West Fork Smith River

A History of Land Use, Habitat Impacts, Restoration Actions and Monitoring Results

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I. Introduction

The West Fork of the Smith River (WFSR) is located in southwest Oregon, northeast of Reedsport and southwest of Eugene. The WFSR is a tributary of the Smith River, and part of the greater Umpqua River system. 68 percent of the basin is federally owned and administered by the Bureau of Land Management. The majority of private land in the basin is owned by Roseburg Forest Products, a privately owned timber company. The WFSR like many other coastal streams saw declining salmon and steelhead runs as the result of past land use practices. These declines resulted in actions aimed at increasing the size of these runs and monitoring their population responses. These monitoring efforts have shown sometimes dramatic population responses to the restoration actions taken.

II. Executive Summary

This report outlines the recorded history of past land use practices, past assessments of aquatic habitat, restoration actions, the results of monitoring projects, and recommendations for future actions based on monitoring results. We analyzed long-term trends alongside restoration actions to determine if these trends can be attributed to treatments performed. It should be noted that the WFSR is not representative of all salmon bearing streams, or even of those within the Oregon Coast Range area. Many site specific factors may cause a given stream system, or aquatic population to respond differently to treatments than another. Such factors include aspect, basin gradient, floodplain height, geology, forest age, soil depth, state of human development, downstream predation, estuarine habitat, ocean conditions, etc. This report is intended to provide a case study of the WFSR; inferences may be drawn from the results of other systems, but those results may not translate directly based on the contributing factors listed above, as well as additional factors we may not yet fully understand.

The WFSR has seen numerous anthropogenic actions over the years that have affected its fluvial geomorphology, instream structure, riparian composition and structure, water quality, streamflow, and its aquatic populations. Many past land use practices degraded ecological processes that are known to be critical to cold-water anadromous fish production. These have greatly reduced productivity, limiting juvenile salmonid production and decreasing adult salmon and steelhead returns, which are of cultural and economic importance. The WFSR has also received numerous treatments designed to restore these processes or mitigate the damage caused by these practices. Fish passage improvement projects were undertaken to increase stream habitat connectivity. Large wood and boulders were placed to slow water velocities, increase sediment deposition, and increase high quality and complex habitats. Sites for these placements were selected based on stream characteristics, degree of human impact, and landownership (prior to the Wyden Amendment in 1998, federal funds for these types of projects would only be appropriated to projects implemented on federal land; today however, federal funds are able to be used on private property through landowner agreements). Bedrock sites with little to no gravels or other substrates had the greatest potential for ecological uplift as well as low gradient habitats with low floodplains that could have more connectivity restored at high winter flows.

Monitoring of this system has been conducted by the Coos Bay District Bureau of Land Management (BLM) and the Oregon Department of Fish and Wildlife (ODFW). The BLM has a gaging station located 1 mile from the mouth of the WFSR. The BLM has been monitoring stream stage and temperature since 1980. Water depth shows a high degree of seasonal variability and large spikes in water depths are observed November through April, coinciding with the majority of precipitation occurring in the winter season. Temperature loggers at the stage station show that peak temperatures occur in July and August, reaching 23 degrees centigrade (73.4°F). Temperature was evaluated based on the 7- day average maximum temperature (7-DAMT). The 7-DAMT for salmonid summer rearing and migration has consistently exceeded the upper tolerance criteria for the state of Oregon (DEQ, Umpqua River Basin TMDL, Chapter 3, 2006). A Department of Environmental Quality (DEQ) simulation estimated that 55% of the solar heat load was potentially resulting from anthropogenic causes or actions (Figure 1) (DEQ, Umpqua River Basin TMDL, Chapter 3, 2006).

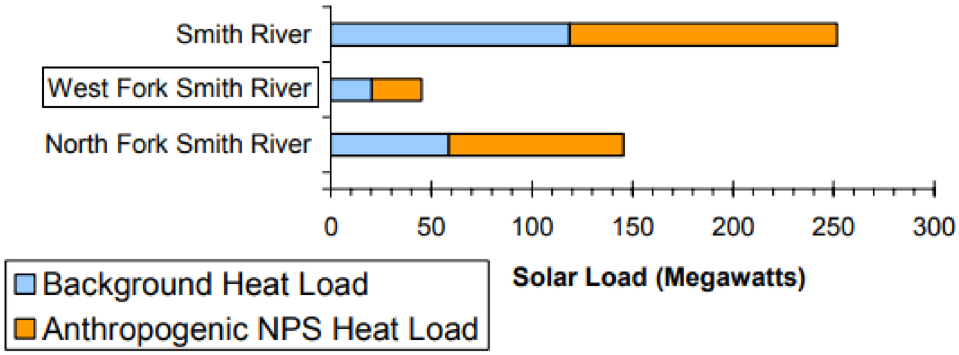

Figure 1: *Nonpoint Source (Anthropogenic) and Background Solar Heat Loads, Umpqua Basin Stream Temperature Total Maximum Daily Load, ODEQ* (2006).

ODFW spawning ground surveys have been conducted on Beaver Cr, a WFSR tributary, since 1958. The annual peak Coho Salmon (*Oncorhynchus kisutch*) count, or highest number of fish seen on a single survey throughout the season, was analyzed. The peak Coho count showed a declining trend through the late 1970s, and in 1976 and 1977, no fish were observed. From 1980 to present, the trend has been extremely promising. Our most recent 6 year average (2 Coho brood cycles) shows peak Coho counts are at 1880% of their 6 year low in the late 1970s. ODFW also manages a Lifecycle Monitoring Project (LCM) since 1998 where returning adults and out-migrating juvenile salmonids are trapped, and population sizes are estimated through a Peterson mark recapture study. Coho adult and juvenile numbers have increased over the course of this study. Chinook (*Oncorhynchus tshawytscha*) juvenile estimates show an increasing trend as do the number of Chinook adults observed at the trap site. Steelhead (*Oncorhynchus mykiss*) estimates for both adults and juveniles remain stable with no increasing or decreasing trend. Pacific and Brook Lamprey (*Entosphenus tridentatus, Lampetra richardsonii*), are enumerated when caught in the juvenile fish trap. Adults and juveniles of both species showed drastically decreasing trends through 2007. Following the 2007/2008 flood event and subsequent restoration actions, numbers of juveniles and adults of both species show an increasing trend. Year-to-year variation of salmon and steelhead populations have been significant, however, long-term population trends are the most useful in evaluating recovery from the effects of human management of the system.

Rebounds in population numbers for multiple species show that instream habitat and fish passage improvements may have been beneficial. Restoration sites that are likely having the greatest effect on fish productivity are those designed and placed to capture large sediment deposits. Chinook responses are likely driven by increased spawning habitat and large pools throughout the WFSR mainstem created by boulder placements. These large pools provide slow water habitat with foraging opportunities that were absent prior to boulder placements. Coho spawning habitat is no longer considered a limiting factor, although, much of the historic spawning habitats have not yet recovered. Winter rearing habitat has been shown in several studies as the greatest limiting factor for Coho, including a study conducted by the Environmental Protection Agency (EPA) in the WFSR. The limiting factor analysis was based on migration timing assumptions that have since been disputed by studies conducted in California, Oregon and Washington, which observed a significant proportion of juvenile Coho out-migrating in fall (Roni et al. 2012; Jones et al. 2014; Rebenack et al. 2015). Following these studies, summer rearing habitat could be considered the greatest habitat limiting factor in the WFSR and other coastal streams.

The next focus area should be on projects that increase groundwater residence time and riparian shading, as summer rearing habitat and cool water refugia are essential to growth and survival for juvenile salmonids (see recommendations section). Stable steelhead numbers indicate that habitat limiting factors for 2 year old smolts have not been addressed, or any improvements in habitat quality are being nullified through increased competition from juvenile salmon and/or stream temperature increases. Over 90% of returning adult steelhead in the West Fork reared in freshwater for 2 years (ODFW scale analysis). To improve steelhead returns, managers should focus on creating/improving high quality complex pool habitat that can support 2-3 year old steelhead juveniles. This will also benefit Cutthroat Trout as juvenile steelhead and Cutthroat have similar habitat requirements.

Lamprey responses are likely being driven by large beds of sand and silt that have built up behind placed instream structures and those that formed naturally as a result of large flow events. Fine particle beds are often looked at in a negative light based on the negative impact fines can have on salmon redds. These beds provide a matrix of lamprey ammocete and macro-invertebrate habitat, the production of which provides forage base for juvenile salmonids.

More recent instream restoration treatments focused on large wood and boulder placements. Only one placement incorporated large wood and boulders into the same structure and this site has produced a preferred ecological impact in comparison to sites consisting solely of boulders. Boulders placed low in the stream channel catch substrate while wood placed higher in the stream profile can catch wood moving downstream during high flow events. This structure has created a large pool that Coho stage in before their final push into the tributaries. Large wood and boulder combination structures should be preferred over structures containing only one of these materials. We have seen the dramatic effect of these boulder ballasted log structures in other systems and we cannot over emphasize how dramatically better these structures perform.

IV. History

Prior to European contact in the 1830's, the WFS had been successfully stewarded by indigenous peoples for several thousand years. The group that inhabited the basin was the Quuiich (Lower Umpqua). Today, the Lower Umpqua People are included in two Sovereign Nations: The Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians and the Confederated Tribes of Siletz Indians of Oregon. The archeological record was impacted by splash damming which destroyed midden piles located near stream settlements and fishing weirs located in streams. Salmon, steelhead, trout, lamprey, crayfish and mussels were said to have been harvested from the river. Land management practices included intentional burning to improve and expand elk forage and habitat; increase the quality of weaving materials (e.g. beaked hazel), and to enhance berry production. Fire frequency of stands occurred on average every 48 years.

The mainstem suffers from legacy effects of splash damming and log-driving (methods for transporting logs downstream), and stream cleaning (removal of wood from the channel). Timber cruiser records from the Department of the Interior show that 10 to 11 miles of the WFSR sub-basin mainstem were splash dammed. Log-driving occurred throughout the mainstem and lower tributary reaches. Stream cleaning was a common practice from 1972-1994 and often was a requirement written into timber sales.

Restoration work began in the basin in 1981 with the construction of stream spanning gabions, or wire cages filled with rock that provides physical structure similar to sill logs or large boulders.

Since then, numerous instream habitat restoration and fish passage improvement projects were implemented. Since 1998 this system has been monitored by the Oregon Department of Fish and Wildlife, Lifecycle Monitoring Project as part of the Oregon Plan for Salmon and Watersheds. Trap sites near the mouth of the WFSR allow adults migrating upstream and juveniles migrating downstream to be sampled for biological metrics and marked for a Petersen mark-recapture study. This results in producing estimates of outgoing juvenile and returning adult salmonids. With such an extensive history of restoration activities and intensive monitoring of this basins aquatic populations, this system provides a unique opportunity to study aquatic responses to large scale restoration actions.

In the late 1970's and early 80's, Coho Salmon and steelhead were suffering from a long decline in returning adult abundances. Due to an extended freshwater rearing time, one to two years, freshwater spawning and rearing habitat was identified to be a significant limiting factor. With the arrival of Bill Hudson to the Coos Bay District Bureau of Land Management in 1980, an Aquatic Habitat Management Plan was written for the WFSR. This report detailed the habitat degradation caused by past logging practices and detailed measures that could be taken to restore populations. Key areas were identified as having a low cost-to-benefit ratio, and were targeted for initial restoration. 1981 saw the first efforts at instream restoration in the basin. These efforts focused on increasing spawning habitat. The production of the WFSR was identified as being limited by adult access to spawning gravels and therefore was under-seeded with juveniles. Due to the rehabilitation of spawning grounds, this has dramatically improved. With recent research demonstrating winter and summer rearing habitat to be current limiting factors in adult salmonid production, the emphasis for restoration efforts focused projects that improve rearing habitats has increased.

Management plans:

Past Plans:

Multiple assessments and actions plans were generated for this area that guided restoration actions. Two were generated specifically for this sub-basin by the BLM. These plans show the evolution of instream technique, summaries of these plans can be found in the appendix. The first of these plans was authored by Bill Hudson of the BLM in 1980. Many of the recommendations in this plan were implemented, some as soon as the very next year. The results of his efforts are clearly reflected in the 60-year spawning survey data set from Beaver Creek. Bill Hudson of the BLM should be credited with preventing the extirpation or near-extirpation of Coho Salmon from this system.

Current Management:

BLM land within the West Fork Smith River subwatershed is managed under the Northwestern and Coastal Oregon Resource Management Plan (RMP), which was signed in 2016. The 2016 RMP lays out Management Objectives and Directions for managing Riparian Reserves, fisheries, and hydrology resources. Management Objectives for fisheries include 1) Improve the distribution and quantity of high-quality fish habitat across the landscape for all life stages of ESA-listed, Bureau Special Status Species, and other fish species and 2) Maintain and restore access to stream channels for all life stages of aquatic species. The Management Objective for hydrology is to maintain water quality within the range of natural variability that meets ODEQ water quality standards for drinking water, contact recreation, and aquatic biodiversity. Additionally, under the RMP the WFSR was designated as a Class I subwatershed because it contains both designated critical habitat and high-intrinsic potential streams. Riparian Reserve Management Direction in Class I subwatersheds is designed to benefit fish habitat and improve riparian conditions. More information about the 2016 RMP can be found at https://eplanning.blm.gov/epl-front-office/eplanning/planAndProjectSite.do?methodName=renderDefaultPlanOrProjectSite&projectId=57902&dctmId=0b0003e880abf259. The BLM also manages aquatic habitat and restoration work in line with the Recovery Plan for Oregon Coast Coho Salmon as well as the Special Status Species policy found in Section 6840 of the BLM Manual.

V. Restoration Actions

The first instream work to affect the WFSR was in 1938 when Smith River Falls was modified for anadromous passage. An 1877 cadastral survey found that the river falls the whole width of the channel over sandstone with a drop of 12 feet. Dynamite was used in 1938 to lower a portion of the falls and create a jump pool to improve fish passage. Prior to that, steelhead could only pass the falls occasionally during optimal flows. Prior to this work, the WFSR would have likely been a trout stream absent of salmon. In 1971, the Oregon Fish and Game Commission constructed a fish ladder around the falls, and by the early 1980s, Chinook were introduced into the WFSR.

Mainstem restoration

In 1981, 34 wire mesh, cobble filled gabions were placed in the mainstem at a cost of $48,290. These structures were evaluated in 1987 by BLM stream surveys, and most were observed to have accumulated deep gravel beds, although some showed damage at the center thalweg. In 1991, they were re-evaluated and found to be deteriorating. Many were completely covered in gravel and those exposed suffered from rust and damage caused during high flows. In 1992, 29 of the gabions were replaced with boulder weirs. No material was removed and boulders were placed on the downstream face and atop the substrate that had formed. This effectively contained the accumulated substrate. One wing-dam style deflector was also installed. Boulders were donated by the Campbell Group from the Roman Nose quarry. In 1994, 12 more boulder weirs were placed in the upper mainstem above the influence of major tributaries. This left a series of 19 closely spaced weirs, which subsequently have filled with appropriately sized spawning gravel and all are currently used by adult salmonids.

In 1997, a large number of boulder clusters and wood were placed in boulder weir reaches to increase pool complexity and substrate deposition. At the time of the analysis, only project planning data was available which called for 412 boulder clusters and vast amount of wood at an estimated cost of $134,000. This project was implemented, but exact data has not been located and much of these materials were flushed out of the system or rearranged by major flood events of that winter. From 1999 to 2001, 7 more weirs were installed. 13 trees with attached rootwads, 33 cut logs, and 109 hardwoods were cut. All were placed in streams, many atop 1997 boulder clusters, including 65 rootwads donated by Roseburg Forest Products that were cabled to boulder clusters. Three of the structures placed between 1994 and 2001 where recorded as weirs, but were actually wing-dam style deflectors. In 2003 a 15 meter long x 2 meter dbh (diameter at breast height), windfall old growth log was placed 20 meters upstream of the headwaters bridge at a cost of $1,200. The massive log has since moved downstream past the bridge a distance of 100 meters. This displays the tremendous force of this system at high flows some 11 miles upstream from the mouth.

Large wood was placed in the upper mainstem in 2010 and 2011 which was part of a basin-wide treatment that included all major tributaries at a cost of over $500,000 for 1600 logs. In 2011, 17 boulder weirs were placed starting above Gold Cr., and downstream to below Beaver Cr. This effort targeted non-treated reaches between previous placed boulder weir reaches, leaving multiple miles of contiguous boulder treated mainstem.

In 2013 the most extensive mainstem work was implemented with 36 complex boulder weirs with jump pools, and downstream boulder clusters. One site received a diamond shaped structure of four boulder piles designed to trap wood. The total cost for 2010-2014 log and boulder placements was 1.6 million dollars, which included 2,000 logs/trees and 11,000 boulders.

Approximately 2-2.5 miles of the mainstem remains untreated out of 14.6 miles identified by the original Aquatic Habitat Management Plan. Thirty, old growth Douglas-fir were cabled into the mainstem in 2014; trunk, rootwad and crown. This leaves only one to two miles of untreated mainstem. There are now 98 stream spanning boulder weirs and numerous other boulder structures in the mainstem WFSR. The difference in sediment loading is visually apparent. At higher flows, highly turbid water in the upper mainstem traveling downstream shows clearing as it passes through newly treated reaches. In the past, water showed increased turbidity as it passed through these reaches. This indicates increased deposition and the increased ability of the system to retain material moving downstream during what previously would have been, flushing, and sediment exporting events.

Boulder weirs are intended to mimic large key-pieces of wood oriented at an angle in order to increase the ratio of the structure width to the channel width. With 98 boulder weirs within 14.6 stream miles, that works out to 6.7 “key pieces” per mile. If 80 pieces per mile is considered “proper functioning condition”, the WFSR has only 8% of PFC. (Dan VanSlyke BLM retired)

Tributary Restoration

In 1969, a Memorandum of Understanding was signed by the Coos Bay District BLM and the Oregon Fish and Game Commission regarding replacement of improperly sized and placed culverts on four major tributaries of the WFSR. These tributaries pass under the WFSR road which was built around 1950.

Coon Cr.

Prior to 1969, a U-shaped concrete jump pool was built below the culvert entrance to Coon Cr. In 1972, concrete sills or weirs were built below Coon Cr. to backwater the culvert to increase fish passage and in 1994, the culvert was replaced with a pipe arch culvert. A 1995 observation states that the culvert filled with gravel the first year. In 2011, the creek received extensive helicopter log placements, and many stream side red alder were cut and dropped into the creek to allow for proper helicopter placement and increased safety.

Crane Cr.

Concrete sills were installed (year unknown) to backwater the culvert for fish passage. In 1979, an extensive log jam formed by logging debris was removed and a failed tributary culvert was placed at a cost of $40,000. In 1981, logs and boulders were placed and blast pools (using dynamite) were created at a cost of $15,840. In 2000, the 1.25 miles of road along Crane Cr. was decommissioned, seven tributary culverts were pulled, and the resulting banks were contoured with rip-rap. The culvert at the mouth was replaced again in 2003 with a pipe arch culvert and bed material at a cost of $80,560. In 2010, Crane Cr. received extensive log placements, with many riparian red alder cut to allow for helicopter placement of logs and safety reasons.

Moore Cr.

In 1978-79, stream cleaning occurred following logging of the area. Instream restoration began in 1981 with a log jam removal costing $1,100. Ten "rearing pools" were blasted out of the bedrock at a cost of $3,633. Ten cedar sills were also constructed to recruit spawning gravel. In 1995, the culvert at the mouth of the creek was replaced with a pipe arch culvert with bed material. In 2000, 0.5 miles of road were decommissioned, 16 tributary culverts were pulled, and the banks were contoured with rip-rap. 53 red alder were pulled during the road decommissioning and were placed in the channel. In 2010-11, wood was placed by helicopter and excavator.

Beaver Cr.

Stream cleaning on Beaver Cr. occurred in 1968 and in 1979, and it was noted that the perched culvert at the mouth of the creek "spills onto a sheet of bedrock." The culvert was likely replaced around 1980 along with an unknown amount of instream work that included gabions, logs, and blast pools. Records are incomplete but a description of the first reach of Beaver Cr. was a: "straight shot bedrock." A culvert was replaced in 1995 and in 2001 a 0.75 mile road that ran along the creek was decommissioned, nine tributary culverts were pulled, and the banks were contoured with rip-rap. In 2010, logs were placed by helicopter and many stream side alder were cut and dropped into the creek to allow for safety reasons and helicopter visibility. Beaver Cr. is one of the longest running annual standard Coho surveys in the state, with data starting in 1958 and peak spawner counts show a precipitous decline to their low around 1980 when populations begin to rebound.

Gold Cr.

In 1968, concrete sills were installed in the mainstem below the mouth of the creek to backwater the culvert. This was deemed acceptable for fish passage and could be done at a fraction of the cost of replacing the culvert. In 1979, the culvert was replaced. In 1981, ten cedar sills were placed in the creek. Blast pools may have been created but the reports are not clear. Wood was placed with an excavator and helicopter 2011 along with a large scale riparian hardwood to conifer conversion.

Church Cr.

In 2003, the road running along Church Cr. was decommissioned and the culvert at the mouth of the creek was removed. A description at the time of the project stated: "Culvert was perched and plugged for many years." In 2011, wood was placed with helicopter.

Oxbow Lake

This site is a meander lake that was cut off during the construction of the WFSR road. The lake is approximately 1.5 acres; stream fed, and has an outlet that runs under WFSR road. The culvert was replaced in 2011, and small weirs were built below the culvert outlet to provide a gradient passable by juveniles to access winter refuge habitat in the lake.

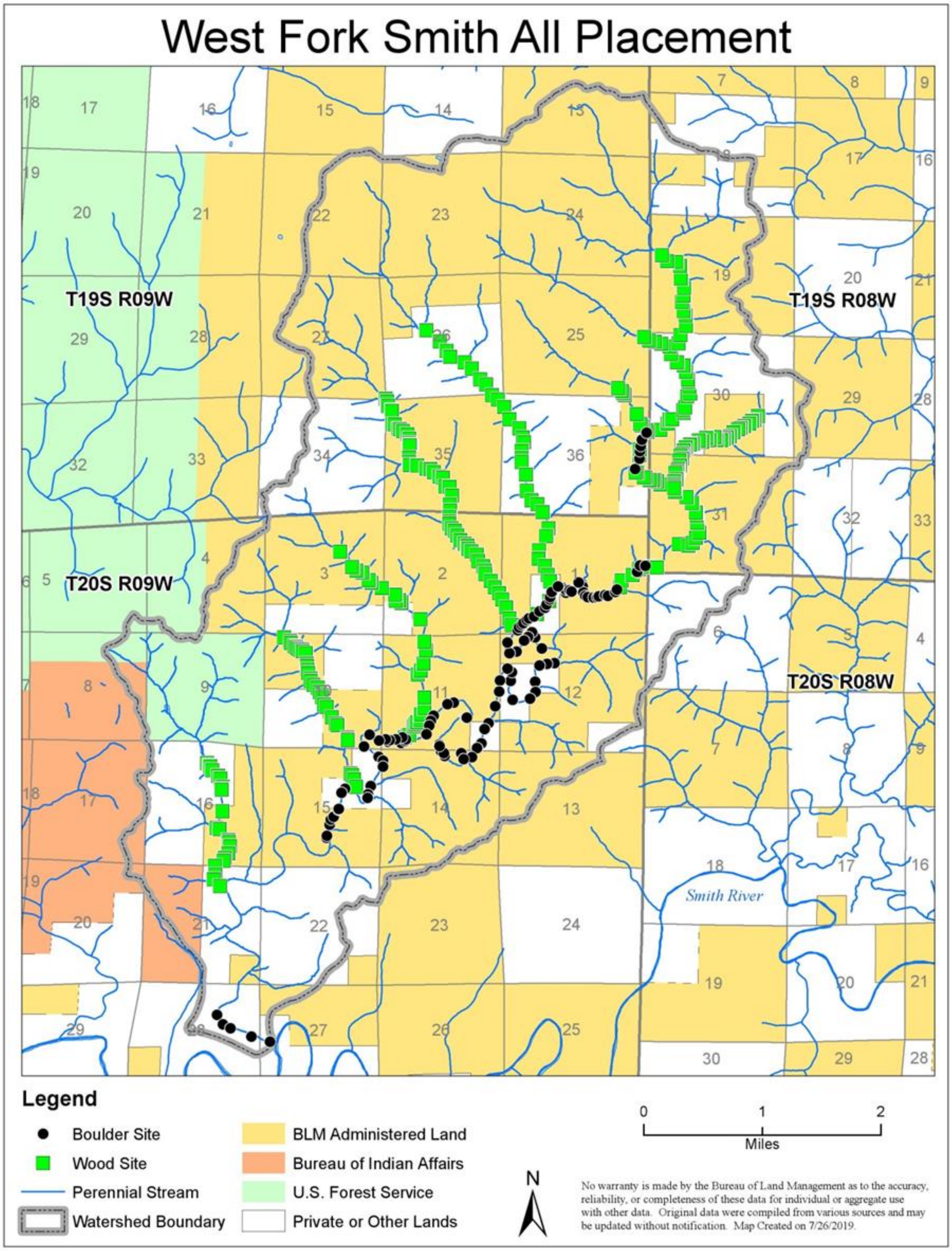

Figure 2: West Fork Smith River Basin restoration action map.

VI. Monitoring Projects

Temperature and Flow Monitoring

The BLM and ODFW use continuous data loggers to measure temperature in the West Fork Smith River watershed. The BLM maintains a stage station approximately one mile upstream from the mouth of the WFSR to continuously record river depth and temperature. The stage station, operating since late 2012, replaced a gaging station that was installed water year 1980 and destroyed during high flow in early 2012.

BLM records stage (water depth) using pressure transducers at the WFSR stage station. The pressure transducer on land measures atmospheric pressure and the transducer in the water measures water pressure, which is converted to water depth.

Beaver Creek Spawning Surveys

Spawning surveys were conducted by ODFW and its predecessor, The Oregon Fish and Game Commission. Survey protocols differ slightly, primarily in survey frequency. The spawning surveyor will walk a predetermined section of stream with fixed start and end points repeatedly throughout the spawning season of a particular target species. The surveyor counts live fish, redds and carcasses. Once counted, carcasses will have their tails removed; carcasses with previously removed tails are also counted to determine carcass retention rates. Flow rates are evaluated; low or dry, moderate, high or flooding. Weather is recorded; clear, overcast or rain. Visibility is also recorded on a 1-3 basis. A 1 indicates all riffles and pools are visible. A 2 is when riffles and pool tail outs are visible but pool bottoms are not. A 3 is where neither riffles nor pools are visible; this data cannot be used and surveys are rarely conducted under low visibility conditions. Fish behavior is also noted: migrating through survey, holding prior to migration, actively spawning and post-spawn. The Beaver Cr. segment 2 standard survey has been conducted since 1958. Beaver Cr. segment 2 has large sections of old-growth timber and fairly intact instream and riparian habitats. Surveys conducted 1988 and after were conducted at a regular frequency of 10-14 day intervals. This allows for an area under the curve analysis and a population estimate using the shell method of integral calculus. Surveys conducted before 1988 were not done at this frequency and cannot generate a population estimate. We chose to analyze the peak spawner count, or most fish seen on any one spawning survey.

The ODFW Lifecycle Monitoring Project now conducts all spawning surveys in the basin. Survey frequency is conducted every 7-10 for Chinook, every 10-14 days for Coho, and 14 days or less for steelhead. Steelhead surveys focus on redd enumeration for population estimates due to the behavior of this species, which are far more skittish around surveyors and perceived threats because they can survive spawning and return to the ocean. Coho and Chinook deteriorate quickly after spawning and females will often be seen guarding their redd site against other females that might dig and disturb their eggs. Coho and steelhead, live fish and carcasses, are checked for floy tags, which are applied at the adult fish trap and recorded as marked, unmarked or unknown marking.

Lifecycle Monitoring Project

Adult fish estimates

As part of the Oregon Plan for Salmon and Watersheds, the Lifecycle Monitoring Project was established. This looked at a number of specific watersheds throughout the Coast Range. Site selection was based on a number of factors; the most pertinent was the ability to build fish trapping structures. Both trapping sites, juvenile and adult, are located approximately 1 mile upstream from the mouth of the WFSR.

In October, the trapping season begins with the onset of large precipitation events. Increased flows raise the river levels and signal to Chinook and Coho to start migrating upstream. These fish then encounter a floating PVC picket weir that does not allow fish to pass upstream at low to moderate flows. At high flows the weir becomes covered with leaves and other debris that causes the water to flow over it, pushing the weir to the bottom of the water column. At this point, fish are free to move up or downstream. Large rocks are placed on this weir under low flow conditions in a V formation, this creates a shallow pool directing fish to the tip of the v where they can move over the weir and pass downstream. This benefits Chinook, as the males are quite gregarious and move in and out of multiple systems; steelhead benefit as well, as they will survive spawning and migrate back to the ocean. Coho do not seem to require this except when under stressful conditions.

Fish encountering this weir moving upstream, then move into the fish trap, and are enclosed in a concrete runway. ODFW employees work these fish up typically once a day in the morning as the majority of migration occurs during the night for these three salmonid species. Fish are netted and metrics are taken: species, sex, length and body condition are recorded. Body condition includes predator marks, lamprey bites, net marks, and disease or hatchery origin fin clips. Hatchery fish are killed per ODFW policy and returned to the stream for nutrient supplementation. Coho and steelhead are tagged with Floy tags on each side of the dorsal fin. Two tags are used, as sometimes these tags fall out. Recording of single tag fish allows an estimate for total tag loss. Post-spawn fish are recorded, but put back down below the trap as their introduction would contribute to the spawning population estimate without actually contributing to in basin spawning. Pre-spawn tagged fish are released upstream into a low-flow recovery area where they can rest, lower stress levels, and recover before resuming migration. Small upstream openings in this recovery area allow the fish to exit volitionally once recovered. Tagged fish are then present on spawning ground surveys with other untagged fish that entered the system at high water events by passing over the weir. The ratio of marked to unmarked fish observed on spawning surveys is compared with the total number of fish marked to create a population estimate. This is computed using the Lincoln-Petersen Method the following way:

$N = K*n/k$ where

N = The estimate of total animals in the population.

n = The number of animals marked.

K = the number of animals captured on the second visit.

k = The number of recaptured animals that were marked.

Coho carcass counts also produces a population estimate using this method. Carcass and live fish estimates are then compared. Chinook estimates are not being produced at this time. As noted earlier, Chinook do not have as high a degree of natal stream fidelity and will move across stream systems to a much greater degree. For the purposes of evaluating adult Chinook, we looked at the total number of adult pre-spawn fish encountered at the ODFW trap. The lamprey spawning seasons stretch past the trapping and spawning survey period. Lamprey are encountered in the juvenile trap and counted. For the purpose of evaluating population trends, adult Brook and Pacific Lamprey counts were graphed and evaluated. The larval stage ammocette lamprey and smolting Pacific Lamprey were also evaluated using this method.

Juvenile sampling

The juvenile fish trap is a modified Archimedean screw. The cone has an inclined plane set into a cone that allows the flow water to exert force causing the entire cone to spin. This funnels the fish into a live well where they are worked up every morning. High flow events can pose a danger to the trap as well as juveniles caught within it. For this reason the trap will be moved to the side of the stream and will not be functioning during high flow events. A Bayesian estimator is used to fill in the gaps of these unsampled days by using data from the previous and following days for species that Petersen Estimates are produced.

Fish are counted by species and by size/age categories:

- Chinook are young of the year or fry only
- Coho are either fry or smolt size.
- Steelhead are broken up by size class: 60-89mm, 90-119mm, 120+mm
- Cutthroat Trout are broken up by size class: 60-89mm, 90-119mm, 120-159mm, 160-249mm and 250+mm
- Cutthroat Trout and steelhead trout fry below 60mm are not readily distinguishable and are counted as a separate class.
- Lamprey, Shiner, Speckled Dace, Umpqua Dace, Sculpin, Large Scale Sucker and Pike Minnow are counted but no population estimate is produced.

Chinook, Coho, steelhead, Cutthroat Trout and trout fry are all measured to the nearest millimeter, and mass is recorded (except for the fry classes for a sample of 25 individuals per Julian week). Up to 25 individuals for each species size class were marked with a caudal clip and placed approximately 300 meters upstream of the fish trap each day. Marked fish that then reentered the trap were counted. This allowed the determination of trap efficiency and a Petersen mark recapture estimate on a daily basis.

VII. Results and Discussion

Fall Chinook

Fall Chinook were found in low levels prior to instream restoration. It is unclear whether fish passage work at the Smith River Falls introduced Chinook into the upper Smith, or whether it increased their ability to pass the falls. A hatchery program was in place on the Smith River, and 1997 represents the last year of hatchery fish returning to spawn in large numbers. For this reason fall Chinook juveniles out-migrating in 1998 were not included in this analysis as they were not naturally produced. A mark/recapture population estimate is available for juvenile Chinook leaving the WFSR and migrating to the ocean. Both the population estimate and the natural log of the population estimate show a significant increasing trend.

Adult Chinook have been found to exhibit less fidelity to their natal stream and exhibit a higher degree of in-basin straying. For this reason, ODFW does not produce a mark recapture estimate for adult Chinook. As a metric for abundance we have used the number of wild adult Chinook that were caught and handled at the adult fish trap. Fall Chinook exhibit a maximum 7 year lifespan. We took the average of fish encountered at the trap over the first 7 years of the Lifecycle Monitoring Project and the past 7 years. Fall Chinook observations over the last 7 years are 300% of the initial 7 year average.

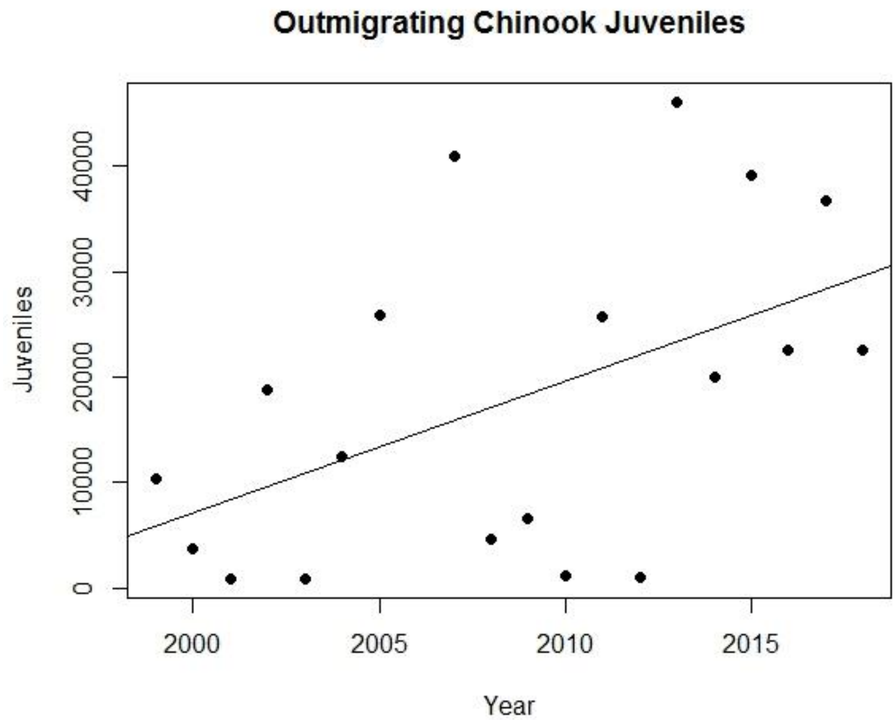

Figure 3: Mark/Recapture Population Estimate for fall Chinook Juveniles

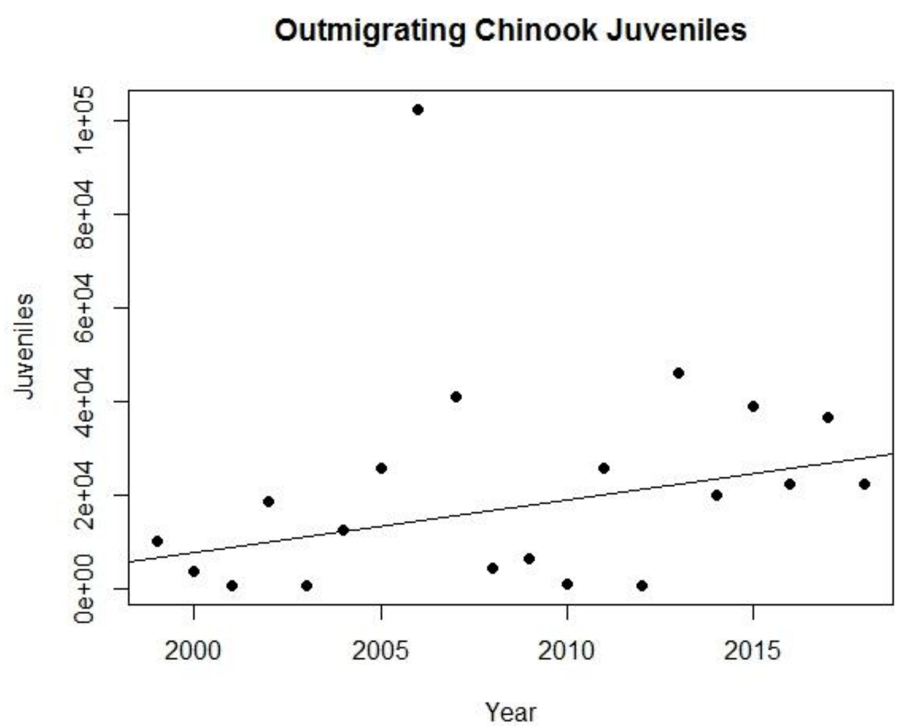

Figure 4: Natural Log Chinook Juveniles (p = 0.5476, r2 = 0.0294)

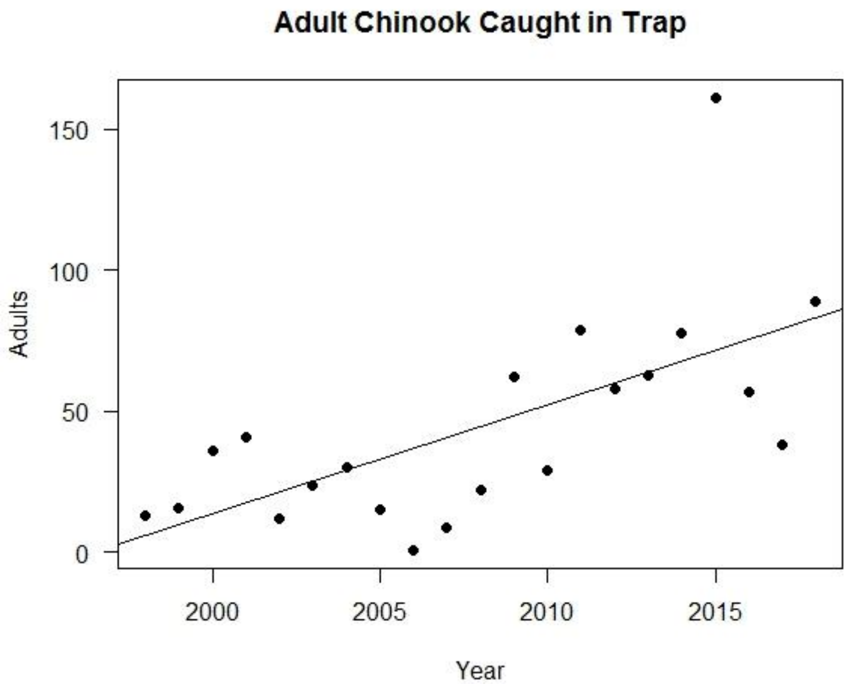

Figure 5: Trap catch of wild fall Chinook adults

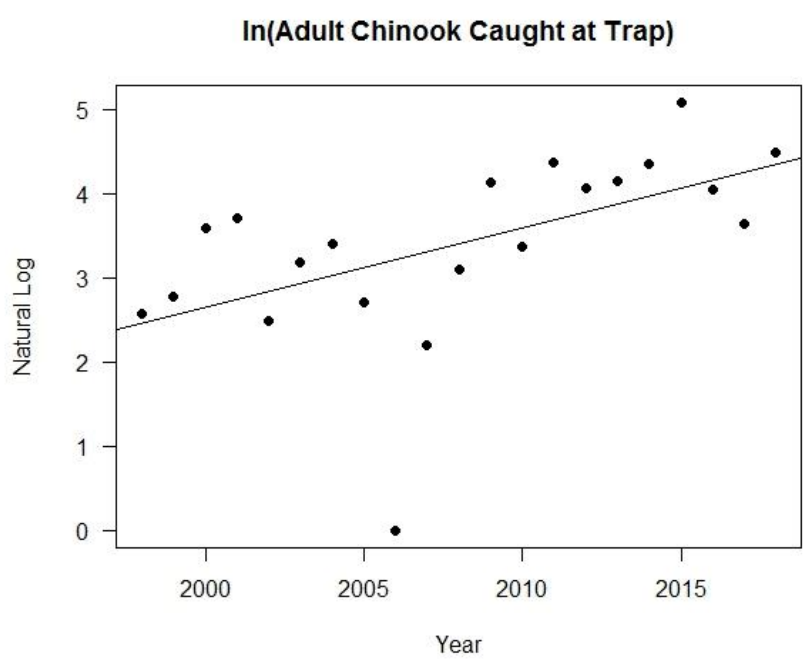

Figure 6: Natural log of adult Chinook caught in trap. ($p = 0.01163$, $r2 = 0.2908$)

Discussion

The increases in adult fall Chinook observations and juvenile Chinook estimates are likely due to 2 factors in the WFSR mainstem; spawning habitat and spring rearing habitat. Fall Chinook hatch in early spring and begin their migration to the ocean very quickly. Fall Chinook spend comparatively little time rearing in freshwater habitats and are not limited by summer or winter rearing habitat like Coho or steelhead. Chinook spawning in the WFSR are limited to the mainstem; rarely spawning in tributaries. Increased gravel beds provide increased spawning habitat. Larger complex pools that have been created by boulder weirs and other structures are likely providing increased foraging opportunities during downstream migration.

Coho

Monitoring of Coho Salmon numbers is the primary reason for the Lifecycle Monitoring Project. Coho are analyzed at multiple lifecycle stages so that limiting factors and survival rates can be estimated. Female spawner estimates allow for an egg deposition estimate based on female sizes. Out migrating Coho fry (age 0) are found to leave the system in greater rates when more females spawn, indicating density driven migration. Fry in one low-flow warm year were found to exhibit silvering or smolting coloration. It is possible these fish reached a threshold size and began to smolt for ocean acclimation. Size is a major factor influencing ocean survival. Smolt numbers have increased over the course of the study. The most significant increases were found following the replacement of under sized culverts on multiple major tributaries of the WFSR. The mitigation of these culverts undoubtedly increased adult passage, juvenile passage or both. Smolt numbers produced by the WFSR also vary, though we see a typical stock recruitment curve. More smolts are produced per female at low female spawning levels, and much fewer smolts are produced at high female spawning levels. This is extremely indicative of freshwater habitat limitations. Our stock recruitment curve has shifted upwards for smolts. This means that post 2008, the WFSR produces more smolts for any given number of female spawners than it did prior to 2008. This might be attributed to watershed restoration work that began in 2010 and/or to large scale flooding in 2007/2008, or both. Adult Coho returns show the highest variability, marine survival being perhaps the most major driver of variability. Return years of 2002 and 2003 had marine survival rates over 15%, and as such are outliers. The high returns estimated for these years do not track well with other estimates for adult returns those years for the Umpqua strata, Lower Umpqua Strata, or the Oregon Coast Coho ESU. These points are outliers and have a large influence on the population trend as they occur early on in the project. We have presented graphs with both the outliers included and excluded. Marine and freshwater survival rates are shown and are typically used to estimate the adult return rate for the Oregon Coast Coho ESU.

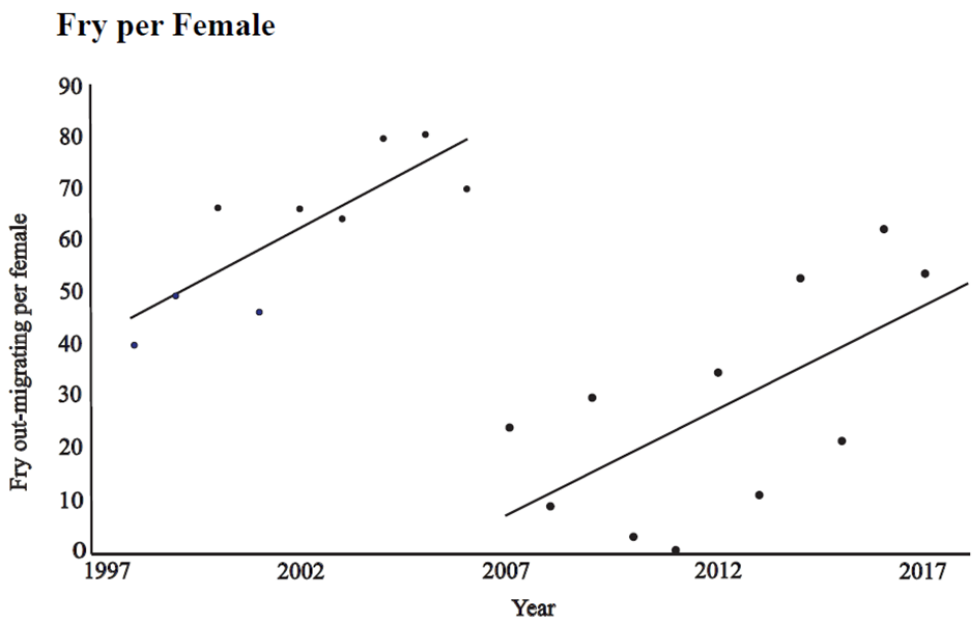

Figure 7: Fry out-migrating per female by year (notice shift)

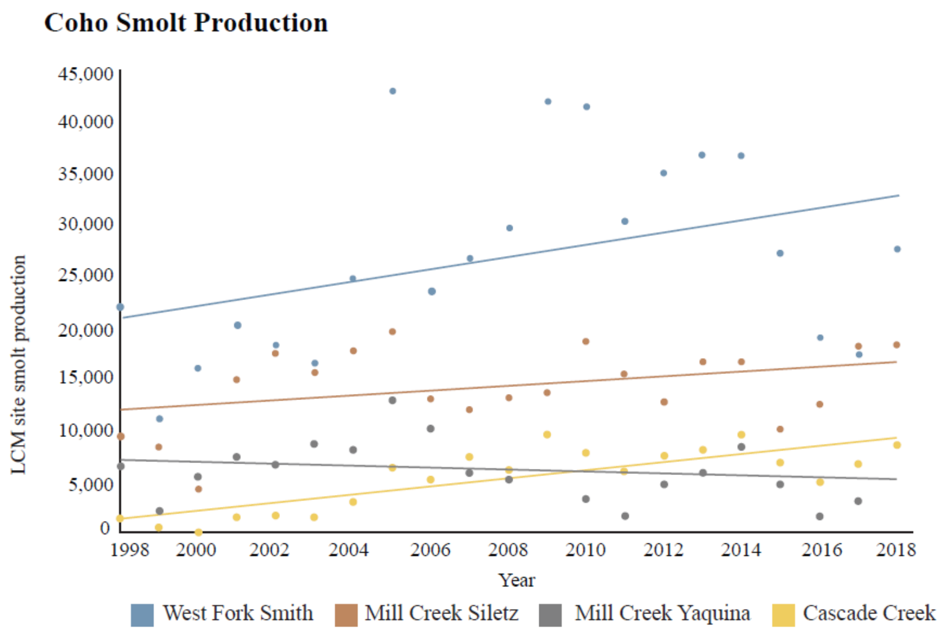

Figure 8: LCM site smolt production.

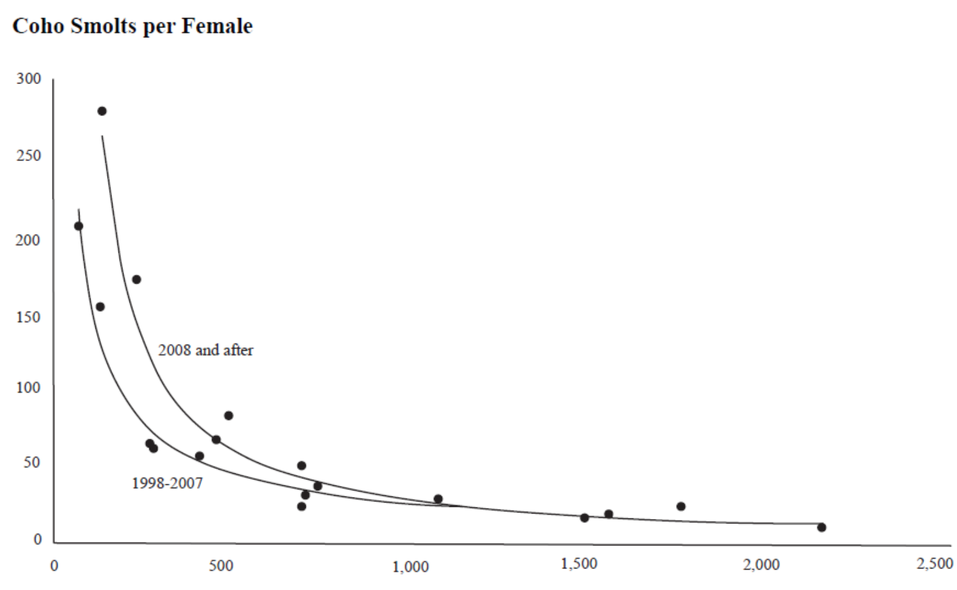

Figure 9: Coho smolts produced per female

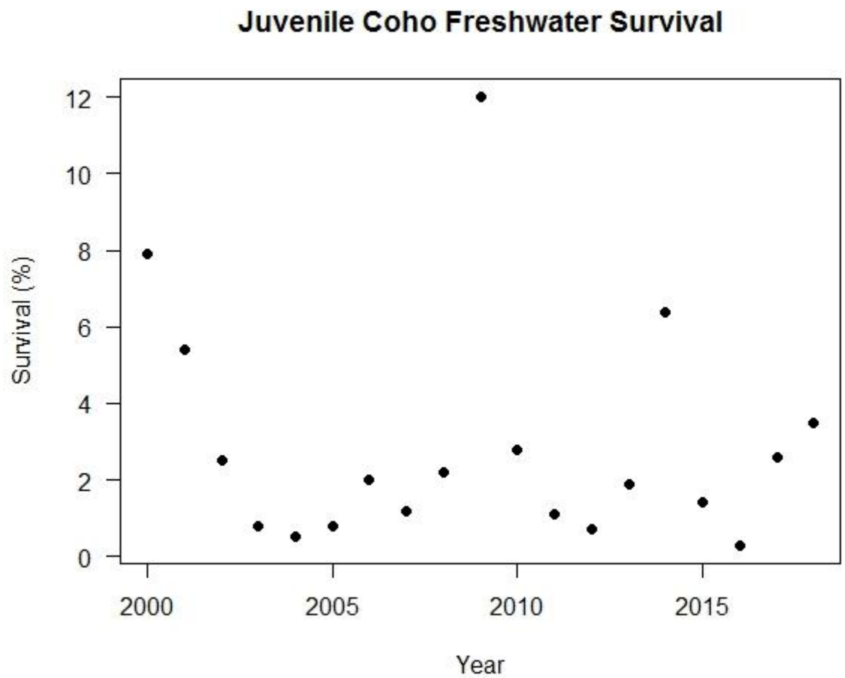

Figure 10: Freshwater Survival, deposited egg through smolt stage

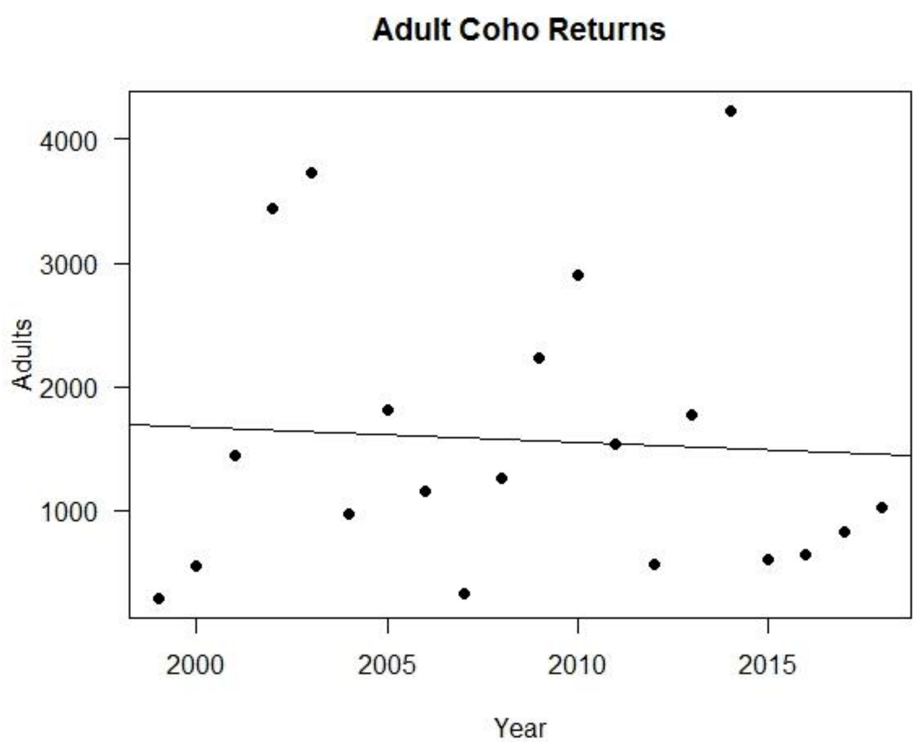

Figure 11: Coho adult returns outliers included

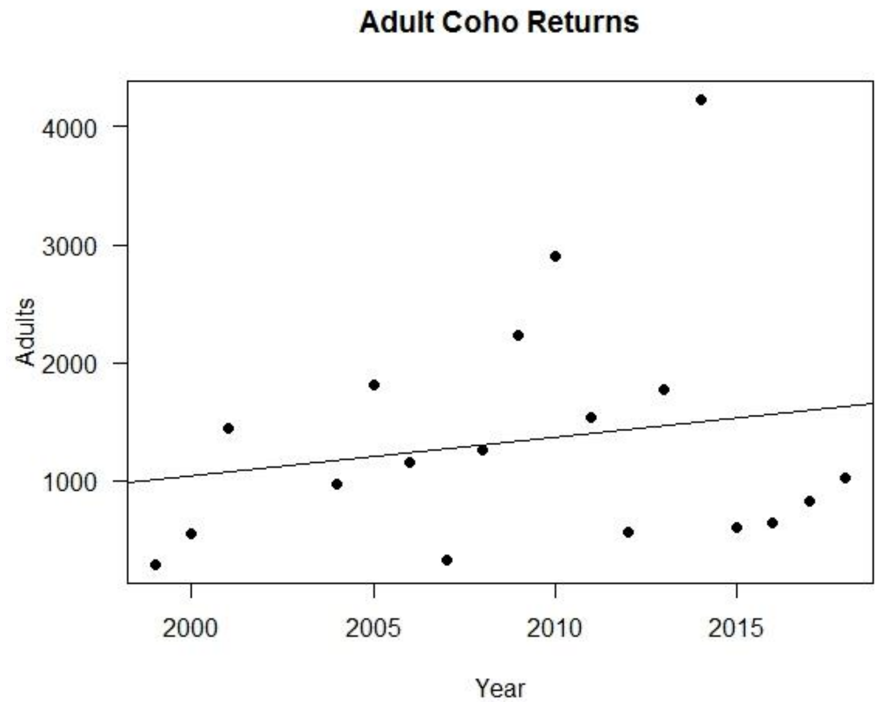

Figure 12: Coho Adult returns, outliers removed

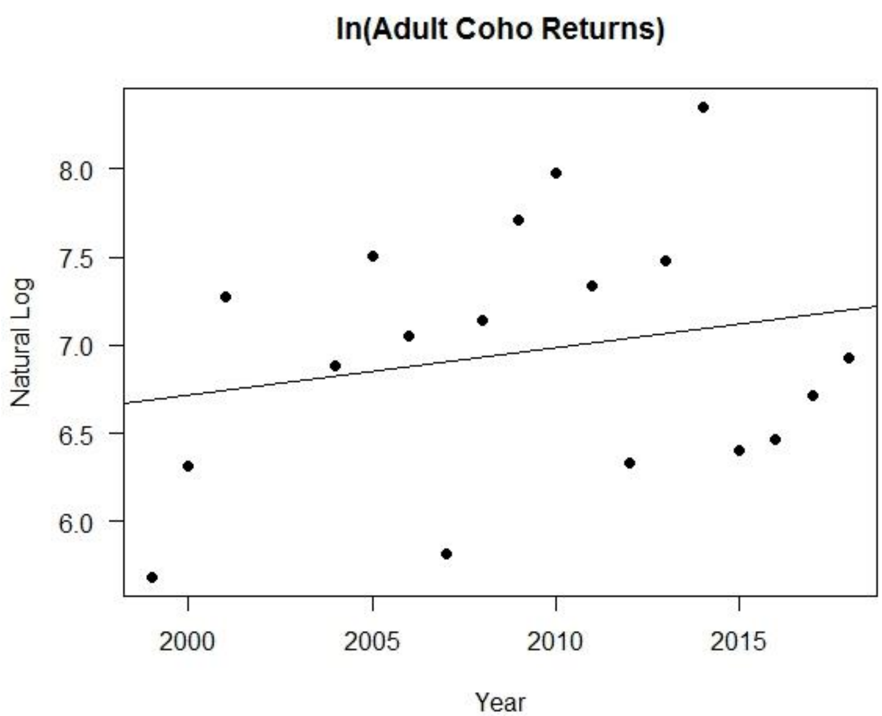

Figure 13: Natural log of adult Coho returns (p = 0.37448, r2 = 0.0496)

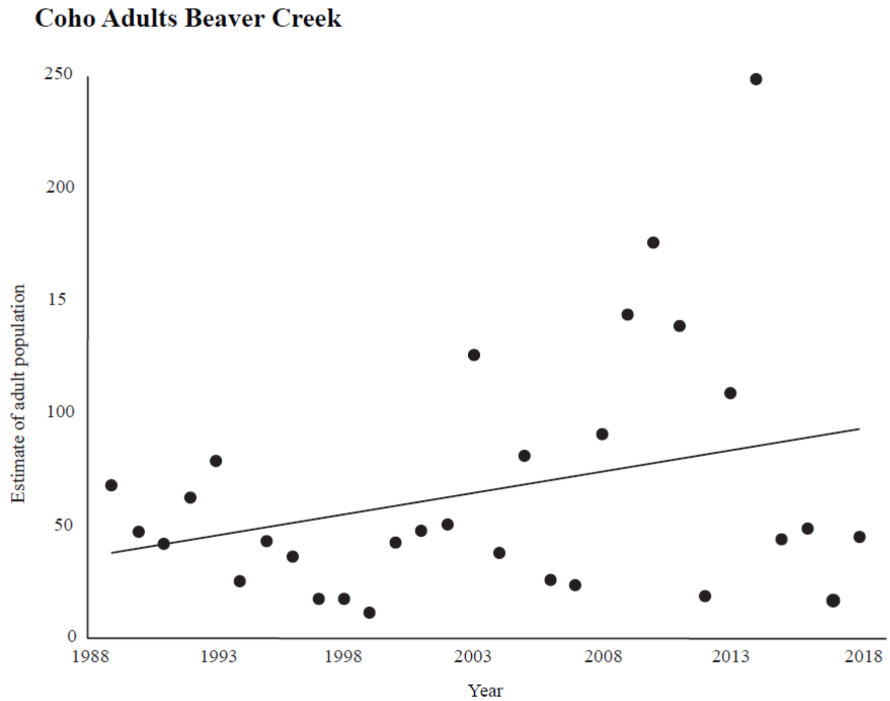

Figure 14: Area under the curve estimate for Beaver Cr seg 2 1989-present

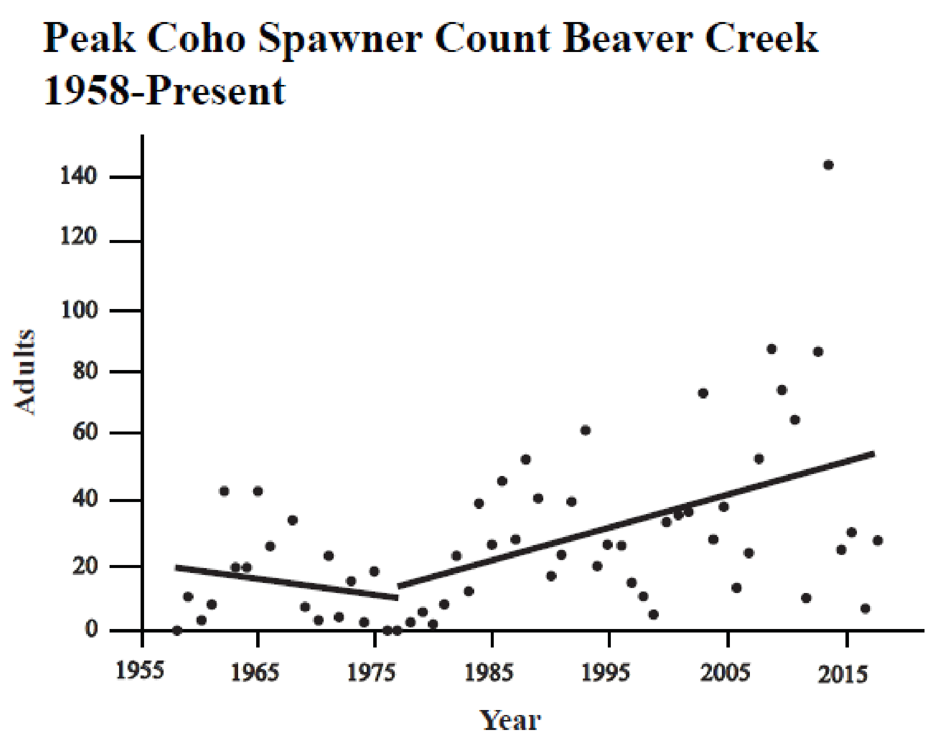

Figure 15: Beaver Cr. peak Coho spawner count 1958-present

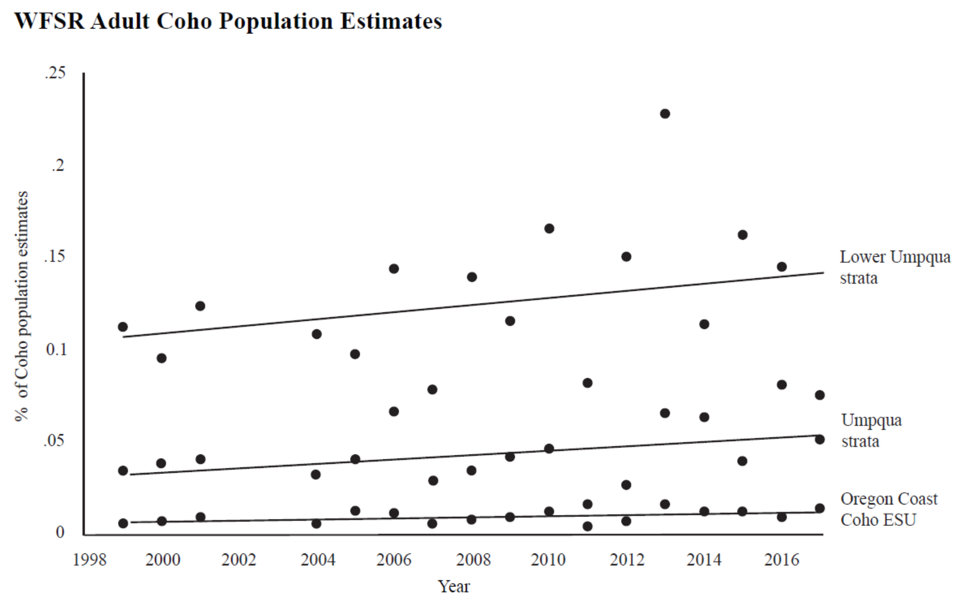

Figure 16: WFSR adult Coho population estimates graphed as a percentage of Lower Umpqua strata, Umpqua strata and the OCC ESU.

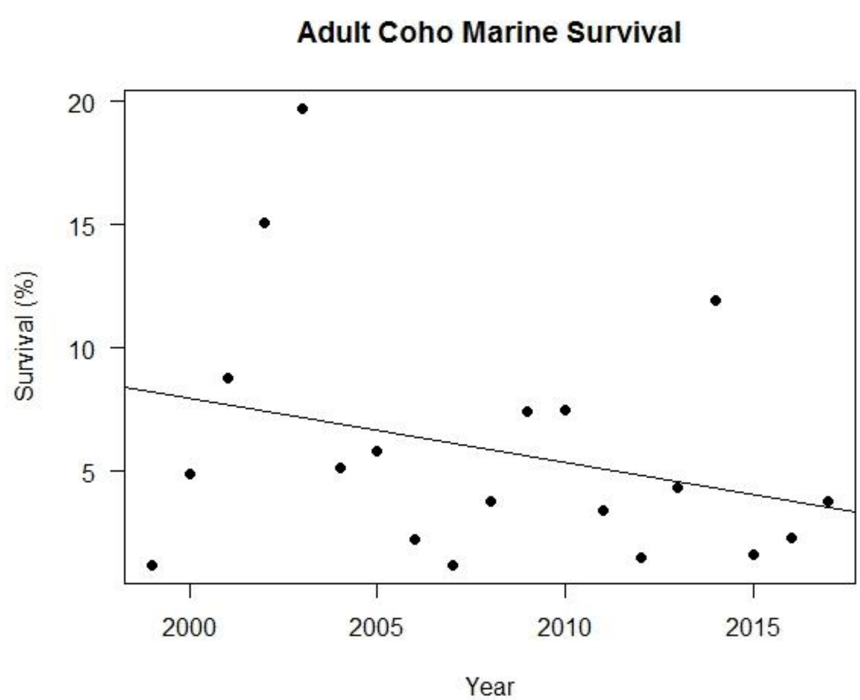

Figure 17: Percent survival from smolting to returning adult, with extreme outliers

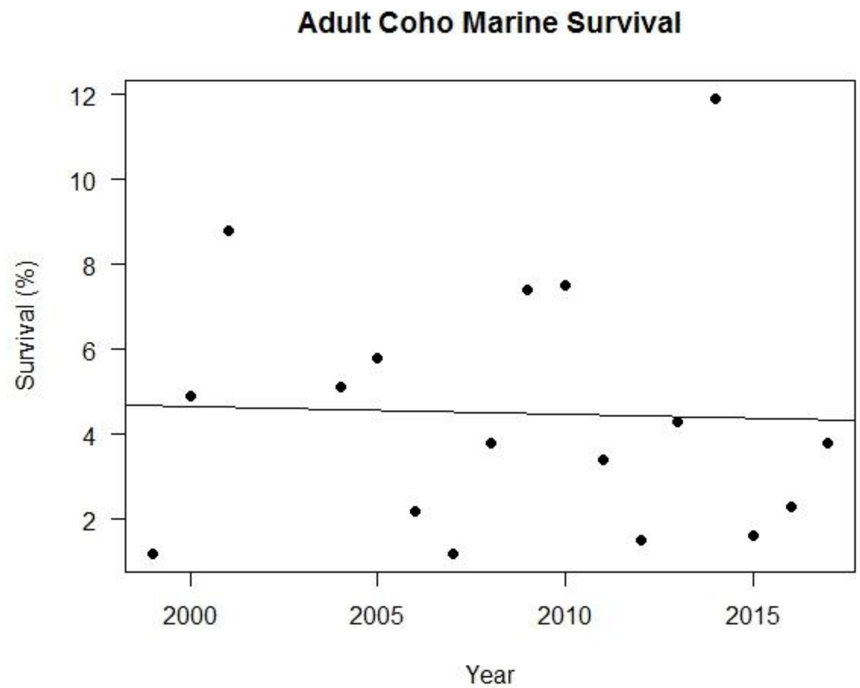

Figure 18: Coho marine survival estimates with outliers removed.

Discussion

Coho production was found to be limited by rearing habitat. We see that increased numbers of female spawners do not produce an associated increase in number of 1-year old smolts. This means that availability of freshwater rearing habitat is a limiting factor and that spawning habitat is not a limiting factor in this basin. For many years now, winter rearing habitat has been cited as the greatest limiting factor to juvenile Coho production. This was based on a number of studies including, Ebersole et al. (2009), which found that a decreased apparent overwinter survival was driven by contributing basin area. This "apparent survival" made the assumption that Coho juveniles did not volitionally leave system during the fall, but were flushed out of the system during high flow events in the early winter. This assumption was driven by biologist's inability to trap or monitor Coho migration in the fall due to high flow rates and stream debris loading. Multiple studies have now shown that Coho volitionally leave the system in the fall, exhibit multiple lifecycle histories subsequent to fall migration, and return to spawn in significant numbers (Roni 2012, Jones 2014, Rebenack 2015). If the assumption that these fish are simply flushed out and die as a result of stream flow trauma is not accurate, we can no longer say for certain that winter rearing habitat is the greatest habitat limiting factor.

Summer habitat quantity and quality should be investigated. Habitat area decreases as groundwater inputs are reduced throughout the summer. In many systems we can observe large pools connected by flowing riffles with abundant Coho parr early in the summer. As the summer progresses, surface water flow reduces, and pool area decreases leading to isolated pools. Survival for Coho in these isolated pools connected only by subsurface flow is then dependent on whether or not the pool completely dries out, which is all too often what happens. Without surface water flow, macro-invertebrate food source delivery is greatly reduced to these fish as well. Growth rates are significantly reduced in the summer as shown by scale analysis. Increased water temperatures also have a depressing effect on growth rates when adequate food supply is not available (Sullivan et al. 2000). The Recommendations section will go into further detail for focuses for future restoration efforts, but as a whole, we are recommending increased focus on the riparian area and retention of woody debris in intermittent and non-fish bearing tributary streams that feed into Coho bearing streams. This effort could increase groundwater residence time and shading. Leading to increased summer flow rates and decrease summer water temperatures.

Winter steelhead

Mark/Recapture estimates were available for both juvenile and adult steelhead populations. Juvenile sampling has been problematic from 2015 to the present (2019), with drought-like low flow conditions that allow the larger steelhead juveniles to avoid the trap. Steelhead juveniles are found to leave the system in spring and likely in the fall as well, as identified in other studies as a previously unknown lifecycle history. The majority of steelhead adults returning to the system have spent 2 years in freshwater systems and 2 years in marine habitat. This is based on adult scale analysis by ODFW. A large increase in scale annuli width is associated with the greater forage opportunities juvenile steelhead find in a marine environment. Steelhead fry and 1 year old fish exit at lower numbers than 2 year old steelhead, but are not found in significant numbers in the returning adult populations via scale analysis.

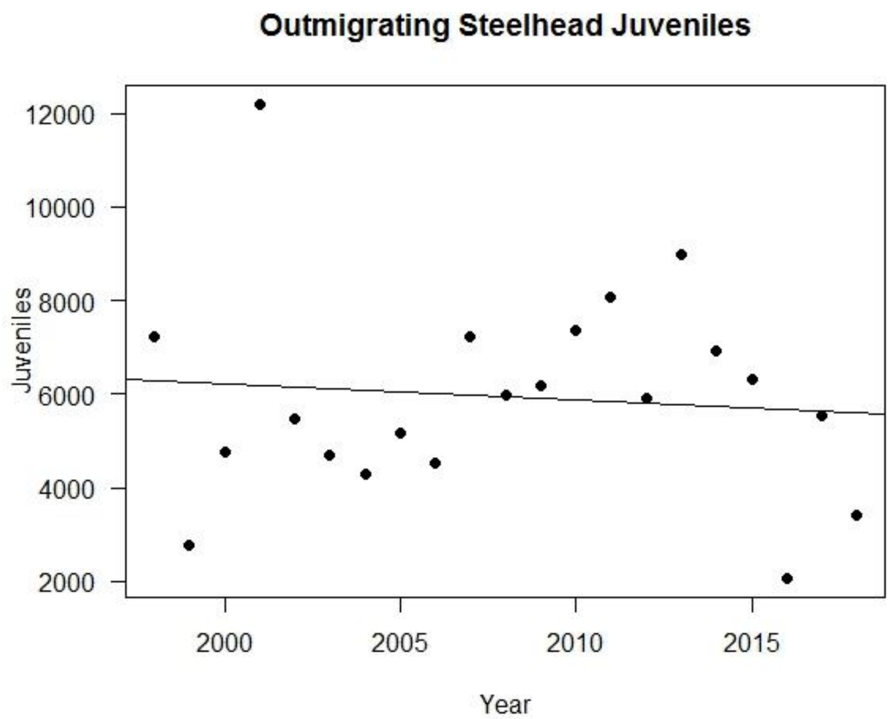

Figure 19: Juvenile steelhead population estimate

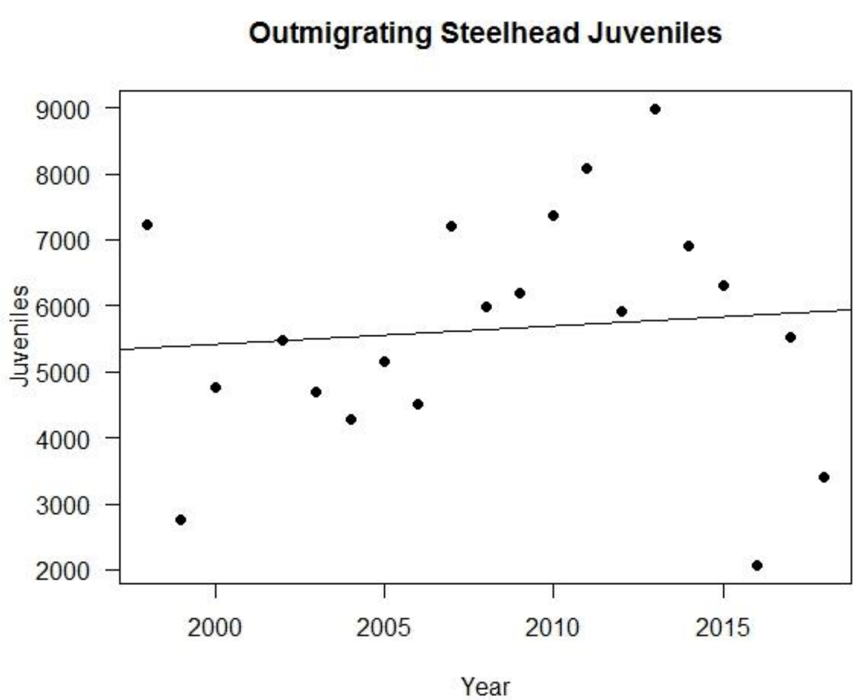

Figure 20: Juvenile Steelhead population estimates, outlier removed.

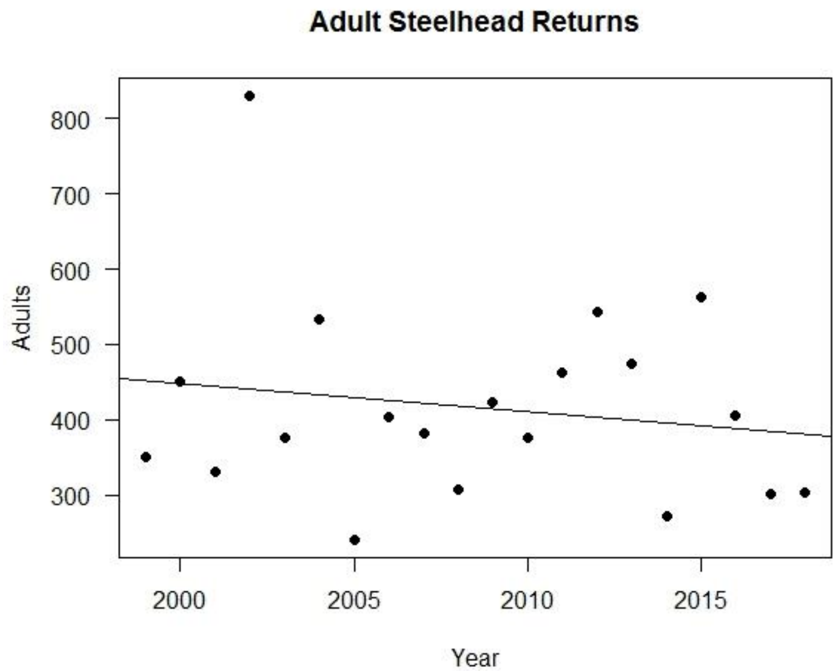

Figure 21: Adult Steelhead population estimates, with 2002 outlier.

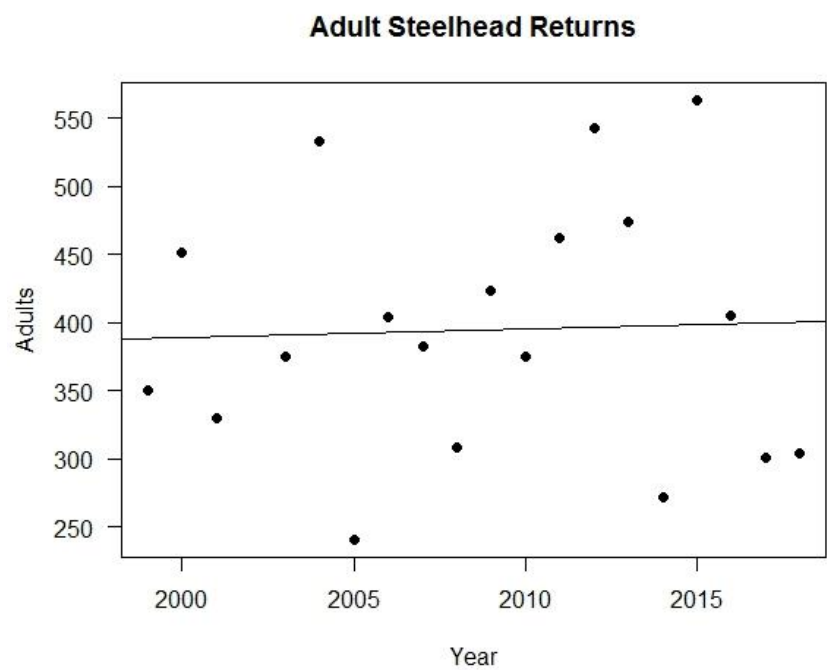

Figure 22: Adult Steelhead population estimates, outlier removed (ln of steelhead returns p = 0.9666, r2 = 0.0001)

Discussion

Scale analysis indicates that steelhead move out of the WFSR towards the estuary after 2 years of rearing. Scale evidence of steelhead migrating seaward in earlier life stages is nearly absent in returning adults. This suggests they either are not surviving at appreciable rates, or that they are utilizing other freshwater habitats, or re-entering the WFSR prior to final ocean migration. Adult steelhead are given numbered floy-tags. These allow for the recording of adults returning subsequent years to spawn. Growth between years was often limited to just a few centimeters in fork length. This shows that steelhead growth during their first sea run to be the most important, as size is positively correlated with survival. Repeat spawners were also found to enter the system within just days of the date they entered the system in previous spawning years. This could indicate that there are sub-groups of winter steelhead with isolated breeding driven by a sub-division of run timing.

Lamprey

Both Pacific and Brook Lamprey are found in the West Fork Smith; River Lamprey have not been observed. Lamprey were found in significant numbers early on in the Life Cycle Monitoring Project, but by 2010 had shown significant declines across both species at multiple life history stages. The figures shown below are the juvenile trap catch numbers and are not a population estimate. The decreasing trend and subsequent rebound in population are found in all four categories analyzed, although only one smolting Pacific Lamprey has been observed since 2006.

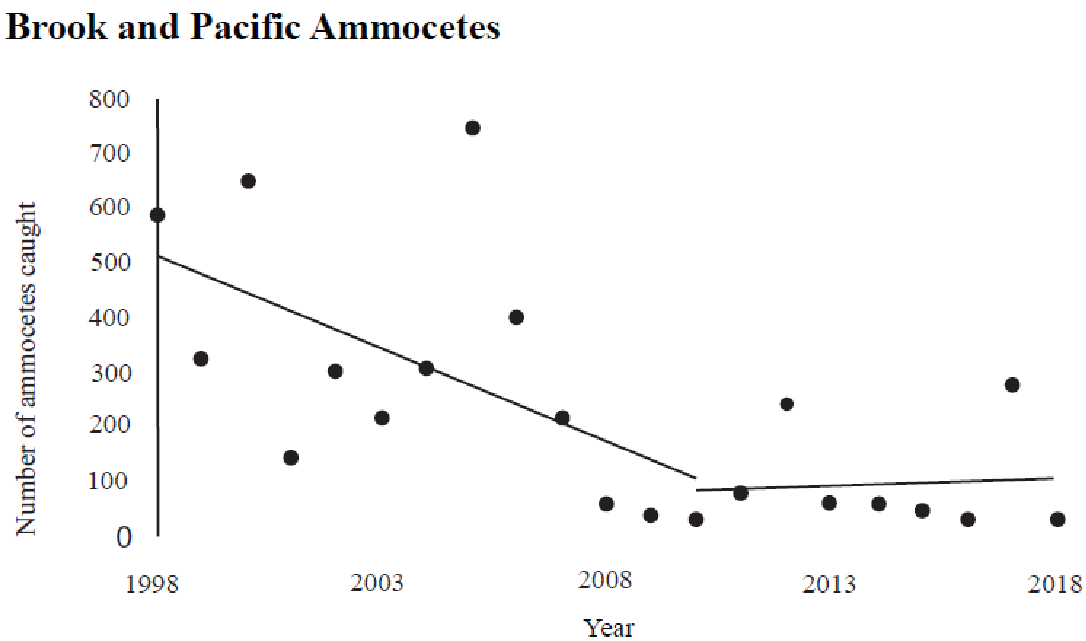

Figure 23: Number of ammocettes caught (brook and pacific combined)

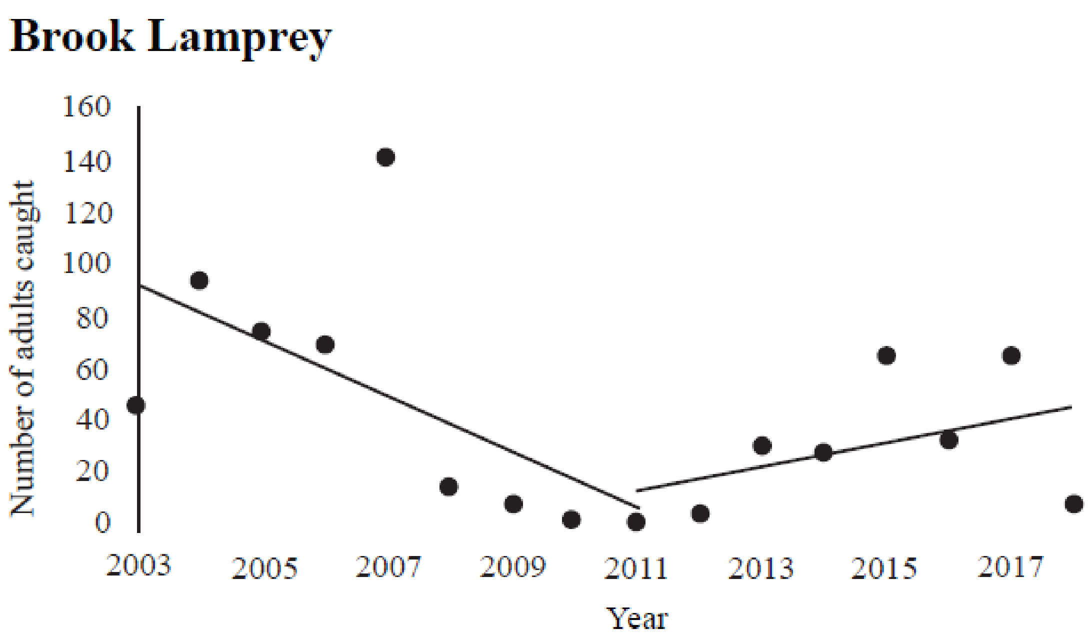

Figure 24: Number of adult brook lamprey caught.

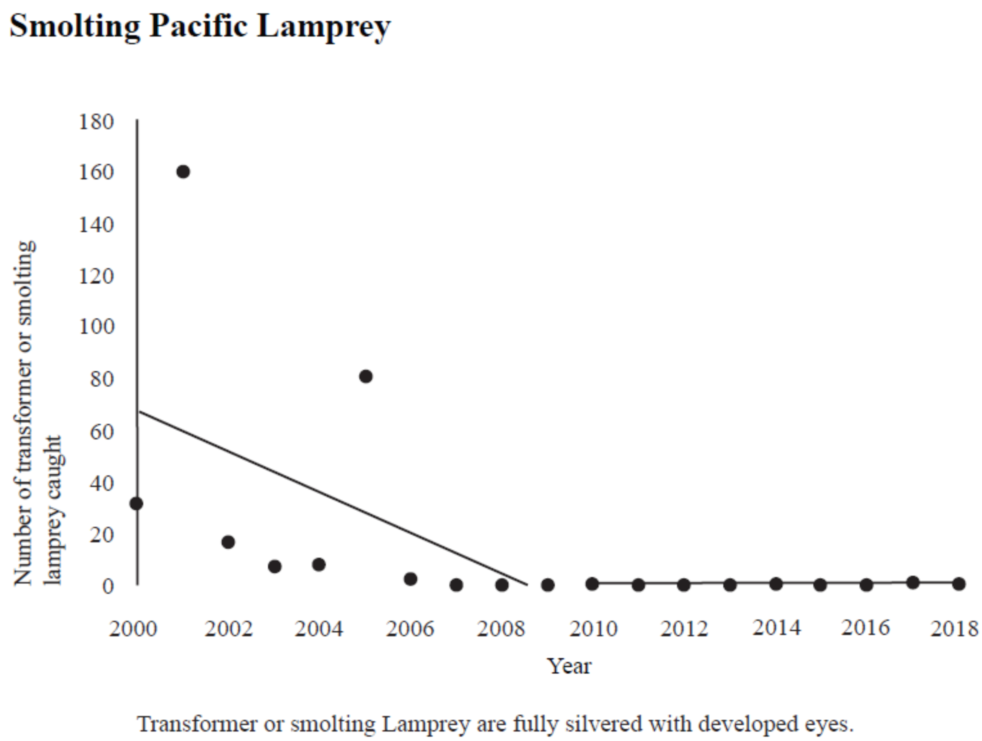

Figure 25: Number of Transformer or Smolting Pacific Lamprey (fully silvered with developed eyes)

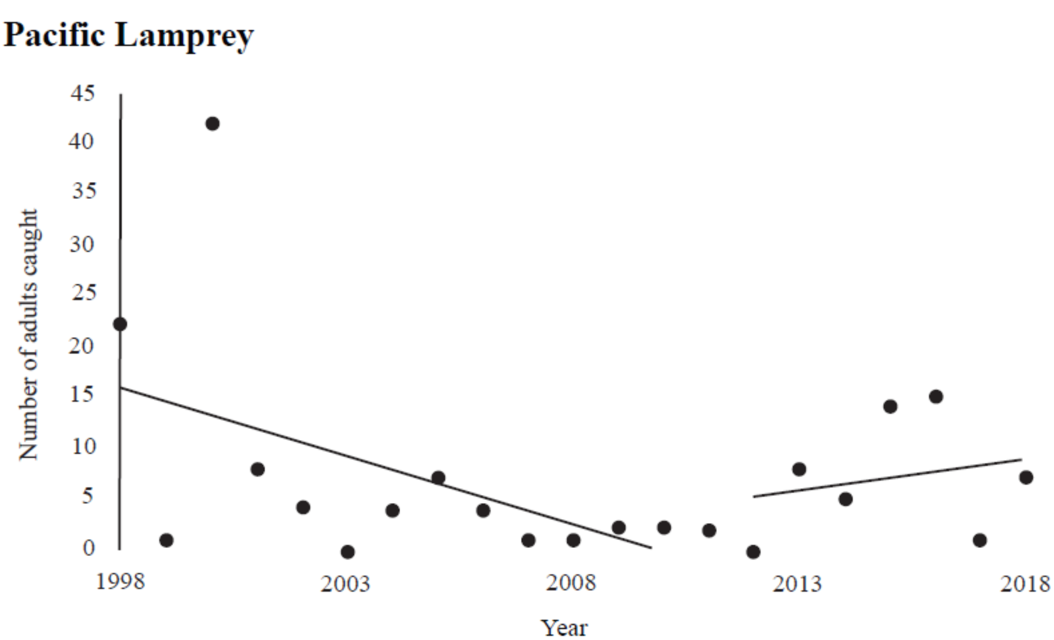

Figure 26: Number of Pacific Lamprey adults caught

Discussion

The rebound seen in lamprey numbers may be attributed either to the large scale restoration efforts that have recruited large sand beds or to a large scale flood in the winter of 2007/2008. A resulting population response can be seen both in lamprey numbers and juvenile Coho numbers. This could indicate that disturbance and habitat reorganization in the form of major flooding could be as critical to ecosystem health, as fire is in fire dependent ecosystems. The observations of large sand bed formations in the mainstem coinciding with an increase in lamprey observation indicates that stable beds of sand and silts are providing increased rearing habitat to ammocettes. Decreases in lamprey numbers may also be associated with invasive species introductions in the lower Umpqua Estuary. Smallmouth Bass (*Micropterus dolomieu*), Largemouth Bass (*Micropterus salmoides*), and Striped Bass (*Morone saxatilis*) are present below the Smith River Falls and in the Estuary. The high caloric value of lamprey, especially smolting Pacific Lamprey, may be causing these to be preferred foods by invasive species and contributing to their decline.

Temperature Monitoring

The WFSR is a groundwater fed system and experiences critically low stream flows resulting in high water temperatures in the summer months (Cairns et al. 2005). Only 4% of the WFSR's annual precipitation and less than 1% of its discharge occurs during the summer, contributing very little to groundwater storage (Rodnick et al. 2008). Water temperature can have a profound influence on aquatic species distributions, physiology and growth rates, disease, morphology, swimming performance, and parasite load; especially for cold water species such as salmonids which are poikilothermic and environmental temperature influences their metabolic rate (Rodnick et al. 2008; Brett 1971; Sullivan et al. 2000). Due to the adverse effects of high temperatures on salmonids, temperature is a dominant variable when assessing impacts of environmental modifications, setting water quality standards, and defining recovery planning and policy decisions for wild salmon stocks in the Pacific Northwest (Richter and Kolmes 2005).

The BLM has monitored summer water temperature approximately one mile upstream from the mouth of the WFSR since 1980. Between 1980 and 2011, water temperature was recorded with gaging station equipment. Since 2012, the BLM has used Onset water temperature loggers deployed according to OWEB and EPA protocols. Each temperature logger was accuracy checked against a DEQ digital thermometer and two BLM-deployed digital thermometers.

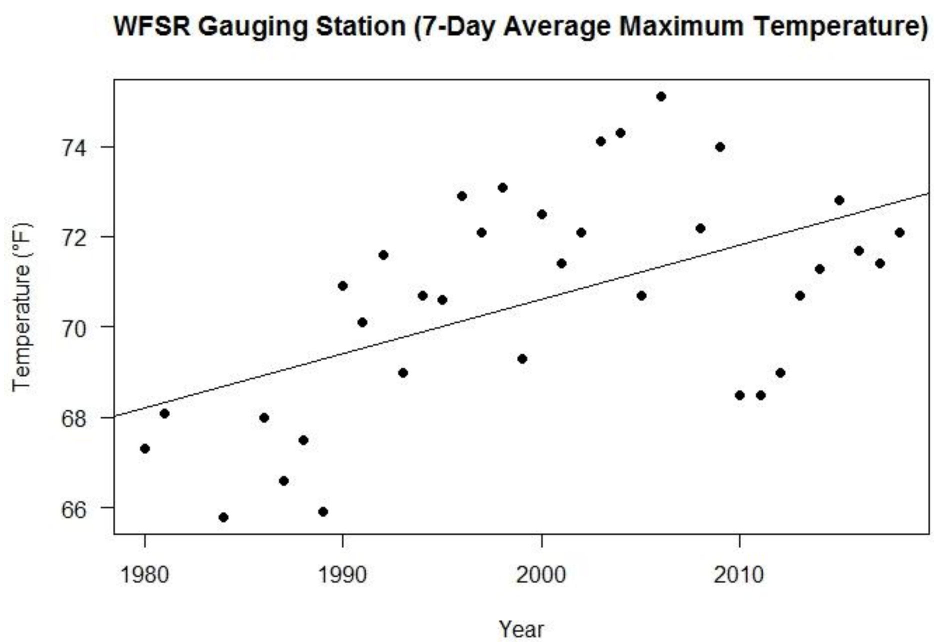

Figure 27: 7-day Average Maximum Temperature recorded at the WFSR BLM Gaging Station 1980-2018.

7-DAMTs from 1980-2018 have varied between 65.8 and 75.1 degrees, exceeding Oregon salmonid temperature standards for migration and rearing. The average of all 7-DAMTs was 70.6°F (21.4°C). In 1984, the lowest peak 7-DAMT, recorded on July 17th, was 65.8°F (18.7°C). The highest peak 7-DAMT was 75.1°F (23.9°C), recorded on July 25th, 2006. All peak 7-DAMTs were recorded between July and August of their respective years. Due to the peak 7-DAMTs greater than the Oregon ambient summer 7-DAMT for biologically based criteria for salmonids, the WFSR is listed as a 303(d) thermally impacted stream (DEQ, Umpqua River Basin TMDL, Chapter 3, 2006).

Cold water salmonid exposure to temperatures >68°F (20°C) for extended periods of time during the summer months can result in weight loss, increased parasite loads, displacement by species better adapted to higher ambient temperatures, or even death (Sullivan et al. 2000). If the duration of moderately negative temperatures is fairly short, cessation of feeding or refuge seeking may be sufficient; however, if this continues for long periods of time, the individual loses growth opportunity and may be displaced by competitors in the population (Sullivan et al. 2000). The swimming performance of juvenile Coho Salmon, which has been shown to be affected by temperature (Davis et al. 1963), might also affect habitat selection, behavioral thermoregulation, and the ability to compete for resources (Rodnick et al. 2008). Assuming a 10% growth loss represents an appropriate risk level, an upper threshold for the 7-DAMT of 61.7°F (16.5°C) is appropriate for Coho and 20.5°C (68.9°F) for steelhead trout (Sullivan et al. 2000). Temperatures at the WFSR Stage Station during the years of 2012-2019 (June-September) were recorded at 61.7°F or higher 56.25% of the time, and temperatures met or exceeded the upper threshold for steelhead 6.6% of the time. Sullivan et al. (2000) found that weight loss for Coho Salmon as small as 20% of the average population weight at the end of the juvenile rearing phase may contribute to a reduced ability at later life history stages including the individual's future reproductive success. Quinn and Peterson (1996) demonstrated that the size of juvenile Coho at the end of the first summer growing period was a strong determinant of their later success in overwintering and smolting, and that that overwintering success was about 50% for fish >89mm (≈8 grams) and 17% for fish <60mm (≈2.5 grams). With increasing yearly stream temperatures, limited availability of thermal refugia from high summer water temperatures may be playing a crucial role for the survival and fitness of salmonids in the WFSR.

Rodnick et al. (2008) found that juvenile Coho in the upper reaches of the WFSR were larger, had deeper bodies, and exhibited a significantly higher body condition factor than those in the lower, warmer reaches of the stream (2005). For Coho within the cooler tributaries, the probability of survival was positively associated with fork length, condition factor, and reach location (Ebersole et al. 2006). Fish occupying the cooler reaches of the stream were also found to carry fewer parasites than those in warmer, lower reaches (Rodnick et al. 2008). Cairns et al. (2005) documented a higher prevalence of black spot metacercariae in the skin of juvenile Coho Salmon in the mainstem reaches of the WFSR than its adjacent cooler tributary reaches. *Nanophyetus salminocola*, one of the parasites found in juvenile Coho in the WFSR (Rodnick et al. 2008), has been shown to adversely impair the swimming performance and survival of Coho Salmon (Butler and Millemann 1971).

Streamflow of the WFSR is highly dependent on precipitation. The basin receives approximately 80% of its annual precipitation (95 inches) between October and March, and as little as one to two inches of rainfall contributes to groundwater discharge (BLM Subwatershed Analysis, 1997). Though the WFSR is a groundwater fed system, its low groundwater storage capacity means streamflow is seasonal and fluctuates dramatically. Stage data collected between 2012 and 2018 indicates the average water depths to be around 1.8 feet, but flows of 9.5 feet have been recorded (WFSR Stage Station). The largest flow recorded over the six years period was a rate of 4,670 cubic feet per second (cfs) on December 12, 2008 at 7:30am. At 23:30 on the same day, the flow decreased to 988 cfs, a difference of 3,682 cfs over the course of 16 hours. This drastic fluctuation in flow demonstrates the challenges fish face rearing in the WFSR as well as the system's ability to move material and reorganize. The lowest flow recorded was a rate of 0.99 cfs on August 1, 2006.

West Fork Smith River - Streamflow (CFS)				
Date	**max**	**min**	**average**	**max - min**
10/1/2005 - 9/30/2006	4630	0.99	130	4629
10/1/2006 - 9/30/2007	2660	1.50	130	2659
10/1/2007 - 9/30/2008	2590	2.00	109	2588
10/1/2008 - 9/30/2009	4670	2.20	91	4668
10/1/2009 - 9/30/2010	1290	3.00	93	1287
10/1/2010 - 9/30/2010	1820	2.30	108	1818
Average	2943	2.00	110	2941

Figure 28: Streamflow recorded at the West Fork Smith River Gagging Station from 10/1/2005 to 9/30/2011. Flow is measured in cubic feet per second (cfs).

As average global temperatures continue to rise, mitigation of increasing stream temperatures in the WFSR should be an important focus of future restoration actions. A simulation model (Heat Source 6.5.1) conducted by DEQ estimated that the amount of heat received per 24-hour period (for July 16, 2000) by the WFSR (total solar heat load) was 45 megawatts, and the anthropogenic non-point source solar heat load (the heat load caused or influenced by human activities) was 25 megawatts. This equates to 55% of the total heat load of the stream influenced by anthropogenic non-point sources such as alterations in near stream vegetation, channel morphology, and flow modifications (DEQ, Umpqua River Basin TMDL, Chapter 3, 2006). The anthropogenic actions likely responsible for increased solar radiation levels are alterations in near stream vegetation that reduce shading, channel morphology, and flow modifications (ODEQ). Riparian alder conversions could increase shading and offer potential future large wood recruitment. Potential vegetation shade curves created by the ODEQ (Umpqua River Basin total maximum daily load technical committee) and Smith River Watershed Council (2006) estimated that mature Douglas-fir in the Smith-River Watershed could potentially shade North-South facing streams up to

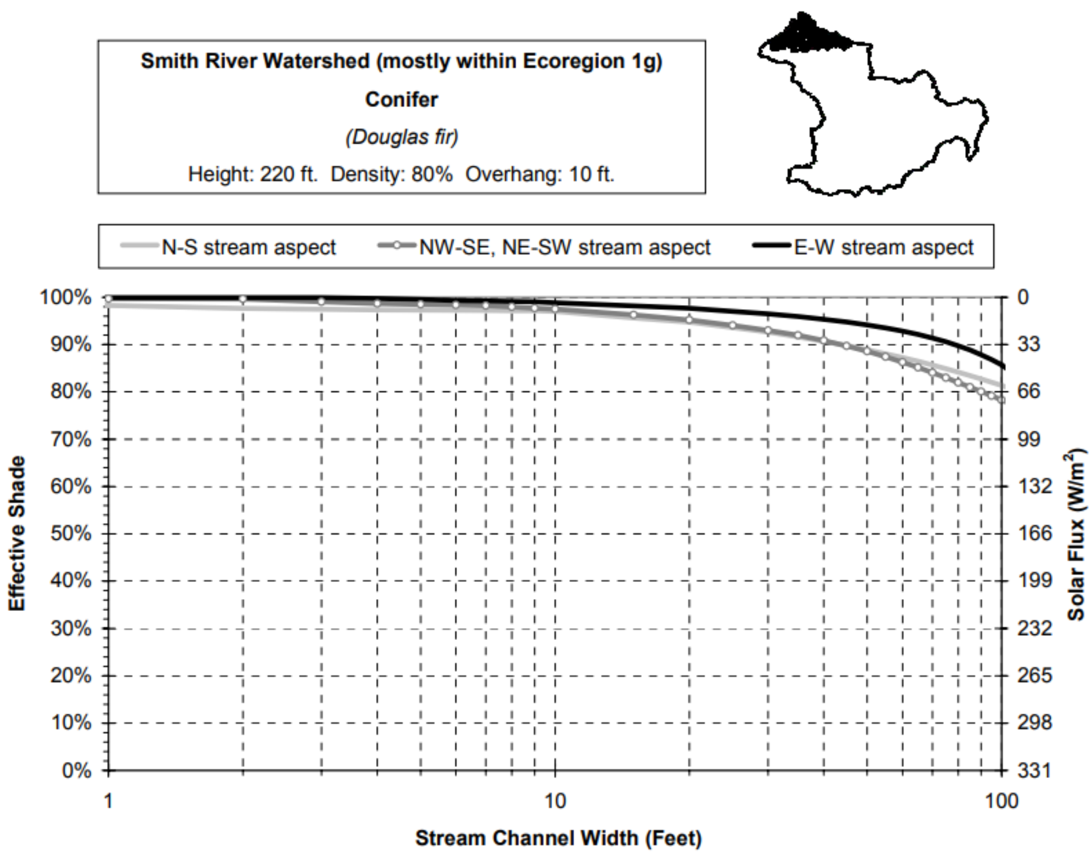

Figure 29: Smith River Watershed Effective Shade Curve – Umpqua Basin Stream Temperature Total Maximum Daily Load, ODEQ (2006).

approximately 80-98%. Alder and bigleaf maple stands in the region were estimated to provide approximately 48-90% effective shade cover for North-South facing streams. This may be a contributing factor to anthropogenic non-point source solar heat loads in the WFSR Basin as past timber practices removed large conifers from the area. Their recommendations were to design more instream log and boulder structures to influence stream temperatures by allowing for accumulation of substrates, increases in groundwater storage, and improved hyporheic exchange through expanded floodplain connectivity.

VIIII. Literature Review of Publications

Coho Salmon dependence on intermittent streams (Wigington et al. 2006)

Coastal Coho Salmon (*Oncorhynchus kitsutch*) use headwater areas where intermittent streams are common. Wigington et al. (2006) quantified contributions of intermittent streams to Coho Salmon production in the West Fork Smith River Basin by comparing Coho use of intermittent streams (Moore Cr. and Crane Cr.), perennial streams (Coon Cr., Beaver Cr., Gold Cr., and Upper West Fork Smith River), and the mainstem West Fork Smith River at several life stages. Specifically, Wigington et al. (2006) provide estimates of the (1) proportion of spawning that occurred in intermittent streams, (2) movement of juveniles into intermittent streams, (3) juvenile survival in intermittent and perennial streams during the winter, and (4) relative size of smolts produced from intermittent and perennial streams. Overwinter survival was also estimated for each reach. Juvenile survival during winter flood events is one of the most important factors controlling smolt production (Nickelson et al. 1992) as high stream-flows can physically displace or fatally injure fish unable to find suitable, low-velocity refugia. In coastal Oregon rain fed streams, refugia from these events is particularly important due to the frequency and severity of flashy discharges. Intermittent streams may also provide summer refuge from increased summer temperatures. Groundwater fed, isolated pools are likely to play an important role in the rearing and growth of Coho juveniles over dry summer months by providing cool water refuge and increased food opportunities.

Table 1. Estimated number of days with no open channel streamflow for two intermittent streams (Wigington et al. 2006)

	Summer		
Stream	2002	2003	2004
Moore Cr.	65	38	0
Crane Cr.	47	21	0

It was estimated that one, or both intermittent tributaries (Crane Cr. and Moore Cr.) experienced periods with no flow during approximately 14 of the 24 years of stream flow record, with 6 years of absent streamflow in intermittent streams for periods of 15 to 87 days. During periods with no streamflow, residual pools were present for a considerable period of time after streamflow had ceased. During some periods of intermittent flow, pools in the lower stretches of Moore Cr. dried completely while residual pools in upper Moore Creek were sustained by groundwater.

Intermittent tributaries were used by Coho Salmon in several ways. During 2002-2004, 11% to 21% of adult Coho Salmon spawned in Moore Cr. and Crane Cr. (9% of total stream network). Most mainstem-tagged juvenile Coho entered the intermittent tributaries during high streamflows in the fall. Juveniles that had been tagged in, or used tributary (intermittent and perennial) streams comprised a higher proportion of smolts and had a higher overwinter survival than juveniles tagged in the mainstem over all years. Wigington et al. (2006) also found that Coho smolts that used intermittent tributaries were larger than smolts that used perennial tributary habitats during 2004 and 2005, and were significantly larger than smolts that used the mainstem in 2004 throughout the middle and end of the migration period.

Table 2. Estimated overwinter survival (%) of PIT-tagged juvenile coho salmon in the West Fork Smith River drainage by stream type (Wigington et al. 2006)

	Winter		
Stream type	2002-03	2003-04	2004-05
Intermittent streams	13	21	41
Perennial streams	12	25	38
Mainstem	9	14	14

Wigington et al. (2006) found that although intermittent streams experience periods with no streamflow, they provide valuable spawning and rearing habitat for Coho Salmon. Even during years in which Crane and Moore Creeks experienced extended periods with no stream flow, they accounted for an important proportion of Coho smolts leaving the watershed. Though pool drying can account for juvenile mortalities in some sections of intermittent streams, permanent pools are important habitat as fish sustained in these pools might experience lower densities and higher food sources compared to Coho in perennial tributaries. Wigington et al. (2006) hypothesized that this would provide higher survival and growth of Coho that overwinter in intermittent streams via release of density dependence. They stated that their observation that, following a particularly dry summer in 2003-04, Coho smolts from intermittent streams were considerably larger than those that used perennial habitats was consistent with this hypothesis. Intermittent, low-gradient streams such as those in the WFSR are common in watersheds with sedimentary bedrock found throughout Oregon coastal drainages. These streams provide valuable spawning and rearing habitat for Coho Salmon and contribute to coastal populations.

Juvenile Coho Salmon Growth and Survival across Stream Network Seasonal Habitats (Ebersole et al. 2006)

Accelerated growth can foster increased survival for juvenile fish. Larger fish may be able to exhibit greater behavioral flexibility in foraging tactics, movement, and habitat use which can be advantageous for fish in heterogeneous habitats, as they can allow multiple strategies for growth during critical periods (Dill 1983). Larger body size may be particularly advantageous for juvenile Coho Salmon (*Oncorhynchus kitsutch*) as it can increase the ability for individuals to survive disturbances such as flooding and high stream flows (Pearsons et al. 1992; Bell et al. 2001), as well as improving competitive fitness for limited food or refuge resources (Allee 1981; Fausch and White 1986; Hughes 1998).

Ebersole et al. (2006) assessed the growth, movement, and apparent overwinter survival of individually PIT tagged juvenile Coho Salmon in the West Fork Smith River from June 2002 to June 2003, relating growth and survival parameters to stream characteristics. The objectives of the study were to (1) determine relative abundance and overwinter residency of individual Coho juveniles and the extent of their movement between mainstem and tributary habitats, (2) characterize spatial variation in juvenile Coho seasonal growth and overwinter survival, (3) relate variation in survival to environmental attributes of the stream network, (4) compare growth rates and smolt size to winter movement or residency patterns, and (5) identify the relative contribution of fall size of juvenile Coho to smolt size and overwinter survival. Habitat variability in the West Fork Smith River basin is influenced by past forest harvest and road building activities, reductions in large wood and losses of spawning and rearing habitat for salmonids. Additional habitat variability occurs among its tributaries due to differences in streamflow. Moore, Crane, and Coon Creeks have very low flows during the summer months and flow ceased for both Moore and Crane creeks during the summer of 2002.

Ebersole et al. (2006) estimated a total population size of 104,088 (95% confidence interval [CI] = 94,082-114,094) juvenile Coho Salmon in the West Fork Smith River in the midsummer of 2002. Juvenile Coho used the extent of accessible habitat in the basin in midsummer and the highest densities occurred in the tributaries. 79% of juvenile Coho were detected, or captured, during the overwinter period within the reach where they were tagged. 17% overwintered within a reach other than their reach of origin, and the remaining 4% were observed in multiple reaches. Overwinter growth rate was highest for juvenile Coho in Moore Creek, lowest in Beaver Creek, and intermediate in Gold Creek, the mainstem, and for fish that moved between tributary and mainstem habitats. Smolts originating from Moore Creek were significantly larger than those originating from all other locations despite being intermediate with regard to weight at the time of tagging in the fall. Estimated apparent overwinter survival was highest for the three tributaries (Moore, Beaver, and Gold) and the upper mainstem reach; intermediate in the upper and middle mainstem reaches, and lowest for the lower mainstem reaches. Smolts overwintering in Moore Creek were significantly larger than fish in all other reaches except for mobile fish (those observed to overwinter within multiple reaches).

Table 1. Instantaneous overwinter growth rate of juvenile coho salmon among overwinter locations within the West Fork Smith River basin, Oregon.

Overwinter location	Count	Mean	SE	95% confidence interval
Beaver Creek	20	0.34	0.057	0.22-0.45
Gold Creek	4	0.42	0.127	0.16-0.68
Moore Creek	36	0.74	0.042	0.65-0.83
Mainstem	10	0.56	0.081	0.40-0.73
Mobile	8	0.56	0.09	0.38-0.75

Table 2. Apparent overwinter survival of Coho Salmon by reach of origin, summer parr densities, and of fall and adult spawners.

Reach	Summer Coho Salmon density (number/100 m^2)	Apparent overwinter survival (%)	Spawner carcass and egg biomass density (kg wet weight/m^2
Beaver Creek	37.5	12	0.08
Gold Creek	61.6	12	0.06
Moore Creek	132.9	13	0.15
Mainstem average	43.6	8.4	0.036

Fish exhibiting seasonal immigration into tributaries had enhanced survival and growth, particularly those using Moore Creek, an intermittent tributary. Though Moore Creek was nearly dry in late summer, fish quickly recolonized newly flooded habitat within 3 days of the first substantial fall rains. This tributary had some of the highest densities of spawning Coho during November-December. This may have contributed to enhanced survival and growth of juveniles in Moore Creek as the carcass and egg biomass densities in Moore Creek in 2002 approached the level at which trophic incorporation of marine-derived nutrients in juvenile salmon becomes asymptotic (Bilby et al. 2001). This would allow the direct consumption of eggs, carcass material, or newly emerged Coho to provide increased nutrients to rearing fish.

Variation in apparent overwinter survival among reaches was related to physical habitat factors, including riparian canopy density, percent bedrock substrate, and maximum temperatures during the preceding summer. Seasonal movement into tributaries may be particularly important in watersheds that have been simplified by logging (Tschaplinski and Hartman 1983) such as the West Fork Smith River where mainstem habitats have been simplified through loss of channel structure and coarse sediments, and experience high summer water temperatures. Small tributaries, as suggested by Brown and McMahon (1988) may contribute disproportionately to smolt recruitment as fish can exploit physically heterogeneous and productive habitats. Ebersole et al. (2006) state that the results of the study support continuing efforts to protect, maintain, and restore seasonally productive habitats, and connectivity between them.

Modeling Stream Network-Scale Variation in Coho Salmon Overwinter Survival and Smolt Size (Ebersole et al. 2009)

In this study, Ebersole et al. (2009) examines the spatial patterns of overwinter survival and size of smolting juvenile Coho Salmon (*Oncorhynchus kitsutch*) in relation to habitat attributes in the West Fork Smith River (WFSR) over a 3 year period. Differences in streamflow within the basin vary widely. Moore and Crane creeks are intermittent, and during the warm summer months, often cease to flow; while Coon, Beaver, and Gold creeks, along with the mainstem WFSR and its headwaters, flow perennially, providing for a wide range of useable habitats for juvenile salmonids. Fish were collected by seining each of the individual habitat units throughout the system and were then weighed and measured (FL), and checked for the presence or absence of black spot parasite infestations, then tagged before release. Apparent survival was estimated for each tagged group per reach. Stream temperature, percent streambed surface area composed of exposed bedrock, percent reach area (pools), discharge, abundance of adult salmon spawners, salmon carcasses, riparian canopy cover, and basin area above sampling point were the habitat variables included in the multiple regression and hierarchical mixed-effects models to explain variation in overwinter survival and smolt length.

This study found little evidence of a relationship of survival with channel substrate composition, pool area, adult carcass biomass density, or percent canopy cover. Instead, variation in overwinter survival was found to be associated with basin area above the sampling site. The highest overwinter survival was consistently observed in reaches with a small basin area above the sampling point (less than 2,000 ha), but not all small areas above sampling points exhibited high survival. In the middle and lower mainstem (basin areas greater than 3,000 ha) survival did not exceed 20%.

The rationale for Ebersole et al. (2009) to include basin area above the sampling site was to incorporate a measure of winter discharge. This was a means of attempt to capture the effect of high winter stream flows. These high winter flows can be associated with the displacement, injury, exhaustion, and mortality for juvenile Coho in Oregon coastal streams (Bilby and Bisson 1987; Lawson et al. 2004). Variation in physical habitat conditions such as structural refuges, off-channel alcoves, and beaver ponds may act as buffers for juvenile Coho during these flashy winter flow events (Nickelson et al. 1992a; Bell et al. 2001). Due to a legacy of splash damming, stream cleaning and other land use practices, the WFSR is greatly lacking in these physically complex structures, potentially making it particularly sensitive to these flow events (Ebersole et al. 2006). Generalized trends of juvenile salmonid habitat suitability along longitudinal gradients of stream discharge suggest that suitability decreases downstream. This study found low densities and survival rates at downstream sites low in the basin. This may be associated with the low suitability of juvenile salmonid habitat and lack of refuge from peak streamflows.

As predicted by Ebersole et al. (2009), FL was positively associated with survival. Observed differences in FL varied by stream type. They found that smolt length was higher than predicted based on fall length in intermittent streams suggesting higher growth rates. These streams are heavily used by adult Coho for spawning which is hypothesized to increase trophic resources (e.g., nutrients for macroinvertebrate production) which may have an influence on growth and survival for juvenile salmonids (Wigington et al. 2006; Robillard 2006). Locations lower in the basin tended to produce larger smolts, although their overwinter survival was low. Ebersole et al. (2009) hypothesized that this may be due to the use of intermittent tributaries in winter months by fish that were originally tagged in the mainstem (Ebersole et al. 2006), as the WFSR lacks floodplain ponds and wetlands adjacent to the mainstem which is often a contributor to large lower basin smolt size.

Based on the results of this study, Ebersole et al. (2009) concludes that current habitat conditions in the mainstem WFSR appear to limit Coho production, although producing few, large smolts. These populations could provide substantial benefits to Coho populations through the protection and restoration of mainstem, tributary, and headwater locations in the WFSR. These actions can be best allocated based upon the understanding of spatial patterns, survival, and smolt production, provided by their study.

Hierarchical Modeling of Late-Summer Weight and Summer Abundance of Juvenile Coho Salmon across a Stream Network (Ebersole et al. 2009)

In this study, Ebersole et al. (2009) quantifies the relationships among summer habitat conditions, Coho Salmon density, and Coho Salmon parr abundance and weight across the West Fork Smith River basin over a period of 3 years. They used hierarchical linear models to assess factors influencing salmon weight and abundance at the levels of individual fish (fork length and parasite burden), habitat unit (surface area, cover, and density), reach (temperature and density) and stream (total nitrogen, soluble reactive phosphorus (SRP), and discharge).

Of the 1,609 models developed relating Coho parr weight to individual habitat variables and their interactions, 98 were included in the confidence model, explaining nearly 94% of the variation in Coho parr weight. As they expected, variation in Coho Salmon parr weight was consistently associated with length. Habitat-unit-level variables that were important in explaining parr weight were habitat unit area (estimated as being positive on weight), and habitat-unit-level Coho density (estimated as being negative on weight) across the range of fish length classes examined. Contrary to their hypothesis, Coho parr infested with black spot parasite did not differ in weight from parr free of parasites at individuals at similar lengths.

At the reach level, they found that temperature was the most important variable explaining variation in Coho parr weight. They found that the stream-averaged late-summer weights of parr were consistently higher in the perennial tributaries and the main-stem WFSR from 2003 to 2005. In Moore and Crane creeks (intermittent tributaries) parr weights averaged 0.9 grams lower. Minimum discharge and SRP were also important stream level factors effecting Coho parr weight, estimated to having a positive effect on weight across a range of fish lengths, although SRP was marginally important in the confidence model. The effect of stream-level total N was not interpretable, but may be correlated with other stream characteristics rather than having a direct cause of increased Coho abundance.

Ebersole et al. (2009) also developed 2,180 models relating abundance to habitat unit variables and their interactions, 19 of which were included in the confidence model, explaining 31% of the variation in Coho parr abundance. Area and overhead cover (estimated as having a small positive effect on abundance) were consistently important in the candidate model but area was not consistently interpretable, which they presume is probably due variation in stream type. Substrate cover did not contribute meaningfully to their abundance models as an effect of substrate cover on Coho weight was not detected. Their models estimated that reach-level temperature on abundance was positive for small habitat areas, but negligible for larger areas. At the stream level, they found that minimum discharge (estimated as having a negative effect on abundance) and total N (estimated as having a positive effect on abundance) had high relative weights, although the effect of SRP on abundance was not consistently interpretable.

Reach-level Coho density variables did not contribute meaningfully to the confidence model set, however, at the habitat unit level, density, abundance, and low discharge were important components to the hierarchical models. This was particularly apparent in Moore and Crane creeks where flow becomes intermittent in the summers of the driest years, decreasing continuity between pools and reducing available habitat area. This reduced stream area might increase intraspecific competition coincident with declines in macroinvertebrate production (Harvey et al. 2006); allowing more dominant and better conditioned fish to force sub-dominant fish into lower quality microhabitats where food resources are lower and predation risks are higher (Grant et al.

1998; Jenkins et al. 1999). This would allow for a few dominant individuals to maintain good condition despite high densities of conspecifics while low-condition fish are unable to acquire adequate forage opportunities, potentially leading to starvation and mortalities. Though abundance was primarily influenced by area, with larger habitats having proportionally greater numbers of parr, Ebersole et al. (2009) hypothesized that cover availability could provide protection from predators, allowing for increased abundances in smaller habitats.

Ebersole et al. (2009) concluded that the results of their study illustrate how environmental factors and their relative influence vary within a basin (intermittent, perennial, and mainstem streams) and the usefulness of using hierarchal linear models to capture them. They state that the consistent and strong effects of discharge and area on weight and abundance observed in this study could inform efforts to protect and enhance Coho Salmon habitat and that their findings have direct management implications of the WFSR and other similar basins. Specific restoration actions, they continue, can be directed more effectively by focusing on appropriate locations within stream networks and considering streamflow can regulate juvenile salmon population abundance and body size via multiple direct and indirect pathways.

IX. Lessons Learned

Restoration Implementation

The evolution of restoration techniques can be seen clearly in this basin. Many of these techniques have been found to be less desirable and are no longer used.

- For example, concrete sills were installed as a less expensive alternative to replacing undersized culverts. These undersized culverts were ultimately replaced leaving these concrete structures. These sills now need to be removed as they require annual work to keep clear of debris and are believed to be impediments to fish passage.

- Boulders provide better spawning habitat than lumber sills. Lumber and rebar sills are not used by spawning fish as they do not have sub-surface water flowing though the gravel to oxygenate eggs. Spawning fish recognize these as unsuitable spawning habitats and rarely spawn on them. In many cases the lumber has rotted away and left rebar anchored in the bedrock. This rebar is now a safety hazard to humans and wildlife and will need to be removed.

- Early restoration methods have not proved to show longevity. Blast pools created with dynamite are not evident and have likely filled in with sediment. Wood placed in the mainstem for the most part was not large enough to remain in place and was flushed out during large events.

- Fish passage improvements show the clearest population response signals seen in Coho. Following the 1981 Beaver Cr. culvert replacement, Coho peak spawner numbers went from near zero to a profound positive long-term trend. Following multiple culvert replacements at the mouths of major tributaries in 2001, WFSR Coho smolt estimates increased. From 1998-2001 Coho smolt numbers never exceeded 22,500. Following these culvert replacements the Coho smolt estimates have never dropped below this number.

- Side channel habitats provide essential rearing opportunities for juvenile salmonids. An oxbow pond was created by the building of the WFSR Road, a disconnected bend in the river, which is now accessible due to a new culvert. During the spring bug hatches, huge numbers of small silvered salmonids can be seen jumping above the surface of the lake to catch newly hatched aquatic rearing insects.

- Since implemented restoration efforts, the LCM project has seen Coho smolts in excess of 180mm. These are far larger than the average Coho smolt size and have been verified as 1 year old smolts. These fish by virtue of their size will have a much higher likelihood of ocean survival.

- Large holding pools created downstream of tributaries provide valuable holding habitat for fish to stage in until stream flows increase, allowing adult fish to access tributaries. Mainstem boulder weirs placed from 1992 through 2001 have worked very well to create large gravel beds for spawning habitat. These consisted of a diagonal line of boulders at a uniform height spanning the stream. These have large planar form gravel beds where the height of boulders across the stream is uniform and where these weirs are placed in close succession to allow the downstream boulder weir to create a pool, backing up water to the next upstream structure. This backwatering effect seems to allow for much greater substrate deposition.

- Care should be taken to when placing boulder weirs to place them in close enough succession to provide fish passage at all life stages through backwatering. Weirs that have low points show substrate loss around this low point. Creating a low point in the weir for fish passage is detrimental to the substrate beds we intend to form. 2011 boulder weirs do not incorporate a low point and are showing much better substrate deposition than 2013 boulder weirs that incorporate a low point for fish passage.

- None of these channel spanning boulder only structures have been successful in trapping large woody debris. During high flow events capable of moving large trees and wood pieces, the height of the water column is such that the wood simply floats well above the weir. The only weir to incorporate a large rootwad has been extremely successful in trapping wood. 30 whole mature to old growth trees were pulled into the mainstem. At least 3 of these were placed in a stream reach with a gradient greater than 2%; these trees have shown downstream movement. Trees placed in pools have been successful in recruiting wood and allowing substrates to drop out in the pool.

In one of the grant applications submitted for 2010-11 helicopter placement funding, it was stated that there was no good road access to the tributaries. This was the reasoning given for treating the majority of the tributaries by helicopter. In this same application a map was provided showing riparian road access to all major tributaries treated by helicopter. Over 10 miles of stream which was accessible by road with ground based equipment was treated by helicopter. Helicopter placements are more costly and often provide lower quality sites than those that are placed by excavator using both logs and boulders. Using ground based equipment to more accurately place structures in tributaries would have yielded more positive results. Log/boulder combination structures are often far more beneficial in recruiting substrates and large wood than structures composed of one or the other, lending difficulty for placement by helicopter. The other item was damage done to the road system. The contractor hauling boulders to the job site in 2013 dropped boulders on paved surfaces causing damage. Project managers should hold contractors responsible for damage to property and should include language in the contract to do so. When land owners and partners report damage to property the project manager should immediately take action to both stop further damage and repair the damage done. Not only in regards to the property but to the landowner relationship as well.

Restoration of spawning habitat has been a success for all species studied with the exception of Chinook which could still utilize additional spawning habitat in the lower mainstem. Research has revealed that summer and winter rearing habitats are now the most significant limiting factors for Coho, steelhead and lamprey recovery. The Smith River Watershed Council is working with partners to design another restoration phase that focuses on both of our traditional ground-based restoration approaches of instream wood and boulder placements and fish passage improvements, as well as, riparian or streamside forest restoration. By improving streamside forest structure and allowing timber to mature, trees will fall into the stream naturally over time, allowing this system to become self-sustaining and not require further human intervention. We hope to have even more promising results to share with you in the future.

X. Future Recommendations

Takeaways for other basins

An integrated, prioritized approach should be taken to address reduced cold-water aquatic productivity. All potential issues should be properly assessed in order to develop a plan to address the most impactful issues and increase the benefit to cost. Fish passage should be evaluated first and foremost. Good quality habitat has little to provide fish if they are unable to access it (natural features that were historically barriers to fish passage should not be altered. Steelhead strongholds have been impacted by increased salmon passage. Invasive species may also move upstream if managers create conditions for increased passage). Perched, undersized and failing culverts should be replaced with appropriately sized culverts or bridges. Human made dams and water retention structures should be removed or altered, where appropriate, to allow for increased passage.

The next effort should be to look at both the riparian system and the instream habitat. When designing instream structures, managers should look for ground-based access first, as this is less expensive than helicopter operations. Where instream structure is lacking, design log/tree and boulder structures to increase complexity and form pools. When doing this evaluate your riparian area by asking the following questions. Are there invasive plant species overtaking the riparian area that need to be controlled? Are there invasive plant species taking a foothold that can be controlled now before they become a larger problem? Is the riparian area going to contribute large coniferous wood to the creek in adequate quantities into the future? If the riparian area will not be a source for large wood going into the future, more human intervention will be required.

Managers will either need to continue placing wood in the stream or intervene in the riparian area. Re-establishing conifers in the riparian area will provide multiple benefits. Primarily the stream will be growing its own future wood contributions. This is far less expensive than purchasing, cutting, hauling and placing trees by machine. This will also lower disturbances to the stream, decreasing the likelihood of invasive species introductions. Conifers are far superior to hardwoods in shading streams as addressed in the temperature monitoring section.

Much of our coastal riparian areas had clear cutting and stream cleaning in the 1970s and 1980s. Red alder being an early successional species, it colonized these areas very heavily. Most of these areas are now dominated by salmonberry and senescing red alder. These alder will die and fall over in the coming decades and leave us with primarily salmonberry as our stream shading canopy. This is likely a major contributing factor to the stream temperature increases seen in the WFSR over the past 40 years. Without fire on the landscape to burn out salmonberry to the mineral soil, the ability of later successional species such as Douglas-fir, Western redcedar and Western Hemlock to colonize these habitats is almost completely removed. Therefore hardwood to conifer riparian conversions should be implemented. Timing instream log placements with riparian work will allow a lot of the alder material to placed instream.

Current Oregon Forest Practices require that logging slash be removed from seasonal and intermittent streams following a logging operation. This removes woody debris from the majority of our stream network. Project managers should work with timber land owners and

Oregon Department of Forestry to design projects to leave woody material in these small and often ignored streams. Without spending a penny and saving timber companies time and money, we could be increasing wood across the majority of our stream network. Wood left in these areas can accumulate sediments and increase the stream networks ability to store and recharge groundwater. Additional groundwater stored for summer months will increase habitat area available through increased surface water flow. Increased groundwater inputs will also decrease water temperatures. This will improve the quality of all downstream habitats and potentially lower water temperatures enough in lower mainstem areas to increase stream habitat that is suitable for salmonid rearing.

For the West Fork Smith

Phase I – Evaluate fish passage to all major tributaries and design road crossings that allow a stream channel at the crossing of at a minimum the active stream channel width, preferably 1.3 times the bankfull channel width as called for in the USFWS Aquatic Restoration Biological Opinion (ARBO II). Complete a plan for removal of 2 of the 3 sets of concrete sills (one is completely submerged by a pool created by a boulder weir).

Phase II – Replace all undersized tributary culverts. Remove concrete sills in the mainstem WFSR. Remove exposed rebar from tributary where lumbar sills were once anchored.

Phase III – Design riparian conversion projects to remove red alder and suppress salmonberry in order to restore a mixed species, conifer dominated riparian area. Design instream log and boulder placements where instream conditions require such an approach. Evaluate decommissioned road removal and stage 0/stage 8 feasibility. Develop a timing strategy to use red alder removed during the conversion process for instream placements. These alders will decay much faster than conifers and should not be treated as key pieces in the structures. The alders will provide cover and help fill in gaps at structures and allow them to mature more quickly. Work with ODFW to establish quality control procedures around temperature monitoring.

Phase IV – Implement log and boulder placements in all WFSR tributaries along with riparian conversions.

Phase V – Work with Federal/ Private Timberland owners and ODF to increase woody material left in seasonal and intermittent streams. This will be done under ODF’s Alternative Practices and will be a continuous effort for the foreseeable future. These efforts will likely have landscape level effects that require less effort than currently exerted. This pursuit will also require no additional regulatory burden on the landowners.

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XII. Appendix

Historical and Relevant Photos

Photo 1: Splash Dam at Johnson Creek, 2 miles from WFSR

Photo 2: Splash Dam being detonated, Coos County

Photo 3: Splash Dam near Coquille

Photo 4: Log Drive Coquille River

Photo 5: Log Drive

Photo 6: Tow Boat moving log rafts, Reedsport

Photo 7: Lawrence D Haines Log Truck, Drain OR

Photo 8: Smith River Falls before modification

Photo 9: Stream cleaning on Crane Cr., jam caused by logging debris 1972

Photo 10: Stream cleaning on Crane Cr., 1972

Photo 11: Lumber/rebar sill placed in Moore Cr

Photo 12: Weirs placed in 1992 in lower mainstem have collected gravel and are heavily used for spawning

Photo 13: Weir placed in 1994 in upper mainstem, it is now completely covered in gravel

Photo 14: 1997 Boulder clusters

Photo 15: 1999 Boulder weir, placed trees no longer present

Photo 16: 2011 Helicopter log placement

Photo 17: 2013 Boulder weir near mouth of WFSR

West Fork Smith River Aquatic Habitat Management Plan

Bill Hudson BLM (1980)

Preface

The aquatic habitat and management plan of Bill Hudson demonstrates the perspectives and viewpoints of stream restoration in its infancy. Though many of the management objectives of the BLM displayed here are outdated and are no longer, or had never been adhered to, Bill

Hudson's recommendations and comments demonstrate the evolving ideas of stream management and restoration.

Executive Summary

The West Fork of the Smith River Basin, located in the coast range of Oregon, is characterized by steep valley walls formed of sequential micaceous Tyee and Flournoy sandstone and siltstone. These rock types make up the bedload of the basin, recruiting from landslides and erosion of steep slopes (10-135%) from heavy winter precipitation of 80-100 inches per year. The five major fish bearing tributaries, Coon, Crane, Moore, Beaver, and Gold Creeks exhibit relatively straight, North-South facing mainstem channels.

Logging practices have been carried out throughout much of the basin, and logging road building practices have greatly altered many fish bearing streams. Coho Salmon, steelhead trout, and Cutthroat Trout inhabit the system. Much of the habitat is marginal but through enhancement projects, could produce more fish. "It is the responsibility of the fisheries [habitat] managers to bring the carrying capacity potential of the habitat up to its maximum…and enhancement efforts will be aimed to provide quality spawning and rearing habitat" (Bill Hudson).

The objectives of the West Fork of the Smith River Habitat Management Plan were to expand and improve habitat for salmonid production by:

1. Maintaining riparian vegetation along all fish bearing streams in order to optimize aquatic productivity (MFPl-WLF 2.5 and 3.1). Protect 16.4 miles of riparian vegetation of the West Fork Smith River and 34.8 miles of its tributaries designated as 3rd order or larger by the Oregon Department of Fish and Wildlife (ODFW). Protection of 1,229 acres of streamside vegetation should allow the vertical structure of the riparian zone to increase from an average of 25 years to full maturity, around 75 to 100 years. Stream salvage operations should be eliminated completely and instream structures lost to timber harvest in the mid-nineteen hundreds should be replaced with artificial structures.

2. Maintaining and enhancing water quality for cold water anadromous fish production (MFPl-W-4). Propose that ODFW introduce 8 female Fall Chinook Salmon producing around 5,000 eggs each (40,000 eggs minimum) per year.

3. Designing and constructing structures to enhance spawning and rearing habitat for wild stocks of salmonids (MFPl-WLF 2.4). Installment of log sills and gabions, which would substitute for large tree boles, could increase spawning gravel deposition for Coho Salmon and steelhead trout.

4. Removing barriers that hinder or prohibit salmonid migration (MFP-WLF 1.1, 1.4, and 2.2). Increasing quality rearing pools in the West Fork, Moore Cr., Gold Cr. , and the upper West Fork could be carried out by blasting, excavating, or by gabion and log sill placement.

5. Monitoring of basin log and beaver jams to ensure fish passage. At present, these obstructions are passable during high winter flows and many are producing rearing habitat. “Biologists used to think that all jams were detrimental and stream clearance programs vigorously and indiscriminately attacked all jams and completely removed all material from the stream channel. This practice of overcleaning allowed high winter flows to scour away bedload materials leaving cobble fields and bedrock where pools and gravel were once” (Bill Hudson). Jams do have the potential to completely hinder fish passage, however, and these jams can be mitigated without removing all logs. Removal of minimal material can allow for fish passage while maintaining rearing pools and spawnable areas behind them. Partial jam removal would be best accomplished under direction of biologists and in the years following, monitoring should be conducted in order to ensure fish passage has been achieved.

6. Collecting and assembling water quality and quantity data at the present gaging station located at T. 20 S., R.9 W., Sec.21 on the West Fork at the WORM maintenance shop on a schedule that will evaluate the effects of management.

7. Making planning goals and procedures known by resource users throughout the Coos Bay District through personal contacts, public meetings, and the distribution of the Aquatic Habitat Management Plan.

8. Providing information about the cooperative Habitat Management Plan for the West Fork of the Smith River through use of information signs.

Report Summary:

West Fork Smith River

Date of Survey: August, 1980

Terrain of Surrounding Area

Along the course of the river there are a few areas of hardwood flats. Most of the adjacent banks and slopes are moderate to steep, 20 to 60%, and in some areas, they are extremely steep, 60 to 135%. The mainstem flows from NE to SW and the major tributaries are on the left, or north side of the river and flow from NW to the SE. These tributaries drain a large area, generally are flat in gradient, and provide habitat and have the potential for producing good numbers of salmonids. These tributaries support hardwood stands, a well-developed riparian zone in undisturbed areas, and a coniferous forest. The tributaries entering from the right, or south side, are low ordered, steep, ephemeral and provide little habitat to support salmonids.

Many areas have been cleared and are presently in a state of recovery. Records of the Department of Interior General Land Office indicate the presence of splash dams on the WFSR in the early 1900s around mile 7.0 and 10.0. An anecdotal account from a local resident, Mr. Don Beckham, recalled that the WFSR was splash dammed in the early 1920s. The WFSR access road (20-9-27.1) encroaches upon the stream channel in many places. The road has taken approximately 45 acres of riparian vegetation out of production.

The BLM has the major portion of ownership of the mainstem. The International Paper Company owns a minor portion of the land in the watershed.

Substrate Composition

The parent rock in the WFSR drainage is comprised of Tyee flourney sandstone. The majority of the river has been scoured down to base rock due to past land use practices such as splash damming, which scoured the WFSR down to its base level leaving a sloped smooth surface of bedrock on which water velocities have increased and continue to clean off the stream bottom. This condition will continue to remain this way until enough woody structure enters the stream to trap sediment. This process could take a long period of time. Only one log structure was observed in the 14.5 miles of the mainstem surveyed. This single structure has created a good pool and has caused the deposition of a gravel bar that is used for spawning by salmonids. There are only a few areas where gravel accumulations are concentrated and deep enough for the anadromous fish to use for spawning. The river has a poor pool/riffle ratio (14/86) because pools occur only where there are depressions in the bedrock. The riffles are primarily bedrock slicks offering little structure, aquatic insect habitat, and fish habitat. There are miles of low quality habitat that have the potential for improvement. The flat to moderate gradient of the river would make the WFSR a good system for gravel retention and fish passage. New depositions of bedload materials have occurred below the Gold Creek weirs and above the Coon Creek weirs since their construction (1968 and 1972 respectively). There is a good composition of gravel sizes suitable for all species of salmonids to utilize built up behind these structures.

Streamside Canopy

Riparian Canopy makeup in order of dominance:
Alder (*Alnus rubra*)
Big-leaf maple (*Acer macrophylum*)
Salmonberry (*Rubus spectabilis*)
Vine maple (*Acer circinatum*)
Thimbleberry (*Rubus parvifloras*)
Huckleberry (*Vaccinium spp.*)
Willow (*Salix spp.*)
Douglas-fir (*Psedutsuga menzesii*)
Western redcedar (*Thuja plicata*)
Hemlock (*Tsuga heterophylla*)

The streamside vegetation along the mainstem of the WFSR is in good to excellent condition with a multistory canopy of big-leaf maple and Douglas-fir. The stream is 70 – 100% covered and water temperatures are within the limits to support salmonids. There are areas that are clear cut to the water's edge and these areas are in a state of recovery. In these areas, Alders (10 to 15 years old) dominate, although they have a dense closed canopy that provides adequate shade (70 – 100% coverage). Coniferous trees have volunteered in these areas and some were old enough to grow through the alders. There is adequate nutrient input from riparian vegetation, but the lack of gravel retention allows nutrients to wash down stream. If retained in traps and gravel pools, these nutrients could support diverse aquatic insect populations.

Population and Habitat Condition

Cutthroat Trout, Coho Salmon, and steelhead trout utilize the entire mainstem of the river. Chinook Salmon presently do not utilize this river. When the West Fork Habitat Management Plan is implemented, spawning sites suitable for Chinook will be constructed. There is not at present a run of Chinook Salmon in the Smith River System. Efforts will be made to promote the establishment of these fish in the basin. It has been observed that Cutthroat prefer areas with deep pools and structure. All species are down in numbers. There were no reaches of the stream where abundant numbers were found. Bedrock slicks offered the least desirable habitat and few fish were found using them. The majority of fish preferred deep pools and riffle area.

Capabilities of Improvement

The WFSR mainstem could be utilized by more fish if appropriately designed structures were placed in the river, reducing water velocities enough to allow gravels to be deposited and thus diversifying the habitat. Gabions, log sills, and trees are all structures that will cause the deposition of gravel in the river. The deposition of gravel on bedrock changes the stream bottom from a smooth surface to a rough substrate type, offering more resistance to flow, lowering water velocity, and causing subsequent deposition of materials; resulting in the following benefits: 1) organic materials (detritus) will be trapped in and on the gravel, 2) aquatic invertebrates will colonize the gravel and feed upon trapped detritus, and 3) pools would be scoured in the substrates where fish could rear and feed upon the organisms produced there. In essence, structure, whether an old-growth Douglas-fir or a gabion filled with rocks, holds and protects gravel depositions from washing away during high water conditions in the winter. Without gravel there would be less organic material trapped, thus less food for aquatic organisms, thus a reduced ability to support rearing fish. There would also be reduced rearing space for fish. It is quite evident that fish abundance is tied to habitat quality. There are many miles of the mainstem and its tributaries that need habitat improvement.

Log jams that are blocking or hindering fish passage should be removed. Logs, rootwads, and slash from old timber sales are subject to washing into the river at any time; therefore, the system should be monitored on a continual basis.

Problem Identification

T. 19 S., R. 8 W., Sec. 31, 0.2 mile up the upper WFSR Road No. 19-8-31.0 – this jam is the result of a sluice out from an International Paper clear cut that went from the top and mid-unit to the stream taking some standing BLM timber with it. The sluice out occurred after the Nov. 13, 1981 storm. It is passable at present and is planned to be removed this spring, 1982. To solve the identified problem, the log jam can be sold as a salvage sale and yarded out of the stream.

West Fork Smith River Headwaters

Dates of Survey: 7/23/80, 7/29/80

Introduction

The headwaters of the West Fork drainage is a tributary of the West Fork Smith River located in T.19 S., R. 8, 9 W., S. 8: 19, 9: 23 and 24. The Headwaters extend for 1.1 miles and have no tributaries of fisheries significance.

Terrain of Surrounding Area

The side slopes in the drainage are steep, ranging between 60 and 70%. These steep slopes extend down to the stream channel, maintaining their extreme gradient. There are no roads in this drainage and vegetation is abundant and diverse, diminishing erosion greatly by holding the soil together with their root systems.

Substrate Composition

An adequate amount of wood structure has captured some gravel, usually found in small quantities throughout. In steeper areas, boulders are the dominate substrate. Due to a lack of disturbance from roads or logging activities, silt and fine substrates are minimal.

Streamside Canopy

Riparian Canopy makeup in order of dominance:
Big-leaf maple (*Acer macrophylum*)
Douglas-fir (*Psedutsuga menzesii*)
Alder (*Alnus rubra*)
Western redcedar (*Thuja plicata*)
Hemlock (*Tsuga heterophylla*)
Salmonberry (*Rubus spectabilis*)
Vine maple (*Acer circinatum*)
Willow (*Salix spp.*)
Thimbleberry (*Rubus parvifloras*)
Huckleberry (*Vaccinium spp.*)

Streamside canopy ranges from 80-90% and is dominated by Big-leaf maple and Douglas-fir. Riparian vegetation has not been recently disturbed and is in good condition, providing many benefits to the stream.

Population and Habitat Condition

Flow is perennial and habitat is adequate to support fish and aquatic invertebrate populations. This habitat is in excellent condition, offering ample supplies of a good mixture of gravels for spawning and rearing, rubble, and woody debris. Though spawning gravels are available, their abundance is low, which is typical for streams in this region.

Cutthroat Trout were present throughout the system and represents potential resident and anadromous populations. Steelhead were found to yard 1,100, and Coho Salmon were not observed to be using this system, though habitat is available. Numbers of returning Coho adults have been the lowest in the history of the run. Chinook do not utilize this system.

Log jams: Yard 210 – Debris jam – 3.5’x2’x12’
Yard 1250 – 7 logs – 4.5’x10’x15’

These jams were natural occurrences form timber falling into the stream. These jams can be removed by hand with a stream clearance crew.

Capabilities of Improvement

Improvements through boulder placement, gabions, log sills, placement of trees in the channel, or cedar board structures can improve riffle-pool ratio, spawning gravel placement and rearing habitat. Removal of selected log jams will enhance fish passage. An important factor in this system is maintaining existing habitat by leaving quality buffer strips and engaging only in proper road building and logging practices.

Coon Creek

Date of Survey: 6/19/80, 8/5/80

Introduction

Coon Creek is a tributary of the WFSR and has perennial flow. The drainage is located in T. 20 S., R. 9 W., S. 8, 9, 16, and 21. Coon Creek extends approximately 2 miles and has no tributaries of significant fisheries importance. The purpose of the present inventory is to compile data on the aquatic habitat of Coon Creek, excluding its tributaries. The resultant information will set the basis of management plans for the area under a multiple use concept. Present aquatic species of principal economic and esthetic importance include Coho Salmon, steelhead trout (*Salmo gardneri,* later changed to *Onchorhynchus mykiss*), and Cutthroat Trout.

The BLM, USFS, and International Paper Company own about equal thirds of this stream.

Terrain of Surrounding Area

The terrain along the banks of Coon Creek is steep, 60 to 70% grade. The road along the left bank of the creek extends for about 1.4 miles up the creek bottom and has encroached on the left bank of the stream in many areas. The gradient of the stream is flat to moderate at the mouth and the middle to upper reaches of the stream is steep.

Substrate Composition

In the lower portion of Coon Creek there are a fair number of pools. The substrate consists of cobble, boulders, bedrock, and a few patches of good spawning gravel. The section of stream below where tributary 5L enters is laden with silt originating from a side hill “popout” in an International Paper Company clear cut in the NW ¼ of Section 16. This is causing heavy siltation below tributary 5L. Upstream from tributary 5L, the substrate is relatively free from heavy silt and there are areas of good spawning gravels. In the middle to upper reaches of Coon Creek, there is a lot of woody structure, much of which is in the form of log jams.

Streamside Canopy

Riparian Canopy makeup in order of dominance:
Alder (*Alnus rubra*)
Salmonberry (*Rubus spectabilis*)
Big-leaf maple (*Acer macrophylum*)
Douglas-fir (*Psedutsuga menzesii*)
Western redcedar (*Thuja plicata*)
Vine maple (*Acer circinatum*)

Willow (*Salix spp.*)
Thimbleberry (*Rubus parvifloras*)
Huckleberry (*Vaccinium spp.*)
Hemlock (*Tsuga heterophylla*)

Between 1/3 and 1/2 of the vegetation along the course of Coon Creek has been logged within the last 10-20 years. Young red alders have returned and are dominating the streamside canopy along the clear cut areas. Salmonberry, big-leaf maple, and Douglas-fir dominate the remaining undisturbed banks.

Population and Habitat Condition

Cutthroat Trout were observed throughout the stream, Coho Salmon were found to a point just downstream from the lake at mile 1.89 on the left fork of the stream. No steelhead were observed during the survey.

The mainstem has ample supplies of spawning and rearing gravels and is adequate to support fish and aquatic invertebrate populations. There is a good mixture of spawning gravel, rubble, and woody debris. Certain sections of the stream are ephemeral with intermittent pools of standing water. The low water discharge in September, 1980 was only 0.03 CFS. The culvert on tributary 5L is clogged and is inadequate and blocks fish movement into 5L; however, this tributary is in a healing over process and does not offer good habitat for anadromous fish at this time.

Capabilities of Improvement

The riffle-pool ratio, spawning gravel placement, and rearing habitat can be improved by blasting rearing pools and constructing gabions or placing log sills at the head of pools.
Log jams that are hindering fish passage should be removed. These log jams are numerous in Coon Creek and are result of several factors. Sluice outs have occurred on old clear cuts and debris still coming down into the stream. Log jams can be removed in several ways, either as stipulated in logging sales contracts or if time is a factor by use of mechanical loaders, wenches, explosives, etc. Small trash and debris should also be cleared either by mechanical or manual

removal. Removal of selected log and debris jams to increase or enhance fish passage will also aid in the redistribution of spawning gravel locked behind them.

The culvert on 5L should be replaced or removed. The popout in the International Paper Company clear cut should be seeded with grass if it is not going to heal over naturally.

Crane Creek

Date of Survey: 7/25/80

Introduction

The Crane Creek drainage is a tributary of the WFSR and is located in T. 20 S., R. 9 W., S. 3, 4, 10, and 15. Crane Creek is a perennial stream that extends approximately 2 miles and has no tributaries of significant fisheries importance. Present aquatic species of principal economic and esthetic importance include Coho Salmon, steelhead trout, and Cutthroat Trout.

The BLM owns the majority of the land in this basin.

Terrain of Surrounding Area

The terrain of the banks of Crane Creek is varied. A road along the left bank extends the entire creek up to where the headwaters fork and encroaches on the stream channel in many areas. Terrain around the mouth of the creek is flat to moderate as is the gradient of the stream. The gradient of the stream remains flat to moderate to the headwater area where the gradient is steep. The slopes along the bank from the mouth steepen to a moderate to steep gradient for the remainder of the drainage.

Substrate Composition

Substrates in the lower portion of Crane Creek consist of boulders, long sheets of bedrock, and silted shallow pools. Spawning gravel is sparse and is of marginal quality. The middle to upper reaches of the stream has some intermittent areas of quality spawning gravel. There are two major log jams although woody debris is lacking throughout the system. These jams have silted pools behind them. Pools are frequent; however, many are shallow and lack cover.

Streamside Canopy

Riparian Canopy makeup in order of dominance:
Alder (*Alnus rubra*)
Big-leaf maple (*Acer macrophylum*)
Salmonberry (*Rubus spectabilis*)
Vine maple (*Acer circinatum*)
Willow (*Salix spp.*)
Thimbleberry (*Rubus parvifloras*)
Huckleberry (*Vaccinium spp.*)
Douglas-fir (*Psedutsuga menzesii*)
Western redcedar (*Thuja plicata*)
Hemlock (*Tsuga heterophylla*)

Much of the vegetation along the course of Crane Creek has been logged within the last 6-15 years. Young red alders have revegetated these disturbed areas. Overstory canopy is young, but coverage is 80-90%.

Population and Habitat Condition

Cutthroat Trout were observed throughout the stream. Coho Salmon were observed throughout the mainstem, including portions of both forks of the headwaters. Steelhead trout were found up to the log jam at mile 1.0. There is adequate habitat to support fish and aquatic invertebrate populations. The mainstem has ample supplies of gravel for spawning and rearing, a good mixture of rubble, and woody debris in portions of the middle reach of the stream. Woody debris and structure is lacking in the remainder of the system. During the period of low flow, 9/18/80, the discharge at the mouth of the stream was measured with a current meter at 0.03 CFS.

Capabilities of Improvement

Log Jams:	Yard 1,760	9’x15’x40’
	Yard 2,400	6’x15’x15’

Siltation behind the two major log jams is extensive and much of the habitat is affected. Log jams that are blocking fish passage should be removed. Logs, rootwads, and slash from old timber sales are subject to washing into the creek and should be monitored until stabilized. Some of the logs in jams could be utilized as instream structures which could aid in the accumulation and redistribution of spawning gravels. Log jams can be removed as stipulated in logging sales contracts or if time is a factor by use of mechanical loaders, wenches, explosives, etc. Small trash and debris should also be cleared either by mechanical or manual removal. When the two major jams are opened the silt should wash out of the system.

Moore Creek

Date of Survey: 6/18/80, 8/5/80, 8/6/80

Introduction

The Moore Creek drainage is a 3 mile, perennial tributary of the WFSR, located in T. 19 and 20 S., R. 9 W., S. 2, 3, 9, 11, and 34. Moore Creek and six of its tributaries are of significant fisheries importance. These tributaries will be included in this report. Present aquatic species of principal economic and esthetic importance include Coho Salmon, steelhead trout, and Cutthroat Trout.

Terrain of Surrounding Area

The terrain of the banks of Moore Creek is varied. A road on the right bank of the creek extends the entire length of the creek up to the headwaters and encroaches upon the stream channel in many areas. Terrain around the mouth of the creek is flat to moderate and the stream gradient is flat. The middle of the stream reach, the slopes are moderate to steep, as is the gradient of the stream. At the headwaters, the stream has a steep gradient and the side slopes are also steep (60-70% grade).

Substrate Composition

Rubble, cobble, boulders, bedrock and silt dominate the lower reaches of Moore Creek. There are a sparse number of shallow pools, primarily in the sheet bedrock. The middle section has a mixture of all substrate types and there are good spawning gravels available. The upper reaches show evidence of scouring and there are large jams holding significant quantities of gravel behind them.

Streamside Canopy

Riparian Canopy makeup in order of dominance:
Alder (*Alnus rubra*)
Vine maple (*Acer circinatum*)
Willow (*Salix spp.*)
Thimbleberry (*Rubus parvifloras*)
Huckleberry (*Vaccinium spp.*)
Salmonberry (*Rubus spectabilis*)
Douglas-fir (*Psedutsuga menzesii*)
Western redcedar (*Thuja plicata*)
Hemlock (*Tsuga heterophylla*)
Big-leaf maple (*Acer macrophylum*)

Much of the vegetation along the course of Moore Creek has been logged within the last 6-10 years. Young, red alder are the dominant streamside over story. Vegetative coverage of the mainstem is 90%+.

Population and Habitat Condition

Cutthroat Trout were observed throughout. Coho were observed from the mouth up to the jam at yard 1,767. Steelhead were observed from the mouth up to the jam at yard 2,217 except in the section from yard 1,167 to yard 1,937.There is adequate habitat to support fish and aquatic invertebrate populations. The mainstem does not have ample supplies of gravel suitable for salmonid spawning and rearing, although a good mixture of spawning gravel, rubble, and woody debris is present to some capacity. Certain sections of the stream are ephemeral with intermittent pools of standing water. In the lower section of the stream, there are long reaches of bedrock with few, shallow pools. The discharge was too slight to measure during the period of low flow.

West Fork Smith River – Subwatershed Analysis (1997)

Introduction

In 1997, the Bureau of Land Management (BLM) performed a subwatershed analysis on the West Fork Smith River (WFSR). The BLM manages 11,587 acres (68%) of the 17,045 acre subwatershed and their management area lies within the BLMs Coos Bay District, Umpqua Resource Area, northeast of Reedsport, Oregon. The analysis was conducted in order to characterize the human, aquatic, riparian, terrestrial features, conditions, processes, and interactions within the watershed. The information provided by the analysis could be used to develop future Environmental Assessments (EA) under the BLMs existing management plan. The key areas of environmental assessment outlined in the analysis were hydrology, erosion processes, vegetation, species and habitats, and human uses. The analysis went further, providing recommendations which can be considered during EA development, project planning, and recommendations which serve to stimulate internal discussion on a second generation ecosystem management plan.

Current Condition

Hydrology

The WFSR is a 6th order tributary to the Smith River and contains 184 miles of stream, with a drainage area of 17,045 acres. The 5 major tributaries of the basin are, Coon Creek, Crane Creek, Moore Creek, Beaver Creek, and Gold Creek. The stream network is a rain-fed hydrologic system that receives an average of 95 inches of annual precipitation. Approximately 80% of annual precipitation occurs between October and March and contributes to extreme fluctuations in stream flow over short periods of time. These "flashy" hydrologic events are indicative of the Oregon Coast Range which is characterized by steep headwall areas, narrow valley bottoms, and low groundwater storage and recharge capacities. As little as 1 to 2 inches of precipitation contributes to groundwater discharge due to the shallow, coarse soils and low permeability of the underlying Tyee/Flourney rock formation. Gravel beds that previously existed within the system that may have increased groundwater storage capacities have been washed out during high flows due to a lack of large wood structure in the stream channel. Currently, the majority of pools in the mainstem WFSR have been artificially created by the placement of boulder weirs.

Erosion Processes

The topography of the basin is defined by the three rock formations underlying the watershed, the Flournoy Formation, the Tyee Formation and the Tertiary intrusive Roman Nose Mountain. These formations are characterized by steep, highly dissected terrain, high gradient streams, and narrow floodplains. Flournoy/Tyee rock is very hard, relatively unfractured, and impervious to water. Its low permeability to water greatly reduces the basins groundwater storage. The Roman Nose basalt formation is hard, igneous, basalt which is the parent material for the areas soils.

Gravels derived from these parent materials are transported out of the system due to bedrock channels absent of large wood, or are broken down into fine particles over the course of a few years. Original gravels and large woody debris in the mainstem were likely lost in splash dam torrents and wood removal. The natural recruitment of large wood was severely reduced after the removal of large old-growth timber from the West Fork drainage network, further decreasing the ability for streams to accumulate gravel beds.

Mass Wasting

Slope failure in this vicinity is related to ground disturbing activities where slopes exceed the angle of the out dipping bedding planes which retain moister longer in the year and readily erode. Landslide hazard analysis showed that 61% of the basin had a moderate (11%) to high risk (49%) for landslide potential. These landslides recruit large volumes of silt, sediment, and other large material into the system over discrete periods of time. Mass wasting also results in heavy fine sediment inputs. Erosion from these events from the early 1960s to 1980s increased dramatically due to land use practices and less restrictive regulations on ground disturbing activities. Timber clear cuts from 70%+ slopes were responsible for much of the drastic increase in landslides due to the loss of stable root networks. Since the mid-1980s, mass wasting has decreased.

Roads

Roads are prevalent throughout the basin, most of which were constructed between the 1950s and 1980s. Of the 182 miles of stream network exists 119 miles of road, largely constructed adjacent to streams on low gradient floodplains; decreasing floodplain area and causing streams to downcut well below the floodplain, restricting connectivity during high winter flows. Cutbanks occurring from road grades are an added source of fine sediment input into the drainage system, particularly from road grades that heavily encroach on streams. Many of these roads and landings are overstepped by sidecast materials and occasionally fail during heavy rains. Erosion has been further exacerbated by road construction and increased runoff from road surfaces particularly, those with dirt or rocked surfaces.

Vegetation

The forest of the WFSR is in the Western Hemlock Zone (Franklin and dryness 1973). Most stands are younger than 80 years due to logging, road building, and land clearing operations. Trees exceeding 80 years of age came in after fires which have since been suppressed. Riparian Reserve composition ranges from alder-dominated stands to old growth conifer stands. Riparian buffers in BLM managed areas have been left along third order and larger streams to provide habitat and ecological stream functioning processes. In private industrial land riparian areas, these buffers are generally narrower with a smaller proportion of older trees remaining. In all areas where timber harvest and road building occurred, riparian areas are dominated by red alder with an understory of salmonberry. Though these low diversity riparian areas are prevalent, the riparian plant diversity in this area is higher than surrounding subwatersheds.

Timber blowdown events occur occasionally in the basin. Since the establishment of the BLM Coos Bay District Office, major blowdown events took place in 1951, 1962, and 1975. These events usually occur when strong winds follow a soaking rain and can cover areas greater than 100 acres.

Type maps from the 1950s show numerous small patches of tree kills from insects. These are likely from a population increase of bark beetles following the 1951/52 windstorms. Though occurring in smaller patches that the insect tree kills of the 1950s, aerial photos from 1992 show tree mortalities comprised of 1 to 12 trees, suggesting insect kill is a chronic condition. This event was likely due to the weakening of trees from laminated root rot and kills from bark beetles. Other beetle species and pathogens such as blackstain have also been known to kill small trees but are not known to cause widespread mortalities.

Forest disturbances forming overstory canopy gaps allow for conifer regeneration, although shrubs and hardwoods can also respond and ultimately outcompete them.

The Roman Nose grassy bald is characteristic of other natural meadows occurring on the upper part of mountains throughout western Oregon. These are usually due to more frequent fires, as fires tend to move uphill. Tree seed sources tend to be limited by fewer surviving trees from frequent fires and the movement of seed downhill. This allows for the growth of a grass bald. From 1952 to 1992, the Roman Nose grass bald has decreased from 30 acres to 5 due to tree encroachment. Tree encroachment is characteristic of meadow reduction unless disturbances, such as fire, suppress tree establishment.

Early surveys in 1878 (Thiel) indicate the presence of a 14-inch Oregon ash and one large mature cottonwood on the WFSR. These species may have been part of the riparian forest on the WFSR floodplains before early settlers cleared the land.

Fire/Fire Suppression

Current stand replacement processes are timber harvest and reforestation. Historically, fire played an important role in the forests succession; however, fire suppression efforts have greatly restricted its influence. Evidence reveals that 6 fires occurred in the basin between the years of 1651 and 1892. The average frequency of these disturbance events was approximately every 48 years. Lack of fire during the 20th century has allowed stands to mature beyond 123 years, which were likely rare between 1651 and 1892. Due to the frequency of fires in the basin, trees older than 200 years were present but not common and would be scattered throughout as individual trees or in small stands. Tree stands exceeding the 200 year age class were more abundant in the 1970s as these trees would have been the result of natural regeneration following the 1769 fire. Older trees are often found in riparian areas as stream buffer regulations restricted their removal and only the most extreme fires kill trees within the riparian areas in the basin.

Plants and animals on the coast range evolved in an ecosystem where fires created a diverse landscape of burned and unburned patches while altering vegetation structure and composition. The degree to which naturally occurring fires altered these structures, fragmented populations, and altered successional stages of plant communities varied due to fire intensity. The suppression of fires has led to an increase in fire-intolerant species (e.g., western hemlock, true fir species, and hardwood), altering stand structure and forest function. Large snags, which provide wildlife habitat, are recruited through wildfires. With a reduction in intensity and frequency of these events, there is no longer a mechanism for the recruitment of large snag stands.

Stream Channels

The mainstem WFSR is dominated by fast water habitat types, making up 62% of habitat with a remainder in scour pools (27%) and backwater pools (11%). Only 6% of pools exceed 1 meter in depth. Substrates in the mainstem vary and are composed of bedrock (45%), sand and organic sediment (7%), and gravels (35%). The lower 11 miles of the mainstem are bedrock dominated while the upper 4 miles are comprised of mostly gravels. This is likely due to the lack of large woody debris in the lower mainstem. In 1997, wood in the mainstem ranged from 7 to 26 pieces per 100 meters, considered poor to good by ODFW benchmarks. Percent shade cover over the stream ranged from 77 to 92% with the overstory primarily hardwood species. Only one section surveyed had a riparian cover comprised primarily of conifer species. Of the 43.5 miles of WFSR Basin surveyed in 1957, 9.5 miles (22%) were considered spawnable for salmonids, although this was likely an underestimate due to the difficulty to define spawning areas during low summer flows.

Aquatic Organisms

Fish species inhabiting the WFSR include Coho, Chinook, steelhead, Cutthroat Trout, four sculpin species, Brook Lamprey, dace, amphibians, and large numbers of aquatic invertebrate species.

A good presence of adult Coho in 4th and 5th order tributaries has been shown through spawning surveys. General field observations note large numbers of juvenile Coho, although juvenile surveys are limited. ODFW designated a one mile stretch of Beaver Creek as a Coho index stream due to its high quality salmonid spawning habitat. Surveys on Beaver Creek began in 1958 with an average adult peak Coho count of 22, half of ODFWs goal of 40 fish per mile.

Prior to the instalment of a fish ladder by ODFW around Smith River Falls in 1977, Chinook Salmon were only present below the falls and in the North Fork Smith River. In 1984, the Salmon Trout Enhancement Program (STEP) released approximately 40,000 Chinook fry per year with the goal of expanding the species current range. Chinook adults have mostly been noted in the mainstem WFSR as the smaller tributaries do not offer suitable spawning habitat for larger fish.

Steelhead and Cutthroat Trout data is very limited, as their spawning seasons occur after Chinook and Coho surveys end. These species tend to spawn in the 3rd and 5th order tributaries. Sea-run Cutthroat Trout population levels are declining throughout the Umpqua Basin as they are discernable from resident Cutthroat and they often interbreed.

Salmonid spawning and rearing habitats are predominantly located throughout 3rd and 5th order streams throughout the basin. 2 miles of potential spawning and rearing habitat on the mainstem WFSR exist within areas where stream enhancement structures have been previously placed. These enhancement structures appear to provide good spawning habitat throughout the winter and rearing habitat in the spring and summer. Freshwater mussels had also been observed in the vicinity of these stream enhancement structures. Aquatic organisms, such as amphibians and invertebrate species, rely heavily on complex channel systems with adequate substrate beds. In portions of stream like the mainstem WFSR, which are bedrock dominant, these aquatic populations are greatly simplified.

Human Uses

Prior to the 1830s, the Kalawaset, two branches of the Coos (Miluk and Hanis), and the Siuslaw lived in the area for thousands of years. The only record of Euro-American inhabitants in the WFSR at the time was 5 homestead residences and 1 splash dam. The earliest logging in the watershed was associated with these 5 homesteads, where residences cut sawlogs for a living. Trees that survived the 1769, 1849 and 1892 fires would have been the only trees large enough to have much value in the 19th century market and were likely the main source of early timber harvester income. Splash damming was employed throughout the WFSR Basin around the turn of the century. Prior to splash damming, large wood was removed from the mainstem WFSR. In the 1960s to 1980s, excessive logging debris was left in tributary streams, however, stream cleaning operations in the 1970s resulted in the removal of logging slash and naturally occurring wood in the lower reaches of the tributaries. These practices led to a lack of large wood in the basin. Major tree harvest began in 1950, but remained slow until around 1980. In the late 1970s and the 1980s, logging patterns changed, setting aside old growth stands for spotted owl habitat.

Although relatively minor when compared to surrounding watersheds, current human uses in the basin include camping, hunting, special forest products harvesting, rock quarrying, and some fishing. The majority of these activities take place near the paved mainstem road (20-09-27.1) and the Roman Nose Tie Road (19-08-29.1). Traffic on these roads is very low and primarily consists of BLM and Roseburg Timber Company to access timber harvest lands or the active quarry located on Roman Nose Mountain. Some communication companies that lease land at the Roman Nose Communication Site on Roman Nose Mountain use these roads as well.

Recommendations

Erosion Processes

Riparian Reserves providing protection to intermittent streams from surface erosion, may need to be widened as widths intended to meet the Aquatic Conservation Strategy do not take into account the benefits of wider riparian buffers to non-riparian-dependent animal species. Widening of Riparian Reserves beyond Forest Ecosystem Management Assessment Team (FEMAT) ecological protection widths may be beneficial in areas where known, or suspected to be present species occur. Stream areas with a high hazard for landslides should be considered for Riparian Reserve widening while Riparian Reserves that expand beyond the drainage of the creek they are intended to protect may be reduced.

The road fill on the Church Creek floodplain ((19-8-31.0) T19S, R8W, S31NW) should be removed. The decommissioning of long roads identified through the Transportation Management Objectives (TMO) could be converted to foot trails for administrative, fire control, and recreational purposes. Remaining portions of decommissioned road bed can be used to build these foot trails. All roads considered for temporary closure should have self-maintaining ditch lines that are not contributing sediment into streams.

All culverts that do not meet the 100-year flood event standard, or do not meet fish passage requirements on fish bearing streams should be removed or replaced with appropriately sized stream crossings. Grade culverts should also be assessed in order to determine whether they are in need of replacement.

Hydrology

Water quality monitoring should be maintained in order to continue long term water quality data sets. Trend data will be used to evaluate the effects of future management activities on streamflow, water temperature, and turbidity. Water quality should meet or exceed ODEQ standards for nonpoint source pollution and temperature. Channel stability and morphology should be monitored through the establishment of permanent channel cross sections.

Vegetation

Begin meadow restoration of the Roman Nose Grass Bald following the Late-Successional Reserve Assessment through management triggers, management criteria, and the appropriate activities. Through the use of the earliest available aerial photos, type maps, and survey notes, the former boundary of the meadow should be reestablished.

Riparian conifers should be reestablished to provide future large woody debris recruitment. Riparian alder conversions should be carried out in areas with no evidence of recent or potential landslides as these areas may have historically had alder dominated stands due to frequent disturbance. Alders cut during riparian conversion should be placed into the stream for structure and hiding cover. Growing space for conifer release should take priority over existing conifers in hardwood dominated riparian stands; however, bigleaf maple, cottonwood, willow, and existing vigorous conifers should remain unless necessary. Red alder sites should be maintained in areas where periodic, naturally occurring disturbances persist. During riparian conversion projects, water temperature should be monitored as the alteration of canopy cover may increase light penetration to the water's surface.

Where appropriate, manage for large woody material to be recruited to the stream structure to provide hydrologic function and aquatic habitat complexity.

As stands reach 80 to 100 years, underburns, or treatments that mimic the effects of underburns will be necessary for understory regeneration and snag recruitment. The stated objectives for underburns in the subwatershed include recruiting snags, creating small gaps, preparing a seed bed for recruiting understory trees, setting back vegetation competition to allow understory trees to get established, improving browse quality, and leaving 50% to 80% stocking of green trees in the overstory to allow for additional underburn treatments 50 to 75 years in the future.

Species and Habitats

<u>Vegetative Species and Habitats</u>

Restoration projects may include soil stabilization along roads and bridges, seedlings for wildlife forage, and restoring native habitats. Native plant materials should be acquired so that adequate native plant material is available for these projects.

GIS/Micro-Storms and other computerized methods for recording noxious weed site data needs to be developed and implemented where the depository of data can be collected, and updated for use in pin-pointing locations, map making, noting histories and treatments, and monitoring. Inventories developed from these data will be used for prioritizing treatment of areas for potential infestation or spread. Efforts should be concentrated on eliminating, containing, and preventing the spread of gorse and brooms already present. New infestations should be treated at the first appropriate treatment window. Inspection of equipment, fill dirt and gravel sources, and reseed stock is needed in order to mitigate unintentional spread of noxious weed species.

Aquatic Species and Habitats

Stream habitat inventories show a need for increasing riparian conifers and large woody debris in the stream channel for:

Mainstem WFSR	Reach 1, 3, 4, 7
Coon Creek	Reach 1
Crane Creek	Reach 1
Moore Creek	Reach 1, 2, 3
Beaver Creek	Reach 1, 3
Gold Creek	Reach 1, 2

Protection of the stream channel and riparian function in Reach 2 of Beaver Creek was also recommended.

Instream enhancement of the reaches listed above might be carried out through tree pulling, and/or placement of boulder fields, and the placement of rootwads or other related structures.

Human Uses

Develop and approve a prescribed burn plan.

Project Name	Year	Type	Organization	Location	Gabions	Boulder Weirs	Boulders	Tree w/ Root Wads	Cut Logs	Fish Ladder	Culverts replaced	Culverts removed	Stream Miles Opened	Instream Miles Treated	Cost	In-kind (OWRI)	Notes
Smith River Falls Jump Pool	1938	Fish Passage	Oregon Fish and Game Commission	Mainstem Smith River													Dynamite used to lower the falls. Prior to that steelhead could only pass the falls and create a jump pool to allow for fish passage, prior to this passage upper reaches of river would have been trout stream absent of salmon.
Coon Creek Fish Passage - Part 1	1969	Fish Passage	BLM	Coon Creek						1							Prior to 1969, U-shaped concrete pool was built below culvert entrance to Coon Creek
Gold Creek Fish Passage	1968	Fish Passage	BLM	Gold Creek						1					$ 2,058.00		Concrete sills installed in mainstem below mouth to backwater culvert, fraction of cost of replacing culvert.
Crane Creek Fish Passage	1969	Fish Passage	BLM	Crane Creek						1							Concrete sills installed in mainstem below mouth to backwater culvert, fraction of cost of replacing culvert.
Smith River Falls Fish Ladder	1971	Fish Passage	Oregon Fish and Game Commission	Mainstem						1							Ladder constructed around the falls allowing all migrating fish species to swim around the falls and access upstream habitat
Coon Creek Fish Passage - Part 2	1972	Fish Passage	BLM	Coon Creek						1							Concrete sills or weirs built below Coon Creek to backwater the culvert to increase fish passage
Crane Cr Fish passage	1979	Fish Passage	BLM	Crane Creek											$ 40,000.00		Log removal of extensive log jam formed from logging debris and failed tributary culvert
Crane Creek Culvert Replacement - Part 1	1979	Fish Passage	USFS	Crane Creek							1						Culvert replacement
Gold Creek Culvert Replacement	1979	Fish Passage	BLM	Gold Creek							1				$ 35,000.00		Culvert replaced
Beaver Creek Channel Restructuring	1980	Instream Habita	BLM	Beaver Creek													Channel restructuring with logs, boulders and blast pools (yes they used dynamite)
Beaver Creek Culvert Replacement - Part 1	1980	Fish Passage	BLM	Beaver Creek							1						Culvert replaced
Gold Creek Fish Passage	1981	Insteam Habitat	BLM	Gold Creek											$ 7,990.00		10 cedar sills were placed in the creek; blast pools have been made but reports not clear
Crane Creek Channel Restructuring	1981	Instream	BLM	Crane Creek											$15,840		Channel restructuring with logs, boulders and blast pools (yes they used dynamite)
Main Stem Gabions	1981	Instream	BLM	Mainstem	10										$ 12,677.00		Wire mesh, cobble-filled gabions placed in main stem; evaluated in 1987 and had accumulated deep gravel beds
Main Stem Gabions	1982	Instream	BLM	Mainstem	24										$ 35,613.53		
Moore Creek Restoration - Part 1	1981	Instream	BLM	Moore Creek											$ 1,100.00		Log jam removal of logging debris
Moore Creek Restoration - Part 2	1981	Instream	BLM	Moore Creek											$ 10,992.00		10 rearing pools blasted out of bedrock; 10 cedar sills constructed to recruit gravel
Moore Creek 3	1981	Instream	BLM	Moore Creek											$ 8,451.00		
Main Stem Boulders 1	1992	Instream	BLM	Mainstem		29									$ 25,000.00		29 of gabions were replaced with boulder weirs due to deteriation; boulders donated by Campbbell group from the Roman Nose quarry
Coon Creek Fish Passage - Part 3	1994	Fish Passage	BLM	Coon Creek							1						Culvert replaced with arch style with flat bottom; 1995 description - "First-year filled in w/gravel"
Main Stem Boulders 2	1994	Instream	BLM	Mainstem		12											Placed in the upper mainstem above influence of major tributaries.
Beaver Creek Culvert	1995	Instream	BLM	Beaver Creek							1						Culvert replacement
Moore Creek Culvert	1995	Instream	BLM	Moore Creek							1						Replaced with arch-style flat bottomed culvert with substrate
Main Stem Boulders 3	1997	Instream	BLM	Mainstem			1862								$ 134,000.00		Implemented but exact project data has not been located
Main Stem Enhancements - Part 1	1999	Instream	BLM	Mainstem		7		13	142								Occurred between 1999-2001
Mainstem tree pulling	2000	Instream	BLM	Mainstem				22							$ 10,715.00		
Moore Creek Road Decommission	2000	Riparian	BLM	Moore Creek				53				16					53 Red Alder were pulled in during road decommissioning
Crane Creek Road Decommission	2000	Riparian	BLM	Crane Creek								7					1.25 mile road along Crane Creek decommisioned

Beaver Creek Road Decommission	2001	Riparian	BLM	Beaver Creek								9					Banks contoured with riprap after road and culvert removal
Main Stem Enhancements - Part 2	2001	Instream	BLM	Mainstem				65									Donated by Roseburg Resources
High Priority Road Decommissioning in Oxbow	2002	Fish Passage		West Fork Smith R								1	1.25		$13,835	$1,250	W.F. Smith River Watershed Analysis; Culverts/structures/fords removed and not replaced; Grass seeding and mulching; Road obliterated, decommissioned, or vacated
Crane Creek Culvert Replacement - Part 2	2003	Fish Passage	BLM	Crane Creek							1				$ 80,560.00		Culvert replaced again to an arch-style flat bottom with substrate
Old Growth log placement	2003	Instream	BLM	Mainstem					1						$ 1,200.00		15-meter long and 2 meter dbh windfall old-growth log was placed in upper mainstem
Church Creek Culvert pull and road decommission	2003	Fish Passage	BLM	Church Creek								1	1.25		$ 15,085.10		Culvert removed. Road bed left but now overgrown.
Phase I	2010	Instream	PUR/BLM	Moore Creek					69						$140,000	?	Extensive wood placement by helicopter
Phase I	2010	Instream	PUR/BLM	Beaver Creek					364						part of above		Extensive wood placement by helicopter
Phase I	2010	Instream	PUR/BLM	Mainstem					15						part of above		Wood placement by helicopter
Oxbow Lake Culvert Replacement	2011	Fish Passage	BLM	Oxbow Lake							1						Meander lake cut-off during WFS road construction; 1.5 acres in size and stream-fed w/outlet under WFS river road
Phase II	2011	Instream	PUR/BLM	Moore Creek					87						$ 708,891.00	$ 293,200.00	Extensive wood placement by helicopter and excavator.
Phase II	2011	Instream	PUR/BLM	Coon Creek					126						part of above		
Phase II	2011	Instream	PUR/BLM	Crane Creek					182						part of above		
Phase II	2011	Instream	PUR/BLM	Church Creek					204						part of above		
Phase II	2011	Instream	PUR/BLM	Unnamed tribs A, B and C					151						part of above		
Phase II	2011	Instream	PUR/BLM	Gold Creek					158						part of above		
Phase II	2011	Instream	PUR/BLM	mainstem					373						part of above		
Phase II	2011	Instream	PUR/BLM	Mainstem		17	2502								part of above		Placed starting above Gold Creek downstream to below Beaver Creek; targeted non-treated reaches between previous-placed boulder weir reaches leaving multiple miles of contiguous boulder-treated main-stem
Phase III	2013	Instream	PUR/BLM	Mainstem		41	8,500							7	$ 729,961.00	$ 73,000.00	41 complex boulder weirs with jump pools, footer pilings and downstream boulder clusters were installed over most of the untreated mainstem
Phase III	2014	Instream	PUR/BLM	Mainstem				30							part of above		30 old-growth Douglas Fir cabled in w/ root wad
TOTAL					34	106	12864	183	1872	5	8	34	2.5	7	$ 2,028,968.63	$ 367,450.00	