Limiting Factors Assessment and Restoration Plan

` Lower, Middle and Upper 6th Fields

Rock Cr Basin

Tributary to the Nehalem River

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Contents

Introduction

This document contains an evaluation of the physical and biological attributes of the Rock Cr subbasin which when combined describe the relationships that drive system function in the basin. The goal of this document is to identify the dominant processes and habitat characteristics that currently limit the production of coho salmon smolts in the subbasins, and to develop a prioritized list of actions ("prescriptions") for removing the limitations in ways that normalize landscape and stream channel function.

The restoration and assessment protocols used in developing the plan are described in "Midcoast Limiting Factors Analysis, A Method for Assessing 6th field subbasins for Restoration", available at www.midcoastwatershedscouncil.org/GIS. It is highly recommended that a review of this document accompany the utilization of the Limiting Factor Analysis (LFA) for the provision of background discussions of the fundamental processes and relationships that are significant for supporting the development of the conclusions constructed within this analysis. Many of these relationships are similar for the myriad of habitat subdivisions that are parsed out within this analysis. Please refer to this document for detailed information on assessment, nomenclature, prioritization rationale and methodology.

The Rock Cr sub basin functions in response to a long legacy of historical impacts that have shaped its current condition and consequently its future trajectory. A historical perspective is required to piece together the time line of formative events that have been critical in the development of its current condition.

The magnitude of the flooding that occurred in 2007 is represented in the active channel and adjacent floodplains of Rock Cr and its tributaries in a multitude of ways that has been both positive and negative for the restoration of system function. Almost all significant wood complexity was removed from the mainstem and not replaced. There are only two significant exceptions. The first is located at RM 10 where a large quantity of wood is currently stored in a full spanning jam that has accumulated transient material for several hundred lineal feet. This jam lies within the confines of what has been classified both in the text and the final prescription map as Mainstem Anchor Site #4. The second is at RM 24.2 (1.2 miles downstream of the confluence of Military Cr) where a large full spanning jam anchored by a collapsed log stringer bridge (Photo 32) still knits together the exceptional function observed in mainstem Anchor Site #8.

This lack of mainstem wood complexity is indicative of the long term trajectory in Rock Cr that has resulted in extreme channel simplification. It's important to note that this process of simplification was already well along in a continuum of events that began with the logging practices of the Oregon American Company that purchased the DuBois Tract in 1917 which included large portions of mainstem Rock Cr, NF Rock Cr , Weed Cr and Ginger Cr. According to Kamholz et al. 2003, almost all of the OAC timber resources in the Rock Cr basin were exhausted by 1957. Within the 40 year span that OAC was operating in the basin, the wildfires of 1933 - 1945 consumed additional large acreages of riparian old growth forest in Rock Cr and some of its primary tributaries such as Selder Cr. where this burned riparian timber was not salvage logged (Selder Cr), you can still view the incredible difference in channel morphology that has been maintained by the slow contribution of this burned timber to the active channel (Photo 20).

According to a Forest Fire Simulation Model developed for the central Oregon Coast Range (Benda and Dunne, 1997), approximately 50% of the total wood recruitment over thousands of years would have been delivered from the post fire toppling of fire killed trees from the riparian. This very critical vector for wood delivery to the active stream channel has almost entirely been exhausted by a significant chain of events (referenced below) that form the story line for the Rock Cr basin. Because of the extensive conversion of native forests to a managed rotational crop and the aggressive fire suppression that is a given in managed forests, this aquatic wood source (fire toppled trees) will never exist again on coast range stream corridors.

Each massive winter flood event since the wildfires of 1933 – 1945 has continued to reduce the aquatic and riparian supply of this fire legacy downed wood. The 1964 flood event caused flooding and massive slope

failures whose legacy can still be observed on steep hillslopes by the torrent tracks recolonized by mature alder. This event recruited to the stream channel, massive quantities of old growth coniferous wood from upslope locations that had burned or been left as a byproduct of the rail logging that occurred in Rock Cr. This harvest byproduct was either an unmarketable species or diameter and they persisted on the forest floor until they were recruited to the stream through slope failure or debris flow. This material was a major bonus for the Rock Cr aquatic corridor. The presence of this woody debris in the stream channel that was recruited from a single storm event 47 years ago could have held Rock Cr together without fail for 5 decades to the present. However, in the late 1960's and well into the 1970's state and federal agencies in charge of managing fishery resources determined that the massive wood jams recruited to the Oregon Coast Range stream channels were having a deleterious effect on anadromous fish populations by denying them access to their historical range for spawning and rearing.

The practice was initiated of removing log jams in coastal streams to enhance access for salmonids that lasted nearly a decade and succeeded in initiating a process that resulted in the unraveling of the system functions required for Coast Range streams to produce large volumes of salmonid smolts of all species. The flood of December 7, 2007 that inundated the town of Vernonia succeeded in pulsing even more of this legacy wood out of the system to accelerate the decline in channel complexity and thus the retention of mobile substrates (gravels). These are the issues in play that have accelerated Rock Cr on its path toward simplification. The places that continue to maintain this old growth wood complexity in the channel are becoming increasingly rare (SF Rock , NF Rock and Selder Cr). The imbalance between the wood resources being recruited to the active channel and those that have been lost has reached an all-time high and Rock Cr may be nearing its simplest form, the result of a trajectory created by a chain of events that began over 100 years ago.

In summary, most potential riparian and upslope large wood resources have been completely removed from the landscape in the Rock Cr basin and limited future potential for replacement exists because of a reduction in the age of industrial forest harvest rotations. This leaves a few remnant accumulations of legacy wood in a very few tributaries that have not been scoured by debris flow and nearly zero wood resources of consequence in the mainstem of Rock Cr. This history leads us to the current condition revealed in numerical terms by the habitat based Nickelson Model that is utilized to determine the seasonal habitat shortage that is limiting the production potential of the habitat as it exists for coho.

Resources used in developing the plan

- Bio-Surveys LLC. 2010.. Field Survey Rock Creek Basin
- Bio-Surveys LLC. 2009, 2010. Rapid Bio Assessment Final Reports
- Averill, Dan, Lewis, Scott, The A.G. Crook Company. Oregon Forest Industries Council 1993 Aquatic Inventory Pilot Project Final Stream Report: Bear Creek, Military Creek, North Fork Rock Creek, Rock Creek, South Fork Rock Creek, Weed Creek.
- Oregon Department of Fish and Wildlife. 1992. Aquatic Inventory Project Stream Report: North Fork Rock. 1995. Aquatic Inventory Project Stream Report: South Fork Rock. 1996. Aquatic Inventory Project Stream Report: Rock Creek, Selder creek. 1997 Aquatic Inventory Project Stream Report: Bear Creek, South Fork Rock Creek. 2002. Aquatic Inventory Project Stream Report: North Fork Rock Creek, Rock Creek.
- Langmaid, Bill. 2005. State of the Nehalem Rock Creek Sub-Basin Report.
- Boswell, Todd, Walczak, Ben, 2006. Upper Nehalem Habitat Assessment Stream Report: Bear Creek, Rock Creek, Rock Creek Tributaries.

Please refer to the appendices to find the tables, figures, photos referenced in the text of the report:

- Appendix 1 - Drainage systems of the study area
- Appendix 2 - Habitat features and survey status of streams which have coho bearing potential
- Appendix 3 - Spawning gravel estimates
- Appendix 4 - Limiting habitat analysis based on the Nickelson model
- Appendix 5 - Summer salmonid distribution charts (coho, steelhead, cutthroat)
- Appendix 6 - Prescription and anchor site location maps

- Appendix 7 - Photos
- Appendix 8 – Rock Cr 6th field HUC base maps with results from data synthesis project

Watershed overview

This analysis combines three separate 6th field HUC subdivisions (Lower, Middle and Upper Rock Cr) into a single natural geographic subdivision. The analysis area includes all of mainstem Rock Cr and its tributaries above its confluence with the mainstem Nehalem at RM 91 in the town of Vernonia. In this case, the larger geographical area represented by the three 6th fields represents the type of watershed subunit that the LFA methodology is designed to effectively interpret. These three 6th fields exhibit a complex interactive relationship that corporately supports what is probably a single deme of OCN coho.

The Rock Creek sub-basin drains an area of 39,947 acres (Langmaid, State of the Nehalem). The sub basin contains 51.7 miles of stream corridor that was utilized by coho salmon during the 2009 RBA snorkel inventory conducted by Bio-Surveys. It also contains fall chinook, winter steelhead, cutthroat trout and pacific lamprey. This analysis is designed to be coho centric and the assumption is made that most restoration prescriptions outlined in this review would also have positive and not negative effects on these other species of salmonids.

The geology according to Langmaid in the State of the Nehalem Report is evenly mixed between tuffaceous volcanic (39%), marine sedimentary (33%), and sandy shale (25%). Soils are extremely varied with no more than 13% of the area in any one type. There are stony complexes and silt loams, but no overabundance of any single type. Over 25,000 acres (62%) are managed forestland owned by a variety of corporations and 30% of the basin is owned by the state of Oregon and managed by the Oregon Department of Forestry. Rural residential properties and small woodlots account for the remaining 2,900 acres.

Within the combined study area there are 21 mainstem Rock Cr tributaries that provide habitat for coho salmon. These tributaries vary significantly in their capacity to provide spawning and rearing habitats for coho salmon and therefore should be viewed as dissimilar and unique components of the whole Rock Cr sub basin. This issue becomes important in the following discussions of system function and how to prioritize actions designed to address the identified limitations.

There are many additional 1st , 2nd, 3rd and even 4th order tributaries that provide potential sources of cold water to the mainstem of Rock Cr, but do not provide significant habitat for salmonids, due to their limited habitat capacity, gradient and or natural migration barriers. The majority of the tributary stream miles are managed for timber production. Management styles vary considerably throughout the various ownerships, with robust, true buffers present on some State and privately owned stream reaches. Some of these tributaries also contain significant sub populations of resident cutthroat trout and are important source locations for maintaining genetic variability (isolated from anadromous or fluvial cutthroat stocks, Ginger Cr and Martin Cr).

Coho distribution in the mainstem of Rock Cr extends for 28.1 miles and exhibits low to moderate gradients throughout (the first 10 miles averages 0.2% and the last 1.9 miles above the confluence of the SF Rock averages 2%). There is a significant change in land use near RM 12.3 (just above the confluence of Selder Cr) from rural residential agricultural operations to exclusive commercial forest use. The mainstem of Rock Cr is 303(d) listed as temperature impaired by the DEQ from the mouth to RM 11. Mainstem temperature gradients reviewed by Langmaid in the State of the Nehalem Final Report document suggest that this limitation is the result of cumulative headwater impacts and not solely the effect of the solar exposure impacting the mainstem reaches associated with rural residential agriculture. The results of the LFA analysis agree with this conclusion and a prioritized strategy for addressing dysfunctional riparian corridors in headwater reaches are included.

A very pronounced legacy of historical beaver colonization in the upper mainstem of Rock Cr and its other low gradient tributaries suggests that the morphological and vegetative conditions existed for stable and persistent beaver colonies to prosper. Current utilization of these legacy habitats is limited. There are however several strongholds where beaver colonization is currently robust, these are Selder Cr, Trib D of

mainstem Rock and Bear Cr, a tributary of SF Rock. These three locations contained 70% of all beaver dams (98) documented in the Rock Cr basin in 2009 by the RBA snorkel inventory. All three of these streams also exhibited the highest levels of large wood loading.

Current status of coho

Basin wide

The status of Oregon Coast Natural (OCN) coho in the Nehalem basin has been well documented for adult spawners by ODFW's Stratified Random Sampling Program, and for the summer standing crop of juveniles by the Upper Nehalem Watershed Councils Rapid Bio-Assessment Inventory (RBA). The adult data provide a sense of basin-wide trends in abundance, while the juvenile data indicate trends within specific 5th and 6th fields.

The juvenile abundances recorded during the summer of 2010 were the result of an adult escapement estimated by ODFW's SRS method to be 21,753 adult Coho for the entire Nehalem Basin during the winter of 2009. This represented a basin-wide increase of 26% in adult escapement from the previous winter. Adult escapement estimates for the Nehalem Basin have exhibited a continuous and increasing trend in abundance since the 2005 parent brood. The adult coho estimate documented for the 2009 winter brood (21,753) is the largest for the Nehalem since the winter of 2003, which was from a related cohort. A similar trend was observed in adult coho escapement for the combined Oregon Coastal ESU (which exhibited an increase of 36% between 2008 and 2009). The estimated coast-wide escapement of 295,208 adult coho was the highest estimate since 1979.

It is unusual to note, therefore, that contrary to these observed increases in adult coho escapement that juvenile Coho abundance within the scope of the Upper Nehalem RBA Inventory actually exhibited a decline of 43% during the summer of 2010 when compared to surveys conducted in the summer of 2009. This important observation is based on a normalized comparison of identical streams surveyed in both years. Declining juvenile coho parr abundance was observed in almost every stream. It appears that significant differences existed between these years in the seasonal survival rates that likely influenced spawner success, egg to fry or fry to parr survival rates. The actual environmental factors driving this decline in juvenile abundance within a year of increased spawner escapement are unknown. There is no doubt that differences in winter and spring flow regimes are important variables to consider.

Exceptional average rearing densities for summer rearing coho parr were one of the most notable observations from the 2009 Upper Nehalem RBA data set. Average pool rearing densities between 3.5-6.5 Coho/sq m were observed (from highest to lowest) in Trib A/East Fork Nehalem, Green Timber/Clear, West Fork Pebble, South Fork Rock, and South Prong/Clear. These levels currently stand as the highest average densities observed within the Oregon Coastal ESU during 13 consecutive years of summer snorkel inventories that included more than 8,000 miles of broadly distributed (geographically) coho rearing habitat. This includes RBA inventories conducted in the Nestucca basin (194 miles) during the summer of 2003 that followed the second largest coast wide escapement of Coho (287,607) since 1979. During the 2003 Nestucca inventories, only 2 tributaries exceeded an average pool density greater than 1.5 Coho/sq m (Elk Cr at 2.8 Coho/sq m and Baxter Cr at 2.0 Coho/sq m). Unusually high densities (up to an average of 7.0 Coho/sq m) were also observed in Oglesby Cr in the Yaquina Basin during the summer of 2009. This historical data is presented here to suggest that conditions can exist in the Nehalem basin that appear exceptional within the ESU for the production of OCN coho.

Average summer rearing densities observed for coho parr were considerably lower during the 2010 Upper Nehalem RBA as a result of the 43% decline in juvenile abundance (3.2 Coho/sq m in Green Timber/Clear was the highest). The observed average rearing density for a stream segment is utilized as a metric for evaluating inter-annual variation and identifying trends. The average has been calculated by dividing the sum of the raw pool averages by the total number of sample pools. This is not a weighted average that would divide the total metric surface area of the sampled pools by the total number of fish observed. The average rearing density for a surveyed reach (fish/sq m of pool surface area) is an excellent measure of

trend that can be monitored from year to year. However, it tends to portray only a general description of the current status within a reach.

Understanding how each reach is functioning is more accurately interpreted in a review of how the rearing density changes within the reach. This type of analysis allows us to get a sense of what the true rearing potential is for a subset of the highest quality individual pool habitats (anchor sites). This analysis utilizes the distribution pattern within stream segments (tributaries) to assist in identifying the key anchor habitats that exhibit exceptional function. Identifying these key zones of high production potential aids in understanding the unique biological and morphological characteristics that create and maintain exceptional ecosystem function. Anchor habitats may be capable of rearing salmonid juveniles at disproportionately higher rates than historically observed. In many cases, these unique habitats require special conservation measures to be applied to their management in order to maintain and enhance their potential for salmonid production.

The Combined 6th fields of Rock Cr

Bio-Surveys LLC conducted a summer juvenile abundance survey for the entire Rock Cr subbasin in both 2009 and 2010. This included all of the habitat occupied by juvenile coho within all 3 of the Rock Cr 6th fields (Lower, Middle and Upper). The survey was designed to quantify the summer abundance of coho parr from the 2008 and 2009 spawning class of OCN adult coho (not available separately for Rock Cr in the basin scale review above). The RBA inventory of Rock Cr refines the basin scale review by summarizing juvenile coho parr abundance in just one of the upper Nehalem's most productive tributaries. In 2009 there was a total of 235,278 coho parr rearing in the Rock Cr sub basin. In 2010 there were 160,752 coho parr observed. This represents a 32% decline in abundance (compared to the 43% decline noted for the broader basin wide inventory discussed above). The 6th field level assessment of a declining trend in abundance although not as severe as the broader basin scale review, still concludes that increases in adult escapement did not result in comparable increases in juvenile abundance.

Core Area

The core describes the full extent of the summer distribution of juvenile coho. The core area for the 6th fields discussed in this report extends from Rock Creeks confluence with the mainstem Nehalem to the end point of their distribution in the mainstem at RM 28.1. In addition, the core includes 23.6 miles of tributary habitat (appendix 1). Each of the listed tributaries remain a part of the Core Area to the end of anadromous potential. Within the extent of this Core area however, the mainstem of Rock Cr from its confluence with the Nehalem upstream to RM 12 can currently be classified as summer limited for juvenile salmonids because of elevated summer temperatures that initiate upstream temperature dependent migrations. The Rapid Bio-Assessment surveys conducted in 2009 and 2010 observed very low summer rearing densities in the lower Core area.

The dysfunction observed in the lower Core area is the result of the cumulative impacts to water quality that begin high in the basin as a result of low gradient stream channels and un-buffered non fish-bearing (Type N) streams. These impacts are magnified in the lower mainstem by inadequate riparian buffers for protecting the broad lower mainstem from solar exposure.

Limiting seasonal habitat analysis

Data sources

The limiting habitat model uses the amount of spawning gravel and the amounts of spring, summer, and winter rearing habitats to estimate potential smolt production. Stream valleys as well as upper basin and estuarine lowland habitats are included in the estimation process. Data were obtained from the following sources:
Summer habitat surveys, usually conducted by the ODFW AQI research team.
RBA juvenile coho surveys, which collect pool dimension data. These surveys were conducted by Bio-Surveys, LLC.

LFA field studies conducted by Bio-Surveys during the course of the current investigation. This work provided habitat data for stream sections not included in the surveys listed above.
Topographic maps, which were used to identify and characterize valley morphologies that generate stream habitats suitable for coho rearing.

Model limitations

The Nickelson model was employed to determine whether spawning gravel or one of the seasonal rearing habitats constitutes the resource that most limits coho smolt production. Information for this analysis came from two principle sources: 1) The Field Assessment phase of the project, which provided estimates of the quantity and quality of spawning gravel; and 2) ODFW habitat inventories, which provided most but not all of the necessary habitat data.

Habitat conditions and distribution are then compared to an overlay of summer juvenile salmonid distribution. These two data layers provide a real world display of interaction between populations and physical habitat variables. These distribution and abundance layers (fish and habitat) are then compared to the Nickelson modeling exercise that looks at hypothetical subbasin relationships utilizing only total seasonal habitat surface areas and their associated seasonal survival rates (the data available for the basin does not allow us to actually estimate the abundance of spring habitat and winter habitats are estimated utilizing a regression equation developed from existing summer habitat inventories to identify a habitat bottleneck (limiting factor).

It is important to clarify that the modeling exercise is not capable of evaluating all existing density dependent factors and their impacts on seasonal survival rates. Habitat quality, levels of sedimentation, temperature thresholds, intra and inter-specific competition and similar potentially important factors are not included in the Nickelson model. Because of this important weakness, we also apply seasonal survival rates summarized from the Alsea Watershed Study that better reflect the impacts of these other factors.

At this point we incorporate professional judgment into the process of identifying limiting factor issues. We utilize all of the information consolidated in the following assessment to specify both the short-term and long-term issues of concern in the subbasin that when addressed are expected to restore functional processes and boost subbasin smolt production

South Fork Rock Creek assessment

Migration barriers

The only passage barrier on mainstem South Fork Rock Creek is a boulder pinch at RM 2.5. Based on RBA juvenile distribution data , adult coho passage ended at this site in both 2009 and 2010 . The barrier is created by a 6 ft vertical drop that is complicated by large woody debris. The barrier could become passable if a wood redistribution event occurs clears an effective jumping lane. (Photo 1)

Trib A has an ephemeral log jam at its mouth that forms an adult and juvenile passage barrier. Based on RBA data, this jam terminated adult coho passage in 2009 but not in 2010.

Temperature Issues

The headwater location of the SF Rock assists in the provision of cool summer stream temperatures for optimizing juvenile salmonid production (not too cold not to warm). RBA inventories in 2009 and 2010 did not find mainstem SF Rock temperatures above 64 deg. There are however, solar impacts to the aquatic corridor that in the lower system (below the Sunset Hwy Park) that initiate th[illegible]mulative impacts that will become habitat limitations in the lower 12 miles of the mainstem of Rock Cr.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

A total of 4,666 sq ft of spawning gravel was identified during the Bio-Surveys 2010 field inventory of SF Rock Creek. Of this, 100 sq ft (2%) were classified as fair quality and 4,566 sq ft (98%) as good quality. None was classified as poor quality.

Almost all spawning gravels are located within South Fork Rock Creek's three anchor sites. A large portion, 1,885 sq ft (40%), is within Anchor Site 1 (mouth to RM 0.36). Another 902 sq ft (19%) is in Anchor Site 2 (extends approximately 0.5 mile downstream from the Hwy 26 culvert crossing). An additional 1,418 sq ft (30%) is in Anchor Site 3 (from the confluence of Trib A upstream 0.9 RM).

Additional minor gravel accumulations are scattered within several transport reaches.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

The distribution of coho juveniles is based on RBA summer surveys conducted in 2009 and 2010. Both 2009 and 2010 surveys documented strong juvenile coho densities from the mouth to the end of distribution at the RM 2.5 barrier falls. Average density was 3.02 coho/sq m in 2009 and 2.03 coho/sq m in 2010. Densities increased as pool size diminished toward the end of distribution. Individual pool counts were strong throughout the entire survey.

Highest pool counts occurred between the mouth and the confluence of Bear Cr. This zone exhibits a combination of physical attributes (low gradient, wide valley floor and interactive floodplain terraces) that have coalesced to produce extremely high quality rearing conditions. Although pools are not complex, they were formed by legacy wood and are well established, providing high quality summer rearing habitat. Water quality and temperature conditions are also high quality.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The 1993 AQI aquatic habitat inventory found modest amounts of large woody debris in the system that contributed little to habitat complexity. The average complexity score was 2 on a scale of 1-5. The 2009 RBA survey also found that pools, although well established with good depth and water quality, lacked good cover complexity. The average pool complexity rating was 2.1 (scale of 1-5).

During the 2010 LFA field inventory, we observed that large quantities of legacy large wood on the flood plain continue to contribute greatly to the form and function of the summer pool habitat, but are not currently contributing substantially to pool complexity and in-water woody debris. This legacy wood has retained a deep bedload of mobile gravels, which has maintained floodplain connectivity while providing an erodible substrate susceptible to deep pool scour. (Photo 2)

The 1993 AQI survey determined that riffle and glide habitats were the dominant habitats throughout SF Rock Cr. Pool percentage decreased and gradient increased decreased progressively upstream. A well-defined transition occurred at the Sunset Hwy Wayside Park, where pool surfaces gave way to primarily riffle /rapid /glide habitats upstream of the park.

Cobble and gravel made up the majority of the observed substrate.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Habitat structure is currently limited in mainstem SF Rock Cr, and the channel is trending toward simplification as the powerful effects of legacy old growth conifer buried in the active channel diminish over time.

Some (un-quantified) high quality winter habitat in the form of back waters and low terrace floodplain associated with the remaining key wood pieces. located downstream of Hwy 26. There is a visible legacy of very complex floodplain interaction that has created channel braids and back waters, but much of this habitat is no longer connected during winter flow regimes because of the diminishing abundance of large wood in the active channel. Currently the majority of quantifiable wood complexity in stream is composed of alder contributed during the 2008 / 2009 ice and wind event. This material is providing short-term complexity but will not be able to prevent vertical incision and simplification of the channel.

In-stream habitat structures were observed at the upper end of Anchor Site 3 during the 2009 LFA survey. The structures start at the confluence of Bear Cr and continue upstream to the next logging road bridge. The area exhibits a very high level of function because of these structure placements, and offer the best winter habitat observed in the upper reaches of SF Rock.

In other regards, juvenile winter habitat is absent above highway 26, and naturally recruited wood occurs in limited amounts.

A 0.3 mile reach of the active channel above the Hwy 26 crossing has long stretches of exposed bedrock and is not currently retaining woody debris or gravel.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

From the confluence with Rock and extending upstream to Sunset Park, there is an exceptional legacy of broad channel meander.(Photo 3) This reach has a low interactive terrace (2-3ft) with a 140-300 ft band width (including both sides of the active channel). A legacy of large conifer stored in the active channel has contributed to this high level of function. Currently this reach is trending toward simplification because of the lack of beaver and diminishing supplies of large wood being recruited to the channel. Immediate recruitment potential is low because large conifers are scarce in this recently logged riparian corridor.

Starting at Sunset Park and continuing up stream to the confluence of Trib A the channel becomes hillslope confined on both sides. The portion of Hwy 26 that exists on the valley floor also contributes to this confinement. SF Rock is then confined by alternating hillslopes for an additional 0.9 mile above the confluence of Trib A (average floodplain width of 60 ft). This section should be seen as a transport reach with higher gradients, abundant exposed bedrock and very limited floodplain interaction. Wood retention is limited.

Instream habitat structures were visible in the upper 0.3 mile of the reach during the 2009 LFA survey. The treated area currently exhibits a high level of floodplain interaction. Upstream of these log structures, channel width decreases quickly as gradient increases.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The potential for improving channel complexity in the segment of SF Rock downstream of Hwy 26 is very high. The legacy of large wood in this reach still supports remnants of complex, channel characteristics, frequent low terraces, legacy back waters, and side channels (habitats that exhibit a history of being linked to the active winter channel). These conditions maintain the potential for re-establishing future linkage. Large wood placement in this zone would be extremely beneficial for restoring and then maintaining exceptionally high winter function.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) A scarcity of long lasting coniferous woody debris both in the active channel and within the riparian corridor. The majority of wood complexity in SF Rock is deciduous and short lived. The potential for future recruitment is limited because the riparian corridor lacks large conifers.

2) Limited beaver activity in the reach below Hwy 26. Very little evidence of beaver activity was observed in SF Rock during the LFA field review (May / June 2010). Beaver activity would create off-channel habitat for rearing salmonid juveniles.
3) The concrete divider at the inlet of the highway 26 culvert is restricting woody debris transport to the downstream reach of SF Rock where it would provide its greatest benefit.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

Addition of full spanning structures would provide a short-term solution to the problems of compromised channel complexity in SF Rock Creek. Possible long-term solutions include:

1) Protection of upslope wood source areas, riparian buffers and buffers on 1st order streams subject to failure. Riparian planting would also be beneficial in the reach downstream of Hwy 26.
2) The re-establishment of a robust beaver population (natural recruitment with a no-take policy, or re-introduction) through long range planning that provide forage species such as willow in the reach downstream of Hwy 26.
3) Removal of a concrete channel divider (not a structural component of the installation - Photo 6).

Anchor Site 1

Location and length

Anchor Site 1 starts at the mouth of SF Rock and continues upstream 0. 4 mile to just before the first bridge crossing.

Channel structure

The creek is moderately sinuous in this area, and spawning gravels are abundant. Gravel retention is aided by low terraces that dissipate hydraulic potential during high winter flow regimes and prevent vertical scour and entrenchment.

Floodplain structure

Terraces in this anchor site are approximately 2 ft high for the first 1,200 ft and extend out 150 ft on both sides of the stream. The upper 600 ft has 36 inch high terraces, with reduced terrace. Floodplain interaction is high throughout the anchor site. The primary vegetation is alder and shrubs with an increasing infestation of Reed Canary Grass.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

This 1,900 ft segment of SF Rock Creek contains all of the attributes necessary to complete the coho life cycle from spawning through winter rearing. The quality and current level of function of these habitats is currently high. However, this function is at risk due to low wood abundance and low recruitment potential (no late successional conifers in the riparian corridor).

RBA inventory data indicate that Anchor Site 1 reared 3,890 summer coho parr in 2009, representing nearly 16% of the SF Rock mainstem total. Average coho densities exceeded 2.5 coho/sq m. Estimates for 2010 were 2,200 summer coho parr and at an average pool density of 2.1 coho/sq m.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Low levels of large wood and loss of beaver impoundment have led to channel simplification within Anchor Site 1. This reduces rearing capacity during both summer and winter flow regimes. Areas of extensive solar exposure are also present within the anchor site, contributing to temperature problems that have been identified in mainstem Rock creek.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Enhance floodplain interaction by injecting large wood in full spanning structure complexes. The structures will boost the abundance of off channel habitat surface areas, increase channel braiding and contribute to the linkage of the existing legacy of side channels and backwaters.
2) Provide for the re-colonization of beaver within the subbasin by planting forage species that will attract and sustain active breeding colonies of beaver. (willow, vine maple, cottonwood, ash)
3) Riparian Planting to develop the long term riparian conifer potential for recruitment.
4) Elevate the level of riparian protection for the existing conifer within 1 site potential of the active channel.

Anchor Site 2

Location and length

Anchor Site 2 starts 550 ft upstream of the first concrete bridge and extends 2,500 ft upstream to Sunset Park.

Channel structure

The creek is moderately sinuous in this area and spawning gravels are abundant. Gravel retention is aided by alternating low terraces that dissipate hydraulic potential during high winter flow regimes. Gravel retention is also aided by several legacy wood jams.

Floodplain structure

Anchor Site 2 has alternating low terraces that are approximately 24 to 36 inches in height, extending out 100 ft from the channel. Floodplain interaction is limited. The over-story is a mix of deciduous and coniferous species with a complex under-story of native shrubs.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

This 2,500 ft segment of SF Rock Creek contains all of the attributes necessary for the complete coho life cycle. Spawning gravel is plentiful and good quality. Pools are well developed and summer temperatures do not limit the rearing capacity of the habitat. Pools are not highly complex and cover for juvenile rearing is limited. However, the current level of function is poor for the provision of winter habitat because off-channel low velocity refugia from high water events is limited.

Based on the 2009 RBA data, Anchor Site 2 reared an estimated 4,398 summer coho parr. This represents almost 18% of the SF Rock mainstem production. The high quality habitat is seen in high pool densities, exceeding 2.4 coho/sq m.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Low levels of large wood interacting directly with the active channel and a loss of historical beaver impoundments have led to channel degradation (incision) within this anchor site. These changes have reduced both summer and winter rearing capacities.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Enhance floodplain interaction by injecting large wood as full spanning structure complexes. These structures will stimulate development off-channel habitat, increase braiding, and increase the frequency of inundation for existing side channels and backwaters.
2) Plant riparian forage species that support beaver colonization within this anchor site, as part of the overall goal of establishing a strong population though out the subbasin.

Anchor Site 3

Location and length

Anchor Site 3 begins at the confluence of SF Rock and Tributary A and continues upstream 4,700 ft to the first bridge crossing upstream from Bear Creek. It also includes the lower 1,200 ft of Tributary A.

Channel structure

From the confluence of Tributary A to the confluence of Bear Creek, the stream channel has low sinuosity, and spawning gravels become less abundant than observed downstream..

Above the confluence of Bear, treatment with full spanning log structures has increased sinuosity, gravel retention, and floodplain interaction (Photo 7).

Near Tributary A, sinuosity is high, and is accompanied by low interactive terraces. These conditions are primarily the effects of a legacy debris jam located at the tributary mouth.

Floodplain structure

Terraces are approximately 24-36 inches high for the majority of the anchor site. Floodplain width is approximately 60 ft. The riparian canopy is a mix of deciduous and coniferous species.

In the treated area above Bear Cr, appropriately placed wood structures have interacted well with low terraces to create a high level of floodplain interaction. These improvements could be duplicated below Bear Cr with similar work.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Above Bear Cr, Anchor Site 3 contains all of the habitat conditions needed to complete the coho life cycle, from spawning through winter rearing. Below the confluence of Bear Cr, the anchor site very clearly lacks wood complexity, as well as high quality floodplain interaction during winter flows. The two sections differ strongly because the upper section has been treated with wood structures.

Based on the 2009 RBA survey, this anchor site reared 54% of the 13,045 summer parr supported by mainstem SF Rock . The average summer rearing density for coho was 3.35 fish /sq m, which includes both the high and low functioning segments. These density levels are uncommon in coho bearing streams of the Oregon Coast. High quality individual pools within the treated segment above the confluence of Bear Cr exhibited summer pool densities as high as 5.7 fish /sq m.

The 2010 RBA survey observed 38% (5,340 coho) of the total summer parr in the mainstem rearing within the anchor. The average rearing density was lower than observed in 2009 at 1.8 fish /sq m. However, maximum densities were still very high, greater than 4 fish/sq m.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Low levels of large wood and the loss of beaver impoundment are the primary limitations on production potential. These conditions will lead to channel degradation, reducing rearing capacity in both summer and winter flow regimes.

Below Bear Cr, both summer and winter rearing potentials are definitively lower than those in the treated section above Bear Cr because of the absence of large wood and/or beaver impoundment.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Enhance floodplain interaction and protect upstream structure investment by injecting large wood in full spanning structure complexes below the confluence of Bear Cr. The structures will boost the abundance of off-channel habitat sites, increase braiding and contribute to the use of existing side channels and backwaters. In addition, these structures would capture additional spawning gravels to address the primary basin scale limitation.
2) Provide for the re-colonization of beaver within the subbasin by enhancing the development of forage species in the riparian (cottonwood, willow, vine maple, ash).

Anchor site rankings

Function

Rank the identified anchor sites in terms of current function (1= best).

1) Anchor Site 1
2) Anchor Site 2
3) Anchor Site 3

Restoration potential

Rank the identified anchor sites in terms of restoration potential.

1) Anchor Site 1
2) Anchor Site 2
3) Anchor Site 3

Secondary Branch 1 Trib A

Location and length

Trib A enters SF Rock Creek from the south west 1,100 ft upstream of the Highway 26 road crossing. A 1995 AQI survey inventoried the lower 7,735 ft of this tributary. However, a 2010 RBA survey found coho only up to RM 1.0.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

The LFA field review documented 13.8 sq m of spawning gravel near the mouth of Trib A. Very limited spawning gravel resources exist above the broad interactive terrace located in the first ¼ mile of stream corridor.

Beaver activity in Trib A was rated as high in both the 1995 AQI and the 2010 LFA surveys.

Secondary Branch 1 Trib A is an important part of the Rock Creek rearing system when woody debris near the mouth allows upstream adult passage. It has sufficient spawning gravel near the mouth (13. 8 sq m found by the LFA field survey), and some gravel upstream to seed the lower 1.0 mile of the tributary. Access to these habitats has varied. In 2009, an RBA survey found no juveniles above the jam indicating that no adults had passed through it. However, the 2010 RBA survey found large numbers of juveniles rearing up to RM 1.0. The RBA estimate for 2010 was 5,245 summer parr.

The primary source of this high rearing potential is a legacy of beaver impoundments located near the confluence of Trib a of Trib A, augmented by the woody debris. The impoundments have created large amounts of off-channel habitat that provide low velocity winter refugia.

In sum, Trib A provides a rare package of all the right habitat components for completing the entire year long life cycle of coho salmon. Because of these features a significant anchor habitat area has been designated within Trib A (see map).

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Currently this tributary is functioning very well. A high abundance of woody debris and an active beaver population have created complex and highly functional habitats. The primary limitation for coho production in Tributary A is the inverse distribution of spawning gravel from the mouth: Most of the high quality gravel exists near the mouth. Upstream valley morphology does not encourage the development of channel structures that retain suitable gravels. Large wood and beaver structures are also absent. Efforts to develop the storage of gravels above the mapped anchor habitat would be highly beneficial for expanding the production capacity of the tributary for salmonids.

Addressing the limitations

Protect existing conditions to ensure long-term success. To accomplish this, maintain a broad and intact Riparian Management Area, and plant beaver forage (cottonwood, vine maple, willow and ash).

Install log placements upstream of the anchor site in the confined portion of the active stream channel. This will improve gravel retention in Tributary A, as well as increase pool surface area and summer /winter rearing habitat.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

In the 1993 ODFW AHI report, the riparian vegetation from the mouth to Sunset Springs Rest Area consisted of a conifer/hardwood mix dominated by 86% hardwoods. The canopy closure was 87%. In 2010 Bio-surveys noted that a sparse logging buffer in the lower 1,500ft had resulted in accelerating blow down which left the stream in this reach exposed to solar impacts. While these conditions do not pose a temperature threat to the SF Rock, limiting this type of exposure is favorable for reducing the cumulative impact to lower mainstem reaches with known temperature limitations.

The highest percentage of conifer in the riparian corridor during the 1993 inventory was 67% in AHI reach 2, which extended from RM 0.15 to RM 0.7. The remaining surveyed reaches were a hardwood/conifer

mixture ranging from 45% to 63% conifers. During the 2010 LFA survey there was no canopy exposure greater than 70% from the first concrete bridge to the end of coho distribution.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

The recruitment potential in the first 2,000ft of SF Rock is limited. The accelerated recruitment of existing alder caused by blow down adjacent to a recent harvest unit is a short lived benefit to active stream channel. The few existing conifers are young suggesting only long term recruitment potential. The trajectory toward channel simplicity will continue with limited assistance from the riparian in the short term. Above this lower 2,000 ft, recruitment potential is higher because of higher conifer densities but the riparian still exhibits limited short term potential (50 years).

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

Currently the only potential thermal issue is located from the mouth to the first concrete bridge crossing. The exposure on the aquatic corridor in this lower stream segment has been created by an inadequate harvest unit buffer for maintaining the integrity of a functional riparian corridor. Many of the alder remaining in the harvest buffer have blown down and sun scalded (Photo 5). Stream temperatures here remain adequate for juvenile salmonids but when protection of these headwater cool water resources begins to be compromised in multiple locations simultaneously on the watershed scale, it results in temperature impacts to the mainstem of Rock Cr. The end result of these cumulative effects is the declining lineal distribution of summer salmonid parr in the mainstem of Rock Cr.

Bear Creek (South Fork Rock Cr) assessment

Bear Cr. is the largest tributary of SF Rock Cr. It joins the SF 2.3 RM upstream from the mouth.

Migration barriers

There were no migration barriers noted during the LFA field survey in 2010.

Temperature issues

Summer temperatures are cool as a result of broad floodplain storage in the identified anchor site and because of an intact riparian canopy.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

Forty seven sq m of good quality gravel was present during the 2010 LFA inventory. Bear Creek had much higher sediment levels than the rest of SF Rock, but areas of increased gradient were present throughout the lower one mile of stream that assisted in sorting and cleaning the existing gravels.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

In 2009, Bio-Surveys recorded juvenile coho distributed 1.5 miles from the mouth of Bear Cr. ending in a large beaver swamp. The peak rearing density of 3.2 coho/sq m was reached at RM 0.7, shortly after the peak, densities declined rapidly. The average rearing density for Bear Cr was 1.1 coho/sq m Even though the average rearing densities were not high, Bear Cr. was rearing a large number of coho (5,110). The 2010 RBA inventory of Bear Cr observed a slightly shorter distribution at 1.1 miles with an average rearing

density of 1.5 coho/sq m and a total coho production estimate of 5,202 summer parr. The many beaver pond habitats here are creating ideal rearing conditions for juvenile coho during both summer and winter.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The average complexity score given by the 1997 ODFW Aquatic Inventory was 1.4. During the same inventory there were six beaver dams counted. This was just one year after the major flood event of 1996. Since 1997 the stream appears to have gained complexity in part from beaver re-colonization. During the 2009 RBA survey conducted by Bio-surveys there where a total of 33 beaver dams counted and the average pool complexity score was 2.7 on a scale of 1-5. This scale is based on the total percentage of pool surface area that is associated with some form of structural complexity that is capable of providing cover (Over hanging vegetation, large substrate, wood, undercut bank, etc.) 2 is 1-25% of pool surface area, 3 is 26-50% of pool surface area associated with cover.

As a result of the extensive beaver activity in the lower 0.7 RM, there is a very large amount of pool surface area (un-quantified since the 1997 AHI which does not include the rearing capacity of the current 33 beaver dams) in relation to the size and flow of the stream. This increase in habitat due to beaver activity allowed for much higher summer rearing juvenile numbers than would have been physically possible with the normal active channel pool dimensions. During the 2009 RBA survey conducted by bio-surveys 85% of the summer rearing coho where located in the first 0.7 RM. In the 2010 survey 91% were rearing in the first 0.7 miles.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The lower 0.7 RM of Bear Creek offers ideal winter cover during high winter flow regimes. A wide floodplain, good wood complexity, low interactive terraces, and extensive beaver impoundment provide the high quality cover and low velocity habitat that defines winter refugia (Photo 8) Much of the stream above RM 0.7 is hill slope confined and offers only minimal winter refugia.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

For the first 3,000 ft the flood plain in Bear Creek is 100 to 150 feet wide. Above the first bridge, terraces become low (<1 ft) with a high level of winter and summer interaction enhanced by the presence of beaver. According to the 1997 Habitat Inventory conducted by ODFW, the stream gradient is 1.9% on average in this area. Continuing upstream the floodplain becomes more hill slope confined but gradient does not increase dramatically.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The greatest possible potential for channel complexity is currently being realized in the 1,400ft reach of stream directly above the first road crossing. This is a stream segment that is easily accessed and is a classic reference location for viewing a stream segment that has climaxed into nearly peak performance condition for the production of both coho and cutthroat. The reach of stream from the mouth to the first road crossing does not display this same level of functionality and would benefit from log placement or beaver impoundment..

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Channel complexity below the first road crossing in Bear Creek is limited by higher terraces and a lack of impoundment.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Channel complexity could be increased in the lower portion of Bear Creek by encouraging beaver colonization by planting key forage species (Vine Maple, Willow, Ash, Cottonwood) . In addition, wood complexity could provide the aggradation necessary to engage higher terraces while providing a platform for beaver to anchor winter persistent dams.

Anchor Site 1

Location and length

Anchor Site 1 begins at the first road crossing and extends 1,400ft up stream ending in hill slope confinement on both sides.

Channel structure

The anchor site is currently exhibits exceptional sinuosity that utilizes the full extent of the meander belt within the floodplain. Additional enhancements are unnecessary.

Floodplain structure

Terraces are low (<1 ft) and exhibit indicators of frequent interaction as a result of large wood and beaver impoundment. They have been formed by the deposition of fines and sediments and exhibit an even age class of older alder and understory shrubs.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

This Anchor does not contain a large quantity of spawning gravel (13.5 sq m), but it does exhibit large surface areas (un-quantified) of impounded beaver dam habitat that is providing both high quality summer rearing habitat and extremely high quality winter refugia. The current status of this site would be classified as highly functional.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The shortage of spawning gravel in Bear Cr within and above this anchor site limit it production potential significantly. The modest average rearing densities (1.1 and 1.5 coho/sq m) observed in two consecutive years, suggests that even on years of high spawner escapement (2008), all gravel resources are being used to capacity.

In addition, the lack of conifers in the riparian corridor suggests there is no long term stability in the wood complexity that currently assists the beaver in holding this site together during high winter flow regimes. The lack of beaver forage will also eventually force beaver to disperse from the site and abandon the dams that currently are providing the bulk of the functionality for salmonids.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Riparian planting of beaver forage would help ensure continued function. This could be accomplished by strategic girdling to encourage sunlight and then cluster planting and caging forage species such as willow.

2) Riparian planting and caging of conifers clustered on high ground. Some alder girdling may be required to accelerate growth and enhance survival.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

In the 1993 AHI conducted by ODFW, the riparian canopy was described as consisting of a mixture of 75% hardwoods and 25% confers. Canopy closure remained above 79%. Canopy closure remained excellent throughout Bear Creek during the 2010 LFA field inventory. The area of the highest conifer concentration was in reach 3 above Highway 26 with 75% conifer dominant. In 2010 it was noted that the lower 2,500ft of Bear was dominated by older age class alder with conifers increasing upstream of the identified anchor habitat.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

The short term recruitment potential of wood resources from the riparian corridor on Bear Creek is almost exclusively alder. There is contemporary conifer recruitment potential within the riparian but its limited by low conifer density and young seral condition (<50 yrs old).

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

At present there are no indicators that thermal problems exist in Bear Creek. However, the known temperature limitations in the lower mainstem Rock, suggest that maintaining the delivery of high quality cold flow from Bear Creek is an important factor for addressing basin scale limitations for summer rearing salmonids. This becomes critically important when harvest activities threaten the integrity of the standing riparian. The alder here is susceptible to blow down (saturated soils from exceptional floodplain water storage) and sunscald. Additional buffer widths (beyond the standard 100 ft) should be negotiated for the next harvest rotation within the identified anchor site (see map).

NF Rock Creek assessment

NF Rock Creek enters mainstem Rock Creek 2.5 RM downstream from SF Rock and 3 RM downstream from the Highway 26 crossing.

Migration barriers

According to Bio-Surveys 2009 RBA survey of the NF, coho distribution terminates at a six foot falls 4.1 RM from the mouth. It was also noted that there were two natural bedrock falls within the first one RM that were definitive juvenile barriers (Photo 9). Several more similar bedrock steps were encountered further upstream.

One of the largest tributaries of the NF Rock (classified by flow) enters on the left 1.0 RM from the mouth. This tributary is inaccessible to anadromous species because of a boulder falls / cascade at the mouth.

Temperature issues

There are no indications of temperature issues in NF Rock Creek that immediately impact the summer rearing of juvenile salmonids. However, recent un-buffered harvest units on headwater tributaries with significant summer flows have likely contributed to elevated pinch period temperatures in the mainstem of Rock Cr (unverified). The issue of cumulative impacts that affect the mainstem of Rock Cr applies within the NF sub basin as a part of a subset of impacts occurring simultaneously throughout the watershed. The intent of the LFA field inventory was not to gather single point temperature data but to assess the status of these critical issues (temperature) on a landscape scale. There may be creative ways to reduce the upslope impacts of solar exposure on non fish-bearing streams until early seral vegetation can be recovered to protect the aquatic corridor from solar exposure (retention of logging slash, etc.).

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

High quality spawning gravel is plentiful in NF Rock. There are 358 sq m of good quality spawning gravels in the mainstem of NF Rock Creek. Seven sq m of good quality gravel in Trib A and another 24 sq m of good quality gravels in Trib B. The most exceptional abundance of spawning gravel exists in Anchor Site #4 as a result of a large wood jam from a debris flow event during the 1964 flood. This jam has trapped acres of spawning gravel near the junction of Trib B and is responsible for the continued high function that can be observed here (Photo 10). The obvious shortage of complex woody debris however, indicates that the NF Rock has great potential for trapping and storing additional spawning gravels with the addition LWD. This is one of 4 primary spawning destinations for adult coho.

The existing abundance of gravel appeared to be utilized to capacity for the 2008 brood. Enhancing gravel storage in the NF Rock is very high priority on the basin scale because of its capacity to deliver nomadic fry to vast rearing areas existing in the lower mainstem once temperature limitations can be addressed there.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

NF Rock was a major contributor to the Rock Cr sub-basin during the 2009 RBA survey, carrying 17% of all of the coho Parr enumerated for the entire basin (40,645), while only containing 11% of the total lineal distance in the Rock Cr. system. The average rearing density was 2.2 coho/sq m reaching a strong and even peak of 3.5 coho/sq m at RM 1.6. The 2009 adult escapement of coho into the NF Rock was large and may have succeeded in fully utilizing the available spawning gravels. From the total spawning gravels documented in the 2009 LFA field inventory (399 sq m). The Alsea Watershed Study seasonal survival rates (appendix 4, table D1) predict a summer parr abundance of 30,398 (this is utilizing 1.7 coho/sq m as full seeding). Rock Cr surpassed this summer abundance in 2009 with 40, 645 coho estimated rearing in the mainstem. The higher rearing density of 2.2 coho/sq m certainly was responsible for some of this additional production.

It is likely that unless higher average pool densities can be sustained by the quality of the habitat in the NF Rock (> 2.2 coho/sq m) then the production observed during the summer of 2009 (results of the 2008 brood year) is near capacity. From RM .4 to RM 2.8 (Pool #6 to Pool #38) held almost all of the 1+ Steelhead present in NF Rock. These numbers describe an important and productive stretch of habitat that was functioning well at the time of survey. For comparison, the 2010 RBA inventory observed only 13,640 coho parr rearing in the mainstem of NF Rock Cr. This was just 7% of the Rock Cr watershed total (194,658).

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Summer cover for juvenile salmonids is often expressed in quantitative inventories as the abundance of wood. NF Rock Creek has a fair supply of transient small woody debris. It was noted during the 2010 LFA field inventory that several legacy wood jams had created complex habitats starting around RM 2.8. There are also areas that have been treated with large wood that are currently functioning at a very high level. These wood placement sites begin at RM 0.6.

In 2009 the Bio-Surveys rapid bio-assessment rated pool complexity at 2.1 on a scale of 1-5. This scale is based on the total percentage of pool surface area that is associated with some form of structural complexity that is capable of providing cover (Over hanging vegetation, large substrate, wood, undercut bank, etc.) 2 is 1-25% of pool surface area, 3 is 26-50% of pool surface area associated with cover.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Areas of exceptional winter cover where noted during the 2010 LFA ground work. Extending 800ft upstream from the first bridge crossing a wide floodplain, braided channel, and exceptionally low terraces offer the potential for high quality winter habitat low in the system where it has the potential to benefit all non-volitional migrants displaced from upstream habitats by winter flows.

Starting at RM 0.6 and extending upstream 3,000ft the creek has been treated with large wood structures that are beginning to create channel braiding, backwaters, and floodplain interaction. The highest quality winter habitat in NF Rock is located from the confluence of Trib A extending upstream one mile past the confluence of Trib B. Much of this stream reach is characterized by interactive floodplains, good sinuosity, high quality gravels, and good wood complexity. There were five full spanning wood jams noted in this reach during the 2010 LFA ground work

In 2002, the ODFW aquatic habitat inventory documented wood densities ranged from 8.2 to 97.3. pieces / 100m, increasing as the survey progressed up stream. The ODFW benchmark for desirable quantities of wood is >20 pieces/100 m. Because of the December, 2007 flood event, this 2002 AHI data does not represent the current instream wood densities which are reduced (un-quantified).

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

Much of NF Rock that was not hill slope confined was exhibiting varying levels of floodplain interaction with the potential to greatly increase complexity in some areas with the placement of full spanning wood complexes. From the mouth extending 1.4 miles the average stream gradient did not exceed 2% according to the 2002 ODFW Aquatic Habitat Inventory. During the 2009 RBA Bio-Surveys, a 1,700ft reach starting 800ft from the first bridge was almost completely scoured to bedrock. Sinuosity was varied but reached very high levels near the confluence of Trib B. At this juncture, complex channel braiding, mid channel islands and terraces <1ft exhibited reference characteristics for high floodplain connectivity.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The potential for development of complex channel features is currently being realized in several locations on NF Rock Creek. Anchor Site 4 near the confluence of Trib B, exhibits extensive channel complexity and floodplain interaction as a result of a legacy wood jam. Also the large wood treatment that begins at RM 0.6 has initiated a trajectory toward complexity that has created meander, braiding, and side channel development. These locations illustrate the effectiveness of large wood in creating complex and interactive channels.

The potential for further channel development is extensive, and the results would mirror the current complexity that can be observed in these two locations. Evidence of historical beaver impoundment was observed near the top end of Anchor Site 4 and extended into the headwaters (Photo13). A limited beaver legacy was observed below the confines of Anchor Site 4. This was the same summary of beaver use documented in the 2002 ODFW Aquatic Habitat Inventory .

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) No active beaver impoundment in the lower 3.5 RM (including likely side channel sites)
2) Limited riparian potential for the recruitment of large conifer to the aquatic corridor for providing long term persistent structure.
3) Low wood densities and decaying legacy wood from the 1964 flood in obvious transport out of the system.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Encourage beaver colonization by planting forage sources.
2) Leave current high quality buffers in place long term, riparian planting in areas with scarce conifer presence (may include alder girdling and cluster planting).
3) Place full spanning wood structures throughout the mainstem except in Anchor Site 4 where complexity is peaking and providing for the majority of the current productive spawning gravel.

Anchor Site 1

Location and length

Anchor Site 1 begins at the first bridge crossing over NF Rock Creek and extends upstream 800 ft ending at a bedrock step that exhibits a three ft falls.

Channel structure

There is potential for increasing the current low level of sinuosity observed within this anchor. Currently sinuosity is low because of the lack of large wood to encourage deflection (Photo 12).

Floodplain structure

Terraces are approximately 1 ft in height with off-channel braiding and signs of frequent interaction during high water regimes. An even aged and mature class of riparian alder exists on the low interactive terrace for providing future channel complexity. Younger age class conifers make up the majority of the upslope vegetation.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

There are 9 sq m of good quality spawning gravel in the anchor site. In 2009 the Bio-Surveys rapid bio-assessment observed strong coho numbers in this location. Winter rearing potential is excellent with frequent inundation of adjacent low floodplain terraces. Habitat conditions here would improve dramatically with the injection of large wood structures.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Currently the anchor site is trending toward simplification and lacks the large conifers within the riparian corridor to recruit key wood components to the channel that are capable of retaining spawning gravels.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Large wood structure placement would protect the current level of observed function and enhance the anchors carrying capacity during both summer and winter flow regimes..
2) Protection of existing conifers that will contribute to the long term future of this sight. This might involve a special designation during the next harvest rotation that is site specific for the 800 ft long anchor site.

Anchor Site 2

Location and length

Anchor Site 2 is located 2,850ft upstream from the mouth of NF Rock Creek and extends 4,000 ft upstream to end at an extended reach of hill slope confinement that suggests a transition to a transport reach where wood placement would not only be inappropriate but would result in limited benefit to aquatic complexity..

Channel structure

Sinuosity is limited in the majority of Anchor Site 2. There is however a 700 ft segment of this anchor that starts immediately where sinuosity has been increased as a result of well-established and well-constructed large wood structures (Photo 11).

Floodplain structure

The active floodplain is not extensive with a variable width of 75ft-150ft, but three foot terraces are present and potentially accessible, during winter flow regimes with enhancement. The active channel would respond rapidly with horizontal migration with an addition of wood complexity. This is illustrated by the high level of function achieved lower in the anchor site from the addition of large wood complexity (ODFW). The first 3,000ft of the anchor site has been treated with large wood structures that have persisted and are performing effectively to create a very dynamic mix of aquatic habitat complexity.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

There are 157 sq m of good quality spawning gravel in the anchor site. In 2009 the Bio-Surveys rapid bio-assessment observed strong coho parr numbers with average pool densities exceeding 1.7 coho/sq m The expanded total of summer rearing coho within this Anchor was 8,785 during the 2009 RBA. That represents 24% of NF Rock total. Pools where well developed within the treated segment of the anchor site and provided good summer cover. The abundance of winter rearing habitat was weak but additional wood injections will complement the existing structures by dissipating hydraulic potential and boosting complexity. There are recent log placements located within this anchor that should soon recruit smaller transient wood and begin to address this problem. Water quality and temperature are both good.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) The high flow winter refugia created by impoundment from large wood placement or beaver colonization are missing and likely limit the local conditions within this habitat segment.
2) It is also important to state that the abundant gravels in the NF Rock are beyond adequate for seeding the available summer rearing habitat. When the scale of the review is expanded to include the entire Rock Cr sub basin and we consider how the NF Rock factors into the provision of different seasonal habitats, it's clear that additional capacity for the Rock Cr basin for fry production can only come from a few key places. One of these key locations is the NF Rock. With this frame of reference, the abundance of spawning gravels in several headwater tributaries (NF Rock included become a primary limitation for coho on the entire Rock Cr sub basin scale.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) There is a 1,000ft section at the top of this anchor that has not yet been treated with large wood. This reach would greatly benefit from log placement to increase floodplain interaction and sinuosity. This would likely be a helicopter project. Additional wood treatment increases the potential for floodplain connectivity during winter flows and traps mobile gravels that provide additional capacity for incubating nomadic fry to supplement the mainstem of Rock Cr.
2) Protect and expand the current buffer to insure the future recruitment of large wood to the active channel.

Anchor Site 3

Location and length

Anchor Site 3 starts 1,400 ft above Anchor Site 2 or 500 ft above Quarry Cr (Trib left looking upstream). The anchor extends upstream to end 500 ft below the confluence of Trib B at the site of a large 1964 flood event debris flow jam. Anchor habitat characteristics extend far above this jam but the physical metrics of the anchor site above this jam are so distinctly unique that it has been classified as a separate site. The first 300ft of Trib A is also included in this anchor. The total distance of the anchor site is 9,100ft and includes several small transport reaches within the anchor.

Channel structure

Sinuosity varies throughout this long anchor. Some areas are highly sinuous with side channel habitats that exhibit historical channel meander created by the presence of woody debris that is long gone. Other stream segments exhibit low sinuosity and a trend toward channel simplification.

Floodplain structure

The active floodplain varies from 100ft-150ft with terraces of 18”-36”. Terraces exhibit indicators of interaction during winter flow regimes. The channel has the potential to migrate with the addition of large wood complexity. The riparian corridor is varied with good recruitment potential for coniferous large wood.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

There are 73 sq good quality spawning gravel in the anchor site. In 2009 the Bio-Surveys rapid bio-assessment observed strong coho numbers in this reach. Average rearing densities continued to exceed 1.7 coho/sq m. Approximately 15,000 summer rearing coho Parr where rearing within this anchor during the summer of 2009. This represents 37% of the total production for the entire NF Rock Creek in 42% of the lineal distance.

Rearing limitations

Which functions limit the site’s production potential, and what causes these limitations?

1) This anchor is currently trending toward simplification and a lower level of function driven by the natural decay and then transport of legacy LWD from within the floodplain and active channel. The process of simplification is reducing habitat complexity, the capacity for gravel storage and sorting and the frequency of floodplain interaction. There are several old large wood structures (ODFW) and legacy wood jams (containing old fire scars) that are unraveling as a result of recent flood flows (2007).

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Augmentation with large wood in key areas throughout this anchor would greatly increase the level of function which would result in higher production capacities for coho during all seasons of the year.
2) Planting prescriptions to add a conifer component to the alder dominated riparian corridor for the provision of long term structure.

Anchor Site 4

Location and length

Anchor Site 4 begins 500ft downstream of Trib B at the 1964 era debris flow jam and continues upstream 5,500ft to end at a significant gradient transition in the headwaters of NF Rock. The lower 800ft of Trib B is also included in this anchor.

Channel structure

The anchor site exhibits a very high level of sinuosity. By comparison, this may be the highest sinuosity observed throughout the entire Rock Cr LFA .The sinuosity is represented by a complex network of channel braids and mid channel bars and islands. The high sinuosity (fostered by the debris flow jam below) has been responsible for the reduction of the hydraulic potential resulting in deep accumulations of well sorted spawning gravels.

Floodplain structure

Terraces are broad and interactive averaging 300ft in width and 12”-24” in height. There is extensive channel braiding, side channels, and backwater features. Older age class (45 yr) alder dominate the riparian vegetation for much of the anchor. A substantial legacy debris flow jam formed at a hill slope pinch during the 1964 flood event 500 ft downstream from Trib B. This jam has resulted in a massive accumulation of bedload that has formed the broad flat terraces in the lower portion of Anchor Site 4. This site exhibits extensive potential for the encouragement of beaver to ramp up year round flood plain water storage.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

There are 102 sq m of good quality spawning gravel in the anchor site. In 2002 the Bio-Surveys rapid bio-assessment observed average rearing densities well above 1.7 coho/sq m in the lower portion of the anchor. The densities here were lower than observed in Anchors 2 and 3. Coho rearing densities began to decline in the upper ½ of the anchor site as a result of diminishing gravel resources. A total of 7,705 summer rearing coho Parr where using this anchor during 2009. This was 19% of the NF Rock total rearing in 26% of the lineal distance. The abundance of winter habitat is average and falls below the classification of exceptional because of the lack of highly complex cover in the form of woody debris. There is however great potential for achieving an expansion of winter habitat surface area with the successful re-colonization of beaver here.

Rearing limitations

Which functions limit the site’s production potential, and what causes these limitations?

1) This anchor site is currently a model of a properly functioning stream segment. The primary long term limitation is the lack of large riparian conifers to maintain floodplain interaction.
2) The current scarcity of beaver forage also predisposes the anchor site to winter rearing limitations from the decline in active beaver colonies (and their dams) that were obviously abundant within the anchor site historically (visual on abandoned beaver flats).

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Riparian planting of conifers would ensure long term function. May require girdling and caging.

2) The planting of beaver forage would also encourage the development of additional winter habitat surface areas (beaver impoundments).

Anchor site rankings

Function

Rank the identified anchor sites in terms of current function (1= best).

1) Anchor site 4
2) Anchor site 2
3) Anchor site 3
4) Anchor site 1

Restoration potential

Rank the identified anchor sites in terms of restoration potential.

1) Anchor site 3
2) Anchor site 1
3) Anchor site 2
4) Anchor site 4

Secondary Branch 1

Location and length

Trib A enters NF Rock Creek from the west 2.6 RM from its mouth. There is approximately 1,500ft of stream utilized by summer rearing coho.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

The lower 300ft of Trib A is included in the mainstem Anchor Site 3 and exhibits the potential for quality off channel rearing during winter flow regimes. This tributary is also an important cold water contributor for the maintenance of cool mainstem temperature profiles. The RBA data from 2009 indicated a summer rearing estimate of 795 coho Parr.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

This is a small tributary with small summer pool surface areas. These small pool surface areas limit the tributaries capacity for coho production. However it was noted during the 2009 RBA that a recent clear cut with a sparse riparian buffer was compromising the cold water contribution with direct solar exposure.

Addressing the limitations

1) Including this tributary into a mainstem treatment of large wood would increase pool surface areas and increase both winter and summer rearing contribution.
2) Protection of the riparian corridor in even these small tributaries is important for reducing the cumulative temperature impact to the lower mainstem of Rock Cr during pinch period summer flows.

Secondary Branch 2

Location and length

Trib B enters NF Rock Creek from the east 3 RM from its mouth. There is approximately 4,000ft of stream utilized by summer rearing coho.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

The lower 1,000ft of Trib B is included in the mainstem Anchor Site 4 and exhibits the potential for quality off channel rearing during summer and winter flow regimes. Floodplain terraces were wide (up to 200ft total width) but were beginning to show signs of entrenchment. A strong legacy of beaver dam impoundment was observed here that was historically responsible for providing large quantities of pool surface areas for both summer and winter rearing. Beaver are not currently active in this reach and all high quality forage species are missing.. This tributary is also an important cold water contributor. The RBA data from 2009 estimated a summer rearing population of 1,085 coho Parr.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Currently, Trib B is limited by the abundance of spawning gravel (appendix 4, table E1). There are significant amounts of nutrient rich sediments stored in the legacy beaver terraces in the first 1,000 ft of stream corridor. The majority of the identified spawning gravels are also stored here. Recent harvest activity in the headwaters of Trib B. have recently elevated sediment contributions (visual observations of turbidity during active harvest, May 2010).

Addressing the limitations

1) Provision of beaver forage in the lower ½ of the current coho distribution (2,000 ft) would help to encourage re-colonization. Planting conifers would also provide the riparian wood source for the long term recruitment of structure.

Secondary Branch 3

Location and length

Trib C enters NF Rock Creek from the right 2,100ft above the confluence of Trib B. There is approximately 1,000ft of stream utilized by summer rearing coho.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Trib C is small (wetted summer channel width is 4 ft) with very little opportunity for spawning and rearing. An expanded estimate of 135 summer rearing coho were observed during the 2010 RBA. The primary contribution of this stream is cold water and gravel resources to the mainstem of NF Rock.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

This is a small tributary with small summer pool surface areas. This is the primary seasonal limitation to production.

Addressing the limitations

1) Effective re-colonization of beaver would be the most effective and practical way to increase surface area in this tributary.

Secondary branch site rankings

Function

Rank the identified branch sites in terms of current function (1= best).

1) Trib B
2) Trib A
3) Trib C

Restoration potential

Rank the identified branch sites in terms of restoration potential.

1) Trib B
2) Trib A
3) Trib C

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The 1993 ODFW AHI describes the riparian area as 64% hardwood 36% conifer. This percentage holds fairly steady for length of the survey. Canopy closure at regular transects ranged from 75% to the 90% range. The last reach, near the end of coho distribution was conifer dominated.

In 2010, the Bio-Surveys LLC survey noted recent upslope harvest activity on both sides of the river from RM 0.5 to RM 1.5. A healthy buffer was present with substantial conifer contribution potential. It was also noted that Anchor Site 4 near the mouth of Trib B was dominated by older age class alder with limited conifer present. An abandoned beaver flat 1 mile above the confluence with Trib B is exhibiting 500 lineal feet of solar exposure (Photo 13).

Canopy conditions in the sub basin are high quality and providing extensive protection from solar exposure. The value of maintaining this condition for the temperature limited portions of mainstem Rock Cr cannot be overstated.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Hardwood recruitment potential on NF Rock is currently good throughout the anadromous use area. There are also significant reaches that currently display good potential for riparian conifer recruitment. There are concerns that alternate OFP prescriptions of basal area calculation or alder conversion could threaten the integrity of the existing canopy that is critical for temperature maintenance. This possibility is mentioned because these alternate OFP prescriptions can be observed in other tributaries of the Rock Cr basin.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The current riparian condition on the NF Rock Creek mainstem protects mainstem habitats downstream from reaching thermal thresholds during low summer flows. Proactive protection of the existing riparian area will continue to mitigate for the cumulative downstream impacts occurring in other tributaries of the basin.

There have been recent negative impacts on east side 3rd and 2nd order tributaries from un-buffered harvest activities on Type N streams that have elevated the contributing temperatures of these tributaries. The impact to the mainstem of NF Rock is undocumented. However, these are the cumulative issues that when combined on the basin scale will eventually exacerbate the elevated mainstem temperatures of Rock Cr.

Weed Creek assessment

Weed Creek enters Rock Creek from the north 1.5 miles downstream from the confluence of NF Rock Creek.

Migration barriers

There are no major fish passage barriers on Weed Creek. At RM 2.2 there was an ephemeral wood jam that terminated adult coho migration in 2009. In 2010, adult coho extended their distribution to RM 2.8.

Temperature issues

There are currently no temperature limitations in Weed Creek. In the 1993 Aquatic Habitat Inventory Conducted in mid-August temperatures did not exceed 54 degrees F.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

A total of 129 sq m of good quality spawning gravel was documented in Weed Creek. The spawning gravels were widely distributed with higher concentrations in the two identified Anchor sites. Large wood complexity was essential for gravel storage in this system because of the average gradient (3.4%) and the hillslope confinement. Many legacy wood jams were decayed and unraveling and there is a concern that the high productivity for salmonids currently observed in Weed Cr will be declining in the next decade with this loss of old structure.

The absence of the morphological potential for high quality winter habitat suggests that we should view Weed Cr as an extremely high production site for spawning and incubation. Elevated gradients provide the necessary hydraulics to keep gravels well sorted and cleansed of sediment. Weed is a very important piece of the basin scale puzzle because it is capable of producing large quantities of nomadic coho fry that because of density dependent pressure, drop out of the tributary to summer and winter rear in mainstem Rock Cr habitats.

Based on the abundance of spawning gravels documented in the 2010 LFA field inventory by Bio-Surveys, there is currently 2.5 times more smolt capacity in spawning gravel than the carrying capacity of the summer habitat (Appendix 4, Table E1).

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

The 2009 Bio-Surveys rapid bio-assessment observed juvenile coho to an ephemeral log jam 2.2 RM from the confluence with Rock Creek. For most of the 2.2 miles, Weed was one of the most productive tributaries for coho in the Rock Cr basin. The average rearing density was 2.7 coho/sq m with an extended spawning peak of 4.1 coho/sq m at RM 0.5. From the mouth to RM 1.7 only four pools contained summer rearing densities below 1.7 coho/sq m. Ninety per cent of all coho Parr in Weed Cr were rearing in this same 1.7 mile stretch. The total coho parr production estimate for Weed Cr in 2009 was 14,400. In 2010, total abundance declined to 6,192 coho parr and average rearing densities declined to 1.4 coho / sq m. The regions of high spawner activity remained similar near RM 0.5.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Although Weed Cr. flows in a tight canyon, the gradient is not overly steep (3.4%) and there are areas of good gravel retention and wood complexity due to the legacy of large wood. This legacy wood includes fire toppled wood from the 1930's burn and large quantities of woody debris recruited from hillslope failure. Most of the premium aquatic habitats are located in the first 1.5 miles. It was noted that Weed Cr was a well shaded stream with the primary riparian components alder and Douglas Fir. In the 1993 Aquatic Inventory conducted by ODFW the average wood complexity score was 2.2 on a scale of 1-5.

Pool complexity scores calculated by Bio-Surveys LLC in 2009 averaged 2.2 on a scale of 1-5. This scale is based on the total percent of pool surface area that is associated with some form of structural complexity that is capable of providing cover (over hanging vegetation, large substrate, wood, undercut bank, etc.). A ranking of 2 represents 1-25% of pool surface area associated with cover and 3 represents 26-50%.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

This stream seems to be trending toward simplification at a faster rate than other streams in the Rock Creek system with the same age class of stored legacy wood. This could be the result of its narrow canyon creating higher velocities. Terraces exhibit recent interaction but as wood complexes unravel and are lost to the system, new wood complexity will be required to arrest the process of simplification. There are several sites throughout the extent of coho distribution that exhibit have large wood still functioning at a high level. These are the only significant locations for refugia during winter flow regimes.

The 1993 Aquatic Habitat Inventory did not record any beaver dams in Weed Creek. In 2009 the Bio-Surveys RBA snorkel inventory documented eight beaver dams present in the system; most were insignificant summer dams, providing limited potential for winter habitat. One dam complex was anchored with large wood and provided excellent winter cover that would be stable during winter flows. The location of this large dam pool however was not high in the system and consequently it was unavailable to most non volitional migrants displaced by increasing winter flows..

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

Weed Creek traverses a narrow pinnate canyon with steep hill slopes. The Valley Width Index score provided by ODFW in their 1993 AHI was 2.5. This score was considered "very narrow". Most of the stream is hill slope confined, leaving little valley floor to create meander and functional floodplain terraces. Large wood complexity is very important in this system for providing the foundation that creates impoundment. In locations of impoundment the stream was able to store gravel and create interactive terraces with complex features capable of supporting juvenile salmonids during winter flow regimes.

There are many indicators throughout the stream course to suggest that historical floodplain interaction was much higher. Floodplain connectivity is in decline as the active channel trends toward simplification from the decay and transport out of the system of old wood.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The potential for creating complex channel forms is limited because of the narrow valley form. However, because of Weed Creeks importance as a spawning destination that supports the mainstem of Rock Cr, sufficient amounts of large wood should be supplemented to increase bedload storage and maintain the

current levels of high function observed. This is a stream at risk because of the disparity between the wood in and the wood out of the system. Currently more wood is being lost than there is being recruited.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Narrow valley
2) Accelerating loss of legacy wood
3) Limited beaver population
4) Limited conifer recruitment potential for providing persistent structure naturally

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Large wood placement in first 1.7 miles to aggrade bed materials, create diverse off channel habitat types, and give a foundation for beaver impoundment.
2) Retain riparian buffers on the mainstem and on 1st and 2nd order tributaries capable of delivering large wood.
3) Enhance beaver forage (Willow, Vine Maple, Cottonwood, Ash) in Anchor Site 2 and headwater flat that begins at RM 2.5

Anchor Site 1

Location and length

Anchor site 1 is located 1 mile above the confluence with Rock Creek and stretches upstream 1,200'.

Channel structure

Sinuosity is low because of the limited valley width of this anchor site. There is limited potential for increasing meander.

Floodplain structure

Terraces are not extensive but they are low and interactive. They are primarily the result of a debris flow from an adjacent small tributary that deposited large wood and fines in the mainstem of Weed Cr. Vegetation is mostly young alder recolonized on the disturbed debris flow soils.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

There was 28 sq m of spawning gravel classified as good within the anchor. The impoundment caused by debris flow as a result of slope failure has created conditions capable of supporting all of the seasonal habitat needs of coho salmon.

In both 2009 and 2010, the rapid bio-assessment snorkel inventory conducted by Bio-Surveys observed densities of juvenile coho salmon in excess of 3.0 coho/sq m within the anchor site.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The site exhibits the morphological constraints of a narrow valley floor. In addition, the future recruitment of persistent woody debris will limit the streams ability to continue to function as a key spawning destination.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Protect riparian buffers on the mainstem and steep slide prone contributing tributaries.
2) Enhance wood complexity with full spanning structure to arrest the progression toward simplification.

Anchor Site 2

Location and length

Anchor site #2 is located 1.6 RM from the confluence with mainstem Rock Creek and has a total length of 1,200ft.

Channel structure

Relative to other Anchor sites in the basin, sinuosity would have to be classified as moderate, the result of hill slope constraint. Within Weed Cr, the highest level of sinuosity was observed within this anchor site.

Floodplain structure

Terraces are 2ft-3ft and interactive with an active floodplain width of 75ft. The terraces are a result of the deposition of fines caused by impoundment from a legacy wood jam.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Spawning gravels in this anchor are plentiful and very high quality. Bio-surveys 2009 RBA data indicated that summer rearing here was exceptional with pool densities exceeding 3.0 fish / sq m. Coho rearing densities dropped sharply after this anchor. There were not extensive backwater and side channel complexes but floodplain interaction as a result of impoundment was occurring during winter flow regimes.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

A deficiency of full spanning large wood structures limits floodplain complexity in this anchor site.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Inject additional large wood in full spanning jam complexes

Anchor site rankings

Function

Rank the identified anchor sites in terms of current function (1= best).

1) Anchor Site 1
2) Anchor Site 2

Restoration potential

Rank the identified anchor sites in terms of restoration potential.

1) Anchor Site 2
2) Anchor Site 1

Secondary Branch 1

Location and length

There were no coho bearing Tributaries in Weed Creek. However their cumulative contribution was important to the overall function of the combined Rock Cr 6th fields.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Weed Creek tributaries were small and steep, offering very little in the way of rearing or spawning for salmonids except where they briefly traversed Weed Creeks narrow floodplain. The majority of these tributaries however were exceptionally prone to slope failure. Their value as sources of large wood and gravel for the mainstem of both Weed and Rock Cr has been historically significant. It was noted during the 2010 LFA that several of these tributaries had experienced recent slope failures. These failures were directly responsible for creating the most functional locations in the system through their contribution of stable large wood, terrace forming sediments, and spawning gravels. They also deliver cold summer flows to the mainstem which directly mitigates for elevated temperatures in the lower mainstem.

The steep narrow canyon of Weed Creek predisposes the system to simplification. Without the resource contributions from the tributaries, Weed Creek could not function at its current high level. The protection of riparian buffers on Weed Creek Type N tributaries is a high priority for the future success of the entire Rock Cr system.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

In 1993, the AHI described the species composition of Weed Creek riparian as dominated by 81% hardwoods. In May of 2010, the Bio-Surveys LLC stream inventory noted a similar mix of species. However, there was scattered conifer recruitment potential in some reaches. Weed Creek was well shaded in both the 1993 and 2010 inventories.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Recruitment potential for LWD is limited in the short term by the absence of large conifers in some reaches, but there is significant recruitment potential of large conifers on a limited basis. Some older alder will add ephemeral structure in the short term. Heavy upslope harvest activity has diminished the availability of resources recruited through slope failure and debris flow.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

A contiguous and intact riparian corridor in conjunction with a narrow canyon and a north south aspect have resulted in cool flow emanating from Weed Cr during summer low flow regimes (no temperature data available)..

Tributary D assessment

Migration barriers

There were no migration barriers on Trib D.

Temperature issues

ODEQ temperature monitoring data in the mainstem at the confluence of Rock Creek and Trib D show temperatures close to 64 degrees F for the seven day average of daily maximums. It is possible that large exposed beaver ponds in Trib D are contributing to these elevated temperatures. The impounded terrace is broad (200ft) and beaver dams are modest in height because great surface areas can be inundated with limited dam height. Therefore, deep ponded habitat is not occurring here that would normally stratify and provide cool subsurface leaching. Planting prescriptions here would be classified as high priority.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

There was 3.4 sq m fair quality spawning gravel and 36.1 sq m of good quality spawning gravel observed in Trib D during 2010. The majority of that gravel was observed above RM 0.5. The location of these gravels is perfect for seeding the vast surface areas of impounded habitat in the lower end of Trib D.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

The 2009 RBA conducted by Bio--Surveys observed 7,400 ft of juvenile coho distribution from the confluence with Rock Creek. The average rearing density was 1.3 coho/sq/m. in 2009 and 1.6 coho / sq m in 2010. The expanded production estimate for the stream was 8,675 summer rearing coho Parr in 2009 and 5,244 in 2010. Most of the summer rearing was occurring in the well-developed beaver ponds throughout the system. Confidence in the overall estimate of summer parr is weak in Trib D because of the massive quantities of off channel habitat that was not incorporated into the snorkel inventory as a matter of protocol. Consider the values above as underestimates of the true production.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Summer cover for juvenile salmonids is often expressed in quantitative inventories as the abundance of wood. The 1-5 rating scale is based on the total percent of pool surface area that is associated with some form of structural complexity that is capable of providing cover (Over hanging vegetation, large substrate, wood, undercut bank, etc.) 2 is 1-25% of pool surface area, 3 is 26-50% of pool surface area associated with cover.

The average complexity rating given by Bio-Surveys during the 2009 RBA survey was 2.36, but complexity was considerably higher in areas influenced by beaver activity. Much of the summer rearing appeared to be taking place in the well-developed beaver ponds throughout the system. Solar exposure was heavy in the ponded areas.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The highly complex beaver impoundments exhibit the highest quality winter habitat in all of the Rock Cr subbasin. These large beaver ponds were capable of harboring huge numbers of juvenile salmonids during high winter flows (Photo14). The largest of the beaver influenced reaches encompassed the majority of the lower 0.5 RM. This location low in the tributary system offers refuge for juveniles purged from higher spawning reaches during winter flow regimes.

There are several recent log structures placed above the first road crossing that have not yet developed significant complexity. It is likely that the Trib D at this juncture does not frequently have the hydraulic potential for transporting transient bedload or canopy litter.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction..

The lower portion of Trib D, below the first road crossing, has a wide valley floor with an extensive and highly interactive floodplain. There is a very significant legacy of fire toppled wood in the lower 600 ft that is responsible for everything else that has subsequently occurred in this tributary. With this large volume of large conifer buried in the floodplain, beaver have been able to take advantage of these purchases for dam construction that is winter stable and the site exhibits a legacy of long term colonization. Beaver dams have created a 300 ft wide highly interactive floodplain terrace in the lower 0.5 miles of stream corridor.

Above the road crossing the stream becomes much more constrained by hill slopes and there is no longer any potential for the broad interactive floodplain observed below the crossing. Around RM 1 another well-established but smaller beaver complex creates interactive terraces but hill slope confinement still defines the extent of this 500ft long interactive site.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The reach below the first road crossing may be functioning at full capacity for the provision of meander, braiding and off channel habitat complexity. This is a site that would be classified as reference location in its prime for providing all of the habitat components required to optimize coho production. Above the road crossing, there is limited opportunity for the development of these complex channel forms because of hill slope confinement. Beaver have created a condition of complex habitats above RM 1 even within this narrow valley morphology. The recent structure placements above the road crossing may eventually encourage beaver impoundment.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Currently beaver forage is scarce. This will eventually lead to abandonment of the site which will result in simplification of the complex channel form that can be observed here now..
2) The long term recruitment potential of persistent conifer is limited below first road crossing to maintain the foundation that beaver have succeeded on.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) The planting of willow and other beaver forage would provide an extended food source and also mitigate for the solar exposure associated with ponds.
2) Plant wetland species of conifer on hummocks and dry sites for future recruitment.

Anchor Site 1

Location and length

Anchor site # 1 is located 500ft from the confluence with mainstem Rock Creek and has a total length of 2,000ft.

Channel structure

Sinuosity is exceptional as a result of the wide floodplain, extensive beaver activity, and the presence of legacy wood that creates diversion.

Floodplain structure

Terraces are low and highly interactive with many complex channel features. The terrace structure is a result of the deposition of fines recruited from headwater reaches of Trib D and trapped and stored by the impoundments formed by legacy wood and a long history of beaver activity. Vegetation is dominated by reeds, grasses, skunk cabbage and low shrubs. No Reed Canary Grass was present in 2010. The absence of Reed Canary Grass above the Hwy 26 crossing is especially interesting since it exists just below the Hwy 26 crossing abundantly.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Spawning gravels in this anchor are limited because the low gradient does not provide for scour and sorting, There is however 8 sq m of spawning gravel near the top end of the anchor site that is critical for seeding the available rearing habitats downstream. Rearing densities encountered by Bio-Surveys during their 2009 RBA snorkel inventory hovered around 1.0 coho/sq m within the anchor. 35% of the estimated total coho Parr were documented within the anchor. The 38 sq m of good spawning gravel quantified in the LFA field inventory was not enough to seed the summer or winter rearing habitat available within Trib D. Increases in production within the tributary are solely dependent on increasing the availability of the primary limiting factor (spawning gravel). These gravel limited tributaries are not capable of contributing excess nomadic fry to the lower mainstem of Rock Cr.

With the location of the anchor site low in the system, its exceptional level of function, and its large surface area (capacity) of low velocity impounded habitat, the anchor site provides very high quality and important winter rearing habitat.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

This site is currently a model of a properly functioning stream segment. Excessive solar exposure that contributes to lower mainstem temperature limitations and the lack of beaver forage are the primary issues that challenge the site.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

Planting of beaver forage such as Willow, Cottonwood, Vine Maple and Ash coupled with the judicious location of water tolerant conifers would provide mitigation for both issues.

Secondary branches

No secondary branches were noted on Trib D that contained coho distribution beyond the tributary within the heart of the 0.5 mile anchor site that is completely inundated with beaver impoundment. This tributary and its associated channel morphology are a portion of what has allowed the broad floodplain development to occur in Anchor Site 1.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The lower 2,500ft of Tributary D below the first road crossing is solar exposed with very little canopy cover (Photo 15). Above the road crossing the canopy closes dramatically. The riparian corridor is primarily alder with some conifers mixed in.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

There is some potential for the contemporary recruitment of conifer. Several stands of re-prod will eventually offer recruitment potential in the lower 600 ft of Trib D. This is a critical location for maintaining the long term recruitment of large wood that will hold the anchor site habitat together and prevent channel incision. Alder is currently the primary source of upslope wood complexity above the road crossing.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The solar exposure within the anchor site is likely causing elevated temperatures. These temperatures are likely not an issue at the site, but they do contribute to elevated temperatures in the lower mainstems of both Rock Creek and consequently the Nehalem River. Because of the massive floodplain water storage that is occurring in Trib D, vegetative succession has been retarded by a year around high water table. The quickest remedial step for addressing both the lack of beaver forage and the lack of solar protection is a willow planting blitz. Willow stakes would need to be protected with cages until their roots have stabilized and the plants can be exposed to beaver use.

Ivy Creek assessment

Ivy Creek enters Rock Creek 10.2 RM from the Nehalem confluence.

Migration barriers

There were several natural ephemeral passage barriers throughout Ivy Creek. A log jam beaver dam combination at 3,440 ft stopped adult coho in both 2009 and 2010.

Temperature issues

Limited temperature data is available for Ivy Creek but random summer data points collected August 19, 2009 (59 deg) and July 21, 2010 (57 deg) during the Bio-Surveys snorkel inventory indicate moderate summer temperature profiles. As was observed in other tributaries of the lower Rock Cr mainstem (Fall, Trib C), Ivy exhibits a temperature dependent upstream migration of coho juveniles that extends a short distance above the mouth (500 ft). This behavior was observed in both 2009 and 2010.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

There were 11.1 sq m of fair quality spawning gravel and 9.8 sq m of good quality spawning gravel in Ivy Creek. Gravel was located sporadically throughout Ivy and usually associated with wood complexity. Exposed bedrock was frequent.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

Modest coho numbers were observed in Ivy Creek during both the 2009 and 2010 RBA conducted by Bio-Surveys. In 2009 distribution extended ,3,880 ft from the mouth and an expanded estimate of 1,860 coho

parr was observed.. In 2010, a year with markedly lower adult escapement across the basin, the extent of distribution was similar at 3,440 ft but the summer standing crop was estimated at only 900 coho.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Summer flows in Ivy Cr were very low (un-quantified) with some reaches exhibiting almost no surface flow between pools. The average complexity score given during the Bio-Surveys RBA surveys was 2.16. The 1-5 rating scale is based on the total percent of pool surface area that is associated with some form of structural complexity that is capable of providing cover (Over hanging vegetation, large substrate, wood, undercut bank, etc.) 2 is 1-25% of pool surface area, 3 is 26-50% of pool surface area associated with cover.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The majority of quality winter cover was associated with beaver activity and low gradients in the lower portion of Ivy creek. Some wood complexes show signs of creating floodplain interaction and impounded low velocity refugia during winter flow regimes. Above 2,000ft the canyon becomes tightly hillslope confined and the development of winter cover and complexity is non existent. It is likely that many summer coho parr are frequently recruited to the mainstem of Rock Cr and depend on finding winter refugia there after the first fall freshets.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

Flood plain interaction is limited in Ivy Creek above 2,000ft from the mouth because of narrow canyon morphology. The lower reach of Ivy exhibits signs of floodplain interaction during winter flow regimes. Wood complexity and beaver impoundment are corporately working to provide the limited floodplain interaction observed. Maintaining this mix of Beaver and large wood would be a an important goal for securing the productive capacity of Ivy in the future.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The lower reach has the characteristics necessary for the establishment of complex channel forms in addition to the current level of floodplain interaction. Increases in channel roughness would exhibit immediate benefit to the development of channel complexity.

In the upper reaches of hill slope confinement there is not extensive potential for a high level of channel complexity. This reach is still important for the storage of spawning gravels and summer rearing. In this small low flow stream there in no anchor site capable of supporting all of the coho's seasonal habitat requirement and therefore linkages with other rearing habitats in the Rock Cr basin are important.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) The primary limitation of Ivy Creek is its small summer pool surface areas and its hillslope confined channel morphology.
2) In the lower gradient reach, the lack of beaver activity is the primary limitation.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Protect existing riparian to ensure future large wood recruitment and encourage long term beaver colonization.

Anchor sites

No anchor sites identified.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The majority of this streams lineal distance currently utilized by coho for spawning and rearing has a healthy riparian canopy of mixed hardwood/conifer with an average canopy closure greater than 70%. In the headwaters of Ivy near the end of anadromous use the primary canopy shifts to a young conifer plantation (approximately 15-20 years old). The harvest did not leave a strong riparian buffer and only a sparse alder riparian remained intact.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

There is very limited contemporary recruitment potential in the headwaters of Ivy Cr because of the age class of the managed conifer plantation. Future recruitment potential in the head water reach will be strong as long as there is a commitment to retain a functional RMA. For the majority of Ivy the potential for full spanning LWD recruitment is good for both the short and long term.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The 2010 LFA inventory conducted by Bio-Surveys did not detect the upslope conditions, the aspect or the riparian solar exposure that would suggest that summer temperature limitations would be an issue for Ivy Cr.

Ginger Creek assessment

Ginger Creek enters Rock Creek 15.5 RM from the Nehalem confluence.

Migration barriers

Ginger Creek has an impassable 10+ft falls 150ft from its mouth.

Temperature issues

Ginger Creek has substantial summer flow (un-quantified) and is very important for cold water contributions to the mainstem of Rock Cr during summer flow regimes. Temperatures in the mainstem of Rock Cr become a limitation for summer rearing salmonids approximately 4.5 miles downstream of the Ginger Cr confluence. No site specific temperature data was available for Ginger Cr.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

Spawning gravel inventories were not conducted for Ginger Cr because the habitat is permanently inaccessible to anadromous salmonids as a result of the falls near its mouth. There are likely viable quantities of spawning gravel of the appropriate size for resident cutthroat. These gravels were not quantified.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

In both 2009/2010 RBA snorkel surveys conducted by Bio-Surveys, coho were observed in only the 150 ft segment from the confluence of Rock Cr to the impassable falls. Juveniles were likely upstream migrants from the mainstem of Rock Cr. This habitat segment is insignificant for coho production.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Because the habitat is inaccessible to anadromous salmonids at all seasons of the year, there is no viable summer habitat for coho.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Because the habitat is inaccessible to anadromous salmonids at all seasons of the year, there is no viable winter habitat for coho.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction..

Channel characterizations for Ginger Cr are not possible from the results of the 2010 field inventory conducted by Bio-Surveys. Because the habitat is inaccessible to anadromous salmonids, habitat conditions were not quantified above the falls.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

Channel characterizations for Ginger Cr are not possible from the results of the 2010 field inventory conducted by Bio-Surveys. Because the habitat is inaccessible to anadromous salmonids, habitat conditions were not quantified above the falls.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

No limitations observed because habitat was not inventoried.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

Not applicable

Anchor sites

No anchor sites were identified.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The majority of the riparian corridor of Ginger Cr is dominated by early seral plantation conifer. Approximately 25% of the streams lineal distance is associated with recent harvest but riparian buffers are present and intact. The primary open canopy exists at a large beaver dam complex at RM 0.75.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Because riparian buffers have been maintained in recent upslope harvest actions, there is the potential for future wood recruitment to the aquatic corridor. Because this RMA management strategy is contemporary, the time frame to significant recruitment is long (approx. 50 - 70 years).

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The importance of protecting the riparian corridor long term within the Ginger Creek sub-basin cannot be overstated because of its cumulative importance to the mainstem of Rock Cr and its proximity to the beginning of temperature limitations in the mainstem of Rock Cr. Currently all of the Ginger Cr basin is located within the boundaries of industrial timber land. As was observed in much of the Rock Cr basin, upslope harvest has been significant in Ginger and nearly all of the lineal distance is in some form of early seral conifer regeneration. Currently the majority of Ginger is not suffering from solar exposure. Approximately 25% of the lineal distance is associated with recent harvest but riparian buffers are intact. There is an exposed 0.8 acre pond 0.75 RM from the mouth that could be contributing warm water to the system.

Fall Creek assessment

Fall Creek enters Rock Creek 13.3 RM from the Nehalem confluence.

Migration barriers

There is a 12ft falls at RM 0.5 that terminates anadromous use. At RM .25 a culvert has rusted through and is now dry at low summer flow and passing all water subsurface. This blockage has truncated the upstream migration of all fish at summer flow, most notably Cutthroat and coho salmon seeking cold water refugia from the mainstem of Rock Cr. This is not and adult migration barrier.

Temperature issues

Fall Cr was documented as containing cool summer flows during the RBA snorkel inventories conducted in 2009 and 2010. The confluence of Fall Cr is located very close to the region of mainstem Rock Cr that begins to exhibit elevated summer temperatures for extended periods that exceed the DEQ standards for water quality. In both 2009 and 2010 the highest coho densities were observed in the first 1,000 ft of Fall Cr, a result of the upstream temperature dependent migration of juveniles from the warming mainstem of Rock Cr. It would not be uncommon for large quantities of summer rearing juvenile salmonids to be pushing up from the lower mainstem reaches to reach a location in the mainstem or one of its tributaries that is below their summer temperature threshold. Understanding this behavior helps us identify and prioritize restoration actions to address a specific habitat need.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

Spawning gravel was limited in Fall Creek and heavy depositions of silt burden all observed spawning gravels rendering them dysfunctional for the incubation of salmonids. Only 1 sq m of good quality, 4.4 sq m of fair, and 2.2 sq m of poor quality spawning gravels were present during the Bio-surveys 2010 LFA inventory. Nearly 60% of this gravel was located in the lower 1,000ft of the stream. Silts appear to be originating from significant slope failures upstream of the falls.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

In both 2009/2010 RBA snorkel surveys conducted by Bio-Surveys, Coho were observed from the mouth to the falls at RM 0.5. summer rearing Coho numbers were substantially higher in 2009 with an expanded estimate of 4,002, and an average rearing density of 2.96. In 2010 this estimate dropped to just 1,296 with an average rearing density of 1.52. It is possible that the high numbers documented in 2009 were partially a result of a temperature dependent migration that did not occur in 2010 because of higher sustained summer flows and lower mainstem Rock Cr water temperatures. Actual origins (mainstem Rock or spawned in Fall Cr) of the summer parr are not possible within the scope of this analysis but there are two potential origins that stand out within Fall Cr that warrant further investigation.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The stream has adequate wood abundance associated with the active channel to provide complex summer cover. This feature combined with a consistent closed canopy reduces the impact from avian predation. The cold water refugia presented by Fall Cr to the mainstem of Rock Cr is being utilized during summer pinch period flows by temperature dependent upstream migrants. Consider expanding the surface area available to these migrants in the lower 1,000 ft of stream corridor to boost the summer capacity of this temperature refugia.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

A full spanning wood treatment was implemented above the county road crossing. This reach is hill slope confined and does not offer much opportunity for the development of flood plain interaction. The primary effect of this treatment will be realized in the added pool complexity and the potential for trapping additional spawning resources (limiting). A much more appropriate site for large wood placement exists in the 1,000 ft of sinuous stream corridor between the County road and Rock Cr. The stream traverses the

floodplain terrace of mainstem Rock Cr and there is potential for expanding both summer and winter habitat surface areas here.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction..

Below the county road Fall Creek is in the mainstem floodplain. The channel is interactive during winter flow regimes but complexity and interaction could be increased significantly. Directly above this area large wood has been added and floodplain reconnection is in progress but will never be extensive because of morphological limitations (hillslope confinement).

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The presence of a broad active floodplain suggests that the lower 1,000ft of Fall Cr exhibits extensive potential for the development of complex channel features. Given the proximity to the upper limits of the temperature limitation that exists in the mainstem, this location is important for expanding the capacity of functional summer rearing habitat until elevated temperatures in the mainstem can be reduced. The opportunity for the development of off channel backwater and alcove habitat is high in this reach.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Low beaver abundance
2) Lack of LWD in reach below the county road crossing.
3) Morphological constraints above the county road.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Allow and encourage beaver colonization in Fall Creek.
2) Add LWD in low terrace area below county road.
3) Develop off channel ponds/back waters below county road.
4) Replace degraded county road culvert that is currently creating a barrier to the upstream temperature dependent migration of juvenile salmonids.

Anchor sites

There were no anchor sites independently classified within Fall Cr. This was primarily a function of the limited scope of the high quality habitat (exhibiting anchor characteristics). However, the 1,000 ft of stream channel between the mainstem of Rock and the county road crossing have been functionally incorporated into mainstem Rock Creeks Anchor Site 5. This is unique habitat because it joins the mainstem of Rock at a point where the mainstem becomes temperature limited and upstream temperature dependent juvenile migrants utilize this habitat for cold water summer refugia.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

Alder was the primary riparian species in Fall Creek. Some mature conifers where present throughout the corridor. Canopy closure was generally very good (>80%). Much of the stream above anadromous distribution (barrier falls at RM 0.5) is contained in industrial forest ownership.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

There is mature conifer present along lower portions of Fall Creek sufficient in size to create functioning LWD jams upon recruitment. The retention of the standing conifers in these well stocked buffers is critical to maintaining long term channel and floodplain function. Varying age class conifers are present and maintaining a healthy buffer. This condition will ensure healthy future recruitment unless modified by harvest. Above the county road, alder is the primary recruitment source.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

Currently the 0.5 mile reach accessible to anadromous salmonids in Fall Creek is well shaded. Because the falls truncates anadromous fish use, there is concern that the headwater riparian corridor could be viewed as less significant for fish habitat. Given the special significance of the cold water contribution of Fall Cr to the mainstem of Rock, it is important to maintain a robust riparian buffer above anadromous use to ensure continued function. Currently the Fall Cr basin is in a state of harvest recovery with a largely intact riparian corridor dominated by alder supported by young conifer stands upslope.

Martin Creek assessment

Martin Creek enters Rock Creek at RM 18.5 above the confluence with the Nehalem River.

Migration barriers

At 200ft a 3ft falls terminated coho distribution in 2010. Adult coho passed this falls however in 2009. This falls is a definitive juvenile barrier but does not appear to be a significant adult barrier during years of higher adult abundance. Gradient increases above this falls.

At 850ft a boulder and wood jam in a bedrock pinch coupled with a steep bedrock slide stopped adult coho migrations in 2009. In is likely that both of these features are capable of stopping anadromous migration. It is unlikely that this stream will ever provide significant anadromous production because of these morphological issues that compromise access.

Temperature issues

Currently temperature is not a limitation in this stream, but as observed in many other tributaries of Rock Creek, it functions to provide cool water to the mainstem of Rock during pinch period summer flows and therefore the importance of maintaining a well shaded RMA cannot be overstated.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

There was no spawning gravel documented within the anadromous use area of Martin Creek. Gradient in this reach does not allow for significant gravel sorting (13.8 %% avg for the 1st ½ mile).

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

In 2010 only 6 coho where observed, all in the first sample pool. These fish were the result of a small upstream migration. In 2009 an expanded total of 56 summer rearing coho where present 850ft from the mouth. Given the fact that juvenile coho where present above the 3ft falls at 200ft it is highly likely that a pair of adults were able to partially spawn in lower Martin Cr. This is not likely a frequent event given the poor conditions.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Summer cover is very limited and the habitat would be more suitable for steelhead use if spawning gravels were available for seeding the limited amount of available habitat.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Winter cover is almost nonexistent in Martin Creek given the steep gradient and poor pool complexity.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

The confined active channel combined with steep average gradients (13.8%) suggest insignificant floodplain interaction exists. Hillslope confinement was common, further indicating a lack of floodplain interaction.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

There is very limited potential for the development of the complex channel forms provided by sinuosity and channel braiding. In addition, no backwater or off channel habitat types were observed.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Hillslope confinement
2) Steep stream gradients

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

No.

Anchor sites

No anchor sites identified.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

Martin Creek is within industrial forest ownership. Protecting riparian buffers is important for the overall health of the watershed. Nearly 70% of the Martin Cr basin has been recently clear-cut. The riparian buffer is sparse and primarily alder.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Recruitment potential is limited because of shortened upslope harvest rotations. A narrow band of riparian alder and early seral Douglas Fir are the only available sources of future wood recruitment.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The poor riparian condition does not immediately impact Martin Cr aquatic habitats but the potential to contribute to the cumulative temperature impacts in the Rock Cr mainstem clearly exist.

Olson Creek assessment

Olson Creek enters Rock Creek from the South East between Weed Creek and NF Rock Creek at RM 22.9.

Migration barriers

At 1,000ft a 6ft log jam presents an ephemeral barrier that may effect adult migration (Photo 16). However, snorkel inventories in 2009 suggested that the barrier was passed by adult coho. In 2010, there were no coho observed in Olson Cr and it may have played a significant role in denying access to upstream spawning habitats and turning adults completely out of the tributary. This is the only substantial migration barrier on Olson and it currently is responsible for maintaining incredible system function in the form of floodplain connectivity upstream of the jam (Photo 16).

Temperature issues

Temperatures are cool in Olson Cr even though vast surface areas are contained in impounded beaver dam habitats and their associated wetlands near the headwaters. Large volumes of water are currently being ground water stored and cooled in the headwaters of Olson Cr.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

There was a total of 107 sq m. of spawning gravel in Olson Creek. All but one sq m. of this gravel was classified as high quality and 93% of these high quality gravels were observed in mainstem Olson above the barrier log jam at 1,000ft (Photo 17). Bedrock exposure was the primary substrate feature below the jam. These abundant gravels overwhelm both the summer and winter rearing capacity of Olson Cr aquatic habitats (appendix 4, table E1) and therefore provide an important source of nomadic fry for seeding downstream habitats in the mainstem of Rock Cr.

This is the type of seasonal habitat balance that is necessary to utilize the vast rearing surface areas available in the lower mainstem of Rock. This is how the Rock Cr system as a whole used to work until the

loss of integrated large wood in headwater tributaries drove the system toward the channel simplification that resulted in the loss of stored spawning substrates.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

Coho juveniles were observed at moderate densities (1.36 coho/sq. m.) throughout the majority of Olson Creek to RM 1.1 in 2009, during the Bio-Surveys LLC RBA inventory. Densities where much higher below the log jam averaging 3.01 coho/sq.m.sq m. The average densities above the jam when isolated from the habitats below the jam where only 0.87 coho/sq.m.sq m. This suggests that the log jam although not a definitive barrier, is functioning to delay and frustrate access to high quality head water spawning gravels. Much higher utilization of these gravels would be obtained if a series of large wood placements below the existing jam were designed to help step the incised channel up for adult passage. The current log jam is a very valuable asset that forms the foundation for all of the gravels stored above and should be maintained at all cost.

The density spike observed at the mouth of Olson Cr for coho juveniles during the snorkel inventory would normally be associated with a high temperatures in the main stem, but at RM 22.9 temperature data suggests that this is not the case in the mainstem of Rock Cr at this juncture. This leads us to conclude that the partial barrier is crowding adult spawners into a short 1,000 ft stream segment and they are seeding to capacity the limited gravel resources that exist there.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

During the 2009 RBA survey conducted by Bio-Surveys the average complexity score was a 2.2 on a scale of 1-5 (2 is 1-25% of pool surface area, 3 is 26-50% of pool surface area associated with cover). This represents a moderate level of cover.

It was noted during Bio-Surveys' 2010 LFA field inventory that there was significant in stream wood complexity and gravel retention above the jam at 1,000ft, and below the jam wood and gravel where scarce. This reach was dominated by exposed bedrock and pools where not well developed. The lower 1,000 ft has definitively been the recipient of a dam break flood event that completely flushed all stored resources (wood / gravel) from this segment of stream channel.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

In the lower 1,000ft of Olson winter habitat is poor, providing no off channel winter habitat in the form of back waters or interactive floodplain terraces. Above this reach winter cover is high quality with low interactive terraces supplemented by beaver impoundment. Currently beaver activity is not as high as the residual evidence suggests it used to be but dam complexes are being maintained in the upper reaches.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

Directly above the jam there are interactive terraces resulting from the LWD impoundment. The majority of the 0.9 RM has alternating hill slope terrace morphology. In this reach floodplain interaction is frequent in areas with large wood. Above RM 0.9 the gradient begins decreasing and the floodplain becomes highly interactive. This upper reach has the majority of the active beaver colonies documented in Olson Cr. Much of this area is not being utilized by juvenile coho because it is above spawning gravel resources.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

Above the jam, channel complexity increases dramatically with very low terraces (<1ft) and an increased level of sinuosity. This section of the stream is functioning at a high level for the provision of habitats for salmonids at all seasons of the year. Below the jam there is potential to greatly increase the complexity and improve system function with wood placement but this lower reach is more hill slope confined and will never exhibit the level of meander and off channel habitats observed in the upper stream segment.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

The primary limitation in this stream is the inaccessibility of the upper reaches of the system for spawning and incubation. The main cause of this is not necessarily the jam itself but rather the degradation of the habitat below the jam (incised and scoured to bedrock).

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Adding full spanning wood complexity to the lower 1,000ft of Olson would create an approach to the barrier making passage much more likely.
2) Adding full spanning wood to the 3,500 ft upstream of the log jam would be recommended as a secondary priority.
3) Enhance beaver stability in a location of known beaver abundance by planting and protecting beaver forage species (Willow, Ash, Vine Maple, Cottonwood) above the tributary confluence at 4,500 ft.

Anchor sites

No anchor sites identified.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy

The lower 1,000ft of Olson has large mature conifers within the riparian corridor. Above this reach the stream becomes alder dominated with varying age classes of conifer plantation upslope. Above RM 1.0 there are areas of solar exposure due to a long term legacy of consistent beaver activity.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

The contemporary recruitment potential of large conifers in the lower reach of Olson is excellent. Above this, the recruitment of conifers depends on the preservation of riparian buffers.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The majority of the riparian corridor within the Olson Cr basin is intact. Above the mature conifer in lower Olson a strong alder buffer dominates the riparian corridor. The upslope is industrial forest that is all in an advanced state of recovery. The only solar exposure observed within Olson was associated with well-established beaver complexes that work to increase summer flow and are not currently contributing warm water because of stratification and subsurface release.

Military Creek assessment

Military Creek enters Rock Creek from the North West 0.25 miles downstream from the confluence of SF Rock Creek. This is approximately RM 26 on the mainstem of Rock Cr.

Migration barriers

No migration barriers where present during the 2010 LFA survey conducted by Bio-Surveys.

Temperature issues

According to the ODFW AHI conducted on July 28, 1993 the highest water temperature recorded in Military Creek that day was 58.5 degrees F. Since that time there has been extensive logging in the head waters of Military Cr. The impact of headwater harvest activity on current stream temperatures is undocumented relative to this historical temperature data.

There is significant opportunity for solar exposure (Photo 18) related to the abandoned beaver terraces that have not recovered vegetatively, exacerbated by a NW / SE aspect that likely prolongs the duration of daily solar exposure. The active channel has begun to incise within this historical beaver terrace and some solar protection is provided by the shadow of vertical banks.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

There were 28.2 sq m of fair quality spawning gravel observed in Military Creek during the 2010 LFA inventory. 71% of the these gravels were located below the confluence of Trib A (in the first 0.5 RM). The entire tributary is heavily burdened with deep sediments that reduce the incubation capacity of the gravels. There were no spawning gravels observed in Trib A.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

Coho use ended at RM 1.2 in a large heavily silted headwater swamp in both 2009 and 2010. 2009 was the most productive year, with an expanded total of 3,102 summer rearing coho parr and an average rearing density of 1.99 coho/sq m. The first 3,000ft of Military Creek were the most productive in terms of densities and individual pool counts both years, likely due to the lack of quality spawning gravels in the upper reaches.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Good wood densities (60.2 pieces/100 m of stream length; ODFW benchmark > 20 pcs/100 m) were recorded during the 1993 AHI study conducted by the ODFW and an average complexity score of 2.9 was given (on a 1-5 scale). The 2010 LFA survey resulted in a similar conclusion. The first 0.5 RM has the highest wood densities and the best canopy closure. The 0.7 remaining miles of coho distribution exist within the confines of a series of abandoned beaver terraces with limited contribution to cover and complexity from the riparian because of the historical inundation that reset vegetation to early seral grasses and forbes.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The abundance of wood complexity associated with the active channel below Trib A provides substantial floodplain interaction and off channel refugia from high winter flows despite the morphological constraints of a hillslope confined canyon. Above RM 0.5 and including Trib A, the gradient decreases and the valley floor broadens to 100 ft. There are indicators of an extensive beaver legacy in this reach with the potential to provide ideal winter cover (Photo18). During the 1993 AHI there were 4 beaver complexes observed. In 2010 the RBA inventory documented 6 active beaver dams.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction..

Below Trib A the stream is hill slope confined in a steep V shaped valley. Flood plain interaction in this reach is limited to small alternating terraces created and maintained by excellent accumulations of woody debris. Directly below the mouth of Trib A a legacy wood jam (likely from the 64 flood event) has created a wide interactive flat. Above this primary depositional plain, channel gradients decrease and the valley floor widens. The combination of broad floodplain and the presence of beaver has succeeded in maintaining a highly functional interactive floodplain.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The current level of channel complexity in this stream is high. However, there is the opportunity for increased complexity in and above Trib A. This upper 0.7 miles of low gradient channel morphology lends itself to the natural storage of winter run off. Enhancing both the water storage and salmonid production capacity of this upper basin site could be achieved through the development of off channel backwater habitat and the re-colonization of beaver.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Natural hillslope confinement currently limits the development of complex off channel habitat below Trib A.
2) Food sources for beaver are currently extremely scarce and limiting the persistence and potential expansion of beaver colonies.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

Yes. The planting of beaver forage would be required for removing the current limitation to what appears to be the historical productive capacity of the sub basin., This single restoration prescription would improve complexity, production and water storage capacity.

Anchor Site 1

Location and length

Anchor Site 1 begins at RM 0.5 just below the confluence of Trib A and continues up the mainstem 3,500ft to nearly the end of coho distribution. Anchor Site 1 also includes the first 1,500ft of Trib A.

Channel structure

Sinuosity within the anchor site is currently moderate but could be increased in the long term with increased impoundment which accelerates the development of complex channel forms.

Floodplain structure

Terraces within the anchor site are wide (100 ft) and uniform in elevation. They are a result of sediment deposition resulting from a legacy of impoundment, both beaver and LWD. In areas of beaver activity terraces are highly interactive, but reaches that have transitioned out of an impounded state are beginning to incise causing isolation from the floodplain in all but the highest winter flow regimes. The majority of these terraces are dominated by early seral grasses. There is a significant infestation of Scotch Broom beginning to colonize stream adjacent terraces in Trib A.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

The majority of the anadromous spawning that occurs in Military Creek occurs in the 0.5 mile stream segment below the anchor site. This leaves much of the identified anchor habitat under seeded. 2008 / 2009 was a significant return year for adult coho and densities within the anchor site only averaged 1.1 coho/sq m (compared to 2.6 coho/sq m below). 46% of all coho observed in Military Cr were rearing within the anchor site in 2009.The anchor site provides exceptional summer and winter rearing habitat.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Within the anchor site spawning gravel is the main limitation to salmonid production. Only 29% of the total spawning gravel observed in Military Cr was located within the anchor site and no spawning gravel was present in Trib A. the primary reason for the spawning gravel limitation is the heavy silt load. With lower gradients in this reach the stream is unable to sort and clean the existing depositions of gravel.

Recent upslope harvest activity in the headwaters of Military Cr in conjunction with the heavy flooding experienced in 2007 have likely contributed to increased silt loading and the low gradient reach (Anchor Site 1) predisposes this stream segment to higher silt retention rates than observed in other stream segments.(with or without the harvest impacts).

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Riparian planting of forage species to encourage beaver recovery (the identified anchor exhibits a strong and recent legacy of beaver impoundment)
2) Place full spanning log structures to trap and sort mobile gravels. This treatment would likely provide a viable platform for stable beaver dam construction.

Secondary Branch 1

Location and length

Trib A enters Military Creek 3,000ft from its mouth and forks just upstream from its start. Including both forks there is roughly 2,500 ft of stream accessible for anadromous use.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

There was no spawning gravel documented in Trib A during the 2010 field inventory conducted by Bio-Surveys. In 2009 coho juveniles were present in very low numbers (126 expanded) and only observed in the first pool during the 2010 RBA inventory.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The complete lack of viable spawning gravels is the primary limitation here.

Addressing the limitations

There is no viable prescription for addressing these limitations.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The riparian area below Trib A consists primarily of mature conifer with a narrow alder corridor tight to the stream. The canopy exhibits 95% closure. Above and including Trib A there is a mix of Alder and conifer with an open inner riparian dominated by early seral grasses and forbes. The only protection from solar exposure is the perimeter canopy that exists beyond 50 ft on each side of the active channel.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Large wood is readily available and abundant for future recruitment to the active channel below the confluence of Trib A. Above Trib A and including the Trib A corridor, recruitment potential is limited to sparse buffers beyond 50 ft. This predisposes this segment of stream channel to small wood contributions from naturally recruited tree tops well into the future. The recruitment of mobile wood to this section of stream channel is also limited due to the low gradient profile and it's headwater location where flows are diminished from arterial branching (Trib A).

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The wide terraces with grass dominated vegetation and sparse buffers leave much of upper Military Creek exposed to solar radiation. Currently, temperatures do not exceed the threshold for juvenile coho survival, but there may be negative cumulative negative effects to mainstem Rock Cr temperatures when combined with similar impacts in other headwater locations.

Selder Creek assessment

Selder Creek enters Rock Creek from the North West at approximately RM 12.

Migration barriers

Trib A, enters from the North 660ft above the mouth of Selder. A barrier falls terminates anadromous passage 560 ft above the Trib A / Selder Cr confluence. In addition, there is a culvert exhibiting a 4ft perch upstream of the falls (Photo 19). This combination of factors definitively terminates access for migratory fish species. Cutthroat are present and abundant above the falls. The perched culvert is undersized and not allowing natural resource migration (wood and substrates).

Temperature issues

A temperature gage at the mouth of Selder Creek, (UNWC) recorded temperatures that slightly exceeded the DEQ standard for 303 d listing of 64 degrees F from 07/12/03 to 08/01/03. It should be noted that mainstem Rock Creek becomes temperature limited near the mouth of Selder consistently from year to year.

Identifying the temperature impacts to the aquatic corridor in Selder Cr is critical for restoring the summer function of the habitats of mainstem Rock Cr below the Selder Cr confluence. This is a key tributary for addressing cumulative downstream impacts. There is no doubt that the long term protection of riparian corridors in the headwater tributaries (including some type N streams) of Selder will be required to correct the current observed conditions.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

In 2010, 17.6 sq m of fair and 84 sq m of good spawning gravels were quantified in Selder Cr. There were large gravel deposits throughout Selder but heavy silt loading has compromised the capacity of these gravels to provide high egg/fry survival rates (professional opinion, un-quantified). Selder Cr was visually classified as maintaining higher silt loads than any other Rock Creek tributary. The majority of the quality gravels were located above RM 1.0 where the increase in gradient begins to mitigate for silt loading with increased potential for hydraulic scour.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

Coho use terminated 3.5 RM from the mouth of Selder Creek in 2009. The following year distribution extended to RM 4.2. In 2009 the highest juvenile Coho counts and densities were located in the first 1mile of distribution and a peak rearing density of 2.6 Coho/sq m was observed at RM 0.5. 35% of the Coho Parr, including Selder Cr tributaries, were located in the first 0.6 RM of habitat and 19% were rearing in the first .1 RM.

Given the location of Selder Cr near the start of the temperature limited lower mainstem of Rock Cr,. it is likely that a percentage of the summer rearing Coho Parr observed in lower Selder Cr were upstream temperature dependent migrants from the mainstem of Rock Cr. These concentrations of summer rearing parr in lower Selder were not observed in 2010. It is likely that the cooler stream temperatures observed in 2010 in the mainstem of Rock Cr did not trigger the need for upstream migration to cool tributary refugia. In 2010 coho densities were higher above RM 1.0 where gravel quality is higher.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Good large wood densities where present during the 2010 LFA field work (Photo 20). The 1996 ODFW AHI recorded moderate wood levels of (35 pieces/100 m of stream length; ODFW benchmark > 20 pcs/100 m) but their inventory only included the first 2,900ft of Selder. The highest wood densities where located further upstream. Selder Cr contained legacy large wood recruited from the riparian as a result of a historical wildfire. This wood was creating diverse, complex and interactive summer habitats.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The high densities of large wood from historical wildfire were also creating complex winter habitats from enhanced floodplain interaction that has resulted in the development of off channel habitats. These off channel habitat features hold large numbers of winter rearing coho juveniles during even moderate winter flows. This level of naturally occurring large wood complexity is not common in Western Oregon Coast Range streams. The general trend for habitat complexity in Selder Cr will be negative as a result of the continual decay of these key pieces of legacy wood that cannot be replaced by the current riparian corridor.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction..

The lower 0.5 RM of Selder has a wide valley and is terrace constrained. This reach is currently entrenched four to five feet and is interacting with its floodplain at a very low frequency. This lower reach was scoured to bedrock in the 1996 flood from what appears to be a dam break flood event. Above the second culvert crossing the valley transitions to a moderate V valley form but increased large wood densities have retained migratory substrates that have in turn maintained a much higher level of floodplain interaction than observed in the lower 0.5 miles.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The potential for the development of complexity in lower Selder is high.. An increase in the abundance of full spanning large wood would aggrade the scoured stream channel and reconnect the active channel with its floodplain at a much higher frequency than currently occurs. There is also good potential for increasing channel complexity around RM 2.3 with the addition of large wood complexes. The reach of stream from RM 0.5 to RM 2.3 is currently functioning at a high level but additional wood recruitment from the riparian corridor is 75 years out.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) The lack of large wood in lower 0.5 RM
2) Long term riparian recruitment potential from RM 0.5 to RM 2.
3) Undersized culvert on Trib A limits resource transport to lower Selder and mainstem Rock Cr

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Full spanning LWD RM 0 – 0.5
2) Establish a permanent RMA to protect riparian corridor from being harvested to the active stream channel again.
3) Remove and replace culvert. In addition place a series of full spanning structures below the falls on Trib A to attempt to back water and provide passage for adult migrants to spawning gravels above the road crossing.

Anchor Site 1

Location and length

Anchor Site 1 starts 0.8 RM from the mouth of Selder and extends 2,500ft upstream.

Channel structure

The anchor site exhibits a high level of sinuosity. This is provided by the high density of large wood that resulted from fire toppled riparian conifers recruiting continually to the active channel. This natural process

can only rarely be observed in coast range forests and has been a pivotal component of the high function observed in Selder Cr.

Floodplain structure

Most floodplain terraces are less than 2 ft vertical with a width of 75-100ft.. They exhibit indicators of frequent interaction as a result of large wood impoundment. They have been formed by the deposition of sediment and fines behind full spanning legacy wood jams. The primary vegetation that dominates the current floodplain terraces is early seral grasses and shrubs (salmonberry). Alder are scattered and less abundant than early seral vegetation classes..

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Summer and winter rearing capacity within this anchor are excellent because of the complex channel characteristics provided by high wood complexity that result in off channel back waters. These backwater and dam pool habitats provide increases in both summer and winter rearing habitat surface area. Spawning gravels were plentiful in and above the anchor site with 77% of the spawning gravel observed in Selder, in or above Anchor Site 1.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary limitation within Anchor Site 1 is the lack of any long term wood recruitment from the riparian corridor. The recruitment of substantial conifer is 75 years out. No riparian buffer was retained adjacent to the stream corridor within the anchor site during the last harvest rotation and solar exposure is currently present that impacts the mainstem of Rock Cr below the confluence of Selder Cr. Summer temperature profiles within Selder Cr , although currently not a primary limitation for salmonids, are likely to be rapidly degraded above DEQ thresholds with any future harvest impacts that increase aquatic solar exposure.(this includes some Type N streams).

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Riparian planting of beaver forage (willow, ash, vine maple) would mitigate for current solar exposure and encourage additional impoundment.
2) Protection of riparian buffers to ensure long term large wood recruitment and continued long term protection from solar impacts.

Anchor Site 2

Location and length

Anchor Site 2 starts RM 2.2 from the mouth of Selder and includes 3,500 lineal feet of stream.

Channel structure

Sinuosity is very low in Anchor Site 2. The wood complexity required to create the impoundment and aggradation necessary for stimulating floodplain interaction and complex channel forms is absent.

Floodplain structure

Terraces range from 2-3 ft. Floodplain widths are broad and extend to 250ft wide There is little evidence of significant floodplain interaction on the terraces however, suggesting that channel incision is on an increasing trajectory.. Old meander channels have been abandoned by the stream that used to be highly interactive during winter flow regimes. The primary riparian vegetation is 50+ year old Douglas fir with a mixed deciduous understory of shrubs. This is the location of multiple tributary junctions which is the

primary morphological feature that facilitates the wide floodplain character that sets this habitat segment apart as an anchor site from other downstream locations.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Spawning gravels suitable for coho were scarce in this zone but summer rearing coho numbers began to increase in both 2009 and 2010 within the anchor.. Complex channel forms are not present here as a result of low wood density. The ability of this anchor site to provide significant low velocity winter refugia is low.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) Summer and winter rearing is limited in this anchor because of the lack of complex channel forms. This lack of channel complexity is driven by the current low densities of instream wood.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) The addition of onsite large wood would increase floodplain interaction and boost channel and floodplain complexity.
2) The planting of beaver forage would also provide a platform for beaver colonization which would result in increased gravel retention for boosting headwater spawning.

Anchor site rankings

Function

Rank the identified anchor sites in terms of current function (1= best).

1) Anchor site 1
1) Anchor site 2

Restoration potential

Rank the identified anchor sites in terms of restoration potential.

1) Anchor site 2
1) Anchor site 1

Secondary Branch 1

Location and length

Trib A enters Selder Creek 850ft from its mouth and coho distribution only continues a short distance because of an 8ft bedrock barrier falls 435 ft upstream from the mouth. In addition, there is an impassable culvert above the falls with a 4 ft perch

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Because of the location of the barrier falls low in the system, Trib A does not play a significant role in the provision of spawning or rearing habitat for migratory salmonids. This tributary however, is an important contributor of cold water to the lower mainstem of Rock Creek that is temperature limited during low summer flows. There also appears to be considerable potential for gravel contribution from Trib A that is currently being restricted by the undersized and perched culvert above the falls.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary rearing limitation is the natural barrier falls located just upstream from the mouth of Trib A.

Addressing the limitations

There is a possibility that the introduction of full spanning LWD complexes in both the mainstem of Selder Cr and in lower Trib A could result in aggradation within Trib A that lifts the high flow channel elevation enough to provide passage at the barrier falls. The removal of the undersized culvert would be a more appropriate investment of restoration resources if this could be accomplished.

Secondary Branch 2

Location and length

Trib B enters Selder Creek from the west at RM 2.2. In 2009, coho distribution extended 0.7 miles and included utilization of the first few pools of Tributary B1.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In 2009, the summer rearing coho population was 1,625 (expanded). The stream forks at RM 0.5 and 90% of the summer rearing coho found in Trib B were located below the forks. The average rearing density in this same reach was 1 coho/sq m In 2010 a summer rearing population of 36 (expanded) was observed. Winter rearing in this reach is good. Beaver activity and wood densities are high. It appears that substantial spawning and rearing is occurring here during years of strong adult escapement.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The current condition and complexity of the aquatic habitat in Trib B is excellent with the primary limitation being adult escapement.

Addressing the limitations

There are no addressable limitations.

Secondary branch site rankings

Function

Rank the identified branch sites in terms of current function (1= best).

1) Trib B
2) Trib A

Restoration potential

Rank the identified branch sites in terms of restoration potential.

1) Trib A
2) Trib B

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The riparian corridor varies widely throughout the Selder Creek system. The lower 700ft of the stream flows through pasture and exhibits significant solar exposure. Above the pasture reach, to the second road crossing at RM 0.5, large wood recruitment potential from riparian conifer is good with 100% canopy closure. Above the road crossing land use switches to industrial forest management and the primary riparian canopy is young stands of conifer reprod. This reach exhibits zones of solar exposure. In addition, this stream segment was harvested to the active stream channel with no riparian buffer retained. Current elevated temperature profiles are likely a result of the slow recovery of this un-buffered harvest.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Beginning at the top of the agricultural segment near the mouth to the second road crossing (RM 0.5) there is good future recruitment potential. Above the second road crossing and extending to RM 2.0, any significant potential for recruitment is 75 years out. Above RM 2 the riparian contains both a deciduous and conifer component that will be capable of providing wood to the active stream channel.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The reach of pre-commercial thinning that begins at RM 0.5 and extends to approximately RM 2 exhibits consistent solar impacts from a legacy of complete riparian harvest. It is likely that these impacts will decrease as tree height increases with age. There are also beaver flats throughout upper Selder and its tributaries that exacerbate these harvest impacts. These areas would benefit from riparian planting prescriptions designed to provide forage for beaver.(willow, vine maple, ash, cottonwood).

Maynard Creek assessment

Maynard Creek enters Rock Creek at RM 11.3.

Migration barriers

There was an ephemeral log jam that formed a passage barrier at 4,200ft. this jam terminated adult coho migration in 2009 but not in 2010.

Temperature issues

No temperature data was available for Maynard Creek.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

A total of 10.4 sq m of good quality spawning gravel and 7.9 sq m of fair spawning gravel was documented during the LFA inventory. The majority of this gravel was located between 500ft and 2,500ft from the mouth.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

In 2009 the expanded summer rearing abundance of coho parr was 2,184 and the average rearing density was 2.2 coho/sq m In 2010, the expanded summer rearing estimate for coho was 2,550 and the average rearing density was 1.2 coho/sq m. There were two beaver dam pools included in the sample in 2010 and an overall increase in the abundance of beaver dams (up 40%). Beaver dam habitat was responsible for 57% of the summer rearing population of coho in 2010. This illustrates the importance of beaver dam habitat for

immediate expansions of potential rearing habitat. Both years the zone exhibiting the greatest production occurred between 500 and 2,500ft.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The reach providing the highest quality and most productive summer cover was also the reach with the best spawning gravel from 500ft to 2,500ft. This reach had active beaver dams that provided ideal summer rearing surface area.. Above this reach the small size of the stream limited both spawning and rearing potential. The majority of the stream corridor displayed excellent canopy cover and channel roughness.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The majority of winter cover in Maynard is currently provided by beaver impoundment. Additional wood complexity provided supplemental cover in both impounded and un-impounded stream segments. Without the presence of these high quality beaver dam habitats Maynard Cr would exhibit weak winter linkages. The reach of best winter rearing was from the mouth to 2,500ft.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

Flood plain interaction is limited in Maynard Creek above 2,500ft because of the hillslope confinement that results in a narrow canyon morphology. The lower reach of Maynard Cr exhibits highly interactive floodplains during winter flow regimes as a result of beaver impoundment.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The lower reach (0 – 2,500 ft) has the characteristics necessary for the establishment of complex channel forms in addition to the current level of floodplain interaction provided by beaver impoundment. Increases in channel roughness would exhibit immediate benefit to the development of channel complexity. In addition, there appears to be an increasing trend in the abundance of beaver dams with 5 observed in 2009 , 7 observed in 2010. In the upper reaches of hill slope confinement there is no potential for the development of additional channel complexity. This reach is still important for the storage of spawning gravels and summer rearing.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) The primary limitation for coho in Maynard Cr is stream size and channel morphology above RM 0.5. Current conditions within Maynard Cr represent a very high state of function for coho production.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) Protecting the riparian area to ensure future large wood recruitment.
2) Providing for continued beaver utilization by ensuring an adequate food source remains viable in the inner riparian corridor.

Anchor sites

There were no anchor sites identified in Maynard.

Secondary branches

No secondary branches were identified. .

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The first 2,000 lineal feet of Maynard Creek has good canopy cover (75%). However at 2,500 ft there is a 1,000ft reach with little to no harvest buffer which has resulted in extensive solar exposure. Again at 4,200ft a narrow harvest buffer exhibits heavy blow down loss which has also resulted in significant solar exposure. Each of these upslope impacts contribute to the temperature degradation observed in the mainstem of Rock Cr that have been described in this document as the sum total of the cumulative impacts occurring in tributaries just exactly like Maynard.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

Riparian recruitment potential for Maynard Cr is good. Because the active channel width is only 6 ft , both deciduous and coniferous contributions from the riparian will be well retained and form functional instream wood complexity even at winter flows.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

No temperature data was available for Maynard, but the solar exposure associated with the lack of riparian buffer associated with upslope harvest activity has been identified as a primary limitation for salmonids on the Rock Cr basin scale.

Bear Creek (Rock Cr) assessment

Bear Creek enters Rock Creek 670 ft upstream from Rock Creeks confluence with the mainstem Nehalem River. The confluence is in Anderson Park in downtown Vernonia.

Migration barriers

There were no adult migration barriers observed within the inventory.

Temperature issues

Temperature data collected by the Upper Nehalem Watershed Council and its partners was inconclusive because the thermisters deployed were exposed to air during the inventoried year. Bear Cr has been dry (no contiguous surface flow during both 2009 and 2010 summer snorkel inventories). Because the stream regularly dries up during midsummer flows, it is likely that temperature becomes a serious summer limitation for rearing salmonids.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

During the 2010 LFA field inventory there were 3.5 sq m of good spawning gravel documented in Bear Creek above the urban use area (0.5 miles). Within the urban use area, there is no spawning gravel suitable for adult coho.

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

During the 2009 and 2010 RBA snorkel inventories the stream was reported to have no flow and no coho were observed in the first 500ft of the stream. The survey was terminated because of the absence of coho. Coho were however, documented above the urban use area (RM 0.5) during the spring of 2005. This information was extracted from the Upper Nehalem Habitat Assessment Report It is possible that surface flows are retained above the urban use area during pinch period summer flows but this was not verified during the extent of this analysis.

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Because the lower reach of Bear Creek frequently stops flowing during summer months it cannot be considered viable summer rearing habitat. It is possible that the upper reaches of Bear Cr maintain flow and do provide some summer rearing habitat. This was not verified by Bio-Surveys.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Within the urban use area of Bear Creek there is no winter rearing habitat. This condition is the result of low channel complexity, deep channel incision and the historical treatment of the stream corridor as primarily a drainage corridor.. Current channel form is the result of urban manipulation and wood complexity is non existent. Above the urban use area there is more wood complexity and better pool development. The stream still does not exhibit a high degree of floodplain interaction and off channel winter rearing habitat is poorly represented. The best winter rearing location is a large dammed pool just upstream from the urban use area.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

Floodplain interaction is severely limited in the urban use reach because the stream flows through town and has been manipulated to stay well entrenched within its active channel. Floodplain interaction is also limited in the upper reaches because of the lack of large wood and consistently increasing valley constraints.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

The potential for increasing floodplain interaction within the urban use area is extremely low because of the implications for flooding residential terraces. Above the urban use area there is some potential to enhance the storage of winter flows. The addition of LWD complexes or the encouragement of beaver utilization would increase channel complexity.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Human manipulation within the residential landscape constrains natural process.
2) The lack of beaver impoundment.
3) Lack of LWD complexity

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above

1) No restoration prescription is available for addressing the limitations existing within the residential corridor.
2) The lack of beaver impoundment could be addressed by the provision of beaver forage in the upper 0.5 stream miles above the residential corridor.
3) Wood complexity would likely have the least return on the investment because of the low hydraulic potential in Bear Cr that would be required for transporting and aggrading gravel resources for spawning.

Anchor sites

No anchor sites were identified.

Secondary branches

No secondary branches were identified.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.

The 2005 Upper Nehalem Habitat Assessment Stream Report for Bear Creek indicated that the urban use reach was solar exposed, with only 48% canopy cover. The 2010 LFA also observed significant solar impacts within the urban residential area. Riparian planting has taken place throughout this reach over the last several years. This will provide future riparian closure and assist in mitigating for the cumulative impacts to the mainstem of Rock Cr.. Above the urban use area canopy cover was quantified at 81% in the UNHASR.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?

The only reach with riparian recruitment potential was above the urban use area on industrial forest ownership. The upper basin reach exhibits canopy components currently available for recruitment to the active channel.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The solar exposure observed in the lower 0.5 miles of Bear Cr likely contributes to mainstem Rock Cr elevated temperature profiles until surface flow is terminated. The period of elevated temperature contributions is likely very narrow (period un-quantified).

Rock Creek assessment

Rock Creek enters the Nehalem River at RM 91 in the town of Vernonia. This survey started from its mouth and continued up to the end of coho distribution at RM 27.5.

Migration barriers

A trash rack at the inlet end of the undersized HWY 26 culvert on mainstem Rock Creek accumulates large quantities of transient detritus and woody debris (Photo 23). This infra-structure designed to protect an under sized culvert does not appear to be included in a regular highway maintenance schedule. The current accumulation of debris has formed a vertical falls that is a definitive juvenile barrier and likely functions to delay adult salmonid migrants at the very least. This is a high risk impediment to migration because it exhibits the potential for isolating some of the highest quality coho and steelhead spawning and rearing habitat in the basin.

Frequent natural juvenile barriers in the form of bedrock steps where noted starting above RM 12. These steps suggest that tributary habitats are critical for providing thermal refugia during elevated summer temperature profiles in the mainstem of Rock Cr.

An undersized culvert on Trib C of mainstem Rock Cr is a juvenile barrier and isolating important thermal refugia for salmonids seeking escape from elevated summer temperatures in the mainstem .

Temperature issues

The Rock Creek mainstem exceeds DEQ water quality standards for temperature everywhere below the confluence with Selder Creek (at RM 12). This limitation occurs during summer low flows and has been documented multiple years between 1993 and 2005 by the Upper Nehalem Watershed Council and its partners. The thermisters that regularly registered temperatures meeting or exceeding (17.8 C) were located at RM 14, RM 10, RM 3, RM 0.9, and RM 0.1. According to the temperature profiles displayed from these sampling sites, temperature limitations became more acute in the lower three miles of the mainstem of Rock Cr (Photo 24).

Superimposing the 2009 coho distribution layer on top of the mainstem Rock Cr temperature profile suggests that the lower five miles of mainstem Rock Creek maintains summer temperatures that severely limited the aquatic habitats capacity to summer rear salmonids. In 2009 individual pool counts of coho began to increase above RM 5 and the highest individual pool count observed in the mainstem were documented at RM 9.5. This aggregation of coho parr at RM 9.5 supports the existence of an upstream temperature dependent migration in the mainstem for coho fleeing the environmental stress of elevated temperature that has been observed to have significant physiological (survival, prey avoidance, condition factor) ramifications for juvenile salmonids.

In 2010, summer rearing temperature limitations were not as severe with a higher abundance of juvenile coho rearing in the lower mainstem of Rock Cr. Because this extended mainstem distribution was observed on a lower adult escapement year than 2009 the most likely explanation is that nomadic fry from upper basin spawning reaches were able to reside throughout the summer in the mainstem because of cooler temperature profiles (documented).

An extensive legacy of logging, agricultural use and residential development on Rock Creek, dating back to the early 20th century and continuing to the present, has left much of the aquatic corridor over exposed to solar radiation. This is a cumulative impacts issue that begins to develop in headwater reaches long before the lower mainstem of Rock Cr displays its acute symptoms. From the headwaters to the mouth there are many areas that have been identified in this analysis for treatment. These sites include the maintenance of functional harvest buffers and lower basin riparian setbacks that protect the active channel from compounding solar exposure.

Aquatic habitats overview

Spawning gravel

Describe the quantity, quality and location of spawning gravel.

There was a total of 594.8 sq m of spawning gravel observed in the 2010 LFA inventory within the mainstem of Rock Creek from its mouth to the end of coho distribution at RM 27.5. 95% was classified as

good quality. From the mouth to the end of Keasy Rd (RM 14) there was a total of 162 sq m of spawning gravel (27% of the mainstem total). The reach from RM 14 to the confluence of Olson Creek near RM 21.5 contained 138 sq m of spawning gravel (23% of the mainstem total). The reach from Olson Cr to the end of distribution at RM 28.1 contained the remaining 50% of spawning gravels observed in the mainstem. This upper segment of mainstem of Rock Cr is approximately 22% of the total lineal distance.

For perspective, it's important to recall the quantities of spawning gravel documented for Rock Creeks primary headwater tributaries, NF Rock (total spawning gravel = 358 sq m) and SF Rock (total spawning gravel = 434 sq m). All 28.1 miles of mainstem Rock Cr contains only 37% more spawning gravel than just one of these headwater tributaries (SF Rock). This conclusion of low spawning gravel abundance will be important when this analysis reviews the results of the habitat based modeling exercise in the Restoration Analysis section of this document

Summer juvenile distribution

Describe the summer distribution of coho juveniles. Include a description of the resources used.

The 2009-10 RBA snorkel inventory documented an expanded estimate of coho parr of 106,926 in 2009 and 83,466 in 2010 for the mainstem segment of the basin.

Limited summer coho use was documented in the mainstem of Rock below RM 5 in 2009 during a temperature limited summer and increases in utilization were noted for this same reach in 2010 when summer stream temperatures were lower. In 2009, a year with elevated mainstem temperatures, there were only 2,724 (expanded) summer rearing coho parr observed. In 2010, mainstem Rock stream temperature were less of a limitation and 5,898 coho parr were observed in the lower 5 miles of the mainstem. This amounts to 2.5% of the mainstem total coho abundance in 2009 and 7% 2010. The increased utilization during cooler stream profiles occurred even though overall coho abundance was lower in 2010.

Individual pool counts of Coho started to noticeably increase after the first five miles, but densities remained low because of large pool size. Individual pool counts of coho fluctuated greatly from the mouth to RM 21. The abundance of coho in a pool seemed to relate to the amount of large wood complexity associated with it.

Rearing densities increased steadily above Olson Creek reaching pronounced and strong spawning peaks near SF Rock in 2009 and further up near the end of distribution (RM 26.5) during 2010. The mainstem of Rock above the confluence of the SF Rock contains the best spawning gravels in the mainstem In 2010, the average rearing density for this reach was 1.71 coho/sq m and in 2009 it was 2.75 coho/sq m.

Mussels are present in the lower mainstem but not abundant (un-quantified).

Summer cover

Describe the character and distribution of summer cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

The lower mainstem from the mouth to the end of Keasy road at RM 14 in general, offers significant future potential for the provision of high quality summer cover. There are intermittent accumulations of complex wood and side channel habitats that exhibit the structural cover components of high quality summer habitat that are currently underutilized because of summer temperature limitations.

The stream is large in this reach with a 60-70ft active channel width and does not currently display frequent wood interaction from its riparian corridor. Wood exists only in the form of jams that are broadly distributed and rely on the transport hydraulics provided by winter flow regimes. The dominant inner riparian vegetation is Reed Canary Grass which terminates seral progression because of its ability to out compete woody species. This locks the inner riparian into an early seral plant community and compromises the development of the woody band of stream side vegetation that would have historically provided cover to juvenile salmonids from overhang.

There are isolated segments of extremely high cover complexity in the form of large wood that is creating channel braiding, back waters and complex cover from predation. The highest fish numbers in this reach during both the 2009-2010 snorkel inventory were tightly associated with these brief zones of concentrated cover and complexity. Even though stream gradients are not high (0.2%) in this reach , there are still good pool riffle complexes and the flow is not stagnant even during low summer flow regimes

The mainstem above RM 14 transitions into a very constricted zone of hillslope confinement displaying distinctly higher stream gradients (2%) and the riffle / rapid habitat structure that is more heavily utilized by steelhead than coho. This uniquely different stream segment extends approximately 3.5 miles to RM 17.5.

From RM 17.5 to Olson Creek there is very little large wood complexity and bedrock exposure was a more dominant feature than observed below or above. In 1992 the ODFW gave this reach an average complexity score of 1.4 on a scale of 1-5 and classified it as having little to no large wood. Pools consistently lacked any form of summer cover and any coho juveniles were very tightly associated with small clusters of overhanging wood complexity.

Above Olson Creek, gradients decrease to an average of 1% and large wood densities increase. Pools are smaller with more variation and good depth (indications of scour associated with the presence of wood).

Above the confluence of the South Fork stream order decreases resulting in a smaller wetted summer channel width (10ft) and Beaver activity becomes frequent. This stream segment provides the highest quality summer rearing habitat available in the entire Rock Cr basin (on parr with the high quality segments observed in both the SF and NF Rock). In 2002, ODFW noted wood densities from 8-54 M3/100m.

Winter cover

Describe the character and distribution of winter cover. Note that this evaluation generally lacks quantitative measurement, and relies on professional judgment.

Winter cover is present throughout the lower mainstem below RM 14. This winter habitat exists in the same locations that were observed as providing high quality summer rearing habitat. These sites are broadly dispersed but exhibit extensive back waters, side channels, and low terraces. These sites exhibit highly interactive floodplain habitats during elevated flows that are providing high quality off channel refugia during winter flow regimes. Large wood jams in association with low terraces are the key in creating and maintaining the function observed. These sites have been identified on the final map contained within this document and identified as “Anchor Sites”.

From RM 14 to the confluence with Olson Cr (8.3 mile segment) there is virtually no winter refugia. Hill slope constraints steeper gradients and low wood densities combine to reduce the winter capacity of this segment to provide low velocity refugia during high flows.

One mile above the NF confluence, a large full spanning log jam exists at the historical road crossing to the old Inman-Paulsen mill pond. The jam was formed by collapsed bridge stringers that still form the key log foundation for the jam. From this point up to the headwaters of Rock Creek the flood plain widens and there are many locations that exhibit good potential for the provision of winter rearing habitat. Beaver impoundment, interactive terraces, and back water complexes all offer complex off channel winter flow refugia in the upper basin. The abundance of beaver dam habitats has declined substantially since 2002 when ODFW documented 24 dams in Rock Creek above the SF Rock confluence. In 2010 there were only six observed during the summer RBA snorkel inventory.

Channel form and floodplain interaction

Describe the channel form and degree of floodplain interaction.

From the mouth of Rock Cr to RM 14, the valley floor is wide (>300ft) and the stream is terrace constrained with oscillating hill slope confinement becoming more frequent above the confluence of Selder Cr. Land use is largely rural residential and alternates between pasture and managed stands of conifer (<50yr old). Floodplain interaction is not common or extensive overall but there are sites (identified as anchors) with exceptional floodplain interaction that are extremely important for the retention and restoration of habitat diversity for maintaining salmonid populations in the lower mainstem.

There is a radical transition in stream channel morphology above RM 14. Gradients increase and the stream becomes primarily hill slope constrained. Substrates transition immediately to large cobble and small boulder with extensive stretches of exposed bedrock. This begins an area of very limited floodplain connectivity, extending upstream to RM 20. Above RM 20, the floodplain broadens to > 300 ft and the potential for floodplain interaction becomes more frequent. Bedrock exposures are still common with low wood densities resulting in poor substrate retention. This reach continues to the major log jam above the NF Rock confluence.

Floodplain interaction increases substantially above the full spanning jam at approximately RM 24.3. The valley floor is wide with low interactive terraces. Limited wood complexity creates high quality winter cover where it is present and gravels become the dominate substrate. Much of this complex habitat that is currently functioning well is trending toward simplification because of the lack of full spanning LWD complexes.

Channel complexity potential

Assess the potential for the development of meander, braiding, side channel, alcove, backwater channel forms.

There is extensive potential within the Rock Creek mainstem to increase floodplain interaction and complexity. The only reach that does not show potential is the stream segment from RM 14 to RM 18. This reach is morphologically constrained and does not exhibit the potential to develop complex channel characteristics. The high priority reaches for developing channel complexity are contained within “anchor sites” these sites will be discussed specifically in the anchor site section of this document.

Channel complexity limitations

List and rank the factors currently limiting the development of channel complexity.

1) Morphological constraints from RM 14 to RM 18.
2) The lack of full spanning wood jams limits the streams ability to trap and store transient substrates (gravels and cobbles) that cause channel aggradation and consequently interactive floodplains.
3) Diminishing beaver populations in upper Rock Creek mainstem above the Hwy 26 crossing
4) The natural attrition of existing legacy wood jams that are not being replaced from riparian or hillslope failure sources.

Addressing the limitations

Are these limitations addressable through restoration work? Explain for each limitation listed above.

1) The introduction of full spanning LWD complexes would aggrade transient bedload materials reconnecting the flood plain on a higher frequency.
2) Protecting, enhancing and encouraging beaver population recovery throughout upper Rock Creek.
3) Protect riparian buffers and implement riparian plantings to ensure future wood recruitment to maintain natural function.

Anchor Site 1

Location and length

Anchor Site 1 is located at RM 2.5 and includes 1,600 lineal feet of mainstem Rock Creek.

Channel structure

Sinuosity is very high throughout this anchor, with extensive back water habitat resulting from old channel meander. A full spanning wood jam has redirected the channel leaving the old channel acting as a large back water that exhibits high function during all winter flow regimes.

Floodplain structure

Terraces are low and interactive (3 – 4 ft) during most winter stream elevations. The riparian is dominated by Reed Canary Grass which results in extensive solar exposure at this site during summer low flow (Photo 24). There are alder present on the outer riparian but no conifer exists to provide the key log components that this site will need for long term persistence. Because of the current high level of sinuosity, the site may be capable of retaining mobile wood components delivered from the headwaters.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

This anchor site contains gravel resources but it is unlikely that coho spawn here because of its proximity low in the basin. The general nature of adult coho is to push as high as flows will allow them to access in headwater reaches of the basin. Chinook would be more likely the salmonid observed utilizing the gravels present within the anchor. Elevated summer temperatures are also limiting summer juvenile use in this reach.

The abundance of coho parr is very low and will not improve until water quality improves during pinch period summer flows. Because this reach has the characteristics of complex channel form and ample back water habitats it probable that this anchor is primarily functioning as winter refugia for juvenile salmonids flushed out of simplified headwater reaches (low wood complexity).

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) The primary rearing limitation in Anchor Site 1 is the temperature limitation that occurs during pinch period summer flows for the provision of viable water quality for salmonids.

2) Lack of a mature large conifer resource in the riparian that can be effective at providing channel roughness, encourage floodplain interaction and provide the height required to shade a broad active mainstem stream channel.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) The addition of multiple edge oriented large wood structures within the anchor site and below the identified anchor would enhance and maintain the winter linkage of the off channel oxbow habitat.

2) Riparian planting within the anchor site to increase long term recruitment potential very specifically where it will be most effective when recruited to the active channel in future decades. Additional planting throughout zones of solar exposure to mitigate for cumulative temperature impact (this is lower priority because of its lower basin location even though summer temperature is the primary limitation for salmonids).

Anchor Site 2

Location and length

This anchor site is located in lower Rock Creek at RM 5 and includes 3.500 lineal feet of mainstem Rock Cr.

Channel structure

The channel is highly sinuous in this area, with back water habitat and braiding created by large wood complexity and broad channel meander.

Floodplain structure

Terraces are low and wide exhibiting signs of frequent winter interaction. Large wood complexes are present that extend well up onto the adjacent terraces suggesting the site is stable, well anchored and a prime location for structure enhancement that can be effectively secured. Reed Canary Grass is the dominant riparian species and the interactive floodplain terraces exhibit very low densities of any woody species which leaves the site solar exposed and unprotected from scouring winter flows.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Spawning gravel suitable for coho was scarce in this zone and elevated summer temperature remains the primary seasonal limitation to salmonid production. It is within this anchor site that the abundance of summer rearing coho began to increase in both the 2009 and 2010 snorkel inventory. The increased complexity of the habitats within the anchor site described as high sinuosity and low interactive terraces provide an excellent foundation for the provision of winter habitat. Other seasonal habitats appear to limit the production potential of Rock Cr however, long before the competition for viable winter habitat becomes a survival issue.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1 Even though juvenile salmonids were utilizing this zone during both the 2009 and 2010 RBA inventory, their low abundance suggests that elevated summer temperatures still inflict a seasonal limitation on their ability to fully utilize the rearing potential of the habitat.

2 Sparse riparian canopy limits the long term potential of wood recruitment to the active channel. This results in limited cover and complexity and additional solar exposure that exacerbates the cumulative impacts of elevated stream temperature already existing in the mainstem as it arrives to the anchor site.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Riparian plantings within the anchor site in zones of solar exposure would assist in addressing the identified cumulative impact on stream temperature. Planting within the anchor site would also help future recruitment for the provision of habitat complexity and structure.
2) This anchor is currently functioning at a high level but the introduction of edge oriented full spanning LWD complexes would increase terrace interaction and ensure prolonged function of the site.

Anchor Site 3

Location and length

This anchor site is located in lower mainstem of Rock Creek. The center of the 3,500 ft lineal anchor is at RM 8, 1.3 miles downstream from the first crossing of Rock Cr by Keasy Rd.

Channel structure

The channel is highly sinuous in this area, with a large secondary channel habitat created by the recent formation of a new primary channel (Photo 25) that is in the process of abandoning a large mainstem oxbow. The stream has recently carved a short pathway through a 15 ft high peninsula where the primary winter flows are currently directed. This new channel has resulted in a reduction in winter hydraulics in the old channel that will make it premier low velocity winter habitat for rearing salmonids.

Floodplain structure

Terraces are exceptionally low in this anchor with frequent interaction taking place. The primary vegetation is alder and deciduous shrub with scattered conifer present. There is extensive potential for increasing floodplain water storage and off channel rearing habitat within this anchor site. This potential relies on the reconnection of oxbow habitats that remain truncated by the fill from a 220 meter segment of a historical Rail Road that bisects the historical stream channel.

There are both upstream and downstream habitat linkages on the floodplain within this oxbow that have been seriously compromised by the Rail bed and the restoration of this site addresses the issue of accelerated hydraulic power within the mainstem of Rock Cr that have exacerbated historical flooding. There is no better example of unrealized restoration potential within the mainstem of Rock Cr than can be observed within the floodplain of this anchor.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

As with the majority of the lower mainstem of Rock Creek, spawning gravels are more suitable for Chinook within the anchor. The summer temperature limitations documented by the UNWC , although still present, become less severe in amplitude and duration within this anchor. In both 2009 and 2010 RBA inventories, there were significant numbers of summer rearing coho present in this reach. Coho abundance however, was still far below the habitats measured carrying capacity (ODFW AQHI data). Given the high level of function and complexity, the site ranks extremely high for the provision of large surface areas of low velocity winter refugia.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) Floodplain habitats truncated by the historic Rail line that crosses the meander belt of mainstem Rock Cr within this anchor has impacted stream hydraulics and eliminated approximately 500 lineal meters of spawning and rearing habitat.
2) Elevated summer temperatures as a result of cumulative headwater impacts continues to limit summer salmonid carrying capacity.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Breach the Rail road bed on both the upstream and downstream end of the historical oxbow to reconnect approximately 500 meters of historic mainstem Rock Cr stream channel.
2) Riparian planting in zones of solar exposure to assist in addressing cumulative upstream temperature impacts.
3) Acquisition of riparian setback throughout this anchor to ensure future wood recruitment and continuation of a high functional state.
4) Improvement of existing off channel backwater complexes. Could be incorporated with existing small cold water tributary on the North East side of the anchor site and would increase the availability of off channel rearing habitat for both summer and winter. This would also increase winter water storage potential

5) The addition of full spanning LWD complexes throughout the anchor site to ensure continued function (floodplain linkage) and increase habitat complexity. This would also slow winter hydraulics and provide additional winter capacity to service the winter habitat needs of non volitional presmolt migrants from many dysfunctional headwater reaches.

Anchor Site 4

Location and length

Anchor Site 4 begins at RM 10 and extends 3,200 lineal feet upstream on the mainstem of Rock Creek.

Channel structure

Sinuosity is very high throughout this anchor. A large full spanning wood jam (very rare in the mainstem) has created channel meander, braiding and backwater complexes. The jam is ephemeral and largely composed of LWD components that do not necessarily display key log characteristics. Large amounts of gravel are currently being stored by this jam. The active channel is unusually wide within this anchor (100ft). This creates unique channel and flow characteristics that in turn provides beneficial habitat diversity for both summer and winter rearing salmonids..

Floodplain structure

Terrace elevations are highly variable within the anchor site and range between 2 and 8 ft. The lower terraces display indicators of frequent interaction directly related to the presence of the full spanning wood jam. The jam is reducing winter velocities and facilitating the deposition of migratory fines and sediments below the jam that have vegetated and have stabilized into permanent structural features on the floodplain. Again, these low terraces are highly dependent on the stability of the giant wood jam observed here.

An extensive low terrace on the north side of the anchor site has two small tributaries that traverse its 150 ft wide platform. The zone accessed by these tributaries provides extensive potential for the provision of winter refugia. Reed Canary Grass has become the dominant vegetative feature and is beginning to severely limiting the ability of the floodplain terraces to advance from an early seral condition to larger woody species that are important for providing the long term stability within the anchor site not currently provided by the ephemeral wood jam (Photo 27).

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

Even though the anchor site exists within a reach still listed as water quality limited by elevated summer temperature by the DEQ, there is still significant summer rearing of coho occurring . During the 2009 RBA snorkel inventory a pool associated with the large wood jam in this anchor held 1,050 summer coho parr. This was one of the highest pool counts observed in all of mainstem Rock Cr that year. Because the anchor site exists near the zone where temperature limitations begin to weaken in amplitude and duration (classified as temperature limited to RM12), we would expect this to be the zone that was also receiving upstream temperature dependent migrants from the lower 10 miles of mainstem Rock. This transition zone then becomes even more significant when viewed within the context of its basin scale importance. Critical cover (massive full spanning jam) and cold water (north tributaries) provide unique summer refugia here for reducing the physiological stressors of elevated temperature and constant pressure from avian and piscivorous predators in the lower mainstem with low wood density.

Within the anchor, there was 59 sq m of spawning gravel quantified during the 2010 LFA. It should also be noted that an additional 81 sq m of spawning gravel was located in the 3 mile section just above this anchor site. This represents 24% of the total mainstem spawning gravel observed. With the combination of good full spanning wood complexity, interactive floodplain, good gravels, and the cold water contribution of two small tributaries it is likely that this is a unique location capable of rearing disproportionately large numbers of salmonids during both winter and summer flow regimes.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) Even though juvenile salmonids were observed utilizing this anchor site, warm stream temperatures emanating from the Selder Cr sub basin just above this anchor site still predispose the anchor site to the potential of a summer temperature limitation..
2) The active channel is solar exposed because of the Reed Canary dominated riparian that suppresses seral development.
3) Full spanning LWD complexes are not present in the lower anchor. In addition, key log features are also not present to provide long term stability for the ephemeral jam at the top end of the anchor site.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Riparian planting within the anchor site to increase recruitment potential, provide cover, shade and vegetative diversity. Additional planting throughout zones of solar exposure to address cumulative temperature impact.
2) Create backwater/alcove that incorporates adjacent cold water tributary (north side) to increase both summer and winter off channel rearing potential. This would also increase the water storage capacity of this broad floodplain terrace.
3) The addition of edge oriented LWD in the lower portion of the anchor site would store additional gravels and increase the frequency of terrace interaction. These placements would also assist in maintaining higher summer water tables on the broad floodplain terrace.

Anchor Site 5

Location and length

This anchor site starts upstream from the mouth of Selder at RM 12.5, and includes 1.8 miles of mainstem Rock Creek and the lower 1,000ft of Fall Creek. The portion of Fall Cr included in the anchor site traverses the Rock Cr floodplain and terminates at the county road culvert crossing. This habitat segment is integrally associated with mainstem Rock Cr habitats.

Channel structure

Sinuosity in this anchor was high but the channel lacks the complexity and roughness normally associated with wood. There is considerable potential to increase complexity, aquatic cover, pool scour and roughness with the addition of LWD.

Floodplain structure

Terrace height fluctuates from three to five feet. Terraces are not lineally contiguous throughout the anchor site but can be described more accurately as consistently associated with each meander bend. Between these short interactive terraces are zones of hillslope confinement exhibiting no significant floodplain potential. Floodplain interaction is taking place throughout the anchor, but it is not generally extensive. Vegetation is a mix of alder, maple and conifer with a healthy and diverse mix of deciduous understory. Good canopy closure is present throughout the anchor site and there are no impacts from the solar exposure commonly observed below this juncture..

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

The mainstem pools in this reach are still very large so the documented rearing densities remained low. The anchor site exhibited good individual pool counts of coho during both 2009 and 2010 RBA surveys. Coho numbers declined precipitously during both years after proceeding upstream above this anchor site. During

the 2010 LFA inventory there were 97.8 sq m of spawning gravel documented within the anchor. This represents 16.4% of the mainstem total.

Temperature is still a concern in this zone but likely only during the hottest years. Winter rearing is likely taking place here but because of the smaller terrace surface areas and the higher terrace heights, it is more likely that juvenile salmonids wintering within the anchor site are short term residents as they pulse on and off of these stream adjacent terraces with the cycle of winter freshets. There appears to be extensive untapped potential for increasing floodplain interaction and complexity through restoration.. This would greatly improve both the summer and winter rearing capacity of Anchor Site 5.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) Channel degradation from the lack of full spanning large wood complexity results in a simplified channel that limits the anchors potential to form complex off channel habitat types. In addition, the lack of roughness in the form of wood, reduces the streams scour potential within the anchor, which results in poorly sorted gravels for spawning.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) The addition of edge oriented LWD jams would benefit this area by aggrading and sorting bedload material (spawning gravel), increasing floodplain interaction, water retention on the floodplain and the development of interactive backwater habitats. This action will increase the complexity and function of winter rearing habitat. Large wood should also be added to the lower 1,000ft of Fall Cr as part of this prescription.

Anchor Site 6

Location and length

Anchor Site 6 begins at RM 22.8. this is approximately 0.5 miles above the mouth Olson Creek and extends 2,000 lineal feet upstream.

Channel structure

Sinuosity is low in this short anchor. The stream is constrained by a logging road that runs down the center of the floodplain isolating the active channel from its historical meander belt.

Floodplain structure

Terraces are low, broad and capable of being interactive. Currently interaction is limited because the stream lacks the impoundment that would have historically been driven by the accumulation of naturally recruited wood from the riparian. Currently this higher gradient anchor exhibits low function. Bedrock intrusions that intersect the active channel have prevented down cutting and terrace isolation. Vegetation on the south side of the stream is primarily alder with a diverse deciduous understory. The north side of the stream is young re-prod (20years).

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

This anchor was summer rearing significant numbers of coho juveniles but rearing densities consistently fell far below the observed potential of the site. Pool complexity was poor, channel roughness was poor and consequently there was limited cover for protecting summer parr form predation. Spawning gravel was scarce in this anchor an obvious response to extremely low wood densities. Exposed bedrock was present throughout much of this zone. Pools were shallow and not well developed.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) The absence of large wood complexity has resulted is the lack of high functioning winter and summer rearing habitats.
2) Spawning gravels are not being stored because of this systemic lack of large wood complexity.
3) The valley floor road is isolating the stream from a large tributary (Trib C) fed wetland area that was once part of the mainstem floodplain. Currently the stream is flowing through an undersized pipe and is a juvenile barrier.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) The addition of full spanning LWD complexes would aggrade bedload, retain spawning gravels, increase pool complexity, and aggrade the active channel to increase floodplain interaction. This would dramatically improve the primary limitation for the production of salmonids within the anchor site.
2) Remove and replace the undersized culvert on Trib C (within the anchor site) to increase juvenile access to the high quality summer refugia in Trib C.

Anchor Site 7

Location and length

Anchor Site 7 begins at RM 23.6 (0.5 miles) above the mouth of NF Rock Creek and extends 1,500 lineal feet upstream.

Channel structure

Sinuosity is low in this short anchor because it is completely lacking any large wood complexity. The gradient is approximately 1% and no form of channel complexity is present. The simple nature of the channel here suggests a state of poor function.

Floodplain structure

Terraces are low (2.5ft), broad (200ft) and capable of high levels of interaction. Currently interaction is limited because the stream lacks the large wood complexity required to create the deflection and impoundment necessary for initiating floodplain interaction. Bedrock intrusions continue to provide the hydraulic controls that were preventing down cutting and terrace isolation (Photo 28). Vegetation in the riparian corridor is primarily alder with a diverse deciduous understory. Some mature second growth conifers are present in the riparian for the provision of future wood recruitment to the active channel..

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

This anchor is currently summer rearing significant numbers of coho juveniles but still falling far short of its production capacity. Rearing densities were low and pool complexity was extremely poor. Spawning gravel was scarce within the anchor.. Exposed bedrock and large cobble were the dominant substrate components. Pools were shallow, exhibited limited scour and were poorly developed.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) The absence of large wood complexity has resulted is the lack of high functioning winter and summer rearing habitats and the inability to capture, sort and store spawning gravels.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) The addition of full spanning LWD complexes would aggrade bedload, retain gravels, increase pool complexity and increase floodplain interaction. This would dramatically improve the system's ability to function for the production of salmonids.

Anchor Site 8

Location and length

This anchor site begins 1.0 mile upstream from the confluence with NF Rock, and includes 1 mile of the mainstem of Rock Creek. In addition, two significant cold water tributaries enter the anchor site that exhibit the potential of providing vast quantities of interactive off channel habitat.

Channel structure

Sinuosity in this anchor was good throughout the upper third of the anchor. Large wood complexes are present, channel braiding is occurring and the stream is interacting frequently with its floodplain (Photo 31). The lower portion of the anchor site has limited sinuosity because the channel is lacking complexity. There is considerable potential to increase sinuosity within the anchor site through the addition of LWD complexity and the development of off channel backwater/alcove habitats..

Floodplain structure

The flood plain in this anchor varies from 200ft to 750ft. at its widest point. The broad segment of the floodplain is the location of the old Inman-Paulson mill pond. Currently, the site is a Reed Canary Grass dominated terrace that is elevated approximately 4ft above the elevation of the summer stream channel (Photo 29). The stream is subjected to extensive solar exposure in roughly the lower two thirds of the anchor. This reach is lacking large wood complexity and is on a rapid trajectory toward simplification and isolation from its floodplain. The broad floodplain characteristics and relatively low terraces are a legacy of a full spanning wood jam at the bottom of the anchor site caused by a collapsed log stringer bridge (Photo 32). The jam is still in place but breaking down rapidly. This jam has created a long legacy of high function within the anchor site for the provision of both summer and winter habitat. The loss of this jam will initiate the process of channel incision and large quantities of stored bedload will be swiftly transported out of the Rock Cr subbasin.

The upper third of the anchor site has broad 3ft terraces that appear to be formed of highly erodible sediments. In this reach the channel is much more complex with wood structure and braiding. Terraces are vegetated by a mixture of alder, conifer and willow. There is evidence of beaver activity on several small tributaries that enter the mainstem in this location.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In both the 2009 and 2010 snorkel inventories, the average pool densities for coho increased radically over the average densities observed below this anchor. Coho densities remained very strong from this anchor to the end of their distribution in both inventoried years. The 2009 expanded estimate of summer rearing coho within this anchor was 11,934 (11.2% of the mainstem total) and the average rearing density was 1.65 coho/sq m. In 2010, the estimate was 7,716 coho rearing at an average density of 1.49 coho/sq m representing 9.2% of the mainstem total.

Spawning gravels in this anchor are of high quality and plentiful. 164.5 sq m of spawning gravel were inventoried in or adjacent to Anchor Site 8 during the 2010 LFA. This represents nearly 28% of the mainstem total.

Given the heavy summer rearing use observed and the existence of complex channel forms that extend onto very low interactive floodplain terraces, The potential for the provision of winter habitat exists within the anchor. The most significant observation is that there is tremendous unrealized winter potential on the old mill pond site. This would require the development of a new channel matrix that could contain high wood densities, and extensive off channel low velocity aquatic surface area.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) The lack of full spanning large wood currently limits the sites potential to maximize the abundance of both summer and winter habitat surface area.
2) Lack of canopy cover and vegetative diversity caused by the infestation of Reed Canary also limits the anchors riparian corridor from maturing and developing future wood recruitment potential. This lack of seral development also leaves the site solar exposed with no potential for improvement.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Full spanning LWD complexes will maintain and improve the complex function by aggrading bedload material, raise frequency and duration of floodplain interaction, improve sinuosity, and increase the storage of winter flood flows on the floodplain.. The addition of LWD would likely encourage beaver activity in the mainstem.
2) Design supplemental side channel construction for the Inman – Paulson mill pond site. This would include side channel construction and diversion, off channel and back water habitat development and alcove excavation within two tributary confluences. This type of off channel development would be implemented and planted well before the diversion of active channel flows to allow the site to stabilize and vegetatively mature. Final treatment would be the breaching of channel plugs and the placement of full spanning wood in the mainstem to encourage channel bifurcation.
3) Riparian planting on the Inman –Paulson mill pond site in association with the proposed side channel development to reduce solar exposure, ensure future wood recruitment, increase cover, and vegetative diversity.

Anchor Site 9

Location and length

Anchor Site 9 begins at RM 25.6 (confluence with of SF Rock) and continues upstream 1.9 miles to the end of coho distribution.

Channel structure

Sinuosity in this anchor is high because of the broad valley floor with a 100 -300 ft. Meander belt. Channel incision is uncommon and the presence of beaver dam complexes plays a significant role in forming the current channel metrics (Photo 34). There are several areas throughout the anchor site that are currently exhibiting entrenchment that effectively isolates the active channel from its historic floodplain. These reaches are characterized by steep erodible banks and a narrow channel with no impoundment. The most distinct example of this channel form exist just below the Hwy 26 culvert crossing and extends downstream approximately 1,400 ft.

Floodplain structure

The floodplain within the majority of this anchor is wide and unrestricted (100 -300 ft). Terraces fluctuate in height from 1-3 ft. There is evidence of frequent floodplain inundation in multiple locations and a strong legacy of beaver impoundment and homestead use is visible. Beaver utilization is currently far below the historical levels as observed by the abundance of abandoned beaver terraces. The reduced watershed area

for this headwater anchor site (a result of its location above the confluence of the SF Rock) creates an ideal scenario for successful (winter stable) beaver dam construction. There were 2 beaver dams observed in 2009 and 4 observed in 2010 in this 1.9 mile long anchor site. These sites are providing ideal habitats for summer and winter salmonid rearing.

Riparian vegetation on the floodplain terraces varies greatly throughout the anchor. Alder and Fir are the primary canopy cover where there is an intact canopy. Much of the stream flows through historic homestead meadows and still maintains high levels of solar exposure. This zone has remained in early seral vegetation because of extensive year around pressure from large numbers of elk. Currently, Reed Canary Grass is not present and its absence suggests that its upstream migration from known populations just downstream of the Hwy 26 culvert crossing may have been retarded by the deep road fill and undersized culvert that exists under the Highway.. Scotch broom is currently present and abundant above the Hwy 26 crossing . A legacy of old growth Cedar exists in this anchor, 6-8ft DBH stumps were observed.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In both the 2009 and 2010 RBA survey, average coho rearing densities were excellent in this anchor exceeding the commonly referred to standard for full seeding of 1.5 coho/sq m. The 2009 expanded estimate of summer rearing coho within this anchor was 13,080 (12.2% of the mainstem total) and the average rearing density was 2.95 coho/sq m. In 2010 these numbers declined to 10,608 and 2.24 coho/sq m but the reach continued to produce 12.7% of the mainstem total. This describes a very important location within the Rock Creek system.

Spawning gravels in this anchor are of high quality and plentiful. 87 sq m of spawning gravel were documented in Anchor Site 9 in 2010. This represents 14.6% of the mainstem total. Winter rearing is likely occurring within the anchor, but there is limited high quality winter habitat.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

1) The lack of full spanning large wood and the reduction in beaver impoundment from historic levels will eventually result in channel simplification and entrenchment that will slowly isolate the active channel from its winter floodplain.
2) Lack of an intact riparian canopy exacerbates downstream cumulative temperature impacts that effect the lower mainstem of Rock Cr and reduces the potential for the recruitment of future large wood.
3) The unmaintained trash rack at the Hwy 26 crossing has the potential of reducing adult spawner escapement to the majority of the anchor site in years of low winter flows.

Addressing the limitations

List and rank the restoration work at the site that would most effectively increase survival within the site and stabilize the core population at a higher base level.

1) Full spanning LWD complexes will maintain and improve floodplain function by aggrading bedload material that elevates the active channel and increases the frequency of floodplain interaction.
2) Encourage beaver populations by providing abundant forage species that would result in increased pool surface area, rearing potential and floodplain interaction.
3) Riparian planting to provide a reduction in solar exposure, ensure future recruitment, increase cover, and boost complexity.
4) Remove, redesign or commit to the annual maintenance of the Hwy 26 trash rack to improve access to key spawning and rearing habitat

Anchor site rankings

Function

Rank the identified anchor sites in terms of current function (1= best).

1) 9
2) 3
3) 8
4) 4
5) 5
6) 6
7) 7
8) 2
9) 1

Restoration potential

Rank the identified anchor sites in terms of restoration potential.

1) 8
2) 9
3) 3
4) 4
5) 5
6) 6
7) 7
8) 2
9) 1

Secondary Branch 1

Location and length

Trib A enters Rock Creek at RM 18 directly downstream from Martin Creek. Coho distribution ended 1,000ft from the mouth.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In 2009 the expanded total of summer rearing coho was 258 with an average rearing density of 1.3 coho/sq m. Distribution extended 1,000ft from the mouth and terminated at an ephemeral log jam classified as small. It was noted during the 2009 RBA inventory that the stream channel was primarily dry between pools above the end of Coho distribution. In 2010 the expanded summer rearing coho estimate was 120 and the average rearing density declined to 0.6 coho/sq m Distribution extended to 1,600ft from the mouth. It is likely that both years experienced an adult spawning event. This tributary does not likely experience a juvenile upstream migration from the mainstem because of a steep approach at the confluence with mainstem Rock Cr.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary limitation in Trib A is the small size and low summer flows that limit both summer and winter rearing habitat. Upslope harvest activity near the end of anadromous distribution has also resulted in increasing solar exposure to the active channel.

Addressing the limitations

Establishing and maintaining long term guidelines for protection of the riparian corridor within and above current fish distribution is the primary need for the Trib A corridor..

Secondary Branch 2

Location and length

Trib B enters the mainstem of Rock Creek at RM 19.5 near a logging road bridge. Coho distribution extended 0.9 miles from the mouth in 2010..

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In 2009 the expanded total of summer rearing coho was 300 with an average rearing density of 1.7 coho/sq m. Distribution extended only 300ft from the mouth. Coho were only observed in the first two sample pools. In 2010 the expanded summer rearing coho total was 2,220 but the average rearing density decreased to 0.7 coho/sq m. Distribution extended to 0.9 RM from the mouth. The distribution of juvenile coho suggests that adult spawning occurred in both years within the tributary.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary limitation for coho within Trib B is related to the observed decline in its resident beaver population. Evidence of an extensive legacy of beaver use was observed during the 2010 RBA survey. There was however, no recent activity and the high quality attributes associated with beaver impoundment were disappearing. A decline in Trib B production potential for salmonids is expected without the re-colonization of beaver.

Addressing the limitations

The re-colonization of legacy beaver flats would increase both summer and winter rearing habitats within the tributary. Planting forage species for beaver would accelerate re-colonization.

Secondary Branch 3

Location and length

Trib C enters mainstem Rock Creek between the confluence of Weed Creek and Olson Creek. The greatest extent of coho distribution observed between 2009 and 2010 was 600ft.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In 2009 the expanded total of summer rearing coho was 654 with a low average rearing density of 0.4 coho/sq m in 2009 75% were rearing in the first sample pool. This was a beaver pond and densities were low. Distribution extended 600ft from the mouth. It was noted, during the 2009 RBA inventory that an undersized culvert at 650ft was a juvenile barrier and possibly an adult barrier as well. No coho were observed above the culvert. No coho were observed in Trib C during 2010. This Tributary has the potential of providing low velocity winter refugia from the mainstem of Rock Cr..

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

Currently the primary limitation appears to be the truncated access imposed by the perched culvert at 650ft. It is also likely spawning gravel is limited above the culvert because of the low gradient swampy conditions (not verified).

Addressing the limitations

Removal and replacement of the undersized culvert.

Secondary Branch 4

Location and length

Trib E enters Rock Creek 1,100 ft upstream from the HWY 26 culvert crossing. In 2010, Trib E exhibited the greatest lineal distribution of coho at 1,800ft from the mouth that terminated at an ephemeral log jam.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In 2009 coho were observed only in the first sample pool. During the 2010 sample year extended 1,800ft from the mouth and an expanded estimate of 552summer coho parr was observed. The average rearing density was 0.9 coho/sq m. It appears that spawning is occurring in this tributary. Beaver activity in this tributary provides high quality summer and winter rearing habitat.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary limitation of Trib E is its small watershed area. and its lack of high quality beaver forage.

Addressing the limitation

Encouraging beaver with the planting of forage species would assist in maintaining beaver residency.

Secondary Branch 5

Location and length

Trib I enters mainstem Rock Creek at RM 9.7. Coho distribution extended 3,900ft from the mouth.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

During the 2009 RBA inventory there were no summer rearing coho documented in Trib I. In 2010 the expanded summer rearing estimate for coho parr was 990. The average pool rearing density was 1.2 coho/sq m. Distribution extended 3,900ft from the mouth and was terminated by a 3ft perched culvert.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary limitation of this tributary is its small watershed area. The culvert that terminates coho distribution is above a primary fork in the stream and continued salmonid rearing potential above the perched culvert is very limited. It was noted that reaches of solar exposure had been planted within the riparian corridor of Trib I.

Addressing the limitations

Planting of beaver forage would encourage colonization and the resultant beaver dams would add rearing capacity to the tributary.

Secondary Branch 6

Location and length

Trib H enters Rock Creek 1.1 RM downstream from the SF Rock confluence. Coho distribution extended 1,100ft from the mouth and was terminated by an ephemeral log jam.

Rearing contribution

Describe how the site contributes to spawning, incubation, summer rearing, and winter rearing.

In 2009, no coho were documented in Trib H. during the 2010 RBA survey conducted by Bio-Surveys an expanded summer rearing estimate of 1,836 coho was observed. The average rearing density was 2.8 coho/sq m. Distribution extended 1,100ft from the mouth and the combination of good gravel and beaver impoundment created the habitat to support a robust summer population.

Rearing limitations

Which functions limit the site's production potential, and what causes these limitations?

The primary limitation of this tributary was the truncated distribution as a result of natural log jam barriers.

Addressing the limitations

No recommendations are presented for addressing these natural limitations..

Secondary branch site rankings

Function

Rank the identified branch sites in terms of current function (1= best).

1) Trib H.
2) Trib B.
3) Trib E.
4) Trib I.
5) Trib A.
6) Trib C.

Restoration potential

Rank the identified branch sites in terms of restoration potential.

1) Trib C.
2) Trib I.
3) Trib H.
4) Trib B.
5) Trib E.
6) Trib A.

Riparian corridor

Dimensions and location

Describe the lineal dimensions and location of deciduous, coniferous, and open canopy.
The riparian area in the 12 miles from the confluence with the Nehalem to the mouth of Selder Cr is mixed industrial timber and pasture land with the later becoming more dominate in the lower 5 miles. This reach is residentially influenced. 30% of the lineal distance is open canopy, 25% is closed canopy, and the remaining 45% is partially shaded ranging from 25% to 75% closed canopy. The majority of this reach does not have adequate solar protection with exposure being most severe in the lower 5 miles. Banks are dominated by Reed Canary retarding the natural seral progression toward woody vegetation.

From the mouth of Selder Cr extending upstream to the confluence with NF Rock solar exposure is not directly an issue. The overwhelming majority of this reach has a closed canopy with no areas of extensive exposure. The riparian in this reach is primarily alder with scattered conifer. This is typically backed by young re-prod or clear-cut upslope.

One mile upstream from the confluence of NF Rock there is a 1,500ft reach of open canopy located within anchor site 8. This reach is dominated by Reed Canary hindering natural seral progression toward woody vegetation..

Above HWY 26 there is 2.500ft of open canopy through old pasture land located within Anchor Site 9. There is no Reed Canary above the HWY crossing but heavy Elk use has kept old pasture habitat in early seral classes of grasses and forbes.. Above the meadows the canopy is closed with 50+ year old conifer extending upslope.

Recruitment potential

What is the recruitment potential and time frame for delivery to the channel?
From the mouth of Rock Cr to RM 12 there are few large conifers capable of creating full spanning structures at this time. Most of conifer in this reach is decades from reaching its full potential for recruitment if it is not harvested. The majority of this reach is residentially influenced and most woody debris that is contributed to the stream is removed by land owners.

At RM 13 near the mouth of Fall Cr there is a mature stand of Fir with contemporary recruitment potential. From Fall Cr to the confluence of SF Rock Cr there are scattered large conifers that are currently adequate for creating full spanning structures. However, this stretch of Rock Cr is dominated by alder.

Above the SF the stream size is reduced and the size of timber capable of making an impact is reduced. In the Rock Cr headwaters above HWY 26 there are 50+ year old timber stands (ODF) with contemporary recruitment potential if left un harvested.

Thermal problems

Describe the relationship between riparian condition and thermal problems in the aquatic system. Include locations and causes.

The Upper Nehalem Watershed Council and its partners have collected temperature data at set locations throughout the mainstem of Rock Cr in 1993 – 1997, 1999 – 2003, and 2005. The temperature data collected indicates that there is a significant temperature limitation in lower Rock Cr starting near RM 14 and increasing in a downstream progression. This reach is predisposed to having temperature issues because of the wide valley floor, the wide active stream channel and lower stream gradients.

Temperatures at or near RM 14 regularly exceeded water quality standards for salmonids but typically not by more than one degree C and not for long periods of time. However in 2002 temperatures were recorded as high as 20c and exceeded water quality standards for a week in late July, 2002. In the lower 5 miles of Rock Cr summer water temperatures regularly reach 24C and exceed water quality standards for salmonids for weeks at a time. RBA survey data indicated juvenile Coho abundance greatly decreased below RM 5.

Temperatures exceeding 18c from July, 16 to August, 6 were recorded as high in the system as RM 20 in 1995 but this appeared to be somewhat of an anomaly. The fact that the area of high solar exposure is from the mouth to RM 12 and elevated summer temperatures were routinely recorded at and above RM 14 suggests that there are cumulative temperature issues in the tributaries and headwater reaches that influence the lower mainstem most severely. These cumulative impacts are largely a legacy of extensive upslope harvest activities throughout the basin. The clear-cut harvest of Type N stream corridors impacts ambient air temperatures surrounding tributary corridors that in turn elevates water temperatures. The protection of riparian buffers throughout the entire basin including small non fish producing tributaries is very important to addressing Rock Cr temperature limitations in the lower mainstem.

In the reaches that are solar exposed and riparian planting is an option, planting in the upper reaches and tributaries utilizing a top down strategy would likely be the most effective way to address the actual point sources of impact. Selder Cr exhibited stream temperatures exceeding 18c at its confluence with the mainstem of Rock. This confluence is near the upper end of mainstem Rocks temperature limited reach. Protecting buffers and conducting planting projects on Selder could have a very large impact not only for temperature dependent juvenile migration but also by cooling mainstem temperatures. This could effectively shrink the lineal distance of temperature limitations in the mainstem.

Lowland habitats

Describe lowland habitats and locations outside the 6th field.

The Rock Cr sub basin enters the mainstem Nehalem at approximately RM 90. The extreme distance from the Rock Cr subbasin to lowland habitats suggest that the primary potential lowland linkage would be for the provision of winter habitats for fish displaced from Rock Cr during high winter flow regimes. It is likely that some of this type of seasonal migration occurs but there is no historical information available for quantifying its relative importance for juvenile coho originating this high in the Nehalem basin.

Because the Nickelson modeling exercise suggests that the Rock Cr basin is gravel limited and the lower 12 miles of the Rock Cr mainstem is currently functioning far below its capacity for the production of salmonids during summer temperature regimes, it is more likely that non-volitional migrants from headwater reaches would be seeking and finding functional winter habitat within lower Rock Cr for the provision of winter habitat.

Restoration analysis

Defining the connectivity of habitats

The structure of this document by necessity has made distinctions between habitat segments that have assisted us in breaking down the analysis into manageable stream reaches. These reach subdivisions include primary tributaries (4th order) of the Rock Cr mainstem, secondary Branch tributaries that are generally 3rd order contributors and critical contributing areas that are more likely 2nd order aquatic contributions to the stream network.

It is common for habitat types to overlap near the confluences of these larger and smaller order subdivisions. For example, a 3rd order secondary branch often traverses the broad floodplain of its larger 4th order mainstem. The aquatic habitats of this 3rd order tributary are impacted more significantly by the 4th order streams floodplain characteristics (gradient, substrate composition, etc.) than the 3rd order stream that crosses it. These transitional areas between habitat subdivisions provide extremely important seasonal habitats (summer cold water refugia and winter low velocity habitat) for juvenile salmonids.

Understanding that the linkages between these habitats is a critical component of system function is integrally important to achieving success in the development of a restoration strategy designed to restore function. With this concept in mind, we have included some 3rd order streams traversing 4th order floodplains within the designated anchor site of its 4th order partner (see final prescription map).

Nickelson Model results

Appendix 4 characterizes the results of a modeling exercise designed to identify the seasonal habitat limitation for producing coho smolts in the combined Lower, Middle and Upper Rock Cr 6th fields. The foundation of this model are the AHI inventories that quantify the abundance of summer habitats within each tributary and the mainstem. Much of this survey data was collected prior to the major storm events of 1996 and 2007 and fails to accurately represent current habitat conditions.

If you review table E1 of Appendix 4 you will note that the total column for the combined stream segments suggests that the primary seasonal habitat limitation for coho in the 3 combined 6th fields of Rock Cr is the

abundance of ***spawning gravel***. This table utilizes season to season survival rates applied to the measured abundance of each seasonal habitat type (spawning, summer and winter) to predict that season's habitat capacity for smolt production. The goal is to identify the seasonal bottleneck to production. There is in fact only a few tributary segments that currently have an abundance of gravel large enough to seed the habitat available within that tributary segment in either summer or winter. What this suggests is that few precious places within the basin still exhibit the level of functionality required to sustain the core population (all of Rock Cr) for the long term. These places are limited to the SF Rock, NF Rock, Rock Cr above the confluence of the SF, Weed Cr and Olson Cr.

These stream segments, (SF Rock, NF Rock, Rock Cr above the confluence of the SF, Weed Cr and Olson Cr.) when viewed independently, exhibit a seasonal habitat limitation other than the abundance of spawning gravel. Because spawning gravel is abundant, they are limited by either the abundance of summer or winter habitat. These other limitations are irrelevant however because of the geographical location of these stream segments high in the Rock Cr basin.

This condition suggests that any surplus fry emerging from the abundant gravels in these few tributaries that are unable to find a rearing location because of density dependent pressures in the stream of origin need only to drift downstream into the mainstem habitats of Rock Cr where the severe lack of spawning gravel has resulted in large unutilized pool surface areas for summer rearing. This is why the entire Rock Cr basin should be viewed and managed as a unique population segment (a deme). The majority of the habitats in the mainstem of Rock Cr are highly dependent on the incubation capacity of gravels in its headwater tributaries for the provision of nomadic fry to seed its summer pool habitats.

The interaction between headwater and lower mainstem habitats should be viewed cumulatively to determine the seasonal habitat limitation for the functional deme. This broad scale view of the analysis area is why all 3 6th field HUC's of Rock Cr have been combined to describe and understand system function.

The significance of the historical story line developed within the introduction of this document is that the few places that still exhibit a legacy of large wood from the wildfires of the 1930 are still in the process of unraveling as that wood (stored in deep accumulations of migratory bedload) is continually transported out of the system. When the wood is gone the gravel goes with it. If the abundance of spawning gravel is currently limiting, then restoration actions designed to store gravel and retain migratory wood (that critical element that knits each stream segment together) are high priority actions for the system.

Another issue that arises is this analysis is the fundamental disagreement between the results of Table D1 and E1. Table D1 represents an assessment of seasonal survival rates that are density independent from the ODFW Nickelson Model. This suggests that inter and intra specific interactions between rearing salmonids are not accounted for in the smolt production estimates. This method suggests that the availability of ***winter habitat*** is the primary seasonal limitation.

This is why the results of Table E1 have also been incorporated into this analysis. Table E1 utilizes the seasonal survival rates produced by the Alsea Watershed Study that attempted to factor in density dependent interactions. This method suggests that the abundance of functional ***spawning gravel*** is currently the seasonal limitation. The Alsea Watershed Studies seasonal survival rates have proven to more accurately represent real world interactions (density dependent survival and predator prey relationships) and therefore, although this analysis presents the results of both modeling efforts, we have chosen to consider the AWS more appropriate for the situation.

We believe the fundamental purpose of the entire Limiting Factor Analysis is to step back and take a basin scale view of both the biological, morphological and physical interactions that combine to influence survival and consequently smolt production. By taking this larger view, there are two very significant issues that must be factored into the seasonal survival analysis. 1) The current lack of beaver dam habitats in the assessment area. 2) The extensive impact of elevated summer temperatures in the mainstem of Rock Cr.

Both of these issues are strong, reliable indicators of dysfunction. The re-colonization of beaver on the landscape would have an immediate impact on the current seasonal limitation (spawning gravel). Until the abundance of spawning gravel increases, the majority of the mainstem of Rock Cr and the vast quantities of summer habitat that it provides will remain under seeded.

Defining the production bottleneck

Does the seasonal bottleneck identified by the Nickelson Model remain the primary limiting habitat when each of the other issues identified in the assessment process are factored in? Explain.

To further test the hypothesis that the abundance of spawning gravel currently limits Rock Creeks coho production potential, we developed an alternative scenario for the Nickelson model that removed all of the temperature limited summer rearing surface area in the first 12 miles of the mainstem as viable summer habitat for coho and added 80 sq m of spawning gravel for the 8 small tributaries where no gravel data was available, Trib I, H, C, etc.). This dramatically reduced the habitat capacity of the system for summer rearing to represent actual current conditions within the subbasin and bumped up the total available gravel by 4%. Note from table E1 that even after suggesting to the model that the lower 12 miles of mainstem Rock Cr was completely unusable for the provision of summer habitat and that significant quantities of spawning gravel might be available in the 8 un-surveyed tributaries, that spawning gravel remains the primary seasonal limitation with no close numerical second utilizing the density dependent survival rates generated by the Alsea Watershed Study.

In summary, there is still an abundance of functional summer habitat above the 12 mile temperature limited segment of the mainstem to rear all of the summer parr that the systems current abundance of gravel can produce.

To support the assessment that the abundance of spawning gravel limits the system's capacity for producing coho, we reviewed the network of primary headwater contributions (SF Rock, NF Rock, Weed Cr and Military Cr). These 4 highly productive tributaries enter the mainstem of Rock Cr above the 19.3 mile segment of the Rock Cr mainstem below Martin Cr. Each of these major coho producers delivers high quantities of nomadic coho fry in the spring to this mainstem reach. This is nearly a certainty with the production potential of the gravels in these tributaries exceeding the rearing capacity of the summer pool habitats (even with the extremely high average rearing densities observed, 2.2 coho/sq m for NF Rock and 3.0 coho/sq m for SF Rock). The pool rearing surface areas in the 19.3 miles of lower mainstem Rock Cr are massive yet the standing summer crop of coho parr remains very small.

We are attempting to establish that the basin as a whole is limited by the abundance of spawning and incubation habitat in the suite of 3 Rock Cr 6th fields when combined. All of the tributaries of mainstem Rock Cr and the mainstem of Rock above the confluence of the SF Rock exhibited a major historical legacy of beaver presence in both the historic AQHI data reviewed for this analysis and in the field surveys conducted. Beaver are still present on the landscape but their dams are disappearing as a major component of system function. There are glamorous exceptions in Rock Cr as in the case of Trib D, where beaver dams influence ecosystem function so extremely that this small tributary produces as many coho parr (8,675) as Military Cr, Maynard Cr, Olson Cr and Ivy Cr combined.

In this analysis we have the opportunity to overlay fish distribution data on top of the summer temperature profile to look for corroboration. In summary, coho densities in 2009 began to increase dramatically at RM 19.3 near the confluence of Martin Cr. Below the junction of Martin Cr to the confluence with the mainstem Nehalem, there was very limited summer coho production. Summer rearing in the lower 19.3 mile segment of the mainstem was comparatively small when viewed on the basin scale. An expanded total of 38,440 summer coho parr (16% of the Rock Cr sub basin total) were rearing in the lower 19.3 miles of Rock Cr. To put this low level of production into perspective, there was an expanded summer parr estimate of 120,220 coho rearing in the 7.7 miles of just mainstem Rock above the confluence of Martin Cr. This does not include the additional 76,972 coho summer rearing in the tributaries of Rock Cr.

Potential for lowlands contribution

If the abundance of winter habitat has been determined as the primary factor limiting coho production, discuss how lowland habitats existing outside the boundaries of the 6th field might function to provide winter habitat for smolts produced in the 6th field.

The abundance of winter habitat has not been determined to be the primary limiting factor for coho production. Therefore, the contribution of both fresh water and estuarine lowland habitats for the provision of seasonal habitat is likely not the missing seasonal link for restoring system function.
N.A. RM 91

Ownership issues

To what degree would land use and ownership allow restoration work?

In Rock Cr and its primary headwater tributaries, the majority of the landscape is contained in a matrix of private industrial forest ownership. There is a much smaller percentage of State lands managed by ODF. This disparity in ownership suggests that the management of State lands may require a more critical review for the provision of exceptional forest stewardship that may be more difficult to achieve on private industrial forest lands. This assessment has resulted in defining the importance of developing a new vision for the treatment of the riparian corridors on Type N stream corridors. The significance to the Rock Cr basin as a whole of the contribution of mature wood resources from natural headwater slope failure and the addition of headwater shading in Type N riparian corridors cannot be over-stated for the recovery of proper system function.

The remainder of the basin below the confluence of Selder Cr contains many small non industrial private landowners with highly variable riparian management styles. Indications are that it will be difficult to improve the existing temperature limitations in the mainstem by focusing solely on these lower basin landowners. However, a cooperative strategy that brings all Rock Cr landowners to the table simultaneously would likely be very effective in turning the trajectory around for mainstem temperature limitations currently impacting the lower mainstem aquatic habitats.

Channel complexity summary

What is the potential to increase channel complexity in the long term through natural recruitment processes, with and without restoration?

The long term potential for increasing channel complexity by relying on natural wood recruitment is poor based on current riparian and upslope management practices. The lack of standing wood retention in slide prone Type N stream corridors is a significant factor controlling the abundance of natural wood delivery to the stream network. Even well recovered fish bearing riparian corridors are dominated by deciduous species that fail to provide the long term recruitment potential of the key conifer species necessary for long term hydraulic stability.

There are of course exceptions to this condition that can be observed in the headwater reaches of mainstem Rock where it traverses State forest lands and exhibits a mature conifer component. This riparian potential can also be observed in short reaches of the lower mainstem of Rock Cr where small private tracks of riparian ownership have intentionally retained a mature conifer component. The limited lineal distribution of these examples however suggests that additional measures will be required in the future to create a trajectory aimed at boosting the frequency of riparian conifer. This is the long term goal that will bear the greatest long term benefit for restoring natural process that could eventually be self-sustaining.

Restoration prescriptions and potential restoration sites

The following site-specific prescriptions are listed by stream and are not prioritized.

Stream

South Fork Rock Creek

1) Riparian planting in Anchor Site 1 to increase future recruitment potential for structure and increase canopy cover to reduce temperature limitations in the mainstem. Caging necessary.

2) Develop conservation easement strategy for one site potential (200ft each side of stream) for Anchor Site 1.

3) Full spanning wood structures in Anchor Sites 1 and 2 to preserve existing high function and maintain existing gravel resources. Machine placement possible.

4) Full spanning wood structures in Anchor Site 3 below the confluence of Bear Cr. These structures would greatly increase the floodplain function of the anchor site as well as supplement the investment of the structures placed above the confluence of Bear Cr. Machine placement possible.

5) Full spanning wood complexes in Trib A to trap and store spawning gravels in the stream segment above the high quality rearing habitat identified in downstream Anchor Site 1.

6) Develop (excavate) off channel back waters / alcove at the confluence of Trib A and Trib A1 and on the low interactive terraces of Anchor Site 1. Both locations would provide high quality rearing habitat in all seasons plus supplemental water storage for moderating both summer and winter flows.

7) Plant beaver forage (willow, vine maple, ash, cottonwood) in Anchor Site 1 and Trib A to encourage colonization.

8) Remove concrete divider at Hwy 26 culvert.

9) Extend RMA around identified anchor in Trib A to 200ft.

Bear Creek

10) Plant beaver forage (willow, nine maple, ash, cottonwood) in and around Anchor Site 1. May require selective girdling.

11) Conifer planting in and around Anchor Site 1 to ensure future recruitment for structure. Cedar would likely be the best species. Caging necessary.

North Fork Rock Creek

12) Full spanning wood complexity in Anchor Site 1. Helicopter placement preferable. Machine placement possible.

13) Full spanning wood complexity in the upper 1,000ft of Anchor Site 2. Helicopter placement.

14) Full spanning wood complexity in Anchor Site 3. This would protect and enhance the existing structures that are beginning to fail. Helicopter placement

15) Plant beaver forage (willow, vine maple, ash, cottonwood) in Anchor Site 4. Selective girdling may be necessary.

16) Conifer planting throughout Anchor Site 4. Caging necessary.

17) Full spanning wood treatment in Anchor Site 4 in the future (15-20 years).

18) Extend RMA around Anchor Site 4 to 200ft.

19) Develop strategies for second order non fish bearing streams to limit solar exposure (slash accumulation).

Weed Creek

20) Full spanning wood complexity starting at the mouth and working upstream to Anchor Site 1. Machine placement

21) Protect riparian buffers on first and second order tributaries in the first 1.7 miles. (leaving buffer strips, slash retention). These are sites with high slide potential for recruiting resources (wood, gravel).

22) Facilitate beaver colonization with beaver management plan that recognizes the value of the ecosystem services provided by beaver. Could include trapping moratorium.

Tributary D of Rock Creek

23) Plant conifer throughout Anchor Site 1 for future recruitment for structure and canopy cover to mitigate for extensive solar exposure. Would require caging and moisture tolerant species (cedar).

24) Plant beaver forage (willow, vine maple, ash, and cottonwood) throughout lower 1 mile.

Ivy Creek

25) Protect existing riparian throughout to ensure future recruitment and limit solar exposure.

26) Facilitate beaver colonization with beaver management plan that recognizes the value of the ecosystem services provided by beaver. Could include trapping moratorium. .

Fall Creek

27) Replace culvert crossing on county road.

28) Full spanning large wood placement below county road.

29) Construct off channel rearing locations through the excavation of backwater/alcove complexes.

30) Conservation easement below county road. Very significant site providing cold water refugia to upstream migratory juveniles escaping the temperature limited mainstem.

Olson Creek

31) Large wood placement below the jam at 1,000ft to aggrade bedload material and create a passable approach to the jam. This would be considered high priority. Placing additional large wood over the next 3,500ft is also recommended as a secondary priority. Machine placement.

32) Plant beaver forage (willow, vine maple, ash, and cottonwood) in upper beaver flats starting 4,500ft from mouth.

Military Creek

33) Plant beaver forage (willow, vine maple, ash, and cottonwood) to alleviate solar exposure and encourage beaver impoundment. This would increase water storage potential for moderating both summer and winter flows.

34) Large wood placement throughout Anchor Site 1. Using material thinned from adjacent stands outside the riparian would be preferable in this location. Machine placement.

35) Remove invasive scotch broom in Trib A portion of Anchor Site 1 while it is still manageable.

Selder Creek

36) Full spanning large wood placement in lower 0.5 RM to aggrade bedload and restore floodplain connectivity.

37) Replace undersized culvert on Trib A to facilitate resource transport.

38) Establish permanent RMA to prevent harvest to the active stream channel again.

39) Large wood placement in Anchor Site 2 to increase floodplain connectivity and rearing potential. Using on site trees would be possible. Machine placement.

Rock Creek Main

40) The addition of multiple edge oriented large wood structures in Anchor Site 1 to encourage back water development, encourage water storage and provide winter rearing habitat.

41) Riparian planting within Anchor Site 1 to reduce solar exposure, mitigate for temperature limitations and provide a future source of LWD. Because of the potential for storage that currently exists within this anchor site, planting prescriptions should focus on the establishment of conifer. The site exhibits long term significance for maintaining persistent function that traps and retains both large wood and spawning gravel.

42) Riparian planting within Anchor Site 2 to reduce solar exposure, mitigate for temperature limitations and provide a future source of LWD. Because of the potential for storage that currently exists within this anchor site, planting prescriptions should focus on the establishment of conifer. The site exhibits long term significance for maintaining persistent function that traps and retains both large wood and spawning gravel.

43) Place multiple edge oriented large wood structures in Anchor Site 2 to encourage off channel habitat development, water storage and winter rearing habitat.

44) Riparian planting within Anchor Site 3 and throughout zones of solar exposure to address cumulative temperature impact. Planting within the anchor site would also provide large wood recruitment for structure and cover.

45) Conservation easement to obtain a riparian setback and develop the easement platform required for addressing the removal of the Rail Road bed that bisects the historical river channel. All parts of Anchor Site 3 could be included in this strategy starting at RM 7.5 to ensure future recruitment of LWD and floodplain interaction.

46) Improve existing off channel backwater complexes (excavation) in Anchor Site 3. Could be incorporated with existing small cold water tributary on the North East side of the anchor site and would increase the availability of off channel rearing habitat for both summer and winter. This would also increase both summer and winter water storage capacity.

47) The addition of full spanning LWD complexes throughout Anchor Site 3 to ensure continued function and increase complexity and floodplain interaction. This would also increase water storage during both summer and winter flows. Helicopter placement.

48) Riparian planting within Anchor Site 4 to increase recruitment potential, provide cover and riparian diversity. Additional plantings outside the anchor site would also assist in mitigating for solar exposure to address cumulative temperature impacts.

49) Create backwater/alcove in Anchor Site 4 that incorporates cold water tributaries to increase both summer and winter off channel rearing potential. This would also increase the water storage capabilities of the site during both summer and winter flows.

50) Place edge oriented LWD complexes in Anchor Site 4.

51) Place edge oriented large wood complexes throughout Anchor Site 5.

52) The addition of full spanning LWD complexes in Anchor Site 6 would aggrade bedload, retaining gravels, increase pool complexity, and increase floodplain interaction. This would dramatically improve the main limitations at this location. Helicopter/machine placement.

53) Remove and replace the undersized culvert on Trib C in Anchor Site 6. This would increase juvenile accessibility to important off channel rearing habitats.

54) The addition of full spanning LWD complexes in Anchor Site 7 would aggrade bedload, retain spawning gravels, increase pool complexity, and increase floodplain interaction. This would address the primary limitations at this location and on the basin scale. Helicopter/machine placement.

55) Full spanning LWD complexes within Anchor Site 8 to aggrade bedload material, raise frequency and scope of floodplain interaction, improve sinuosity, and increase water storage. Full spanning LWD complexes would likely encourage beaver activity in this portion of the mainstem. Machine placement.

56) Design side channel construction for the Inman-Paulson mill pond site. This would include stream diversion and off channel backwater and alcove development associated with tributaries located within the site.

57) Riparian planting to reduce solar exposure in new side channel at Inman – Paulson Mill Pond site to ensure future recruitment, increase cover, and vegetative diversity.

58) Full spanning LWD complexes in new side channel to encourage complexity, aggrade bedload material, raise frequency and scope of floodplain interaction, improve sinuosity, and increase water storage. There is the opportunity to use wood from onsite sources.

59) Plant beaver forage (Willow, Ash, Cottonwood, Vine Maple) throughout side channel development at Inman – Paulson Mill Pond Site to encourage colonization of the created off channel habitats.. This results in increased pool surface areas and rearing capacity.

60) Riparian planting to reduce solar exposure, ensure future recruitment, increase cover, and vegetative diversity. This is a general prescription that applies to all mainstem locations exhibiting degraded riparian canopies. Prioritize upper basin prescriptions but consider all potential sites.

61) Remove and replace the undersized culvert under the Hwy 26 crossing. This site severely restricts the natural recruitment of natural resources (wood and gravel) to lower mainstem reaches.

62) Permanently remove the trash rack directly above the Hwy 26 crossing because it terminates resource migration (wood and gravel) to lower mainstem reaches and delays and potentially blocks anadromous access to headwater spawning reaches.

63) Eradicate invasive scotch broom infestation from meadows in the upper mainstem of Rock above the Hwy 26 crossing.

64) Full spanning LWD complexes within Anchor Site 9 will provide complexity, aggrade bedload (spawning gravel), increase the frequency and scope of floodplain interaction, improve sinuosity, and increase water storage. Full spanning LWD would also encourage beaver activity in the mainstem. Machine placement.

65) Riparian planting to reduce solar exposure in Anchor Site 9, ensure future recruitment for structure, increase cover, and provide vegetative diversity.

66) Plant beaver forage (willow, vine maple, ash, and cottonwood) to alleviate solar exposure and encourage beaver impoundment. This would increase water storage potential for moderating both summer and winter flows.

67) Conduct temperature monitoring on tributaries of mainstem Rock Cr like Selder, Fall, Olson, Military and others to identify cold/warm water sources to address cumulative temperature impacts.

Issues

All of the prescriptions listed above are included in the following condensed discussion of general issues, goals, methods, complications and results.

1) Mainstem Rock Cr temperature limitations from its confluence with the mainstem Nehalem to RM 12 on Rock Cr impair anadromous distribution and abundance. This is a cumulative problem that begins in many head water tributaries of Rock Cr and in the upper mainstem from the impacts of upslope harvest activities. Many riparian corridors (including non fish bearing and fish bearing stream corridors) were recently logged with no riparian protection retained to protect the aquatic corridor from solar exposure.
2) Because temperature limitations in the mainstem limit its summer carrying capacity, it is also important to protect, maintain and enhance the riparian buffers that currently exist on small private and industrial timber ownership.
3) Because temperature limitations in the mainstem limit its summer carrying capacity, it is important to provide unimpeded escape routes to upstream cold water refugia. Therefore the restoration of passage for juveniles through culvert replacement is critical.
4) The legacy of industrial timber extraction upslope and throughout type N streams has led to a precipitous decline in the system's capacity to provide LWD to the aquatic corridor. This lack of wood complexity is the root cause of the channel degradation that can be observed today in simplified channel habitats scoured to bedrock. The ability of full spanning log structures to raise the stream adjacent water table and to provide vast summer water storage capacity to mitigate for elevated summer flows is well established.
5) The legacy of industrial timber extraction has reduced the riparian corridors capacity for the provision of the coniferous LWD that would historically have been the foundation for the retention and sorting of high quality spawning gravels for Coho.
6) The declining abundance of beaver dam habitat in conjunction with low wood densities has accelerated the migration rates of substrates (including spawning gravels) out of the Rock Cr headwaters where they historically were trapped and retained in the headwater locations utilized by spawning salmonids.
7) Low instream wood densities are resulting in the loss of spawning gravel storage capacity which is currently the primary limitation for the production of coho and cutthroat trout in the Rock Cr basin.

Goals

1) Initiate a change in the trajectory of the mainstem Rock temperature limitation utilizing a broad range of prescriptions that simultaneously addresses the multiple issues that combine to create the downstream cumulative impacts limiting salmonid production.
2) Develop enhancement and conservation strategies for upslope harvest units that take into consideration the importance of protecting existing riparian buffers that currently provide positive benefit to both fish bearing and non fish bearing aquatic corridors.
3) Replace, remove or retrofit culverts and historic rail road fills identified in the LFA as passage issues for juvenile salmonids to provide access to summer cold water refugia.

4) Develop watershed scale management teams to assist in identifying critical slide prone areas for consideration as resource leave areas as a source of future wood recruitment to salmon bearing segments within the Rock Cr network of streams.
5) Restore a conifer component in riparian corridors dominated by deciduous species within one site potential of salmon bearing stream corridors.
6) Restore a forage base appropriate for providing a foundation for the natural re-colonization of beaver.
7) Provide a short term fix for depleted LWD densities within the aquatic corridor until riparian recovery and protection actions can sustain the delivery of large wood through natural recruitment.

Method

1) Riparian management areas must be established and expanded on both public and private industrial forest lands throughout the basin. This would ideally include type N headwater streams with live summer flow. The prescription for these areas would include a variable width no cut buffer (width dependent on stream order). Basal area prescriptions, variable density thinning and alder conversions for the riparian would not be allowed in these areas. This is unlikely to be accomplished within the guidelines of the current regulatory processes so creative strategies for landowner compensation would be an immediate alternative solution for achieving recovery (conservation easements, etc.) Lower on the mainstem, riparian livestock exclusion and the planting of riparian buffers on historical pasture lands would also assist in the long term recovery of mainstem temperature profiles (lower priority).
2) Same as above
3) Culvert replacements and the removal of rail road fill would address compromised passage. Tackle each site in a prioritized fashion that achieves access to the largest tributaries first (higher rearing capacity) and the smaller systems last.
4) Develop an attractive easement program to encourage landowners to limit the future conversion of these highly significant riparian canopies to younger seral stages.
5) Understory plant existing deciduous riparian corridors with conifer to provide a long term source of key wood for recruitment to the active stream channel. This could include girdling, topping or the creation of small openings by felling.
6) Plant the preferred forage species for beaver (willow, vine maple, ash, cottonwood) to encourage natural re-colonization in zones exhibiting legacy beaver characteristics with willow planting.
7) Place large wood structures as a short term solution to the lack of naturally recruited conifer. Select sites with the morphological characteristics for boosting floodplain interaction.

Potential complications

1) *Conservation Easements*: On private industrial forest land, this has not been a well tested restoration tactic. This would require significant commitment and long term planning. In addition, methodologies would have to be developed to create the infrastructure necessary to hold and maintain these conservation easements.
2) *Culverts replacements:* These are generally considered low hanging fruit for restoration with ample willingness from a multitude of partners. No complications anticipated.
3) *Restoring beaver populations as an integral part of a restoration strategy:* This would be a formidable change in how we view the places where we live. With their history as a nuisance species, the education of landowners and agencies on the importance of beaver in system function would have to be accomplished with extensive outreach. This would require a form of support that funding agencies with a desire to show progress on the ground would struggle with.
4) *Large Wood Placement:* Rock Cr exhibits a large watershed area that is capable of developing formidable winter hydraulics in the mainstem. Considerable expertise would be required for the development of design solutions that would remain winter stable. LWD placement within the anchor site habitats identified in this document would be highest priority.

Expected results

1) *Conservation Easements:* This is a long range restoration objective that attempts to deal with the root source of system dysfunction. There would be no quick recovery in mainstem temperature

profiles but there may be immediate impacts on the trajectory of degradation (additional upslope harvest impact that could continue to exacerbate the current condition). Recovery trends could be detectable in 20-30 years when the shade provided by recovering canopies could begin to impact mainstem temperatures.

2) *Culverts replacements:* Each culvert replacement or retrofit for passage unlocks the access for temperature dependent summer migrations of juvenile salmonids to cool water refugia. This has an immediate benefit on survival to smolt and increases production.
3) *The restoration of beaver:* If successful, will have a rapid and profound effect on system function. This single task immediately mitigates for much of the damage currently observed from upslope industrial forestry impacts on stream temperature profiles.
4) *Large Wood Placement:* Provides a short term solution to the lack of channel roughness and the low instream wood densities that have resulted in the primary seasonal habitat limitation identified in this analysis (abundance of spawning gravel). Wood in the active channel creates the foundation for a chain of events that restores system function.

Appendices

Appendix 1. Significant drainages of the Rock Creek (Nehalem) 6th field.

LFA ID	Name	RBA ID	ODFW ID	River mile	Enters from	Slope faces	Gradient	Flood plain width	Relative size
	Mainstem tributaries								
1	Bear Crk			0.12	Left	E	Low	Wide	Small
2		Trib I		9.92	Left	N	Very low	Wide	Small
3	Ivy Crk			10.31	Right	SE	Low	Narrow	Small
4	Maynard Crk			11.45	Left	N	Low	Narrow	Medium
5	Selder Crk			11.94	Right	SE	Low	Medium	Large
6	Fall Crk			13.43	Left	NW	Low	Medium	Medium
7	Ginger Crk			15.82	Right	SE	Very low	Medium	Large
8		Trib A		18.63	Right	SE	Moderate	Narrow	Small
9	Martin Crk			18.92	Right	E	Moderate	Narrow	Small
10		Trib B		20.37	Left	N	Very low	Wide	Small
11	Weed Crk			22.15	Right	S	Very low	Narrow	Large
12		Trib C		22.45	Right	E	Very low	Wide	Small
13	Olson Crk			22.56	Left	NW	Very low	Wide	Small
14	NF Rock Crk			23.58	Right	S	Low	Medium	Very large
15		Trib H		24.76	Left	NW	Low	Wide	Very small
16	Military Crk			25.61	Right	SE	Very low	Wide	Medium
17	SFRock Crk			25.85	Left	NW	Very low	Wide	Very large

18		Trib D		26.38	Left	N	Very low	Very wide	Very small
19		Trib E		26.57	Left	NE	Very low	Very wide	Small
Secondary tributaries									
14.1	NF Rock/Trib A	Trib A		2.54	Left	E	Low	Wide	Very small
14.2	NF Rock/Trib B	Trib B	Trib A	3.25	Right	W	Low	Wide	Very small
14.3	NF Rock/Trib C	Trib C		3.80	Right	SW	Moderate	Narrow	Very small
17.1	SF Rock/Trib A	Trib A	Trib 1	1.37	Right	NE	Low	Wide	Small
17.2	SF Rock/Bear Crk			2.12	Left	NW	Very low	Wide	Large

1) River Miles were obtained from the Terrain Navigator program, and are typically lower than those calculated from field survey data.

2) SF Rock/Trib B and Selder Creek Tribs A, B, C and D are not considered to provide significant spawning and rearing habitat, although a few juveniles have been seen in the mouths of these tributaries in some RBA surveys. These tributaries are not included in the smolt capacity estimates.

Appendix 2. Features and habitat survey status of streams within the Rock Creek (Nehalem) 6th field which contribute significantly to coho rearing potential.

Current ID		Survey					Valley Morphology			Aquatic Habitats			
LFA ID	Name	Surv Rch ID	Type	River Mile			Grad (%)	Valley Width	Constraint	Pools (%)	Bvr Pnds (#)	Wood (pcs/mi)	
				Len	Beg	End						Total	Key
1993 Surveys													
1	Bear Crk	1	ODFW AQI	0.45	0.00	0.45	0.6	Very broad	Terrace-Hillslope	49	0	632	nd
		2		0.39	0.45	0.83	1.2	Very narrow	Hillslope	40	0	600	nd
		3		0.38	0.83	1.22	0.3	Very broad	Unconstrained	19	0	686	nd
16	Military Crk	1	ODFW AQI	1.20	0.00	1.20	1.1	Broad	Terrace-Hillslope	62	0	969	nd
14	NF Rock Crk	1	ODFW AQI	0.33	0.00	0.33	2.7	Very broad	Terrace-Hillslope	22	0	145	nd
		2		0.23	0.33	0.56	2.8	Broad	Terrace-Hillslope	14	0	166	nd
		3		0.12	0.56	0.68	1.0	Broad	Unconstrained	36	0	351	nd
		4		0.08	0.68	0.76	2.1	Very narrow	Hillslope	28	0	105	nd
		5		0.12	0.76	0.88	2.1	Narrow	Terrace-Hillslope	19	0	272	nd
		6		0.18	0.88	1.06	2.7	Very narrow	Hillslope	19	0	542	nd
		7		0.19	1.06	1.24	1.3	Narrow	Unconstrained	16	0	299	nd
		8		0.77	1.24	2.02	1.9	Narrow	Hillslope	37	0	521	nd
		9		0.86	2.02	2.88	1.1	Narrow	Terrace-Hillslope	50	0	869	nd
		10		0.96	2.88	3.84	1.0	Broad	Unconstrained	60	0	620	nd
		11		0.28	3.84	4.12	4.8	Narrow	Hillslope	26	0	827	nd
Main stem	Rock Crk	1	ODFW AQI	0.60	0.00	0.60	0.8	Broad	Terrace	25	0	114	nd
		2		1.00	0.60	1.60	1.1	Broad	Unconstrained	30	0	77	nd
		3		0.85	1.60	2.44	1.4	Very narrow	Hillslope	39	0	72	nd
		4		0.37	2.44	2.81	1.3	Narrow	Terrace	16	0	55	nd
		5		2.42	2.81	5.23	1.4	Very narrow	Hillslope	27	0	45	nd
		6		0.66	5.23	5.89	0.6	Narrow	Unconstrained	13	0	84	nd
		7		0.36	5.89	6.26	0.6	Narrow	Terrace	10	0	92	nd
		8		1.18	6.26	7.43	0.4	Narrow	Terrace-Hillslope	18	0	61	nd
		9		1.19	7.43	8.63	0.1	Very broad	Unconstrained	16	0	68	nd
		10		0.62	8.63	9.24	0.7	Very narrow	Hillslope	56	0	50	nd
		11		1.05	9.24	10.30	0.3	Very broad	Unconstrained	29	0	58	nd
		12		0.57	10.30	10.87	1.7	Very broad	Terrace-Hillslope	19	0	58	nd

		13		0.42	10.87	11.28	2.9	Very narrow	Hillslope	26	0	183	nd
		14		0.49	11.28	11.78	0.9	Very broad	Unconstrained	39	0	150	nd
		15		0.37	11.78	12.15	2.0	Narrow	Terrace	23	0	214	nd
		16		0.48	12.15	12.63	1.7	Very narrow	Hillslope	5	0	172	nd
17	SF Rock Crk	1	ODFW AQI	2.90	0.00	2.90	2.3	Very broad	Terrace	28	0	327	nd
		2		0.12	2.90	3.02	7.5	Very narrow	Hillslope	21	0	863	nd
		3		0.30	3.02	3.32	3.1	Broad	Terrace	52	0	306	nd
		4		1.71	3.32	5.04	5.1	Narrow	Hillslope	15	0	496	nd
11	Weed Crk	1	ODFW AQI	0.25	0.00	0.25	1.7	Broad	Terrace-Hillslope	15	0	312	nd
		2		2.60	0.25	2.85	1.5	Narrow	Hillslope	18	0	594	nd
1994 Surveys													
17.1	SF Rock Crk/Trib A (ODFW Trib 1)	1	ODFW AQI	0.14	0.00	0.14	2.6	Broad	Unconstrained	92	5	348	nd
		2		0.83	0.14	0.97	2.0	Broad	Terrace-Hillslope	60	15	391	nd
		3		0.51	0.97	1.47	2.7	Narrow	Hillslope	16	1	333	nd
1996 Surveys													
Main stem	Rock Crk	1	ODFW AQI	2.82	0.00	2.82	0.4	Broad	Unconstrained	38	0	304	8.0
		2		0.95	2.82	3.77	0.3	Broad	Unconstrained	46	0	140	1.6
		3		0.49	3.77	4.26	0.2	Broad	Unconstrained	68	0	89	1.6
		4		1.01	4.26	5.27	0.5	Broad	Unconstrained	43	0	431	3.2
		5		1.35	5.27	6.63	0.5	Broad	Unconstrained	56	0	212	3.2
		6		1.27	6.63	7.90	1.2	Very narrow	Hillslope	40	0	117	0.0
5	Selder Crk	1		0.00	0.55	0.55						5,021	3.2
1997 Surveys													
17.2	SF Rock Crk/Bear Crk	1	ODFW AQI	0.53	0.00	0.53	1.9	Narrow	Terrace-Hillslope	47	1	568	12.9
		2		0.61	0.53	1.14	1.9	Very narrow	Hillslope	48	1	613	9.7
		3		0.51	1.14	1.66	2.6	Narrow	Terrace-Hillslope	89	4	494	8.0
17	SF Rock Crk	1	ODFW AQI	1.23	0.00	1.23	1.3	Broad	Unconstrained	35	0	246	0.0
		2		0.90	1.23	2.13	1.8	Very narrow	Hillslope	21	0	304	4.8
		3		0.88	2.13	3.01	2.7	Narrow	Terrace-Hillslope	24	0	613	11.3
		4		1.38	3.01	4.39	3.9	Very narrow	Hillslope	15	0	657	16.1
		5		0.51	4.39	4.90	13.7	Very narrow	Hillslope	5	0	724	3.2
2002 Surveys													
14	NF Rock Crk	1	ODFW AQI	0.54	0.00	0.54	1.6	Narrow	Hillslope	22	0	87	1.6
		2		0.76	0.54	1.29	1.9	Narrow	Terrace	29	0	533	30.6
		3		1.50	1.29	2.79	1.8	Narrow	Terrace-Hillslope	34	0	481	27.4

		4		1.22	2.79	4.01	1.8	Narrow	Terrace-Hillslope	63	3	555	64.4
		5		0.43	4.01	4.45	3.3	Narrow	Terrace-Hillslope	55	3	526	30.6
		6		1.33	4.45	5.78	4.0	Narrow	Terrace-Hillslope	57	1	507	24.1
14.2	NF Rock Crk/Trib B (ODFW Trib A)	1	ODFW AQI	1.03	0.00	1.03	2.8	Narrow	Terrace-Hillslope	74	4	803	30.6
		2		0.66	1.03	1.69	10.4	Narrow	Hillslope	25	1	507	27.4
Main stem	Rock Crk	1	ODFW AQI	0.50	0.00	0.50	0.6	Broad	Terrace-Hillslope	38	0	193	0.0
		2		1.34	0.50	1.84	1.0	Broad	Unconstrained	59	7	121	1.6
		3		0.40	1.84	2.25	1.2	Very narrow	Hillslope	60	2	333	22.5
		4		0.49	2.25	2.74	3.6	Very narrow	Hillslope	85	9	444	30.6
		5		0.66	2.74	3.39	8.1	Very narrow	Hillslope	48	8	406	35.4

No Surveys

2	Trib I
3	Ivy Creek
4	Maynard Creek
6	Fall Creek
7	Ginger Creek
8	Trib A
9	Martin Creek
10	Trib B
12	Trib C
13	Olson Creek
15	Trib H
18	Trib D
19	Trib E
14.1	NF Rock/Trib A
14.3	NF Rock/Trib C

1) Early surveys, such as the 1993 surveys, appear to have miss-identified scour pools as glides. This resulted in very low Pool % estimates.

Appendix 3. Habitat data used to calculate juvenile coho carrying capacity and smolt potential in upland stream channels of the Rock Creek (Nehalem) 6th field.

The values are best estimates of current conditions based on USFS and/or ODFW habitat surveys, Bio Surveys Rapid Bioassay surveys of fish populations (which provide pool dimension data), and field work conducted during the current project. Note that in some cases the number of beaver ponds reported by older surveys has been substantially reduced based on more current information.

Identity			Summer Uplands Habitat (m2)												Winter Uplands Habitat Data				
LFA Stm #	Strm	LFA Rch #	Cscds	Rpis	Grv Rffls	Glds	Trnch pls	Plng Pls	Lat Scr Pls	Mid Chan Scr Pls	Dam Pls	Alcv Pls	Bvr Pnds	Bkwtr Pls	Act chan wid (m)	Grad (%)	# bvr pnds	Prcnt pls (fract)	Rch len (m)
0	Rock Crk	1			24,754	38,472			60,273	2,439	18,151				16.8	0.0	0	0.56	####
		2	413	2,622	25,451	21,956	443		19,955	10,285	396	287		315	22.3	0.4	0	0.38	4,532
		3		650	8,879	3,988		4	10,928	476				136	18.7	0.3	0	0.46	1,536
		4		44	3,844	42			7,763	893		48			22.9	0.2	0	0.68	788
		5		1,487	9,274	3,504			10,859	1,956		160		211	21.7	0.5	0	0.43	1,633
		6		236	11,721	2,952			16,914	2,205					21.9	0.5	0	0.56	2,175
		7	3,580	4,179	7,910	2,108	3,125	574	7,026	1,254				105	22.8	1.2	0	0.40	2,042
		8		5,695	26,527	14,780		443	2,890	8,729				5,461	17.0	1.4	0	0.27	3,900
		9	21	489	8,717	5,829			510	1,704				17	16.9	0.6	0	0.13	1,064
		10	42	22	4,749	1,625			404	213				83	17.0	0.6	0	0.10	582
		11		550	10,181	12,468			958	4,071				57	16.5	0.4	0	0.18	1,897
		12		638	6,921	12,057			1,044	2,466				243	15.4	0.1	0	0.16	1,921
		13	982	530	1,792	2,182		170	2,234	4,692				121	16.0	0.7	0	0.56	990
		14	5	1,647	9,968	4,503			4,776	1,679	115			38	14.7	0.3	0	0.29	1,696
		15	597	1,232	3,050	1,663		180	450	848				91	8.2	1.7	0	0.19	920
		16		2,438	232	1,075				384	950				8.5	2.9	0	0.26	669
		17		77	1,049	2,180			857	682	492			47	8.2	0.9	0	0.39	794
		18		441	159	2,135			438	390				39	9.5	2.0	0	0.23	600
		19		1,872	2,725	1,488			264					50	9.5	1.7	0	0.05	779
		20		926	1,642				1,744					7	9.0	0.6	0	0.38	803
		21		545	3,302			173	2,938		1,234		1,417	149	7.4	1.0	7	0.59	2,159
		22	79	939	877			106	461		248			19	8.3	1.2	0	0.30	651
		23	63	12	1,094			105	230				7,197		7.1	3.6	9	0.85	790
1	Bear Crk																		
2	Trib I				1,242				498		47				2.4	4.2	0	0.31	1,310
3	Ivy Crk	1			703			1,564	1,564	51	35				5.5	2.4	0	0.73	1,253

4	Maynard Crk	1			1,420			73	352	327	190		1,401		3.0	3.6	10	0.62	1,798
5	Selder Crk	1			521	308			1,508	54	89		813	6	7.1	0.6	5	0.25	886
		2			7,851				4,159	1,666	1,185		2,264		5.5	3.6	20	0.56	5,837
6	Fall Crk	1			765			78	184	306	297				3.0	1.6	0	0.53	848
8	Trib A	1			326				199	19	41				1.2	9.3	0	0.44	548
9	Martin Crk	1			282			62	129						1.8	1.9	0	0.40	340
10	Trib B				393			75	675	144	2,645				3.0	0.4	0	0.90	1,487
11	Weed Crk	1		432	426			15	284	69					7.2	1.7	0	0.30	408
		2	107	1,067	5,820			214	3,355	613					5.1	1.5	0	0.37	4,179
12	Trib C	1			113				250		73		694		2.4	2.8	10	0.90	389
13	Olson Crk	1			1,582			369	987	412	281				3.4	2.3	2	0.73	1,779
14	NF Rock Crk	1	88	1,789	3,401			216	1,342					35	12.8	1.6	0	0.22	865
		2		2,409	5,079			145	2,862		146	34		31	11.5	1.9	0	0.29	1,218
		3		3,257	7,089			475	5,051					72	10.3	1.8	0	0.34	2,415
		4		227	2,431			82	4,031		60	9	3,169	126	8.8	1.8	3	0.74	1,961
		5	306	587	439			150	639		88	11	794		5.0	3.3	3	0.55	700
		6	167	790	825		13	23	1,108		1,241		106	4	3.9	4.0	1	0.57	2,140
15	Trib H	1			355				73		93		655		1.8	5.7	10	0.70	486
16	Military Crk	1			1,175				2,136	213	4,707		1,003		5.0	1.1	10	0.87	1,927
17	SFRock Crk	1		95	8,170	384		85	4,886						16.2	1.3	0	0.35	1,972
		2		1,263	6,929				2,255			13			8.6	1.8	0	0.21	1,449
		3	141	151	1,856			95	561			23		7	6.7	2.7	0	0.24	1,423
18	Trib D	1			1,811				945	367	747		7,449		4.6	4.9	40	0.85	2,416
19	Trib E	1			499			30	141		152		348		1.5	5.4	5	0.57	738
14.1	NF Rock/Trib A	1			912			49	380	73			205		3.0	3.0	10	0.44	934
14.2	NF Rock/Trib B	1	30	922	1,285			185	2,065		2,296		2,616	30	5.6	2.8	4	0.74	1,659
14.3	NF Rock/Trib C	1			297				51	24	11				1.2	4.5	0	0.23	355
17.1	SF Rock/Trib A	1		20	206			43	29		91		4,246	12	11.1	2.6	5	0.92	222
		2			1,679	429		228	507	176	227		2,056	115	5.4	2.0	15	0.60	1,333
		3			332	126			168	27	107		39		6.2	2.7	1	0.16	815
17.2	SF Rock/Bear Crk	1			1,437			63	1,006				224	12	5.8	1.9	1	0.47	853
		2		157	1,600				1,417	61			1,497		6.8	1.9	15	0.63	1,550

1) No habitat data are available for Bear Cr (Rock Cr).

Appendix 4. Habitat data used to calculate juvenile coho carrying capacity and smolt potential in lowland lakes, ponds, and wetlands of the Rock Creek (Nehalem) 6th field

Descriptive name of habitat area	Summer Lowlands Habitat Data						Winter Lowlands Habitat Data					
	Stillwater with edge habitat		Wetland channels		Flooded wetlands/sloughs		Stillwater with edge habitat		Wetland channels		Flooded wetlands/sloughs	
	Perimeter (m)	Assumed functional width of lake edge (m)	Channel length (m)	Assumed functional width along one side (m)	Wetland surface area (m2)	Fraction wetted	Perimeter (m)	Assumed functional width of lake edge (m)	Channel length (m)	Assumed functional width along one side (m)	Wetland surface area (m2)	Fraction wetted
No lake, pond or wetland coho rearing habitats exist within the Rock Creek (Nehalem) 6th field												

Appendix 5. Coho salmon spawning gravel in the Rock Creek (Nehalem) 6th field.

LFA ID	Stream	Spawning Gravel (m2)		
		Poor	Fair	Good
Mainstem	Rock Creek	0.0	27.3	567.5
1	Bear Creek (mainstem)	0.0	0.0	3.5
3	Ivy Creek	0.0	11.1	9.8
4	Maynard Creek	0.0	7.9	10.4
5	Selder Creek	0.0	17.7	84.1
6	Fall	2.2	4.5	1.1
11	Weed Creek	0.0	0.0	107.8
13	Olson Creek	0.0	1.1	17.0
14	NF Rock Creek	0.0	0.0	358.0
14.1	NF Rock/Trib A	0.0	0.0	6.7
14.2	NF Rock/Trib B	0.0	0.0	24.0
16	Military Creek	0.0	28.1	0.0
17	SF Rock Creek	0.0	9.3	424.2
17.1	SF Rock/Trib A	0.0	0.0	13.8
17.2	SF Rock/Bear Creek	0.0	0.0	46.9
18	Trib D	0.0	3.4	36.2
	Total	**2**	**110**	**1,711.5**

These counts are conservative estimates of the number of spawning sites that are a minimum of one sq m in area and are located in a zone having hydraulics suitable for successful spawning by coho salmon. The counts are qualitatively grouped (Poor, Fair, Good) based on the amount of fines associated with the gravel (state of embeddedness). The counts can also be used to represent the availability of spawning sites appropriate for steelhead trout, but not for chinook salmon or cutthroat trout.

Appendix 6. Rock Cr (Nehalem) 6th field limiting habitat analysis based on the Nickelson model

Worksheet function

This sheet accumulates the results of the calculations performed on the other sheets to estimate the number of coho that can be supported by the rearing system under analysis.

The specific goals are to: 1) Estimate the number of coho that can be supported during each season of the year, and 2) Rank the seasonal habitats in terms of their ability to generate "potential smolts"; this identifies which seasonal habitat most limits the production of smolts from the system.

Ideally, this evaluation would utilize spawning gravel data along with habitat data describing spring, summer and winter rearing conditions. However, physical habitat surveys are almost always conducted during the summer. In practical terms, winter and spring survey data are not available.

To accommodate these deficiencies, we use a work-around to estimate winter rearing capacity, but currently are unable to estimate the spring rearing capacity.

The work-around method for estimating winter rearing capacity utilizes a polynomial regression equation that relates winter rearing capacity to summer habitat conditions. This equation is provided by ODFW research. No such work-around exists for estimating spring capacity, and it is not estimated.

The current evaluation thus aims at determining whether spawning gravel, summer conditions, or winter conditions are most limiting in the rearing system.

The model used to identify the limiting seasonal habitat is "Version 5.0. Coho Salmon Carrying Capacity Model", provided by Tom Nickelson of ODFW Research Division. This model uses season-to-season survival rates to estimate potential smolt production for each seasonal habitat. We have two sets of survival rates, one provided by ODFW research and the other by Jim Hall's Alsea watershed study. We compare model results using both sets of rates.

Results presented

Five tables are presented.:

Table A lists the summer rearing density for each stream habitat type. The same table is presented in the Summer Uplands sheet, where it is used to calculate rearing capacities. It is included here only to illustrate how strongly reach habitat structure affects rearing capacity.

Table B lists the two sets of survival rates used to evaluate potential smolt production.

Table C lists spawning, summer and winter rearing capacities that have been calculated for each upland stream and lowland habitat.

Table D lists potential smolt production for each upland stream and lowland habitat based on ODFW survival rates.

Table E lists potential smolt production for each upland stream and lowland habitat based on Alsea study survival rates.

Table F lists habitat capacity and potential smolt production for each seasonal habitat. This table comprises the primary product of the analysis.

Table A. Stream summer rearing densities

Table A. Coho rearing density for each summer stream habitat type.

Habitat type	Fish/sq m
Cascades	0.24
Rapids	0.14
Riffles	0.12
Glides	0.77
Trench Pools	1.79
Plunge Pools	1.51
Lateral Scour Pools	1.74
Mid Chan Scour Pools	1.74
Dam Pools	1.84
Alcoves	0.92
Beaver Ponds	1.84
Backwaters	1.18

Data of Tom Nickelson based on ODFW reseach.

Table B. Survival rates to smolt

Table B. Season (life stage) to smolt survival rates.

ODFW Reseach		Alsea study data	
Life stage	Survival rate	Life stage	Survival rate
Egg to smolt	0.3200	Egg to smolt	0.0270
Spring to smolt	0.4600	June to Smolt	0.0644
Summer to smolt	0.7200	Fall to smolt	0.1110
Winter to smolt	0.9000	Winter to smolt	0.2870

Rates used by Tom Nickelson (ODFW)

Rates provided by Jim Hall (OSU Dept of F & W)

Table C. Rearing capacities

Table C1. Upland rearing capacities.

Stream ID		Rearing capacity (# eggs or fish)		
Number	Name	Spawning	Summer	Winter
Stream 1	Bear Crk	2,917		
Stream 2	Trib I	8,333	1,458	859
Stream 3	Ivy Crk	12,852	7,796	2,867
Stream 4	Maynard Crk	11,961	5,794	7,683
Stream 5	Selder Crk	77,419	29,427	80,975
Stream 6	Fall Crk	3,252	2,168	1,044
Stream 7	Ginger Crk			
Stream 8	Trib A	8,333	661	124
Stream 9	Martin Crk	8,333	492	243
Stream 10	Trib B	8,333	8,542	2,837
Stream 11	Weed Crk	89,806	11,905	7,774
Stream 12	Trib C	8,333	2,456	1,508
Stream 13	Olson Crk	83,548	5,108	3,944
Stream 14	NF Rock Crk	298,374	56,665	30,326
Stream 15	Trib H	8,333	2,013	1,242
Stream 16	Military Crk	11,729	19,483	15,199
Stream 17	SFRock Crk	357,367	21,597	13,127
Stream 18	Trib D	31,626	23,036	50,027
Stream 19	Trib E	8,333	1,671	963
Stream 20	NF Rock/Trib A	5,574	1,807	3,869
Stream 21	NF Rock/Trib B	19,974	17,551	7,602
Stream 22	NF Rock/Trib C	8,333	243	124
Stream 23	SF Rock/Trib A	11,535	20,067	17,927
Stream 24	SF Rock/Bear Crk	39,097	10,658	22,401
Stream 25	Rock Crk	484,335	415,996	228,879
	Totals	1,608,031	666,592	501,544

Table C2. Lowland rearing capacities.

Habitat type	Rearing capacity (# fish)	
	Summer	Winter
Stillwater with edge habitat		
Wetland channels		
Flooded wetlands		

Total		

Table D. Potential smolt production based on ODFW survival rates

Table D1. Upland potential smolt production based on ODFW survival rates.

Stream ID		Potential smolt production (# fish)		
Number	Name	Spawning	Summer	Winter
Stream 1	Bear Crk	933		
Stream 2	Trib I	2,667	1,050	773
Stream 3	Ivy Crk	4,113	5,613	2,580
Stream 4	Maynard Crk	**3,828**	4,171	6,914
Stream 5	Selder Crk	24,774	21,188	72,878
Stream 6	Fall Crk	1,041	1,561	940
Stream 7	Ginger Crk			
Stream 8	Trib A	2,667	476	111
Stream 9	Martin Crk	2,667	354	219
Stream 10	Trib B	2,667	6,150	2,554
Stream 11	Weed Crk	28,738	8,572	6,997
Stream 12	Trib C	2,667	1,768	1,357
Stream 13	Olson Crk	26,735	3,678	3,549
Stream 14	NF Rock Crk	95,480	40,799	27,293
Stream 15	Trib H	2,667	1,449	1,118
Stream 16	Military Crk	**3,753**	14,028	13,679
Stream 17	SFRock Crk	114,357	15,550	11,814
Stream 18	Trib D	**10,120**	16,586	45,024
Stream 19	Trib E	2,667	1,203	867
Stream 20	NF Rock/Trib A	1,784	1,301	3,482
Stream 21	NF Rock/Trib B	**6,392**	12,637	6,842
Stream 22	NF Rock/Trib C	2,667	175	112
Stream 23	SF Rock/Trib A	**3,691**	14,448	16,135
Stream 24	SF Rock/Bear Crk	12,511	7,674	20,161
Stream 25	Rock Crk	**154,987**	299,517	205,991
	Total	514,570	479,947	451,390

Table D2. Lowland potential smolt production based on ODFW survival rates.

Habitat type	Rearing capacity (# fish)	
	Summer	Winter
Stillwater with edge		

habitat		
Wetland channels		
Flooded wetlands		
Total		

Table E. Potential smolt production based on Alsea study survival rates

Table E1. Upland potential smolt production based on Alsea study survival rates.

Stream ID		Potential smolt production (# fish)		
Number	Name	Spawning	Summer	Winter
Stream 1	Bear Crk	79		
Stream 2	Trib I	225	162	247
Stream 3	Ivy Crk	347	865	823
Stream 4	Maynard Crk	323	643	2,205
Stream 5	Selder Crk	2,090	3,266	23,240
Stream 6	Fall Crk	88	241	300
Stream 7	Ginger Crk			
Stream 8	Trib A	225	73	35
Stream 9	Martin Crk	225	55	70
Stream 10	Trib B	225	948	814
Stream 11	Weed Crk	2,425	1,321	2,231
Stream 12	Trib C	225	273	433
Stream 13	Olson Crk	2,256	567	1,132
Stream 14	NF Rock Crk	8,056	6,290	8,704
Stream 15	Trib H	225	223	356
Stream 16	Military Crk	317	2,163	4,362
Stream 17	SFRock Crk	9,649	2,397	3,767
Stream 18	Trib D	854	2,557	14,358
Stream 19	Trib E	225	185	276
Stream 20	NF Rock/Trib A	151	201	1,110
Stream 21	NF Rock/Trib B	539	1,948	2,182
Stream 22	NF Rock/Trib C	225	27	36
Stream 23	SF Rock/Trib A	311	2,227	5,145
Stream 24	SF Rock/Bear Crk	1,056	1,183	6,429
Stream 25	Rock Crk	13,077	46,176	65,688
	Total	43,417	73,992	143,943

Table E2. Lowland potential smolt production based on Alsea study survival rates.

Habitat type	Rearing capacity (# fish)	
	Summer	Winter
Stillwater with edge habitat		
Wetland channels		
Flooded wetlands		
Total		

Table F. Overall rearing and smolt production capacities.

Table F. Combined upland and lowland rearing capacity and potential smolt production. Smolt production is estimated using both ODFW and Alsea watershed survival rates.

Life stage (season)	Rearing capacity (# fish)	Potential smolt production (# fish)	
		ODFW rates	Alsea rates
Spawning (# eggs)	1,608,031	514,570	43,417
Spring (# fish)	no data	no data	no data
Summer (# fish)	666,592	479,947	73,992
Winter (# fish)	501,544	451,390	143,943

No estimate of spring capacity or potential smolts produced is possible with current data.

Calculation of Spawning (# eggs) is based on the assumptions of 2500 eggs/redd and 3 m2/redd

Analyst notes

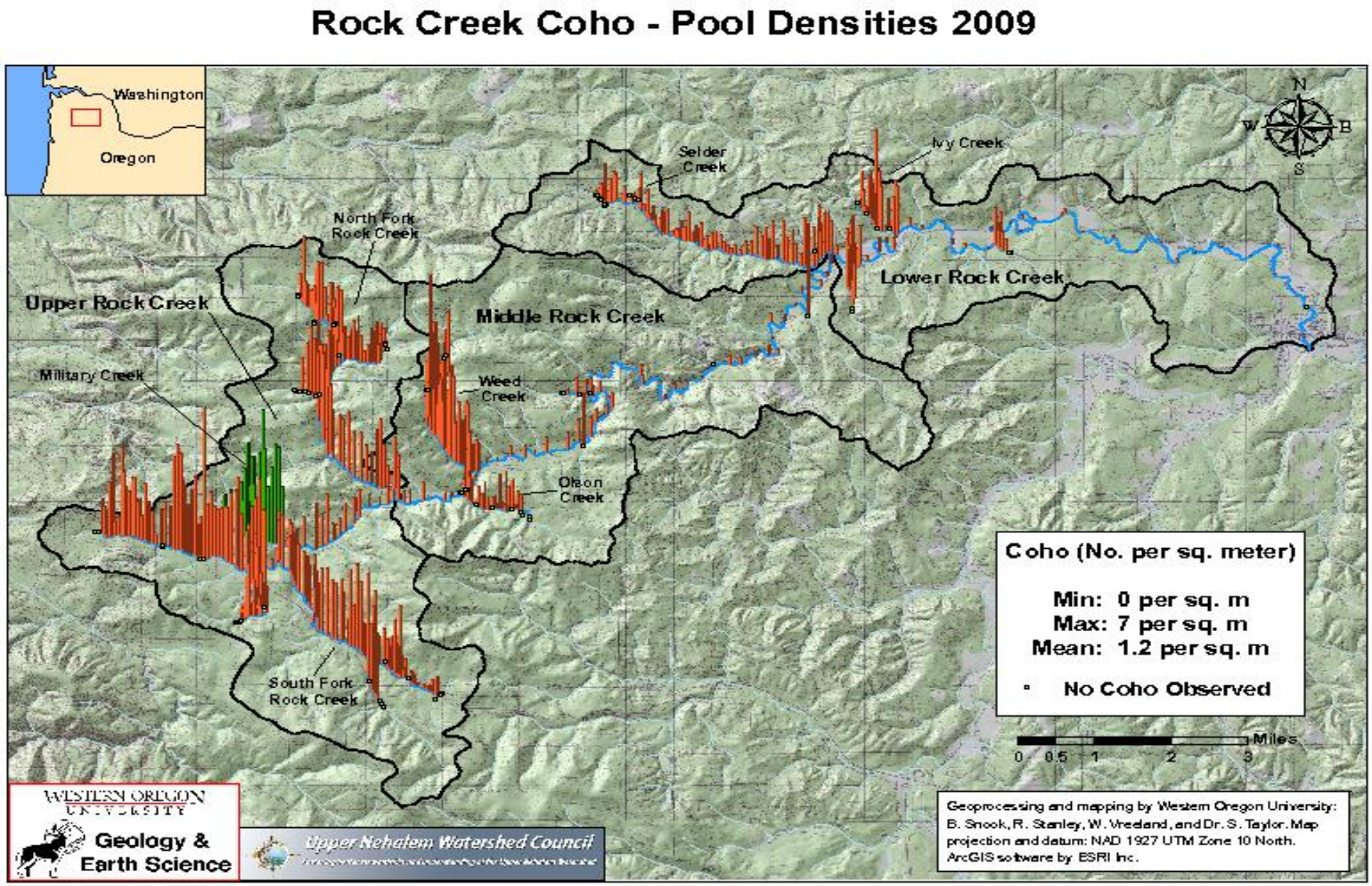
Notations by analyst describing scenario goals and results
Goals

It appears that spawning gravel is limiting utilizing the Alsea Study survival rates. This helps us think about gravel resources and how they move through the system. The steel trash rack at Hwy 26 terminates downstream gravel transport. This may ramp up the importance of removing this structure and working on the undersized culvert at Hwy 26.

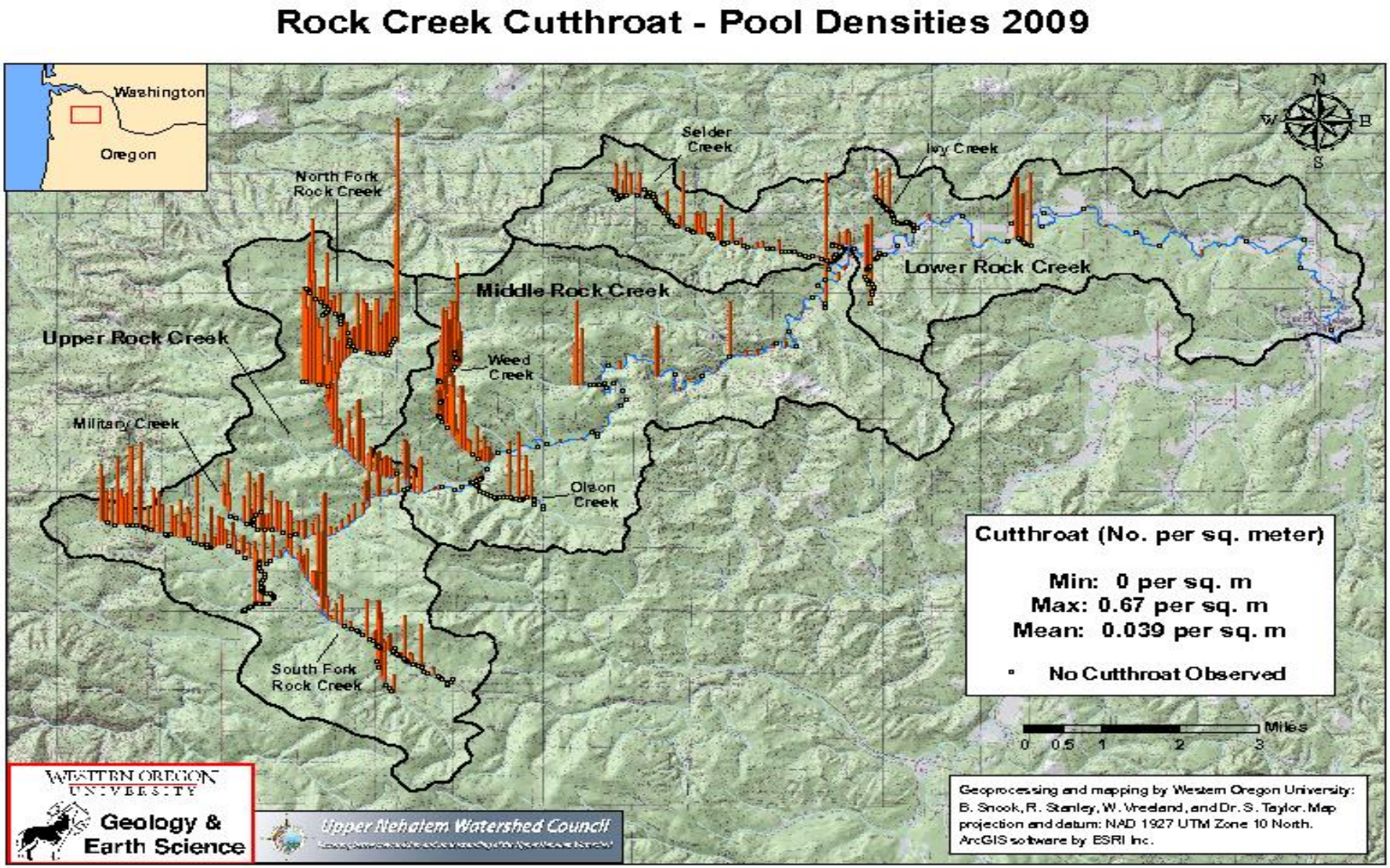
Reaches 1 and 72.3% of Reach 2 of the summer rearing capacity of mainstem Rock have been eliminated from this scenario by making alterations in the summer uplands summary tab. This was done to represent the current temperature limitation that exists in the mainstem of Rock for proper summer utilization of the available habitats by juvenile coho. The temperature limited habitats extend from the mouth of Rock Cr to the confluence of Selder Cr.

Table E1 contains stream reaches with adequate spawning gravel to seed the habitat within the trib to the 2.4 fish/sqm level observed in high quality habitat (Changed in summer uplands tab line 17-24). These streams are highlighted in red in Table E1. These streams are the ones that have the potential of pumping supplemental nomadic spring fry into downstream habitats (mainstem Rock) that don't have significant spawning potential. The big players are SF Rock, NF Rock and mainstem Rock above the SF confluence.

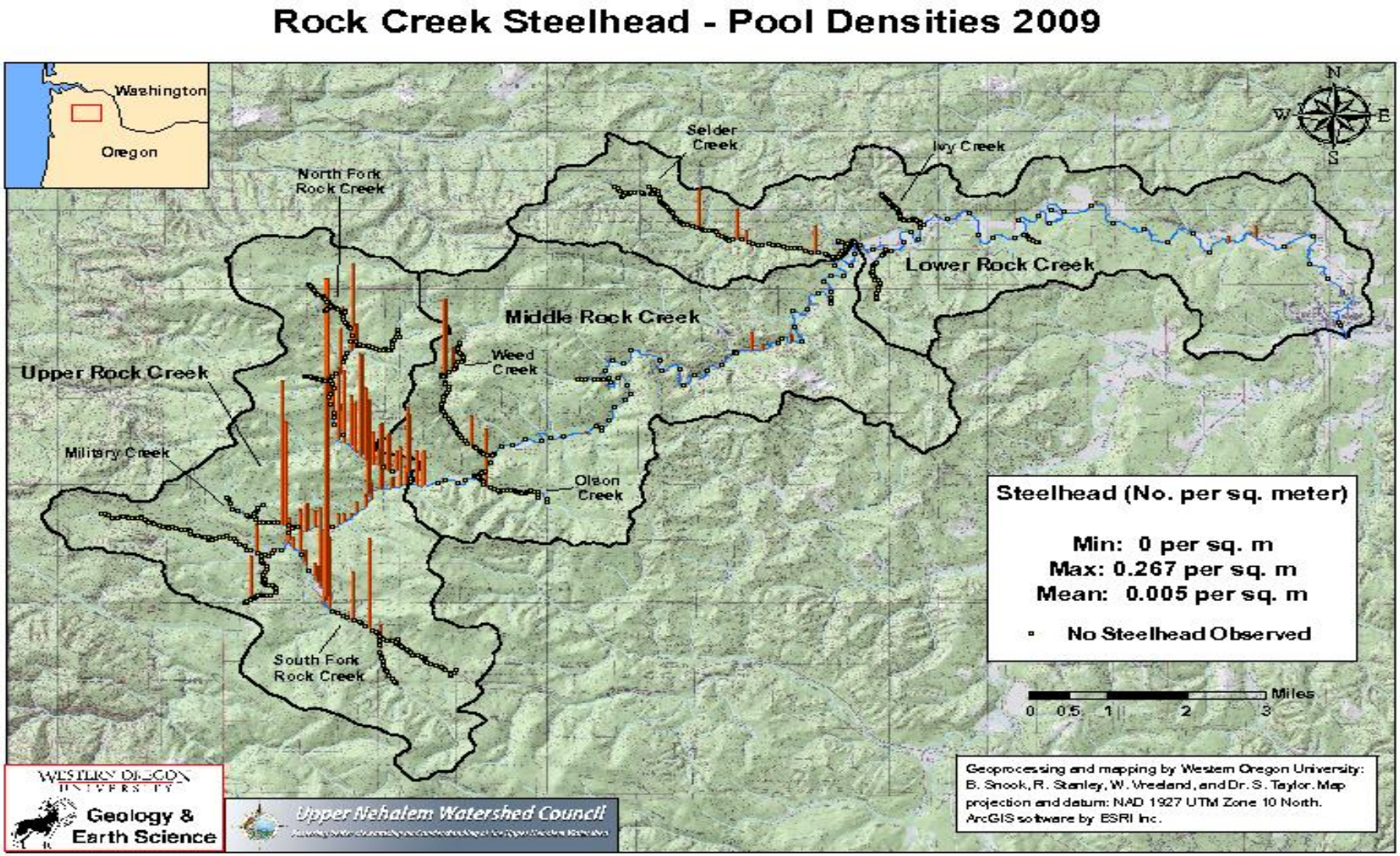
Appendix 7. Rock Cr (Nehalem) 6th field summer coho distribution chart.



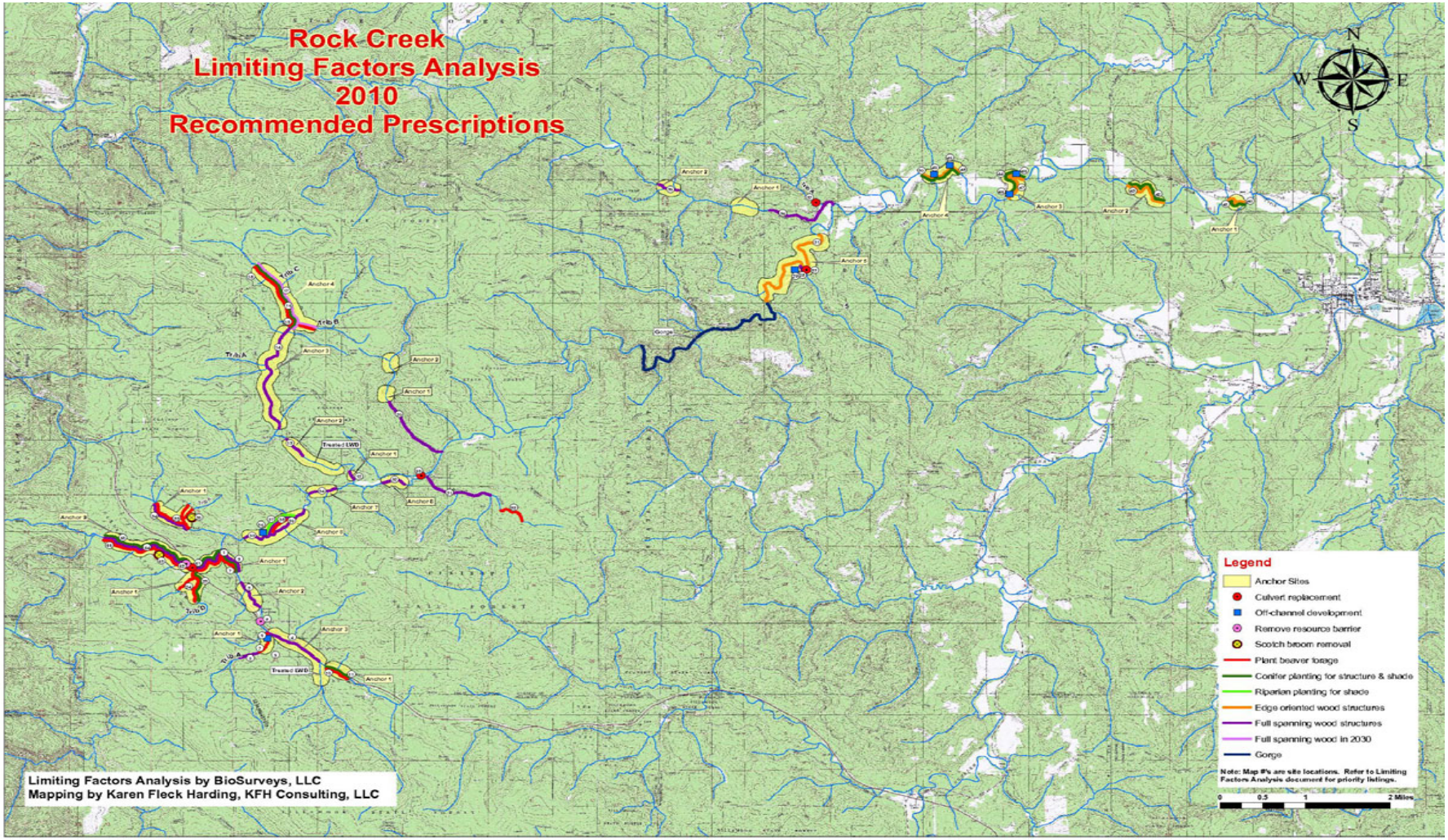
Appendix 8. Rock Cr (Nehalem) 6th field summer cutthroat distribution chart.



Appendix 9. Rock Cr (Nehalem) 6th field summer steelhead distribution chart.



Appendix 10. Rock Cr (Nehalem) 6th field prescription chart.



Appendix 11. Photos.

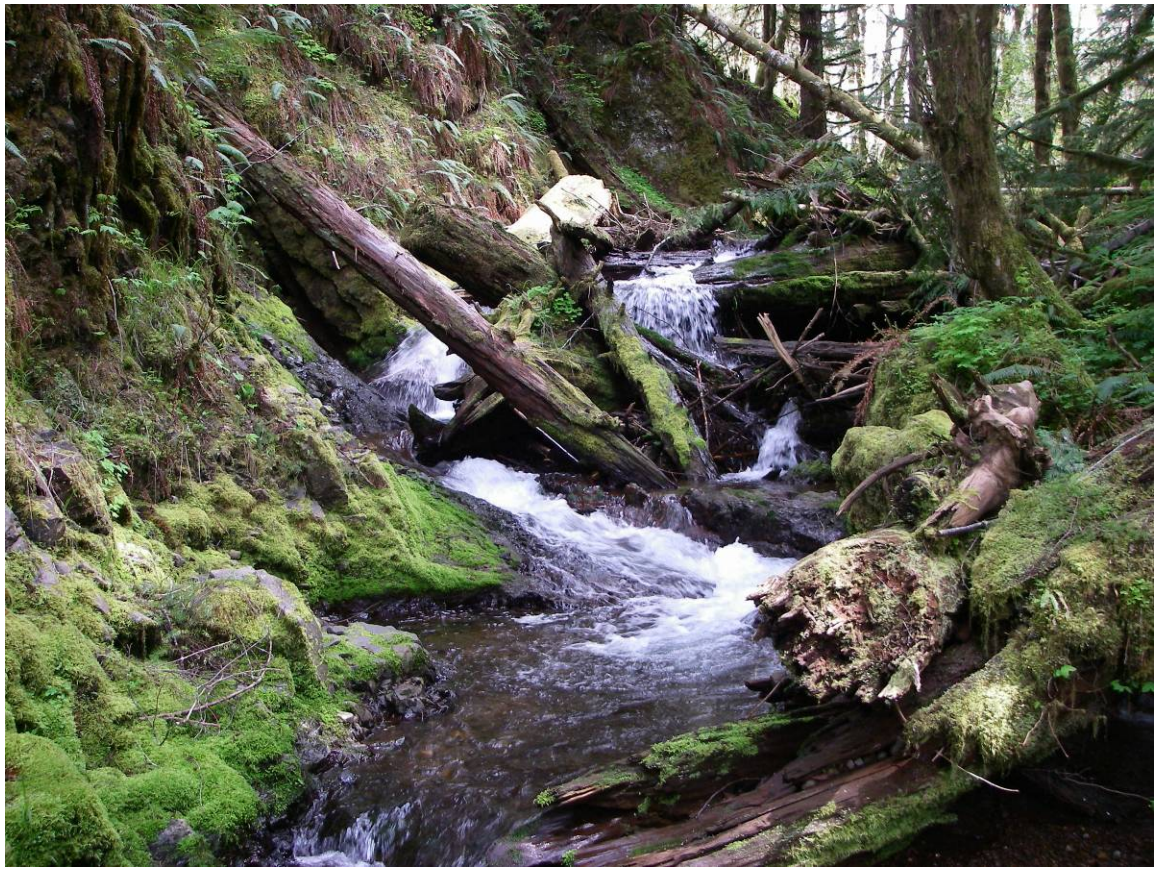


Photo 1. End of anadromous use, SF Rock.

Photo 2. Old growth legacy wood SF Rock, rare.

Photo 3. Backwater and low terrace SF Rock.

Photo 4. Floodplain interaction and potential SF Rock.

Photo 5. Accelerated alder recruitment from inadequate harvest buffer SF Rock Anchor Site 1.

Photo 6. Hwy 26 culvert SF Rock.

Photo 7. Area treated with full spanning wood jams, Anchor Site 2 in SF Rock.

Photo 8. High functioning habitat, Anchor Site 1 of Bear Creek on SF Rock.

Photo 9. Juvenile barrier at top of Anchor Site 1 in NF Rock.

Photo 10. Gravel deposition above wood complexity, exhibiting potential for habitat development in NF Rock.

Photo 11. Old and new structure logs creating great habitat in Anchor Site 2 NF Rock. Model of effective restoration.

Photo 12. Low terraces but little wood complexity, Anchor Site 1 in NF Rock.

Photo 13. Exposed historic beaver flat at upper end of Anchor Site 4 in NF Rock. Proposed willow planting site.

Photo 14. High quality beaver impoundment and floodplain interaction on Trib D of Rock Cr.

Photo 15. Solar exposure in beaver flat, Trib D of Rock Cr.

Photo 16. Ephemeral wood jam barrier on Olson Creek.

Photo 17. Terrace development above barrier jam on Olson Creek.

Photo 18. Beginning of Anchor Site 1 on Military Creek.

Photo 19. Culvert in Trib A of Selder Cr.

Photo 20. Naturally recruited riparian LWD from fire-toppled conifer on Selder Cr. Still exhibiting extreme high function; rare.

Photo 21. Fire legacy wood still available for recruitment in Selder Cr.

Photo 22. Slope failure adjacent to legacy jam. Only small reprod available for recruitment in Selder Cr. Historically logged to stream edge with no buffer retained.

Photo 23. Un-maintained trash rack above HWY 26. Mainstem Rock.

Photo 24. Large backwater and extensive solar exposure. Lower mainstem Rock Cr, Anchor Site 1.

Photo 25. New channel cut in Anchor Site 3 on mainstem Rock Cr. Result of railroad fill in floodplain restricting natural flow characteristics.

Photo 26. Wood jam and low terraces on old meander bend in mainstem Rock Cr, Anchor Site 3.

Photo 27. Reed Canary infestation. Anchor Site 8 of mainstem Rock Cr. Inman Paulson Mill Pond site.

Photo 28. Bedrock intrusion providing grade control and preventing entrenchment in upper Rock Cr mainstem.

Photo 29. Rock Cr Anchor Site 8 showing large terrace; site of proposed channel realignment. Inman Paulson Mill Pond site.

Photo 30. Off-channel habitat potential in Anchor Site 8 of mainstem Rock Cr.

Photo 31. Legacy channel and backwater habitat in Anchor Site 8 of mainstem Rock Cr. Downstream reconnection site for proposed channel realignment.

Photo 32. Large full-spanning jam formed on collapsed log stringer bridge still holding Rock Cr Anchor Site 8 together.

Photo 33. Under-sized HWY 26 culvert in Rock Cr Anchor Site 9. Compromising resource migration and delivery to lower mainstem Rock Cr.

Photo 34. Beaver impoundment un upper Rock Cr, storing spawning gravels and creating high quality summer and winter habitat within Anchor Site 9.