE = 0.12) because ground cover has largely recovered from the 2008 Panther Fire that was far more severe and widespread that the 2014 Fire that largely burned at low severity. Modeled mass wasting is way over threshold (GEO = 2.85); and modeled runoff risk is well over threshold (ERA/TOC = 1.40). Therefore, sediment delivery rate to mainstem Elk Creek is likely to remain excessive for at least the short-term (10 years). **At-Risk.**

Riparian Reserves: There is hardly any road (0.05 mile) and no stream crossings in the Middle Elk Creek composite watershed, and there is minor disturbance from past timber harvest/salvage. The 1987 Fires damaged some stream buffers but these were largely recovered to the point that tributary channels were well-shaded prior to the 2008 Panther Fire. The 2007 Elk Fire burned intensely in some stream buffers but most stream buffers were un-affected and only a total of 28 acres of stream buffer burned at moderate to high intensity. The 2008 Panther Fire burned the stream buffer along most of the length of mainstem Elk Creek in the Middle Elk HUC14 at moderate to high severity killing most of the large conifers that dominated the riparian zone, and burned large swaths of riparian vegetation along the tributaries which later experienced debris flows that reset the channel and streambanks. The 2014 Happy Camp Complex burned 8% of the stream buffer in the HUC14 at moderate to high severity; and burned at moderate to high severity on 27 acres of active landslide, 7 acres of toe zone, and 42 acres of inner gorge. **Not Properly Functioning**.

PROJECT AND SITE #

Westside Fire Recovery, O'Neill Creek 7th Field Watershed Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** O'Neil Creek 7th-Field Watershed PROPERLY FUNCT	AT RISK	NOT PROP FUNCT	**EFFECTS OF THE ACTION(S)** O'Neil Creek 7th-Field Watershed RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	**TEMP**					
Sediment-Turbidity			**KNF GIS ND/PO/PJ**			
Chemical Contamination	**ND/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character			**KNF GIS ND/PO/PJ**			
Large Woody Debris	**KNF GIS PJ**					
Pool Frequency/Quality		**KNF GIS ND/PO/PJ**				
Off-channel Habitat	**NA**					
Refugia	**TEMP PJ**					
Channel Cond & Dyn Width-to-Depth Ratio		**KNF GIS Flood ND/PO/PJ**				
Streambank Condition		**KNF GIS Flood ND/PO/PJ**				
Floodplain Condition	**NA**					
Flow /Hydrology Change Peak/Base Flow		**KNF GIS RSS ND/PJ**				
Drainage Network Increase			**KNF GIS RSS ND/PJ**			
Watershed Cond. Road Density/Location			**KNF GIS**			
Disturbance History/Regime			**KNF GIS RSS Flood ND/PO/PJ**			
Riparian Reserves			**KNF GIS ND/PO/PJ**			

TEMP = Water temperature monitoring of O'Neil Creek near mouth from 2010 to 2014; **FPI** = Fish Passage Inventory (KNF, 2003); **ND** = No data; **NA** = Not Applicable; **PO** = Personal Observation; **PJ** = Professional Judgment; **Flood** = 1997 KNF Flood Assessment; **RSS =** KNF Road Sediment Source Inventory and Risk Assessment (USDA 2012); **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015) **Environmental Baseline and Checklist completed by Jon Grunbaum, March 6, 2015.**

O'Neil Creek 7th field (HUC14) watershed is a true watershed with an area of 2,429 acres. Mainstem O'Neil Creek is a 2rd-order (Strahler 1957) stream and the primary stream in the watershed. There are several 1st- and zero-order tributaries to the mainstem but none are named and none are fish-bearing. Mainstem O'Neil Creek provides 0.8 miles of habitat for steelhead/rainbow trout and about a tenth of a mile of habitat for Coho salmon. There is a constructed off-channel pond on the Klamath River floodplain that is connected to O'Neil Creek that is used by Coho salmon and other salmonids. O'Neil Creek is not known to be used by Chinook salmon. Juvenile salmon and steelhead use the cool water at the mouth of O'Neil Creek for thermal refugia when the river gets too warm. There are no recent stream surveys of O'Neil Creek.

O'Neil Creek 7th-field (HUC14) Watershed Environmental Baseline Elements:

Water Quality

Temperature: Summer water temperature in mainstem O'Neil Creek just upstream from the mouth was monitored from 2010 to 2014 – see table below for a summary of monitoring results. In this four year period of record the maximum instantaneous water temperature ranged from 16.7°C to 19.1°C; the maximum weekly average temperature (MWAT) ranged from 15.4°C to 17.4°C; and the maximum weekly maximum temperature ranged from 16.4°C to 18.6°C. Near record low base flows may have been a primary factor in the much higher than average water temperature in 2014. It is possible that rate and magnitude of stream heating and cooling will slightly increase due the 2014 Happy Camp Complex Fire because: (1) the wildfire burned areas of riparian vegetation that had provided stream shade and thermal buffering to stream channels, (2) pools may partially infill with excess sediment which will increase surface area to volume ratio, and (3) the wildfire may increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. **Properly Functioning**.

Recent Water Temperature Monitoring Results for Mainstem O'Neil Creek Near Mouth						
Start	**End**	**Max Daily Max Temp C**	**Max Average Daily Temp C**	**Max Diurnal Variation Temp C**	**Maximum Weekly Average Temp C (MWAT)**	**Maximum Weekly Maximum Temp C (MWMT)**
6/28/2011	10/4/2011	16.7	15.6	2.7	15.4	16.4
6/14/2012	9/24/2012	17.8	16.9	2.9	16.4	17.4
6/7/2013	10/16/2013	18.6	17.5	2.6	16.9	17.9
5/29/2014	9/23/2014	19.1	18.0	3.0	17.4	18.6

Sediment - Turbidity: No data. Before the 2014 Happy Camp Complex burned much of the watershed it was assumed that turbidity was low and that sediment delivery, storage, and transport was near equilibrium because: (1) there is low density of stream crossings and road in stream buffers, (2) there have been no recent [25 + years] wildfires of any significance, and (3) there has been little recent stand-replacement forestry.

The 2014 Fire significantly increased rate of erosion, sedimentation, and turbidity as witnessed at the mouth of O'Neil Creek where it crosses under the Klamath River Highway. The 2014 Fire

burned about 166 acres of stream buffer RRs at moderate to high intensity which is 28% of the total stream buffer in the HUC14 watershed. This much moderate and high severity fire in hydrologic RRs is expected to significantly increase streamside mass wasting and decrease the nutrient spiraling and sediment buffering function of stream course RRs. The frequency, magnitude and duration of turbidity is likely to be elevated for at least the next the next few years until vegetation gets re-established and ground cover increases, and excess fines are winnowed out of the system. The 2014 Fire caused 25% or greater basal area mortality on 789 acres of unstable ground RR as follows: 135 acres of inner gorge [note: much of the acres of inner gorge are within hydrologic RR so these acres should not be double-counted] and 654 acres of highly dissected granitics. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the rate of mass wasting and excess sediment delivery to the stream network. Excessive delivery of fine and coarse sediment to streams due to mass wasting is likely to be excessive for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots.

Modeled surface erosion risk (USLE = 1.37) and modeled mass-wasting risk (GEO = 1.50) are way over threshold; and modeled runoff risk is moderately high (ERA/TOC = 0.80). **Not Properly Functioning**.

Chemical Contamination: No significant source of chemical contamination is known to exist in the O'Neil Creek watershed. **Properly Functioning**

Habitat Access

Physical Barriers: No man-made barriers to fish passage exists in the O'Neil Creek watershed. P**roperly Functioning.**

Habitat Elements

Substrate Character: See discussion for the Sediment–Turbidity indicator above. **Not Properly Functioning**.

Large Woody Debris: No data. It is assumed that LWD and potential for future LWD recruitment is near site-potential because there has been little timber harvest in the watershed near a stream course, there is little access to perennial streams via roads. There is very limited access to the stream so that the potential for removal of LWD and/or potential future recruitment tree from the riparian zone is small – the only access to the stream network occurs at the mouth where there is a campground and the Klamath River Highway, at one powerline crossing of the mainstem, and at several stream crossings in the headwaters. The 2014 Happy Camp Complex Fire may have burned up some streamside trees that could have become future LWD but it is more likely that the fire killed trees will recruit to the stream earlier than if they had not been killed in the fire. **Properly Functioning**.

Pool Frequency/Quality: No data. Prior to the 2014 Happy Camp Complex Fire it was assumed that the Pool Frequency/Quality indicator was properly functioning because there was very little disturbance in the watershed particularly near a stream course. The 2014 Fire caused 25% or greater basal area mortality on 789 acres of unstable ground RR. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the rate of mass wasting and excess sediment delivery to the stream network that could fill or partially infill

pools. Excessive delivery of fine and coarse sediment to streams due to surface erosion and mass wasting is likely to be excessive for a decade or more. **At-Risk.**

Off-Channel Habitat: Not applicable in the Rosgen A- and B-channel types that characterize channels in the O'Neil Creek watershed. There is negligible potential for off-channel habitat development. **NA**.

Refugia: Cold water delivered to the lower mainstem, the off-channel pond on the Klamath River floodplain, and the Klamath River is the primary element of anadromous fish refugia associated with O'Neil Creek. Water temperature is believed to be within suitable to optimal range for salmonids. **Properly Functioning**.

Channel Condition and Dynamics

Width-to-Depth Ratio: No data. The rate of debris flows is likely to increase due to large area of severe burn on 789 acres of geologic RR. Debris flows are likely to alter width-to-depth ratio by scouring V-shaped channels to U-shaped channels. Debris flows may deposit excess sediment into channels which could fill or partially fill deep spots (pools). **At-Risk**.

Streambank Condition: Prior to the 2014 Happy Camp Complex Fire streambanks were assumed to be in good condition because there has been little past timber harvest, road construction, or moderate to high severity wildfire in stream buffers.

The 2014 Fire burned about 166 acres of vegetation on streambanks at moderate to high severity. Streambanks are likely to be degraded from accelerated rate of debris flows from 789 acres of geologic RR that burned at moderate to high severity in the 2014 Fire. **At-Risk**.

Floodplain Connectivity: Not applicable in the Rosgen A- and B-channel types in the O'Neil Creek watershed. There are no floodplains. **NA**.

Flow/Hydrology

Change in Peak/Base Flow: Road density is high but only 4% of the road system is hydrologically connected to the stream network so there is little potential for drainage network increase due to roads. Overland flow and the extent of the drainage network is likely to be significantly increased in the tributary watersheds that burned in the 2014 Happy Camp Complex Fire because large areas of the watershed burned at moderate to high intensity in upslope and riparian areas. Modeled runoff risk for the entire composite watershed is moderately high (ERA/TOC = 0.80).

There is one water diversion that has a domestic use limit of 4,200 gallons per day. The campground is planning to re-build its' water system and will once again draw from O'Neil Creek (probably much less than 4,200 gallons/day). These diversions will slightly reduce base flow. **At-Risk**.

Drainage Network Increase: The road density is high at 3.3 miles of road per square mile of watershed and 4% of the road system is hydrologically connected to the stream network. Overland flow and the extent of the drainage network is likely to be significantly increased in the short term because large areas of these watersheds burned at moderate to high intensity in upslope and riparian areas. **Not Properly Functioning**.

Watershed Conditions

Road Density/Location: The road density is high at 3.3 miles of road per square mile of watershed and 4% of the road system is hydrologically connected to the stream network. There is very little valley bottom road (except for the Klamath River Highway and a short section of the campground road). **Not Properly Functioning**.

Disturbance History/Regime: There is high road density but roads are generally on ridges or upper mid-slopes and stream crossing density is low. Only about 4% of the road system is hydrologically connected to the stream network.

There were three landslides and five major road failures in the O'Neil Creek watershed during the 1997 Flood which altered about 36% of the stream channels. The channel was well into recovery when the 2014 Fire hit.

The 2014 Happy Camp Complex Fire is the primary disturbance currently affecting watershed processes. It could be argued (but not proven) that fire suppression was a primary factor that contributed to the large areas of moderate to high severity burn that is outside of the range of natural variability. About 166 acres of stream buffer RRs was burned at moderate to high intensity, which is 28% of the total stream buffer in the HUC14 watershed. This much moderate and high intensity fire in hydrologic RRs is expected to significantly increase streamside mass wasting and decrease the nutrient spiraling and sediment buffering function of stream course RRs. The 2014 Fire caused 25% or greater basal area mortality on 789 acres of unstable ground RR as follows: 135 acres of inner gorge [note: much of the 588 acres of inner gorge are within hydrologic RR so these acres may be double-counted] and 654 acres of highly dissected granitics. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the rate landsliding.

Modeled surface erosion risk (USLE = 1.37) and modeled mass-wasting risk (GEO = 1.50) are way over threshold; and modeled runoff risk is moderately high (ERA/TOC = 0.80). Roads are the primary disturbance factor in the USLE model with wildfire a close secondary factor. Wildfire is the primary disturbance factor in the mass wasting risk and runoff risk models with roads as a distant second factor. Past vegetation management and fire lines are negligible components of the total disturbance. **Not Properly Functioning**.

Riparian Reserves: Road density is high but only 4% of the road system is hydrologically connected to the stream network. Stream crossing density is low.

The function of stream buffers was adversely affected by the 1997 Flood when 36% of the channels in the watershed were altered. The channels were largely recovered when the 2014 Fire hit.

The 2014 Happy Camp Complex Fire burned about 166 acres of stream buffer RRs at moderate to high intensity (which is 28% of the total stream buffer in the HUC14 watershed) and caused 25% or greater basal area mortality on 789 acres of unstable ground RR as follows: 135 acres of inner gorge [note: much of the 588 acres of inner gorge are within hydrologic RR so these acres may be double-counted] and 654 acres of highly dissected granitics. **Not Properly Functioning**.

PROJECT AND SITE #

Westside Fire Recovery, Tom Martin Creek-Klamath River 7th Field Checklist

Pathways: **INDICATORS**	**ENVIRONMENTAL BASELINE** TomMartinCk_KlamathR HUC14 PROPERLY FUNCT	AT RISK	NOT PROP FUNCT	**EFFECTS OF THE ACTION(S)** TomMartinCk_KlamathR HUC14 RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature	**TEMP**					
Sediment-Turbidity		**KNF GIS ND/PO/PJ**				
Chemical Contamination	**ND/PJ**					
Habitat Access Physical Barrier	**FPI**					
Habitat Elements Substrate Character		**KNF GIS ND/PO/PJ**				
Large Woody Debris	**KNF GIS PJ**					
Pool Frequency/Quality		**KNF GIS ND/PO/PJ**				
Off-channel Habitat	**NA**					
Refugia	**TEMP PJ**					
Channel Cond & Dyn Width-to-Depth Ratio		**KNF GIS Flood ND/PO/PJ**				
Streambank Condition			**KNF GIS Flood ND/PO/PJ**			
Floodplain Condition	**NA**					
Flow /Hydrology Change Peak/Base Flow		**KNF GIS RSS ND/PJ**				
Drainage Network Increase		**KNF GIS RSS ND/PJ**				
Watershed Cond. Road Density/Location	**KNF GIS**					
Disturbance History/Regime			**KNF GIS RSS Flood ND/PO/PJ**			
Riparian Reserves			**KNF GIS Flood ND/PO/PJ**			

TEMP = Karuk Tribe water temperature monitoring data from 2004, 2005, and 2006; **FPI** = Fish Passage Inventory (KNF, 2003); **ND** = No data; **NA** = Not Applicable; **PO** = Personal Observation; **PJ** = Professional Judgment;**Flood** = 1997 KNF Flood Assessment; **RSS =** KNF Road Sediment Source Inventory and Risk Assessment (USDA 2012); **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015) **Environmental Baseline and Checklist completed by Jon Grunbaum, March 6, 2015.** This environmental baseline primarily covers conditions in main tributary watersheds to the Klamath River in this composite watershed. See the Mid-Klamath River Corridor Environmental Baseline for watershed, water quality, and aquatic habitat conditions in the Klamath River and in face drainages to the Klamath River.

Tom Martin-Klamath River is a composite 7th-field watershed (HUC14) of 10,690 acres. The composite watershed is 92% National Forest and the rest is mostly private residential and some industrial timberland. The composite watershed includes a 4.8 mile section of the mainstem Klamath River that supports Coho and Chinook salmon, and steelhead trout throughout its' length. There are three named 3rd-order tributaries (Mill, Macks, and Tom Martin Creeks); two named 2nd-order tributaries (Kuntz and Muck-a-Muck Creeks), three named 1st-order tributaries (Mitchell Creek, China Creek, and Hicks Gulch), and several un-named first-order tributaries and zero-order draws to the Klamath River in the composite watershed. None of these tributaries to the Klamath River support salmon except for Tom Martin Creek that provides important thermal refugia for salmon at the mouth of the creek and for several hundred feet up the creek including a constructed off channel pond fed by water from Tom Martin Creek. Tom Martin and Macks Creek support steelhead and resident rainbow trout in their lower segments (about 0.5 mile each). Kuntz, Mill, and Mitchell Creeks support resident rainbow trout in their lower segments (0.8 mile, 1.5 miles, and 0.3 mile, respectively). None of the other tributaries to the Klamath River in this composite watershed are fish-bearing. There are no known stream surveys of any of the tributaries to the Klamath River in this composite watershed.

Tom Martin-Klamath River 7th-field Watershed (HUC14) Environmental Baseline

Water Quality:

Water Temperature: Summer water temperature of Tom Martin Creek at the mouth was monitored in 2004, 2005, and 2006. The instantaneous maximum temperature recorded was 65°F in 2004 and 2005, and 66°F in 2006. There is no data on water temperatures in the other tributary streams to the Klamath River in this composite watershed but it is believed that water temperatures are properly functioning in all or nearly all these small well-shaded streams – particularly the north-facing drainages on the south side of the river. **Properly Functioning**. (Water temperature in the Klamath River is analyzed in the mid-Klamath Corridor environmental baseline and checklist).

Sediment - Turbidity: No data. Before the 2014 Happy Camp Complex burned nearly the entire composite watershed area south of the river it was assumed that turbidity was low and that sediment delivery, storage, and transport was near equilibrium because: (1) road density is low, (2) there is low density of stream crossings and road in stream buffers, (3) no recent [25 + years] wildfires of any significance, and (4) little recent stand-replacement forestry. The 2014 Fire significantly increased rate of runoff, erosion, sedimentation, debris flows, and turbidity as witnessed at the mouth of burned tributaries from where they cross with the Klamath River Highway. The frequency, magnitude and duration of turbidity is likely to be significantly elevated for at least the next the next few years until vegetation gets re-established and ground cover increases, and excess fines are winnowed out of the system. Landslide risk will be increased for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots – and excessive sediment delivery to streams is likely during this period. Modeled surface erosion risk is moderately high (USLE = 0.78); modeled mass-wasting risk is moderate (GEO = 0.44); and modeled runoff risk is moderate (ERA/TOC = 0.53). **At-Risk**.

Chemical Contamination: No significant source of chemical contamination is known to exist in the tributaries to the Klamath River in this composite watershed. **Properly Functioning**. (Water

quality in the Klamath River is analyzed in the mid-Klamath Corridor environmental baseline and checklist).

Habitat Access

Physical Barriers: An inventory of fish passage barriers related to roads was completed in this HUC14 and no man-made barriers were found on National Forest land without easement. The Klamath River Highway degrades habitat and poses passage problems because it crosses the mouths of all the tributaries on the south side of the river, however, there is no or not much suitable steelhead or salmon habitat upstream of the highway. **Properly Functioning**.

Habitat Elements

Substrate Character: See discussion for the Sediment–Turbidity indicator above. **At-Risk**.

Large Woody Debris: No data. It is assumed that LWD and potential for future LWD recruitment is near site-potential because there has been little timber harvest in the watershed near a stream course, there is little access to perennial streams via roads. There is very limited access to the stream so that the potential for removal of LWD and/or potential future recruitment tree from the riparian zone is small – the only access to the stream network occurs: (1) near the mouths of tributaries where there are private parcels and the Klamath River Highway and (2) at one powerline crossing of the tributary watersheds. The potential for growing large trees is significantly diminished on private lands on the south side of the river that were hydraulically mined leaving no topsoil and compacted ground. The 2014 Happy Camp Complex Fire may have burned up some streamside trees that could have become future LWD but it is more likely that the fire killed trees will recruit to the stream earlier than if they had not been killed in the fire. **At-Risk**.

Pool Frequency/Quality: No data. Many of the tributary channels on the south side of the river have already had debris flows that are largely the after-effect of heavy rain on severely burned ground from the 2014 Happy Camp Complex Fire. More 2014 Fire related debris flows are likely to occur over the next decade of longer. Channels of tributaries on the south side of the river are being scoured by debris flows and more is expected. Debris flows in south-side tributaries are likely to reduce pool frequency and depth due to sediment in-filling and loss of channel structure. **At-Risk.**

Off-channel Habitat: Not applicable in the Rosgen A- and B-channel types that characterize the Klamath River tributaries in this watershed. **NA**.

Refugia: Cold water delivered to the Klamath River by the tributaries is the primary element of anadromous fish refugia that is contributed by Klamath River tributaries in this watershed. Water temperatures are believed to be within suitable to optimal range for salmonids in all or nearly all the small well-shaded tributaries to the Klamath River in the composite watershed. **Properly Functioning**.

Channel Condition and Dynamics

Width-to-Depth Ratio: No data. Many of the tributary channels on the south side of the river have already had debris flows that are largely the after-effect of heavy rain on severely burned ground from the 2014 Happy Camp Complex Fire. More 2014 Fire related debris flows are likely to occur over the next decade of longer. Channels of tributaries on the south side of the

river are being scoured by debris flows and more is expected. Debris flows are likely to alter width-to-depth ratio by scouring V-shaped channels to U-shaped channels. **At-Risk**.

Streambank Condition: Prior to the 2014 Happy Camp Complex Fire streambanks in tributaries were assumed to be in good condition because there has been little past timber harvest, road construction, or moderate or intense wildfire in stream buffers. Channel alteration that occurred during the 1997 Flood was assumed to be well on the way to recovery because overall watershed disturbance was low.

The 2014 Fire burned much of the ground on the south side of the river – about 4,200 acres. About 951 acres of stream buffer RRs was burned at moderate to high intensity, which is 39% of the total stream buffer in the *entire* HUC14 composite watershed, therefore, *much* of the stream buffer on the south side of the river burned at moderate to high intensity. Many of the tributary channels on the south side of the river have already had debris flows that are largely the after-effect of heavy rain on severely burned ground from the 2014 Fire. More 2014 Fire related debris flows are likely to occur over the next decade of longer. Streambanks of tributaries on the south side of the river are in poor condition due to loss of vegetation and accelerated rate of debris flows. **Not Properly Functioning**.

Floodplain Connectivity: Not applicable in the Rosgen A- and B-channel types that characterize the Klamath River tributaries in this composite watershed. There are no floodplains. **NA**.

Flow/Hydrology

Change in Peak/Base Flow: Road density is low and only 3% of the road system is hydrologically connected to the stream network so there is little potential for drainage network increase due to roads. Overland flow and the extent of the drainage network is likely to be significantly increased in the tributary watersheds that burned in the 2014 Happy Camp Complex Fire because large areas of these watersheds burned at moderate to high intensity in upslope and riparian areas. Modeled runoff risk for the entire composite watershed is moderate (ERA/TOC = 0.53), however, nearly all the disturbance in the model is from the 2014 which burned only on the south side of the river on about 2/3 of the composite watershed. Therefore, modeled runoff risk would be considerably higher, possibly near threshold, if just the burned area (south side of the river) of the composite watershed was modeled.

There are numerous domestic water diversions from tributaries on the south side of the river in this composite watershed that undoubtedly reduce base flow but the details of the diversions are not known. **At-Risk**.

Drainage Network Increase: Road density is low and only 3% of the road system is hydrologically connected to the stream network so there is little potential for drainage network increase due to roads. Overland flow and the extent of the drainage network is likely to be significantly increased in the tributary watersheds that burned in the 2014 Happy Camp Complex Fire because large areas of these watersheds burned at moderate to high intensity in upslope and riparian areas. **At-Risk**.

Watershed Conditions

Road Density/Location: The road density is low at 1.4 miles of road per square mile of watershed and 3% of the road system is hydrologically connected to the stream network. There

is very little valley bottom road (except for the Klamath River Highway and roads/compaction on private lands). **Properly Functioning**.

Disturbance History/Regime: There is low disturbance from timber harvest and roads in the composite watershed on National Forest lands. Roads are generally on ridges or upper mid-slopes and stream crossing density is low. Only about 3% of the road system is hydrologically connected to the stream network. Much of the watershed area on the south side of the Klamath River is released roadless area. There is considerable disturbance from past mining, roads, and development on some of the private land along the south side of the river in the Hamburg vicinity.

There were seven major road failures in the Tom Martin-Klamath River composite watershed during the 1997 Flood which altered about 7% of the tributary channels. Short sections of Mill, Macks, and Tom Martin Creeks were altered but there was no obvious link between channel alteration and past management and the channel alteration was likely within the range of natural variability.

There was a small fire (less than 40 acres) in 2007 that burned primarily at low intensity and is not a significant watershed concern.

The 2014 Happy Camp Complex Fire is the primary disturbance currently affecting watershed processes in the portion of the composite watershed south of the Klamath River. It could be argued (but not proven) that fire suppression was a primary factor that contributed to the large areas of moderate to high severity burn that is outside of the range of natural variability. The 2014 Fire burned most of the ground on the south side of the river – about 4,200 acres. About 951 acres of stream buffer RRs was burned at moderate to high intensity, which is 39% of the total stream buffer in the *entire* HUC14 composite watershed, therefore, much of the stream buffer on the south side of the river burned at moderate to high intensity. This much moderate and high intensity fire in hydrologic RRs is expected to significantly increase streamside mass wasting and decrease the nutrient spiraling and sediment buffering function of stream course RRs. The 2014 Fire caused 25% or greater basal area mortality on 630 acres of unstable ground RR as follows: 28 acres of active landslide; 23 acres of toe-zone; and 588 acres of inner gorge [note: much of the 588 acres of inner gorge are within hydrologic RR so these acres should not be double-counted]. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the rate landsliding.

Modeled surface erosion risk is moderately high (USLE = 0.78); modeled mass-wasting risk is moderate (GEO = 0.44); and modeled runoff risk is moderate (ERA/TOC = 0.53). Modeled watershed disturbance is primarily due to the 2014 Fire with roads as a distant second. Past vegetation management and 2014 fire lines are small components of the total disturbance. **Not Properly Functioning**.

Riparian Reserves: Road and stream crossing density is low with stream buffer RRs.

The function of stream buffers were adversely affected by the 1997 Flood when 7% of the channels in the composite watershed were altered, however, this much channel alteration during a major flood was likely within the range of natural variability.

About 951 acres of stream buffer RRs was burned at moderate to high intensity, which is 39% of the total stream buffer in the *entire* HUC14 composite watershed, therefore, much of the stream buffer on the south side of the river burned at moderate to high intensity. The 2014 Fire caused

25% or greater basal area mortality on 630 acres of unstable ground RR as follows: 28 acres of active landslide; 23 acres of toe-zone; and 588 acres of inner gorge [note: much of the 588 acres of inner gorge are within hydrologic RR so these acres are double-counted]. **Not Properly Functioning**.

PROJECT AND SITE #

Westside Fire Recovery Walker Creek 7th Field Watershed Checklist

Pathways: **INDICATORS**	ENVIRONMENTAL BASELINE **Walker Creek 7th-field watershed** PROPERLY FUNCT	AT RISK	NOT PROP FUNCT	EFFECTS OF THE ACTION(S) **Walker Creek 7th-field watershed** RESTORE	MAINTAIN	DEGRADE
Water Quality Temperature		TEMP				
Sediment-Turbidity			SS07/08 KNF CWE PO PJ			
Chemical Contamination	ND/PJ					
Habitat Access Physical Barrier	FPI					
Habitat Elements Substrate Character			SS07/08 KNF CWE PO PJ			
Large Woody Debris			SS07/08			
Pool Frequency/Quality		Flood SS07/08				
Off-channel Habitat		PO				
Refugia		TEMP SS07/08				
Channel Cond & Dyn Width/Depth Ratio			Flood SS07/08			
Streambank Condition			SS07/08 Flood KNF GIS			
Floodplain Condition		PO				
Flow /Hydrology Change in Peak/Base Flow			KNF GIS RSS			
Drainage Network Increase		KNF GIS RSS				
Watershed Cond. Road Density/Location			KNF GIS			
Disturbance History/Regime			KNF GIS Flood			
Riparian Reserves			KNF GIS Flood			

TEMP = Water temperature monitoring near mouth of Walker Creek from 2010 to 2014; **FPI** = KNF Forest-Wide Fish Passage Barrier Inventory; **SS97/98** =1997 and 1998 KNF stream surveys of the lower mainstem of Walker Creek; **RSS =** 1999 KNF Road Sediment Source Inventory and Risk Assessment; **Flood** = KNF analysis of the 1997 New Years Flood; **ND** = No Data; **PJ** = Professional Judgment; **PO** = Personal Observation based on 20+ years observing; **NA** = Not Applicable; **KNF GIS** = KNF GIS database query and CWE modeling for WFR Project (Fall 2014 to Winter 2015). Environmental Baseline completed by Jon Grunbaum on February 10, 2015.

The Walker Creek 7th-field watershed (or HUC14) is a true watershed of 7,635 acres. Walker Creek is 99% National Forest land and 1% private residential land. Walker Creek is a 4rd-order (Strahler 1957) stream and is the primary stream in the watershed. Walker Creek has numerous zero- to 1st-order tributaries, one 2nd-order tributary, and two 3rd-order tributaries. The only named tributary is East Fork Walker Creek (2nd-Order). Walker Creek supports resident rainbow trout in the lowest 6.1 miles of mainstem, steelhead trout in the lower 4.8 miles, and coho salmon in the lower 2.1 miles. Chinook are not documented in Walker Creek. The tributaries to Walker Creek are non fish-bearing. The last stream survey of the entire mainstem of Walker Creek was in summer 1998. Approximately 0.60 mile of mainstem Walker Creek was surveyed in 2007.

Walker Creek 7th-field watershed Environmental Baseline elements:

Temperature: Summer water temperature was monitored near the mouth for most years from 1997 to 2014 – monitoring results for the last five years is given in the table below. In the five year period of record the maximum instantaneous water temperature ranged from 18.2 ^{o}C to 20.4 ^{o}C; the maximum weekly average temperature (MWAT) ranged from 15.7 ^{o}C to 17.5^{o}C; and the maximum weekly maximum temperature ranged from 17.7 ^{o}C to 19.9^{o}C. Although water temperature in mainstem Walker Creek has been within the properly functioning range in the last five years it is likely that the rate and magnitude of stream heating and cooling will significantly increase due the 2014 Fire because: (1) the wildfire burned large swaths of riparian vegetation that had provided shade to stream channels, (2) pools are likely to infill or partially infill with excess sediment which will increase surface area to volume ratio, and (3) the wildfire is likely to significantly increase the frequency of in-channel debris flows and upslope landslides that can remove riparian vegetation and widen-and-shallow stream channels. **At-Risk**.

Recent Water Temperature Monitoring Results for Mainstem Walker Creek Near Mouth

Start	End	Daily Average Temp C	Daily Max Temp C	Daily Min Temp C	Diurnal Variation Temp C	Maximum Weekly Average Temp C (MWAT)	Maximum Weekly Maximum Temp C (MWMT)
6/27/2010	10/8/2010	18.2	20.4	9.6	6.6	17.5	19.9
6/7/2011	10/5/2011	16.1	18.2	8	6.1	15.7	17.7
6/13/2012	9/25/2012	17.0	18.5	9.8	5.3	16.5	18.1
4/26/2013	9/30/2013	17.9	19.6	6	5.6	17.2	18.9
5/29/2014	9/23/2014	18.1	19.9	8.8	5	17.4	19.2

Sediment/Turbidity: During the 1997 New Years Flood there were 78 landslides and 51 major road failures, and approximately 81% of the channels in the Walker Creek HUC14 were altered. There was massive aggradation in many reaches of Walker Creek as evidenced by almost complete lack of deep pools in the 1998 stream survey, and lenses of sediment over eight feet deep in the mainstem upstream of the East Fork confluence. Some reaches were still aggraded and recovering just prior to the 2014 Happy Camp Complex fire. In the 1998 stream survey of mainstem Walker Creek the percent fines in pebble counts ranged from 19% to 21%, fines in pool tail-outs was 4%, and embeddedness averaged 18%. In the 2007 stream survey, average percent fines in pool tail-outs was low at 7% and average percent fines in pebble counts was low averaging 4%. Post 2014 Happy Camp Complex Fire water quality and sediment conditions in lower mainstem Walker Creek were observed and photographed in the winter after several light to moderate precipitation events: the observations and photographs revealed that (1) turbidity

was very high during and long- after precipitation events and (2) large quantities of fine sediment had been delivered to the mainstem which had partially filled in pools and has partially smothered the pre-Fire streambed and salmonid spawning gravels. The frequency, magnitude and duration of turbidity is likely to be significantly elevated for at least the next the next few years until vegetation gets re-established and ground cover increases, and excess fines are winnowed out of the system. Risk of landslides that can cause bouts of acute turbidity will likely be increased for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots. Modeled surface erosion is near threshold (USLE = 0.93) and mass-wasting is way over threshold (GEO = 1.89) in the Walker Creek HUC14. **Not Properly Functioning.**

Chemical Contamination: No significant source of chemical contamination is known to exist on National Forerst lands within the Walker Creek watershed. **Properly Functioning**.

HABITAT ACCESS

Physical Barriers: A fish passage assessment and inventory in the Walker Creek watershed found no fish passage barriers. **Properly Functioning.**

HABITAT ELEMENTS

Substrate Character: During the 1997 New Years Flood there were 78 landslides and 51 major road failures, and approximately 81% of the channels in the Walker Creek HUC 7 were altered. There was massive aggradation in many reaches of Walker Creek as evidenced by almost complete lack of deep pools in the 1998 stream survey, and lenses of sediment up to eight feet deep. Some reaches were still aggraded just prior to the 2014 Happy Camp Complex fire, however, partial recovery from the 1997 Flood had occurred: *in the 1998 stream survey of mainstem Walker Creek the percent fines in pebble counts ranged from 19% to 21%, fines in pool tail-outs was 4%, and embeddedness averaged 18%. In the 2007 stream survey, average percent fines in pool tail-outs was low at 7% and average percent fines in pebble counts was low averaging 4%, however, percent embeddedness was high (average = 38%, range = 20% to 50%, mode = 45%, median = 40%) which suggests that there still may be excessive course sediment from the 1997 Flood filling up deep areas of the pre-flood channel.*

Post-2014 Fire water quality and sediment conditions in lower mainstem Walker Creek were observed and photographed in the winter after several light to moderate precipitation events: the observations and photographs revealed large quantities (excess) of fine sediment had been delivered to mainstem Grider Creek which had partially filled in pools and smothered the pre-Fire streambed and salmonid spawning gravels. The frequency, magnitude and duration of turbidity is likely to be significantly elevated for at least the next the next few years until vegetation gets re-established and ground cover increases, and excess fines are winnowed out of the system. Landslide risk will be increased for a decade or more due to decreased evapotranspiration, decreased ground cover, increased groundwater, increased overland flow, and/or loss of soil cohesion provided by living tree roots. Modeled surface erosion is near threshold (USLE = 0.93) and mass-wasting is way over threshold (GEO = 1.89) in the Walker Creek HUC14. **Not Properly Functioning**.

Large Woody Debris: Down and standing stock of large wood in stream buffers is suspected to have been reduced by past timber harvest and salvage, road construction through RRs, and by virtue of the increased access roads provide to down and standing wood sources within stream

buffers. Much LWD was eliminated from mainstem Walker Creek by debris flows during the 1997 Flood. In the 1998 stream survey, there were 14 pieces of wood at least 24 inches in diameter per mile, but many of these were less than 50 feet long. In the 1998 survey, there were only 23 pieces of wood at least 24 inches in diameter in the five miles plus reach of Walker Creek that was surveyed – which equals less than five pieces of LWD per mile. In the 2007 stream survey there was no LWD in the 0.60 mile section of mainstem that was surveyed. It appears that potential for future LWD production and recruitment was lost or setback due to widespread debris flows (many from stream crossing failures) that scoured the channel and streambanks of many Walker Creek tributaries during the 1997 Flood. Potential for LWD to be delivered to Walker Creek is diminished due to past wildfires, salvage, and stand-replacement timber harvest, and due to easy access to the stream buffer via numerous roads and via private property near the mouth.

Streamside trees killed in the 2014 Happy Camp Complex fire are expected to be recruited to the stream channel in high numbers over the next ten years or so. This is likely to bring in-channel LWD levels up to desired condition level within the next few years. However, the 2014 Fire intensifies the problem of having few large conifers left in stream buffer for future LWD recruitment after the 2014 Fire killed trees have mostly all fallen. **Not Properly Functioning**.

Pool Frequency/Quality: Many tributaries and most of mainstem of Walker Creek were scoured and/or aggraded as a result of debris flows triggered by the 1997 flood (see Disturbance History/Regime Indicator). This resulted in simplification of channel structure and filling in of pools. In the 1998 stream survey there was one pool every 8 bankfull widths defined as habitat unit showing distinct scour, or ponding, but there was a distinct lack of deep (greater than three feet depth) pools with only one “deep” pool in six stream miles surveyed. There was considerable recovery from 1998 to 2007. In the 2007 stream survey there were 30 pools in the 0.60 mile surveyed with an average depth of 2.3 feet, including six deep pools, however, primary pool frequency was still low with only one deep pool approximately every 18 bankfull widths. This indicates that much mainstem channel recovery from the flood had occurred.

The 2014 Happy Camp Complex fire greatly increased the rate of sediment delivery into Walker Creek stream. Pools have already partially filled with sediment and that trend is likely to increase over the next several years or longer due to increase rates of surface erosion and mass wasting on moderate to high severity burned ground. Pools are likely to decrease in frequency, depth, area, and volume over the next several years or longer. **At-Risk**.

Off-Channel Habitat: NA to most of the stream channels in the Walker Creek watershed which are Rosgen A-, B-, C-, F-, and G-channel types. Off-channel habitat is not characteristic of these channel types. There is one unconstrained reach along mainstem Walker Creek that is impacted by a main road crossing the valley floor at that point – and by trying to maintain this crossing in this unstable area. Maintaining this crossing impacts movement of the stream channel across it’s’ floodplain, therefore, impacts the development of off-channel habitat. **At-Risk**.

Refugia: Cold water and cover are the primary elements of refugia that Walker Creek could potentially provide. Water temperature in Walker Creek is still slightly elevated from channel effects associated with the 1997 flood (channel widening and shallowing, loss of streamside vegetation). On a hot day when fish need to find cooler water - the water temperature in Walker Creek near the mouth may be cooler than the river but is still often sub-optimal. LWD cover is lacking. Overall cover complexity was medium in the 1998 survey and low in the 2007 stream

survey. Water diversions and streambank alteration associated with private property and State Highway 96 within the lower 0.5 mile of stream degrades refugia qualities by diverting water, channelizing the stream, modifying the streambanks, and removing riparian vegetation. The 2014 Happy Camp Complex fire burned 35% of the stream buffer riparian vegetation in the Walker Creek watershed at moderate to high severity. This loss of riparian vegetation is expected to significantly increase rate of stream heating/cooling and summer high water temperature. **At-Risk.**

CHANNEL CONDITION AND DYNAMICS

Width to Depth Ratio: During the 1997 New Years Flood there were 78 landslides and 51 major road failures, and approximately 81% of the channels in the Walker Creek HUC 7 were altered including most of the mainstem. Many tributaries and long reaches of mainstem Walker Creek were "blown-out" by debris flows, scour, and aggradation triggered by the 1997 flood. The streambank was scoured and riparian vegetation was ripped out along many reaches of the tributaries. Stream channels are still re-adjusting and recovering. There was massive aggradation in many reaches of mainstem Walker Creek as evidenced by almost complete lack of deep pools in the 1998 stream survey, and lenses of sediment up to eight feet deep. Many mainstem reaches are still aggraded today. Debris flows in tributaries scoured the channel changing their cross-section profile from V-shaped to U-shaped. The altered channels and stream buffers of the Walker Creek watershed are in mid-stage of recovery from the 1997 Flood disturbance. Increased mass wasting and debris flows related to the 2014 Fire is expected to setback channel recovery. **Not Properly Functioning**.

Streambank Condition: Streambanks along much of the mainstem and many tributaries of Walker Creek were scoured or aggraded in 1997 flood, resulting in the loss of riparian vegetation and simplification of channel structure. Channel bank erosion occurred after the flood as flow routed around deposits of course sediment. Stream shading is recovering quickly but some reaches where trees and other vegetation were removed by debris flows or buried are still not recovered. Streambank scour from large debris flows in tributaries could take many more years to fully recover. The 2014 Happy Camp Complex fire burned 35% of the stream buffer riparian vegetation in the Walker Creek watershed at moderate to high severity. This loss of riparian vegetation is expected to significantly setback streambank recovery and likely lead to new impacts to the streambanks such as increased streamside landsliding. **Not Properly Functioning**.

Floodplain Connectivity: NA to most of the stream channels in the Walker Creek watershed which are Rosgen A-, B-, C-, F-, and G-channel types. Floodplain is not characteristic of these channel types. There is one unconstrained reach along mainstem Walker Creek that is impacted by a main road crossing the valley floor at that point – and by trying to maintain this crossing in this unstable area. Maintaining this crossing restricts movement of the stream channel and its' interaction with the floodplain. **At-Risk**.

FLOW/HYDROLOGY

Change in Peak/Base Flow: Road density is high at 3.8 miles of road per square mile of watershed, there are many miles of valley bottom and/or inner gorge road, and a high density of stream crossings. About 4% of the road system is hydrologically connected to the stream network. The 2014 Fire that burned large swaths of forested ground at moderate to high intensity is expected to significantly increase surface runoff and peak flows and slightly elevate

base flows due to less evapotranspiration for up to ten years of longer. Modeled runoff risk is slightly over threshold (ERA/TOC = 1.03). Base flows in the lowest reach of mainstem Walker Creek are reduced by an unknown amount by several private water diversions. **Not Properly Functioning**.

Drainage Net Increase: There is low to moderate potential for drainage net increase due to roads because road density is high but only 4% of the road system is hydrologically connected to the stream network. Drainage network increase is expected to significantly increase due to increased overland flow over large swaths of previously forested ground that was burned at moderate to high intensity during the 2014 Fire. **At-Risk.**

Road Density/Location: Road density is high at 3.8 miles of road per square mile of watershed and there are many miles of valley bottom and/or inner gorge road. There is a high density of stream crossings. **Not Properly Functioning.**

Disturbance History/Regime: During the 1997 New Year Flood there were 78 landslides and 51 major (over $2500 to repair) road failures. Approximately 81% of the channels in the Walker Creek watershed were altered by debris flows. Debris flows originated from some natural mass wasting sources, however, road failures, primarily stream crossing failures, appear to have triggered many of the debris flows that made a significant contribution to altering stream channels and depositing excessive sediment in the mainstem. Many of the tributaries were scoured by natural and road failure related debris flows that changed the channel configuration of many Walker Creek tributaries from V-shaped to U-shaped channels. Extensive damage to the road system (and aquatic habitats) occurred because much of the upslope road system that failed was constructed on geologically unstable ground. Several of the most heavily flood damaged roads were decommissioned to reduce future watershed threat.

The 1999 Thom Seider Watershed Analysis determined that the Walker Creek watershed is "impaired". *Impaired* watersheds are places where levels of natural and human-caused disturbances may have exceeded the ability of the area absorb and/or be resilient to additional disturbances. [note: the definition of "impaired' in the Thom-Seider WA is no longer used by the Forest; water quality impairment is defined in the Klamath Basin Water Quality Plan (California State Water Board)].

Prior to the 2014 Fire it was determined that the fire regime and vegetative attributes in the Walker Creek watershed and surrounding landscape were moderately to significantly departed from historical range [Fire/Fuels Condition Class 2 and 3] due to fire suppression - which could result in moderate to dramatic changes to one or more of the following: fire size, intensity and severity and landscape patterns. All this did happen in the 2014 Happy Camp Complex fire. Therefore, the major stressor (cumulative with the road system) that is adversely affecting watershed processes now, and that will continue to affect watershed processes/conditions and set the stage for future disturbance regimes in the next decades or longer, was the 2014 Happy Camp Complex Fire that burned large swaths of forest at moderate and high intensity in upslope and riparian areas. The 2014 Fire burned 836 acres of stream buffer RRs at moderate to high intensity, which is 35% of the total stream buffer in the HUC14 watershed. This much moderate and high intensity fire in hydrologic RRs is expected to significantly decrease the nutrient spiraling and sediment buffering function of stream course RRs and will significantly compromise the potential of hydrologic RRs to buffer the stream from upslope ground disturbances and landslides, and will increase streamside landsliding. The 2014 Fire caused

25% or greater basal area mortality on 2,736 acres of unstable ground RR as follows: 7 acres of active landslide; 568 acres of inner gorge; and 2151 acres of highly dissected granitic. [note: most or all of the 568 acres of inner gorge are within hydrologic RR so these acres should not be double-counted]. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the rate, risk, and cumulative watershed effects of landsliding.

Even before the 2014 Happy Camp Complex fire, modeled CWEs in the Walker Creek watershed were moderate to high due to high road density, with past wildfire and logging distant seconds: [USLE = 0.39; GEO = 0.88; ERA/TOC = 0.50]. The 2014 Happy Camp Complex fire increased modeled CWEs to near threshold for surface erosion (USLE = 0.93); way over threshold for mass wasting (GEO = 1.89); and just over threshold for runoff (ERA/TOC = 1.03). **Not Properly Functioning**.

Riparian Reserves: Streambanks along much of the mainstem and many tributaries of Walker Creek were scoured or aggraded during the 1997 flood resulting in the loss of riparian vegetation and simplification of channel structure including increased width-to-depth ratio and infilling of pools. Approximately 81% of the channels in the Walker Creek watershed were altered by debris flows. Lower gradient mainstem reaches were heavily aggraded with a lens of new sediment up to eight feet deep, and streambank erosion occurred as river stage increased over the elevated streambed. Debris flows in tributaries scoured the channel changing their cross-section profile from V-shaped to U-shaped. The altered channels and stream buffers of the Walker Creek watershed are in mid-stage of recovery from the 1997 Flood disturbance. Stream shading was largely recovered from the 1997 Flood debris flows before the 2014 Happy Camp Complex fire hit and burned extensive areas of stream buffer at moderate-to-high severity.

Stream buffers and watershed processes are impacted and at-risk from numerous valley bottom/inner gorge roads and high density of stream crossings. Roads constructed on geologically unstable ground and within stream buffers/inner gorge continue to elevate surface erosion, mass wasting, and peak flows. Easy road access to the riparian zone provided by valley bottom roads and numerous road-stream crossings impedes development of desired condition in stream buffers because of the roads' very existence and maintenance thereof, and because it provides easy access to LWD in the channel and to standing trees that would provide for future LWD recruitment.

The major stressor (cumulative with the road system) that is adversely affecting hydrologic RRs and geologic RRs was the 2014 Happy Camp Complex Fire that burned large areas within stream buffers and on unstable ground. The 2014 Fire burned 836 acres of stream buffer RRs at moderate to high intensity, which is 35% of the total stream buffer in the HUC14 watershed. This much moderate and high intensity fire in hydrologic RRs, coupled with a high-density road system, is expected to significantly: (1) decrease hydrologic retention, (2) decrease the sediment filtering and nutrient spiraling function of riparian vegetation compromising the potential of hydrologic RRs to buffer the stream from upslope ground disturbances and landslides, and (4) increase streamside landsliding. The 2014 Fire caused 25% or greater basal area mortality on 2,736 acres of unstable ground RR as follows: 7 acres of active landslide; 568 acres of inner gorge; and 2151 acres of highly dissected granitic. [note: most or all of the 568 acres of inner gorge are within hydrologic RR so these acres should not be double-counted]. This much moderate and high intensity fire on geologic RRs is expected to significantly increase the risk, rate, and adverse cumulative effects of excess sediment delivery, transport, and deposition in stream channels. **Not Properly Functioning**.

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