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History, Ecology and Restoration Potential of Salmonid Fishes in the Umpqua River, Oregon

by:

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B.S. The University of Montana, Missoula, Montana, 2005

Presented in partial fulfillment of the requirements

For the degree of

Master of Science  
in Organismal Biology and Ecology

University of Montana  
Missoula, MT

August, 2012

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## Abstract

Coates, Kelly M.S. August, 2012

Organismal Biology and Ecology

History, Ecology and Restoration Potential of Salmonid Fishes in the Umpqua River, Oregon

Chair: Jack A. Stanford

Salmonid populations are decreasing across their historic range in the Pacific Northwest, and throughout the lower 48 states. This study incorporates a retrospective analysis of historical literature, traditional ecological knowledge as well as current ecology to determine historic salmonid abundance in the Umpqua River, Oregon and current conditions for salmonids in the context of wild salmonid restoration. Results for the Umpqua were compared to other Pacific Rim Rivers. The history of the basin and impacts to the river including settlement, agriculture, logging, mining, dam building, hatchery supplementation and non-native species introduction were reviewed. Decreases in runs were compared to impacts to the river over time to determine the impact that had the largest effect on salmonid abundance. Although anthropogenic impacts have occurred throughout the river basin, the most detrimental impact to wild salmonids was overharvest in the late 1800's and early 1900's. Freshwater habitat metrics were sampled to determine impacts to salmonid sustainability in the basin, and possible restoration opportunities. The metrics examined were: juvenile salmonid density, non-native fish species, water chemistry, temperature, aufwuchs, benthic invertebrates, stable isotopes of  $\delta N^{15}$  and  $\delta C^{13}$ , and landscape scale attributes. All metrics were compared to those of other Pacific Rim rivers. Within the Umpqua River system, juvenile salmonid density was highest in the North Umpqua. Overall, juvenile salmonid density for the Umpqua River was comparable to pristine floodplain rivers across the Pacific Rim. Non-native species and hatchery influences have a detrimental effect on wild salmonids, and more research should investigate possible impacts. While water chemistry is not apparently limiting salmonid sustainability in the Umpqua River, water temperatures are above lethal limits in months of July and August. Marine nitrogen ( $\delta N^{15}$ ) signals were highest in the Main Umpqua River, and may be compounded by agriculture, however further studies are necessary to determine agricultural influence. Restoration recommendations for salmonids in the Umpqua River include a basin wide conservation and restoration plan that addresses the underlying problems of habitat fragmentation and degradation, and high water temperatures. Addressing these issues will inform restoration possibilities for related habitat concerns including the amount of available spawning habitat, available gravel for spawning and proper incubation and growing conditions for juvenile salmonids and lamprey. Given the legacy of overharvest in the basin, careful examination of the impact of increasing the limit of wild salmon and steelhead harvest to various stocks is also necessary.

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# History, Ecology and Restoration Potential of Salmonid Fishes in the Umpqua River, Oregon

## 1.1 INTRODUCTION

Decline of salmonid fishes in the Pacific Northwest is a global concern. Salmon are now extinct in almost 40% of the rivers in Oregon, Washington, Idaho and California, where they historically spawned (Lichatowich 1999). Since the turn of the 20<sup>th</sup> century the productivity of salmon in the rivers of Oregon, Washington, California, and Idaho has declined by approximately 80% as riverine habitat has been destroyed (Lichatowich 1999). Poor land use practices usually associated with mining, logging, road construction, fire suppression, livestock grazing, dams, irrigation and flooding have constrained or seriously damaged salmon habitat in Pacific Northwest rivers. Consequently, degraded habitat can have lasting negative effects such as: decreased water quality, changes in riparian plant associations, isolated fish populations and altered flow and sediment patterns (Wissmar 2004).

Native Americans, including the Cow Creek Band of the Umpqua Tribe, historically lived along the banks of the Umpqua River in Southwestern Oregon, and depended on the salmonids and lamprey that lived in the river for their survival. Unfortunately, like most rivers in the Pacific Northwest, salmon runs in the Umpqua have declined over time (Meengs and Lackey 2005, Drake and Naiman 2007). Of 214 wild salmon stocks identified as at risk of extinction in the Pacific Northwest, those that use the Umpqua included: sea run cutthroat trout (*Oncorhynchus clarkii clarki*); chum (*Oncorhynchus keta*); coho (*Oncorhynchus kisutch*); and spring Chinook (*Oncorhynchus tshawytscha*) in the South Umpqua River (Nelsen 1991). In the North Umpqua River, winter steelhead (*Oncorhynchus mykiss*) and coho salmon were determined to be of special concern, summer steelhead were considered at moderate risk, fall Chinook salmon were considered at high risk, and coastal cutthroat trout were determined to be at very high risk of extinction (Allendorf et al. 1997). Historically, the large abundance, predictability and distribution across the West Coast of North America made salmon an important part of native peoples existence (Dose 2009). Today, salmonids are still an important part of Native American culture, but as a result of declining numbers they are no longer relied upon for survival.

## **1.2 OBJECTIVES**

The purpose of this study was to examine restoration and conservation potential for wild salmonids and lamprey in the Umpqua Basin. To accomplish this, we performed a retrospective synthesis of existing scientific and historic literature, and incorporated the knowledge of local people. The objective of the retrospective analysis was to examine the history of salmonid fisheries in the context of the legacy of anthropogenic influences and determine likely causes for declines in numbers of salmonids, based entirely on existing data and publications. In addition, we examined current conditions in the North, South and Main Umpqua Rivers in an effort to determine factors that may be limiting salmonid production in the system. The objective of the study was to determine the current condition of salmonid habitat in the mainstem North, South and Main Umpqua Rivers (referred to as the North, South, and Main) and identify factors that are potentially limiting the native anadromous fishery, and to address problems indentified in the context of restoration and conservation of wild salmonids. We collected and synthesized information on juvenile salmonid densities, water chemistry, water temperature, aufwuchs, benthic invertebrates, stable isotopes, and landscape scale attributes. We then compared the data we collected to a suite of salmon rivers across the Pacific Rim to determine similarities and differences between the systems and inform conservation and restoration opportunities.

## **1.3 SITE DESCRIPTION AND BASIN HISTORY**

The Umpqua River is located almost entirely in Douglas County, Oregon, in the southwestern portion of the state. The Umpqua has fringing gravel bars only in the most aggraded areas, and has few, narrow gravel bed flood plains that characterize the more productive salmon rivers of the Pacific Rim (Luck et al. 2010). The physiography of the three mainstem river sub-basins, the North, South and Main Umpqua differs substantially, so herein these are treated as unique regions of the catchment (Figure 1, Abell et al. 2000). The headwaters of the North and South Umpqua Rivers begin in the Western Cascade Mountain terrestrial ecoregion, in the central and southern Cascade forest (Ricketts 1999) where the land surface form is comprised of high mountains, and is part of the Oregon Lakes aquatic ecoregion (Abell 2000). The channel slopes are about 20% where the relief exceeds 914m (Hughes 1987).

Part of the South Umpqua River is located in the Klamath Siskiyou Forest (Ricketts 1999) in the southern portion of Douglas County. The rivers flow through the town of Roseburg, located in the Umpqua Valley, and join to form the Main Umpqua River. The South Umpqua begins as a constrained bedrock river, but flows through open valleys that have a few areas of floodplains and gravel bars. The North Umpqua is mostly a constrained bedrock river with few gravel bars. The Main Umpqua River flows through the Coast Range Mountain terrestrial ecoregion in the Central Pacific Coastal Forest (Ricketts 1999) where the land surface form is low mountains, and a relief of 305 to 914 m (Hughes 1987) and lies entirely within the Pacific mid-coastal ecoregion. The Main Umpqua River is mostly a constrained bedrock river that opens into an estuarine floodplain near its mouth. The mouth of the Umpqua River is located at the town of Reedsport, on the Pacific Ocean. The South Umpqua sub-basin area encompasses 4,669km<sup>2</sup>, the North Umpqua sub-basin areas is 3,502km<sup>2</sup> and the Main Umpqua sub-basin area is 11,005km<sup>2</sup> (RAP 2010) (Figure 1-1).

A remote sensing analysis of river geomorphology produced a geospatial data base that examines a suite of metrics that was used to compare the Umpqua River with other rivers around the Pacific Rim in the context of salmon habitat (Luck et al. 2010) This data base is the product of the Riverscape Analysis Project (RAP) at the Flathead lake Biological Station (Whited et al. 2012, <http://rap.ntsg.umt.edu/>). The RAP metrics included river attributes such as the numbers of floodplains, nodes of channel separation and returns, sinuosity, and the number of lakes in the watershed. RAP ranks salmon streams for salmonid productivity based on those measures. Out of over 1500 watersheds and over 30 metrics examined, the Umpqua watershed, including the North, South and Main Umpqua Rivers, has an overall ranking of 582 for salmonid sustainability (RAP database). The Umpqua is the 201st largest river basin overall (>1,000km<sup>2</sup>), and is ranked 165<sup>th</sup> for overall salmonid production potential in the RAP database. The Umpqua ranks low based on RAP metrics as a result of its geomorphology. The Umpqua River is mostly a constrained bedrock system, with limited but important segments having floodplains and nodes of separation and return. Higher ranking watersheds exhibit extensive floodplain attributes, and thus increased salmonid habitat. The South Umpqua has a total of 20 floodplains and 84 tributaries compared to the North which has 11 floodplains and 59 tributaries. The Main

Umpqua sub-basin (separate from the North and South Umpqua sub-basins) has more tributaries (220) and floodplains (60) compared to the North and South sub-basin (<http://rap.ntsg.umt.edu/>).

Thirty-seven fish species are reported in the Umpqua River system, and twenty of them are native (Table 1-1). Currently there are anadromous runs of summer and winter steelhead, spring and fall Chinook, coho, coastal cutthroat trout and Pacific lamprey (*Entosphenus tridentatus*) in the Umpqua Basin. Run timings for these species vary (Figure 1-2). Runs of coho, winter steelhead, spring and fall Chinook, cutthroat, and Pacific lamprey also occur in the South Umpqua. Coho, summer and winter steelhead, spring Chinook, cutthroat, and Pacific lamprey are found in the Main Umpqua River as well (ODFW1992). Thus, anadromous runs of fish enter the river during every month of the year. These species have current and historic importance to Native Americans, and the local community.

## **1.4 METHODS**

### **1.4.1 Historic literature review**

To assess historic salmonid population declines over time, and historic impacts to the Umpqua River that may have affected salmon and steelhead populations, an extensive literature review was conducted of historic published and un-published agency data, published peer reviewed scientific papers, and published local ecological histories. Cannery pack data and fish counts from agency reports and scientific papers were reviewed to determine increases or decreases in run sizes.

### **1.4.2 Traditional and local ecological knowledge**

Traditional Ecological Knowledge (TEK) and Local Ecological Knowledge (LEK) can help fill the gaps in historic data and clarify historical accounts of watershed or fisheries conditions. TEK and LEK refers to the experience and insights acquired through extensive observation of an area or a species (Huntington 2000). This may include knowledge passed down in an oral tradition, or shared among users of a resource (Huntington 2000). For

ecologists, TEK and LEK offer a means to improve research, resource management and environmental impact assessment. Semi-directive TEK interviews (interviews conducted in person with a set of pre-determined questions; Huntington 2000) were conducted with three tribal elders from The Cow Creek Band of The Umpqua Tribe of Native Americans. Semi-directive LEK interviews were also conducted with three long term local residents that have lived, worked and fished on the Umpqua River for 30 or more years. TEK methods followed Close et al. (2004). Individual interviewees were chosen based on the amount of time they had lived in the basin, and their familiarity with the Umpqua River. The TEK and LEK interviews focused on questions about locations of traditional fishing sites, known salmonid spawning areas and notable changes to the river over time (Appendix A).

### **1.4.3 Current literature review**

Information about current adult salmonid and lamprey counts, non-native fish species, and hatchery practices were obtained from the Oregon Department of Fish and Wildlife's Roseburg, OR office and the Rock Creek Hatchery Operations Plan (ODFW 2009). Fish counts from Winchester dam on the North Umpqua River were reviewed for trends in adult counts over time. In addition, the annual count of spawners in the context of their potential contribution of marine derived nutrients was calculated for the North Umpqua River. This analysis is based on previous studies which observed a strong correlation between adult counts and marine derived nutrient proxies in riparian vegetation (Bilby et al. 1996, 2003; Thorpe et al. 1998; Helfield and Naiman 2001; Mathewson et al. 2003; Hicks et al. 2005; Naiman et al. 2010). Rivers with high marine derived nutrients had higher numbers of adult salmonids, were more fertile and therefore more productive (Morris 2012 manuscript). Information on non-native fish species presence and absence, and overall use of the river system is important for determining habitats where non-native fish are located, and if those habitats overlap with salmonid habitat use. Non-native fish species, such as the smallmouth bass that inhabit the Umpqua, have increased in number over time since they were first introduced into the Umpqua River (ODFW 2009) and can have negative effects on salmonid sustainability such as, habitat competition, predation (Tabor et al. 1993, Sanderson et al. 2009) and ecosystem alterations (Stouts et al. 2010). An increase in the number of non-native predatory species such as smallmouth bass may have an impact on juvenile

salmonid survival, and consequently adult return rates. Electrofishing events were used to indicate presence or absence of smallmouth bass. Information on hatchery releases and counts in the Umpqua were reviewed to parse out the numbers of wild fish and hatchery fish in the system. Hatchery bred fish in the Umpqua are used as a tool for salmon recovery and to increase the numbers of harvestable fish available for sport fishing (ODFW 2009). It is important to understand hatchery practices in the Umpqua in the context of wild fish restoration. Additional information regarding current ecology of the Umpqua River basin was obtained from agency reports (ODEQ 2006, ODFW, 2005, and Stout et al. 2011).

#### **1.4.4 Site selection**

Each sampling site was located on a main channel gravel bar or shallow bedrock shelf that was approximately 200 m in length. Sampling mainstem sites allowed comparison of the data with that for other mainstem sites sampled on rivers across the Pacific Rim as part of the RAP. Sites were sampled from May through October of 2008 and 2009. Field sites consisted of three sites on the Main Umpqua River, and four each on the North and South Umpqua Rivers. Sites were chosen based on geomorphological characteristics, and complexity for comparison with other RAP rivers. The Umpqua River is a constrained bedrock system, and sites were chosen that had gravel bars, or a shallow bedrock shelf that are used as refuge and rearing areas for juvenile salmonids. Five sites were located in close proximity to known Spring Chinook, fall Chinook, and steelhead spawning areas and six sites were located in areas that were not known spawning areas. Sites extended throughout the entire river system, including headwater reaches and a reach just above tidal influence.

#### **1.4.5 Juvenile salmonid densities**

In order to determine juvenile salmonid densities and document juvenile salmonid use of the main channel shallow shoreline habitat in the Umpqua, three-pass electrofishing for juvenile fish species composition and fish abundance was performed in the summer and fall of 2008 and the spring, summer and fall of 2009. Electrofishing density results were calculated using Bayesian methods (Goodman et al. 2012 in draft). Understanding juvenile salmonid densities

will help determine a baseline in each river fork of fish utilizing main channel habitats for growth and development. Salmonid densities were compared between each of the three river reaches to determine if the North Umpqua had higher densities of juvenile salmonids compared to the South and the Main. Juvenile densities were also compared among other RAP rivers for similarities and differences in the context of restoration potential.

#### **1.4.6 Water chemistry**

Water chemistry samples were measured for nitrate and nitrite, ammonium, soluble reactive phosphorous, total persulfate nitrogen, total phosphorous, dissolved organic carbon, and total organic carbon. Water chemistry samples were analyzed at the Flathead lake Biological Station's Freshwater Research Laboratory (Polson, MT). An Oakton (Vernon Hills, IL) pH con 10 specific conductance and temperature meter and YSI (Yellow Springs, OH) dissolved oxygen and temperature meter were used during water chemistry sampling events for point measures of conductivity, pH, and dissolved oxygen. Measurements of pH were not taken for the summer of 2008. Water chemistry samples were analyzed at the Flathead lake Biological Station's Freshwater Research Laboratory. Water chemistry and temperature results were compared with current standards for salmonid sustainability (ODEQTMDL 2006).

#### **1.4.7 Water temperature**

Temperature loggers were installed in the summer and fall of 2008 and recorded hourly at three locations upriver, mid -river and down river on each of the river forks. Temperature results were compared with current standards for salmonid sustainability (ODEQTMDL 2006).

#### **1.4.8 Aufwuchs**

Periphyton (aufwuchs) were sampled to provide a proxy for primary productivity in the river. Sampling occurred at each site by collecting 3 rocks at 5 m points along a 20 m transect and scraping a 2cm<sup>2</sup> area of each of the three rocks onto an ashed filter for a total of 5 samples per site, aufwuchs sampling results are from summer and fall of 2008. Carbon to nitrogen ratios



(C:N) were determined from the aufwuchs samples which were used as proxy for primary productivity within the river (Hauer and Lamberti 2007). Aufwuch samples were also analyzed for a mass measure of grams of carbon to get an estimate of the quantity of algal biomass. Aufwuch samples were processed at the Flathead lake Biological Station's Freshwater Research laboratory (Polson, MT).

#### **1.4.9 Benthic invertebrate density and biomass**

In order to examine biological conditions of the river, benthic invertebrate sampling was performed using a kick net downstream from a 0.5 by 0.5m<sup>2</sup> frame (Hauer and Lamberti 2007) in 2008 and 2009. Three replicate samples were taken during each sampling event within a riffle section of the river and invertebrates were field picked for species composition and quantity. Samples were later dried and ashed to examine quantity of biomass available for forage at the Flathead lake Biological Station's Freshwater Research Laboratory (Polson, MT). Percent Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa was calculated for samples collected in 2009 using the calculation (total number of Ephemeroptera, Plecoptera and Trichoptera / the total number of organisms in each sample).

#### **1.4.10 Stable isotope composition**

Riparian vegetation and juvenile fish tissues were sampled once during summer 2008 and 2009. Samples were analyzed for the stable isotopes of nitrogen  $\delta\text{N}^{15}$  and carbon  $\delta\text{C}^{13}$  to determine marine nitrogen subsidies.  $\delta\text{N}^{15}$  is used as an indicator of nitrogen sourced from the ocean, and  $\delta\text{C}^{13}$  is an indicator of trophic position within a food web.  $\delta\text{N}^{15}$  results from riparian vegetation were compared between river reaches in the Umpqua to examine if different reaches have a differing  $\delta\text{N}^{15}$  signal.  $\delta\text{N}^{15}$  results were also compared with other rivers from around the Pacific Rim. Dominant riparian plants were sampled at each site including blackberry, (*Rubus* genus) sedge, (*Cyperaceae* family) willow, (*Salix* species) and cottonwood (*Populous* species). Three samples of each of the four dominant species were collected for stable isotope analyses. Juvenile trout fry (cutthroat or rainbow) were opportunistically sampled for  $\delta\text{N}^{15}$  and  $\delta\text{C}^{13}$  from incidental electrofishing mortalities and were compared between river reaches in the Umpqua.

Stable isotope samples were analyzed at the University of Georgia's Stable Isotope Laboratory (Athens, GA). As a result of the increased nitrogen signal found in the Main Umpqua, a Paired Sample T-test for Two Means was performed for samples in 2008 and 2009 by comparing samples taken from sites above agricultural influence and below agricultural influence on the North and South Umpqua Rivers in order to determine if agricultural run-off was influencing the nitrogen signal. The availability of marine nitrogen to a river system can be calculated by converting the counts of returning adult salmon into kg of available nitrogen using the following equation:  $(kg \text{ available N} = (w * f * 0.03) / r_m)$  where  $w$  is the average weight of the fish,  $f$  is the number of returning adult salmon, 0.03 is the standard for nitrogen and  $r_m$  is the number of river miles (Morris et al. 2012 manuscript). Marine nitrogen was calculated for the North Umpqua River.

#### **1.4.11 Landscape scale attributes and comparison to other RAP rivers**

The Umpqua was included in the RAP project and was ranked in comparison to other Pacific Rim rivers based on the physical nature of the river system and watershed. The RAP also analyzed the anthropogenic impact in basin by ranking metrics such as the number of dams, roads and land use in a basin to determine the average Human Footprint Index. (for the full project description and information visit: <http://rap.ntsg.umt.edu/>). The Salmonid Rivers Observatory sampling protocol was used to compare sites within the Umpqua and among RAP rivers (Detailed methods available upon request from the Flathead Lake Biological Station).

### **1.5 RESULTS**

#### **1.5.1 Historic literature review**

Prior to 1800 the Umpqua Valley was home to multiple Native American tribes including the Cow Creek Band of the Umpqua who lived along the banks of Cow Creek and throughout the South Umpqua River (Beckham 1986). Radio carbon dating from the Umpqua-Eden archaeological site on the Main Umpqua River indicates that Native Americans inhabited the Basin approximately 2,980 years ago. This is one of the oldest human settlements known on the

Oregon Coast (Beckham 1986). The Cow Creek tribe was primarily a fishing society, and important camps were established based on available fish resources (Beckham 1986). Historic use of salmon by native peoples can be very informative for determining historic run sizes (Meengs and Lackey 2005, Schalk 1986). Native Americans depended on salmon as a food source and salmon abundance has been used as a predictor of historic aboriginal populations. Meengs and Lackey (2005) determined that the coastal Athapascan (Takilma) and Interior Athapascans, harvested approximately 1,779,896 kilograms of salmon annually during the 1700's. Today, there are not enough salmon in the Umpqua River to support a sustainable subsistence fishery for the Native American Tribes that still inhabit the region.

From 1800-1850, there was extensive European settlement in the Umpqua valley. They were mostly farmers, ranchers, fur trappers and miners (Beckham 1986). The Umpqua basin has a history of log drives, splash dams, extensive timber harvest including clear cutting, hydroelectric projects, hydraulic mining, gravel mining in the mainstem rivers, extensive water withdrawal especially in the South Umpqua sub basin, and non-native species introduction (Oregon Fish Commission 1946, Oregon Water Resources Board 1958, Beckham 1986, Winterbotham 2000, Dose 2001, Geyer 2003, Miller 2010, Wallick et al. 2010, ODFW 2010). Based on Cannery pack data and previous studies (Oregon Fish and Commission 1946, Meengs and Lackey 2005, Drake and Naiman 2007), Chinook salmon runs in the North Umpqua have declined by 63%, coho salmon runs in the Main Umpqua have declined by 85% and overall anadromous runs have declined 63-99% based on species, with coastal cutthroat trout and Pacific lamprey showing the largest declines over time (Winchester Dam Fish Count, ODFW 2009). Historically there were at least twenty different runs of salmonids throughout the Umpqua basin (Roth 1937, Oregon Fish Commission 1946, Winterbotham 2000, TEK and LEK 2009). Today only sixteen runs are present, and of those, coho in all three river forks are considered threatened under the Endangered Species Act. Moreover, there is strong evidence that runs have been routinely overharvested (Oregon Fish Commission 1946, Lichatowich 1999). Commercial fishing in the lower Main Umpqua River and estuary began in the 1850's. Catch rates and cannery pack data indicate periods of heavy commercial fishing in the late 1800's and early 1900's (Oregon State Fish Commission 1946). Cannery operations at the mouth of the Umpqua began in 1878 (Lichatowich 1999). By 1946 there were four fish processing plants in operation

at the mouth of the Umpqua (Winterbotham 2000). Catch records and cannery pack data indicate that by the mid 1900's the Umpqua River Estuary and lower river had been overfished (Oregon Fish Commission 1946). Ocean trolling further decreased populations of anadromous salmonids (Oregon Fish Commission 1946, Mullen 1981). As runs declined with increased fishing pressure, hatcheries were constructed to supplement salmon returns. The first temporary hatchery in the Umpqua was built in 1900 and located on Hatchery Creek, a tributary to the North Umpqua. In 1937, a permanent Oregon Department of Fish and Wildlife fish hatchery was built on Rock Creek, another tributary to the North Umpqua (Winterbotham 2000). Aside from a closure in 1975-1977, the hatchery has remained in operation through present time (Winterbotham 2000, ODFW 2009).

Parts of known historic spawning areas are no longer used, including areas that were once fishing sites of the Cow Creek Tribe. Both Calapooya and Cow Creek watersheds, historic spawning areas for coho Chinook and steelhead (Oregon Water Resources 1958), underwent extensive logging and ranching historically. Cow Creek has also had extensive mining. Hydroelectric projects and water storage dams have contributed to over 41 miles of lost steelhead distribution in the Upper North Umpqua and Cow Creek (Muck 2004). The South Umpqua has consistently had low base flows, further compounded by water abstraction. The loss of water in the river reduced flows and subsequently increased water temperatures to lethal limits during summer months (Oregon Fish Commission 1946). In 1958 the Oregon Water Resources Board published a report describing conflicts between consumptive and non-consumptive water uses in almost all parts of the basin except for the Main stem of the Main Umpqua, and the North Umpqua and indicated water was insufficient to provide for the demands of domestic, industrial, municipal, and irrigation (Oregon Water Resources Board 1958). Since 1931, when consumptive water use began, portions of the South Umpqua experienced flows close to zero (Oregon Water Resources Board 1958).

### **1.5.2 Traditional and local ecological knowledge**

The fishery was a staple of food for all the tribes that lived along the Umpqua. During the salmon runs, Native Americans built weirs across the streams, and put funnel shaped traps woven from hazel shoots into the narrow channels. Men frequently dove for lamprey and used

rolled grass lines and a two-piece bone hook joined with sinew to angle for fish. At this time the streams had crayfish, freshwater mussels, salmon and trout (Beckham 1986). The Native Americans practiced sustainable fish harvest and land management prior to European settlement in the watershed. Native peoples understood the value of selective harvest and letting a large number of salmon return up river to spawn. They would only take enough salmon to sustain the Tribal way of life. This sustainable harvest is corroborated by almost 2,800 years of sustained natural resource use prior to European settlement in the Umpqua. Salmon and lamprey were respected and honored by Cow Creek Tribal members. The Tribe would use certain areas of the South Umpqua River, including South Umpqua Falls to harvest fish. TEK and LEK interviews reflected common themes, such as concerns about increasing water temperatures in the South Umpqua and Steamboat Creeks, loss of large woody debris jams for salmonid and lamprey habitat, agricultural practices such as allowing cattle to access the river, water withdrawals, hydroelectric project construction and increased fishing pressure over time. Interviews also indicated that historically there were more salmonids in the South Umpqua River than there are today, though specific numbers were not ascertainable.

### **1.5.3 Current literature review**

The Umpqua River has one of the strongest summer and winter steelhead runs in the contiguous United States (Huntington et al. 1996). In addition, runs of spring and fall Chinook, coho, coastal cutthroat trout, and lamprey have persisted over time even in the face of human caused alterations to freshwater habitat. In 2009 the run sizes of wild (hatchery and jack counts are in parentheses) anadromous salmonids and lamprey over Winchester Dam on the North Umpqua are as follows: spring Chinook 5,310 (8,951/4,823); fall Chinook, 200 (run not supplemented, 58 jacks); coho 8,233 (682/511); summer steelhead 3,701 (1,292 no jack count); winter steelhead 7,640 (191/no jack count); cutthroat 182; Pacific lamprey 495. Counts for cutthroat trout, winter steelhead and coho are for the period of 2008-2009 (ODFW 2010). Spring Chinook inventories for the South Umpqua in 2008 indicated 215 fish, with an average of 176 spring Chinook returning annually (USFS 2011). Population escapement for South Umpqua fall Chinook were roughly estimated to be 5,622 for 2007 (ODFW 2010). Coho counts for the South Umpqua for 2007 indicated 4,549 wild fish and 682 hatchery (Stout et al. 2010). For 2007, the

Main Umpqua had 5,824 wild coho and 600 hatchery coho. Counts of summer and winter steelhead, coastal cutthroat, and lamprey for the South Umpqua River and counts of summer and winter steelhead, coastal cutthroat, lamprey, and spring and fall Chinook for Main Umpqua Rivers were not available.

Smallmouth bass were introduced into the Umpqua River in the mid 1900's (Winterbotham 2000). Over time the numbers of non-native species have increased. Creel surveys from 1977 indicated a catch rate of .85 bass per hour of effort, in 1988 the catch rate was .96 per hour of effort, and anecdotal information from a fishing guide's creel survey in 1994 indicated a catch rate of 50 bass per hour of effort (ODFW 2008). Smallmouth bass have been documented as abundant in the lower Umpqua River and Cow Creek, and are present in the South Umpqua River and parts of the lower North Umpqua River (ODFW 2010).

There is evidence that the Rock Creek hatchery provides fish for the sport fishery. For 2009 62.77% of the total run of Spring Chinook in the North Umpqua was of hatchery origin, 7.65% of the coho run was of hatchery origin, 25.89% of the summer steelhead run was of hatchery origin and 2.44% of the winter steelhead run was of hatchery origin. In 2009 the Rock Creek hatchery produced spring Chinook for release in the North Umpqua River, fall Chinook for release in the Main Umpqua River, coho for release in the South Umpqua River, summer steelhead for the Main Umpqua River, winter steelhead for the North and South Umpqua Rivers and rainbow trout for release throughout the system in standing water bodies (ODFW 2009).

As a result of declines in counts of coastal sea-run cutthroat trout at Winchester Dam, sea-run cutthroat from the Alsea River hatchery were released below Winchester Dam on the North Umpqua River from 1961 to 1976 (Johnson et al. 1994). Prior to release of Alsea River cutthroat, Umpqua cutthroat had bi-modal run timing with peaks in the summer and fall (Johnson et al. 1994). During supplementation, numbers of adult cutthroat trout migrating above Winchester Dam increased (Johnson et al. 1994). Alsea River fish have a slightly later run-timing than the Umpqua River fish, and a shift toward later run-timing was observed in fish that returned to Winchester Dam during this period of supplementation (Johnson et al. 1994). After supplementation, there was a shift back toward the original run-timing, suggesting a native

component may remain in the current population, although the later peak of the run disappeared (Johnson et al. 1994).

#### **1.5.4 Juvenile salmonid densities**

In 2008, the North Umpqua River had an average juvenile salmonid density of  $0.53 \pm 0.27$  (N=7) salmonids/m<sup>2</sup>, while the South Umpqua had a lower a juvenile salmonid density of  $0.27 \pm 0.20$  (N=7) salmonids/m<sup>2</sup>, and the Main Umpqua River had a relatively low juvenile salmonid density of  $0.06 \pm 0.01$  (N=5) salmonids/m<sup>2</sup>. For 2009, the North Umpqua had a juvenile fish density of  $0.54 \pm 0.47$  (N=10) salmonids/m<sup>2</sup>, the South Umpqua had a lower density of  $0.20 \pm 0.15$  (N=11) salmonids/m<sup>2</sup> and the Main Umpqua had a much lower density of  $0.07 \pm 0.02$  (N=8) salmonids/m<sup>2</sup> (Figure 1-3, Figure 1-4). The predominant juvenile salmonids found in all three river forks were rainbow or cutthroat trout (fish were too young to determine species). Juvenile Chinook were only found during sampling events in the spring of 2009. Electrofishing events showed the presence of juvenile smallmouth bass at two sites on the main Umpqua and one site on the South Umpqua. Bullhead were present at all sites on the Main Umpqua, and one site on the South Umpqua. It should be noted that one site on the North was not included in spring 2009 sampling (except for water chemistry collection) because of high water. The same site was not electrofished in the summer of 2009 as a result of the Williams Creek forest fire.

#### **1.5.5 Water chemistry**

Patterns in water chemistry data were variable (Table 1-2). Overall phosphorous, nitrogen, and pH measurements for all sites meet ODEQ and OWEB thresholds for salmonid suitability and water quality (Table 1-2). Dissolved oxygen measurements in the South Umpqua were below the desired ODEQ standard of 11 mg/L during fall Chinook spawning (ODEQ 2010). For the rest of the year 8 mg/L is considered suitable and the thresholds were met. Higher specific conductance and pH was noted for samples from the South Umpqua compared to the North and Main for both years, and there were increased levels of dissolved oxygen in the North Umpqua compared to the South and Main for both years (Table 1-2). The average point pH measures for 2008 and 2009 for the watershed were within the range considered acceptable for salmonid

waters (Table 1-2). Point measures of dissolved oxygen ranged from 9.0 to 11.3mg/L, and above the minimum criteria for Oregon salmonids of 8.0mg/L (OWEB (2006)).

### **1.5.6 Water temperature**

Two temperature loggers were vandalized on the Main Umpqua River, ultimately resulting in two data loggers for that reach. The loggers were replaced in different locations. Thermal data are primarily for comparison between river reaches, and in the case of the Main Umpqua are imperfect for comparing over time at a specific site. Temperature results indicate that the South Umpqua had the highest recorded temperatures of each of the river forks, exceeding ODEQ temperature thresholds for salmonids for protecting spawning, rearing and migration life stages of salmon and trout (Figure 1-5).

### **1.5.7 Aufwuchs**

Aufwuchs C:N ratios were highest in the South and lowest in the North (Table 1-3). C:N ratios were higher during the summer than during the fall (Table 1-3). C:N ratios are significantly different between the three river forks (ANOVA,  $\alpha=0.05$ ). Carbon was the dominant element found in all aufwuchs samples (Table 1-3).

### **1.5.8 Benthic invertebrate density and biomass**

The North Umpqua River had the lowest average AFDM, the South Umpqua was intermediate, and the Main had the highest AFDM results (Figure 1-6). During the 2008 sampling season all river forks had higher AFDM (mg/m<sup>2</sup>) than in the 2009 season (Figure 1-6). The density of invertebrates per sampling season did not change drastically between years (Table 1-4). Benthic invertebrate density increased in the South and the North from 2008 to 2009, these results may be attributed to increased numbers of samples taken in 2009 when sites were sampled in the spring (Table 1-4). Compared to AFDM results from thirteen other SaRON Rivers, the Umpqua has comparatively low benthic invertebrate AFDM, with only the Inklin River in Northern British Columbia, having a lower AFDM than the Umpqua (SaRON results



2010). Percent EPT taxa indicated that the North Umpqua had a higher percentage of mayflies, stoneflies and caddisflies compared to the South and Main Umpqua Rivers. Percent Ephemeroptera, Plecoptera, Trichoptera (EPT) taxa in 2009 was highest in the North Umpqua and somewhat lower in the South and the Main (Figure 1-7).

### 1.5.9 Stable isotope composition

Stable isotope results for  $\delta C^{13}$  and  $\delta N^{15}$  indicated the riparian plants sampled on the North and South Umpqua Rivers had similar isotopic signals ( $\delta C^{13} = -28.6$ ,  $\delta N^{15} = 0.28$  and  $\delta C^{13} = -28.3$ ,  $\delta N^{15} = 0.13$ ) respectively (Figure 1-8). The Main Umpqua River had a similar  $\delta C^{13}$  signal (-28.8) but had an increased  $\delta N^{15}$  signal (2.30) compared to the North and South (Figure 1-8). Stable isotope signals in riparian vegetation were statistically significantly different between the three river reaches in 2008 for both carbon and nitrogen (ANOVA,  $N=129$ ,  $\alpha=0.05$ ), and in 2009 for nitrogen (ANOVA,  $N=164$ ,  $\alpha=0.05$ ) but not in 2009 for carbon (ANOVA,  $N=164$ ,  $\alpha=0.05$ ; Figure 1-8)

Stable isotope data for juvenile salmonids indicated that juvenile salmonids from the Main Umpqua had higher average  $\delta N^{15}$  signals (compared to the South and the North (Figure 1-8)). ANOVA results for juvenile salmonid fish tissues sampled showed the differences in  $\delta N^{15}$  and  $\delta C^{13}$  signals were significant at  $\alpha=0.05$  ( $N=45$  for 2008 and  $N=62$  for 2009).

$\delta N^{15}$  values of riparian vegetation above and below agriculture influence were compared for the North Umpqua and no significant difference was found in 2008 (paired t-test,  $N=14$ ,  $t=0.58$ ,  $\alpha=0.05$ ) however, there was a difference in 2009 (paired t-test,  $N=10$ ,  $t=2.84$ ,  $\alpha=0.05$ ). Samples compared for the South Umpqua were significantly different (paired t-test,  $N=15$ ,  $t=4.38$ ,  $\alpha=0.05$ ) for 2008 and (paired t-test,  $N=30$ ,  $t=4.15$ ,  $\alpha=0.05$ ) for 2009 indicating sites above and below agricultural influence were significantly different.  $\delta N^{15}$  values of juvenile fish tissue samples from above and below agriculture influence were compared for differences as well. The results for 2008 show neither the North nor South Umpqua were significantly different (paired t-test,  $N=7$ ,  $t=0.77$ ,  $\alpha=0.05$ ) for the North, and (paired t-test,  $N=9$ ,  $t=-0.26$ ,  $\alpha=0.05$ ) for the South. Results for samples in 2009 for the North Umpqua were not significant (paired t-test,  $N=12$ ,

$t=0.14, \alpha=0.05$ ), However results from the South Umpqua in 2009 were significantly different (paired t-test,  $N=10, t=2.55 \alpha=0.05$ ) indicating a difference in sites above and below agriculture.

### **1.5.10 Landscape scale attributes and comparison to other RAP rivers**

Overall RAP results indicated that the Umpqua ranks relatively high among Pacific Northwest lower 48 United States, but ranks lower compared to Alaska, British Columbia, and Kamchatka Pacific Rim rivers, including five Pacific Rim sites for which habitat complexity, water quality, fish density, and marine derived nutrient data are available (Table 1-5) (Hill et al. 2010, <http://rap.ntsg.umt.edu/>). The Umpqua has lower nitrate and ammonium values ( $13.0 \mu\text{g/L}^{-1}$  and  $5.9 \mu\text{g/L}^{-1}$  respectively), and higher soluble reactive phosphorous ( $19.7 \mu\text{g/L}^{-1}$ ) than the other four rivers. It has comparable total and dissolved organic carbon values ( $2.4 \text{mg/L}^{-1}$  and  $1.9 \text{mg/L}^{-1}$ ). The Umpqua has the second highest specific conductance ( $89.7 \mu\text{s}$ ) and the third highest juvenile salmonid density ( $.29 \text{ salmonids/m}^2$ ), and it had the second highest values of Foliar  $\delta\text{N}^{15}$  (0.75). The formula used for calculating the available nitrogen for North Umpqua in 2009 was:  $(5 \text{ kg} * 13,275 \text{ fish} * 0.03\% / 101 \text{ km} = 19.7 \text{ kg/km}$  of marine nitrogen). Figure 1-10 (modified from Morris et al. 2012 manuscript) shows the North Umpqua compared to other Pacific Rim rivers including the Kol River (which has approximately 1000kg of nitrogen/km). Comparatively, the North Umpqua has relatively low amounts of available marine nitrogen.

## **1.6 DISCUSSION**

Restoring fish stocks has become one of the primary tasks of fisheries management (Ebersole et al. 1997). Effective restoration requires a holistic process for restoration rather than isolated manipulation, repair, replacement or mitigation of individual sites (National Research Council 1992). Research priorities should include an understanding of how to restore the natural services provided by waterways, to design ways to naturalize flow in regulated rivers, and slow extinction rates of freshwater species (Palmer 2004). Most restoration projects are small scale (less than 1km of stream length) and information on their implementation and outcome is not readily accessible (Bernhardt 2005). An average of \$1 billion dollars is spent every year on

restoration, and \$14 to \$15 billion has been spent on restoration of streams and rivers within the continental United States since 1990 (Bernhardt 2005). Greater effort is needed to gather and disperse data on restoration methods and outcomes, especially given the high costs associated with restoration projects (Bernhardt 2005). This study reinforces that historically there were greater numbers of salmonids in the Umpqua Basin than there are today and that restoration efforts are necessary to mitigate for anthropogenic impacts.

Historic impacts to wild salmonids and lamprey included agriculture, logging mining, dam building, hatchery supplementation and non-native species introduction. European settlement in the mid 1800's initiated the legacy of agriculture and livestock grazing effects as the first non Native American impacts to the watershed. Many of the areas that were grazed and farmed on the South Umpqua were on floodplains adjacent to the river where stream bank stability and vegetation could have been lost as a result of livestock grazing (Meehan 1991). Agricultural practices in riparian zones can vastly reduce riparian vegetation and recruitment of wood that serves as in-stream habitat and refugia for fish (Hauer et al. 2003). Mining in the Umpqua has had lasting impacts on the watershed. Placer and hydraulic mining often occurred along small tributary streams such as Coffee Creek and Elk Creek, where sediment was often washed directly into the stream destroying spawning habitat. Mining can pollute streams by releasing bed-load sediments, heavy metals and acids (Meehan 1991). The superfund site at the former Formosa mine on Middle Creek is leaching acidic mine waste into the creek. Parts of the Main and South Umpqua River have had gravel mining operations. Decreased gravel from dredging operations can also impact available spawning habitat (Meehan 1991). Gravel mining in the river has ceased, however suction dredge mining currently occurs in the South Umpqua River Basin, including Cow Creek. Logging and splash damming were common from the mid 1800's through the early 1900's. Logging (including clear cutting on private lands) is still a common practice in the watershed today. Various studies have reported that stream temperatures increase in a forest after clear-cut logging practices are implemented. Stressful or lethal summer stream temperatures may occur many years after the logging, but may improve as forest canopies and riparian vegetation regenerate (Meehan 1991, Holaday 1992). Riparian areas are notably affected (Groom et al. 2011) and decreased large woody debris that juvenile fish use for rearing habitat often is associated with riparian logging (Gregory 1991). Localized influences of

agriculture, mining and logging are apparent in the Umpqua although the cumulative effects have not been quantitatively evaluated.

Dams fragment salmonid habitat and may impede the ability of salmonids to return up-river to spawn. Flow regulations from dams can have detrimental effects on juvenile salmonids that have the potential to which may get stranded during low flow periods. Diverting water from streams can be detrimental to juvenile salmonid survival during the summer months when crop irrigation is at its peak, and water temperatures are at their highest. Water diversions for irrigation in conjunction with other agricultural practices have indirectly contributed to declines in salmon runs (Scholz et al. 2000). The issues of perpetual low flows and high stream temperatures in the South Umpqua River have been compounded by over appropriation of water causing temperatures that remain above the lethal limits for salmonid survival. Summer steelhead, coastal cutthroat trout and lamprey are particularly vulnerable to low summer flows and high summer water temperatures, as they need deep, cold resting pools for up-stream migration (Wissmar et al. 2010). Coastal cutthroat spawn during the summer months at the peak of warm water temperatures and low flows. Water temperature in the up-stream migration path of salmonids has been noted as having a great influence on pre-spawning mortality (Groot, Margolis and Clarke 1995).

Counts of adult salmonids in the Umpqua declined from historic estimates. Pacific lamprey and coastal cutthroat counts at Winchester dam show a dramatic declining trend in returns over time. It should be noted that counts of Pacific lamprey at the fish ladder on Winchester Dam may not be accurate. A recent study of lamprey passage at the dam noted lamprey passing through openings in the dam structure (Lampman 2011). Spring Chinook salmon in the South Umpqua are of particular concern. In 1997, Ratner et al. examined spring Chinook population viability and concluded that if habitat degradation in the South Umpqua continues at the historical rate, it is unlikely that the population will persist into the future. This is consistent with a study by Nehlsen et al. in 1991 that listed spring Chinook in the South Umpqua as being at moderate risk of extinction.

Smallmouth bass have increased in the Umpqua River over time. Currently on the lower Main Umpqua River there is an extensive smallmouth bass fishery. Tabor et. al (1993) conducted a study in the Columbia River and estimated that juvenile salmonids made up 59% of smallmouth bass diet by weight and were present in 65% of the stomachs of smallmouth bass during smolt outmigration in the months of May and June in the Columbia River. Smallmouth bass were estimated to consume from 1.0-1.4 salmonids per predator daily. They determined that predation rates on salmonids by smallmouth bass were high during spring and early summer as a result of sub yearling Chinook salmon being abundant and of suitable forage size, as well as habitat overlap with smallmouth bass (Tabor, et.al 1993). As bass become more active in the spring and summer months, predation on juvenile salmonids in the Umpqua may increase. It has been noted that bass are actively feeding during half of the juvenile salmonid outmigration period in the Umpqua (ODFW 2008). Managing non-native species such as smallmouth bass is crucial for wild salmon recovery in the Pacific Northwest (Sanderson et al. 2009). Future studies of non-native species in the Umpqua are necessary to determine their predation rates on juvenile salmonids, habitat and food web impacts, especially during times of smolt outmigration.

Since 1900, hundreds of thousands of Umpqua salmon, steelhead and cutthroat trout eggs have been taken for hatchery propagation. In rivers that have been undisturbed, salmon populations are composed of several life history stages that have evolved naturally as the riverscape changed from natural disturbances such as floods, fires, and droughts. Hatcheries severely diminish the life history diversity of the populations they produce (Lichatowich 1999). A study at Oregon State University by Araki et al. (2009) determined that fish born from two captively bred parents had only 37% of the reproductive fitness of fish having two wild parents. The study suggests a carry-over effect from captive breeding, which reduces the reproductive fitness of wild-born descendants of hatchery fish in the wild, and the population fitness of subsequent generations (Araki et. al. 2009). Historically, fisheries managers used hatcheries as a tool to maintain declining salmon runs and harvest levels. The hatcheries were built in response to adverse effects caused by dams, habitat degradation, and over exploitation (Lackey, Lach and Duncan 2006). However, hatchery fish have probably accelerated declines of wild salmon as a result of introduced diseases, competition with wild fish, and altering genetic diversity through interbreeding which affects subsequent fitness of future generations of salmon (Waples 1999,

Noakes et al. 2000, Levin and Schiewe 2001, Lynch and O'Hely 2001). Large scale hatchery programs for salmonids in the Pacific Northwest have failed to provide benefits to salmon populations and in fact may pose the greatest threat to the long term maintenance of salmonids (Hilborn 1992). Hatcheries can mask the decline of wild salmon through the presence of abundant hatchery-bred salmon (McGinnis 1994). Hatchery produced fish interbreed with wild fish, resulting in mixed stock fisheries of abundant hatchery fish and lower numbers of wild fish. It is therefore difficult to harvest abundant hatchery salmon and concurrently protect scarce wild salmon. Recent studies have also shown that that hatchery fish are detrimental to wild fish populations. Chilcote et al. (2011) found a negative relationship between the reproductive performance in natural populations of steelhead trout, coho salmon, and Chinook salmon related to the proportion of hatchery fish in the spawning population. The extent to which hatchery fish have a detrimental effect on wild fish in the Umpqua has not been quantified and needs further examination.

Juvenile salmonid densities indicated the North Umpqua has greater numbers of juvenile salmonids rearing in the Main channel compared to the South and Main Umpqua Rivers. High water temperature influences the abundance and distribution of salmonids, and in their work on Jackson Creek, a tributary to the South Umpqua River, Roper and Scarnecchia (1994) determined that high summer water temperatures (approximately 23°C) caused higher numbers of juvenile Chinook salmon and older steelhead juveniles to emigrate from these reaches in the spring, decreasing their survival rates. Consequently an important factor contributing to juvenile salmonids densities is higher water temperatures. Juvenile salmonids in the South and Main may be moving into cooler tributaries and seeking thermal refuge areas to avoid detrimental water temperatures. Compared to the Kitlope and Skeena Rivers in Northern B.C., the Umpqua had high observed juvenile salmonid density (by .15 and .9 fish per square meter respectively). However, compared to the Kwethluk River in Alaska and Kol River in Russia, the Umpqua had a much lower salmonid density (by -2.3 and -3.42 fish per square meter respectively).

Determining the water chemistry of a particular habitat type can reveal stressful or optimal water conditions for salmonids (ODEQ TMDL 2006, <http://www.umt.edu/flbs/Research/Saron.aspx>). The North Umpqua River had consistently

higher concentrations of phosphorous than the Main and South Umpqua rivers. The North Umpqua sites showed a decrease in SRP from the upper most site at Marster's Bridge near Soda Springs Dam (river mile 65) to the most downstream site near Oak Creek (river mile 20). These results are consistent with the findings of Anderson and Carpenter in their study of the water chemistry of the North Umpqua River in 1998 which indicated that phosphorus increased with proximity to Soda Springs Dam. The increased phosphorous signal in the North Umpqua could be associated with the geology of the North Umpqua sub basin. The North Umpqua geology is comprised of highly fractured and porous volcanic lava formations from the high western cascades that are rich in phosphorous (Anderson and Carpenter 1998). The increase in phosphorous related to proximity of Soda Springs Dam might also indicate that water held in the up-stream dam reservoirs is enhancing the phosphorous loading in the North Umpqua, as reservoirs can retain sediment and organic debris that will accumulate and degrade into fine particulate and dissolved organic matter (Anderson and Carpenter 1998). Measurements of pH and dissolved oxygen were within the range of acceptable ODEQ and OWEB standards, however portions of the North, South and Main Umpqua are listed by the State of Oregon as 'impaired' for levels of pH and dissolved oxygen ( DEQ 2006). For sites in this study, especially in the South Umpqua, further continuous 24 hour sampling for pH and dissolved oxygen could further confirm or deny the grab sample results presented in this study.

Several violations of temperature standards for incubation, rearing and migration occurred in summer months throughout the river system. These high summer water temperatures in the South and Main Umpqua Rivers can have detrimental effects to developing salmonid eggs and juvenile fish. Coastal cutthroat trout spawn in the Umpqua during the month of July, and juvenile salmonids and lamprey were noted in the river during these high temperatures. In a system as warm as the Umpqua it is imperative to determine where pockets of cooler water, hyporheic exchange and groundwater sources occur, as these areas will be places of thermal refuge salmonids (Torgerson et al. 1999, Ebersole et al. 2003). Future studies of groundwater sources and areas of hyporheic exchange are crucial to sustaining native salmonids in the Umpqua.

The C:N ratios provide perspective on relative primary productivity or carbon accumulation in the system. A high C:N ratio indicates poor quality forage that is low in nutrients. C:N for all three sub-basins was lower than the optimal C:N:P ratio of freshwater benthic algae which is considered 158:18:1 (Hauer and Lamberti 2007). Based on C:N ratios, the Umpqua River is a nitrogen limited system. Again these results are consistent with Anderson et. al, (1998) findings that indicated low nitrogen concentrations in the North Umpqua River. Nitrogen limitation in a river can lead to a decrease in river food web productivity, including riparian vegetation, benthic invertebrates and microbes. Hence, an increase in marine nitrogen by way of increased anadromous fish migration to the Umpqua could lead to higher rates of freshwater food web productivity and an increase in food availability for juvenile salmonids (Anderson and Carpenter 1998, Helfield and Naiman 2001, Hicks et al. 2004).

The South Umpqua has a greater density of invertebrates than the North and Main, but the Main Umpqua had higher levels of ash free dry mass compared to the North and South. Benthic invertebrate density and biomass is helpful in determining prey availability for salmonids (Merritt and Cummins 1996, Stanford 2004, Hauer and Resh 2007) and can be used as an indicator of relative biological condition in the respective reaches (after Carter et al 2007). These results may be correlated to water temperature patterns. Haidekker and Hering in 2007 found that Plecoptera and Trichoptera were more prevalent at lower water temperatures in small and medium sized streams in Germany. The North Umpqua River's lower recorded water temperatures may explain why the North Umpqua had the highest percent taxa results. If water temperatures were to decrease in the South and Main Umpqua, it could make those river forks more hospitable to key indicator EPT species.

Stable Isotope analysis indicated that juvenile salmonids and riparian vegetation in the Main Umpqua had higher  $\delta N^{15}$  signals than the North or South. Enrichment in  $\delta N^{15}$  due to fertilizers and urban run-off has been noted in previous studies of salmonids (Harrington et al. 1998, Sepulveda et al. 2009). Portions of the lower North and South Umpqua have agricultural influence, therefore the Main Umpqua which is located downstream of both reaches has the potential for agricultural influence at all sites and was not tested. The possibility of picking up a higher  $\delta N^{15}$  signal from agriculture run-off was tested by comparing nitrogen



signals in juvenile fish tissue and riparian vegetation from sites above agricultural influence and below agricultural influence. The South Umpqua had increased nitrogen signals in sites that had agricultural influence compared to sites that did not. Further testing of  $\delta N^{15}$  signals throughout the basin in control and reference reaches are necessary to determine if  $\delta N^{15}$  signals are enriched in sites with agricultural influence.

RAP results were helpful for determining the salmonid production potential of the watershed and restoration potential at the landscape scale, which was linked to the habitat scale attributes that were measured in the field. The Umpqua has comparable water chemistry to other RAP rivers, and juvenile fish densities to other RAP rivers in northern B.C. Considering the human footprint rank (anthropogenic impacts including human population densities) for the Umpqua was higher than the Skeena, Kitlope, Kwethluk and Kol rivers, it is surprising that habitat metrics were comparatively similar. However, it is worth noting that the other RAP rivers mentioned in this study have increased off channel habitat diversity compared to the Umpqua, including orthofluvial and parafluvial side channels, beaver ponds, spring books and backwater areas where most juvenile salmonids were found (*sensu* Stanford et al. 2005). Sub-basin results suggested that the South and Main Umpqua Rivers have higher potential for salmon production compared to the North Umpqua River. This is mainly due to the greater expanse of floodplain habitat and increased number of tributaries, which provide increased areas for spawning and rearing compared to rivers like the North Umpqua which have a single constrained channel, and limited off-channel habitat (<http://rap.ntsg.umt.edu/>). Conserving and restoring the parts of the South and Main Umpqua that have intact alluvial, floodplain and off-channel spawning and rearing habitat, such as the floodplains and gravel bars associated with sites in this study, will provide essential habitat diversity necessary for future salmonid spawning and rearing.

The Umpqua River has one of the strongest runs of steelhead on the Oregon Coast, and Chinook, coho, lamprey and cutthroat are all documented in the system. From this analysis it appears likely that the Umpqua has the potential to produce many more wild salmonids than it currently does. At the sub-basin scale the Main and South Umpqua sub-basins have the highest salmonid production potential, based on landscape scale metrics. The North Umpqua River had

lower water temperatures, and higher numbers of juvenile salmonids compared to the South and Main. The North also had fewer juvenile non-native species. In order to address the underlying problems related to declines of native salmonids and lamprey, native fish restoration must be approached at a watershed scale, working down to site-specific recommendations. River restoration is a complex task involving multi level watershed functions and variability. When attempting watershed scale restoration, it becomes necessary to apply broad -scale information that considers interactions among management actions and natural disturbances thus incorporating how natural and anthropogenic factors interact across landscape scales to form areas that are vulnerable to degradation (Wissmar 2003). In the Umpqua watershed, the headwater streams of the South Umpqua located on USFS lands should be conserved, as these areas currently provide refuge for spawning and early rearing of juvenile salmonids. It is also necessary to address the underlying causes of degradation in the downstream portions of the mainstem river. Chinook utilize the mainstem South Umpqua for spawning, lower in the watershed, and in order to conserve and boost their numbers, mainstem restoration issues must be addressed. The North Umpqua has good quality headwater streams as well, but the headwaters of the North Umpqua are fragmented by Soda Springs Dam. This disconnection of good quality headwater streams for spawning and rearing, and dam related water quality issues has a negative impact on juvenile and adult salmonids and impacts the quality of spawning habitat in the downstream reaches of the river. Because the headwaters for the Main Umpqua are in fact the North and South Umpqua, it is necessary to look to tributary streams for good quality spawning and rearing habitat for juvenile salmonids in the Main. Many of these tributaries were historically sites of splash dams and logs drives (Miller 2010) and have been, and still are heavily impacted by timber harvest practices. Given the current conditions of the three river forks we argue for both a top down and bottom up approach to river restoration in the Umpqua watershed that includes restoration and conservation of both public and private lands. It is crucial to protect the tributaries and headwater streams that are in good condition now, and it is imperative to restore connectivity and good quality salmonid habitat to the mainstem rivers. Because the condition of the Main Umpqua is directly affected by the conditions of the North and South Umpqua Rivers it is necessary to consider the entire basin for restoration of wild salmonids.

### 1.6.1 The North Umpqua River

For the North Umpqua River specifically, while there were water quality and habitat fragmentation issues determined from the analysis, the river overall has good salmonid production potential. The central restoration recommendation for the North Umpqua is the removal of Soda Springs Dam. Soda Springs is the first of a series of 8 hydroelectric dams on the North Umpqua River. Soda Springs dam cuts off over 40 miles of spawning habitat for steelhead, lamprey and Spring Chinook (Dose et al 2001). Soda Springs reservoir has inundated high quality spring Chinook spawning habitat, and has been colonized by brown trout (*Salmo Trutta*). Currently PacifiCorp is in the process of installing a fish ladder to restore anadromy to the upper reaches of the North Umpqua. Soda Springs reservoir conditions and brown trout predation may pose significant threats to egg and juvenile salmonid and lamprey survival. Soda Springs dam is also holding back gravel that has been stored in the reservoir for over 50 years (Dose et al. 2001). Fish Creek is a major source of cobble, gravel, and large woody debris for the North Umpqua (Dose et al. 2001). The North Umpqua River is a bedrock-dominated system, and salmonids and lamprey depend on gravel delivered from tributaries for spawning. A preferable alternative to ladder construction would be to remove Soda Springs Dam altogether, reducing the introduced brown trout population, and restoring the connectivity between the upper reaches of the North Umpqua with the rest of the river, thus increasing available high quality spawning habitat, as well as wood and gravel delivery downstream (Dose et al 2001). Steamboat Creek and its tributaries including Canton Creek have been closed to angling since 1932, and continued conservation of these tributaries is essential to wild steelhead production in the North Umpqua. Further studies on salmonid habitat use in the North Umpqua watershed will give insight to future wild fish conservation strategies. Specific research priorities include determination of fish holding and rearing areas, influence and locations of groundwater storage and hyporheic zones, availability of spawning gravel, water chemistry sampling, and influence of riparian reserve areas on large woody debris recruitment to stream channels and stream temperature.

## 1.6.2 The South Umpqua River

Factors in decreased salmon abundance and habitat in the South Umpqua River include increased summer water temperatures, increased nutrients, and increased numbers of non-native smallmouth bass. Because the river still has the potential that it did historically, addressing underlying problems in the watershed will increase salmonid habitat and ultimately numbers of wild salmonids. Restoration recommendations for the South Umpqua focus on: lowering water temperatures, determining counts of adult steelhead, coastal cutthroat, and lamprey; determining holding locations during summer high water temperatures; and potentially increasing in stream flows during the summer months. These recommendations would make the river more suitable for salmonids and less suitable for small mouth bass that thrive at higher water temperatures. More research on smallmouth bass populations and feeding habits should be conducted to determine their overall effect on juvenile salmonids and lamprey. The South Umpqua River is mostly free flowing, however, one dam (Galesville) on upper Cow Creek, which is a major tributary to the South Umpqua River, prevents fish passage, eliminating historic spawning habitat for wild steelhead (Muck 2004). RAP metrics indicate that the South Umpqua sub-watershed has more floodplain area and tributaries than the North Umpqua. Historic ( Oregon Water Resources Board 1958) and current spawning surveys (ODFW NRIMP 2010) indicate that most of the South Umpqua River and its tributaries including Myrtle Creek, Lookingglass Creek, Jackson Creek and Cow Creek, were and still are used by coho for spawning. Coho prefer lower gradient rivers and tributaries that have increased numbers of pools for spawning (Quinn 2005). Because the South Umpqua is a lower gradient river, coho have the potential to rebound in the system. The RAP data is corroborated by the coho spawner abundance population estimates (ODFW 2010) which indicate that the South Umpqua has larger coho spawning population than the North Umpqua. Consequently, future coho specific habitat restoration efforts should focus on the South Umpqua River. Protection and restoration of important tributary refugia will be the key to coho survival in the South Umpqua. Specific research priorities include: determination of fish holding and rearing areas and locations of thermal refuge, determining counts of wild fall Chinook and summer and winter steelhead, determining influence and locations of groundwater storage and hyporheic zones, habitat analyses of key parcels of land adjacent to the river in close proximity to spawning rearing and

holding areas, analysis of channel constriction resulting from valley bottom roads and the possibilities of road removal to allow the river channel to migrate naturally, and examination of temperature and nutrient influence on toxic blue-green algae blooms.

### **1.6.3 The Main Umpqua River**

Conservation and Restoration of the Main Umpqua River is dependent upon the conditions of the North and South Umpqua Rivers. It is therefore necessary to restore and conserve the headwaters of the Main Umpqua River. The Main Umpqua River, as well as major tributaries to the Main Umpqua River including the Smith River, Elk Creek, and Calapooya Creek were and still are coho spawning areas. Coho spawner abundance estimates indicate that the main Umpqua and its tributaries have a higher coho spawning population than the North Umpqua (ODFW 2010). For coho specific conservation, the Main Umpqua and its tributaries, in addition to the South Umpqua, should be a focal point for coho habitat restoration. As much of the Main Umpqua river and its tributaries are located on private land, it is imperative to engage private landowners in restoration and conservation of salmonids in order to re-connect fragmented habitat and address causes of degradation on private land including road-related issues such as constricting channels and floodplains of tributaries to the Main Umpqua, increased run-off and fine sediment delivery, road failure, timber harvest in riparian areas, and fish passage barriers. Determining counts of steelhead, Chinook, lamprey and coastal cutthroat in the Main Umpqua and its tributaries, as well as determining spawning areas, will inform identification of existing good quality habitat.

## **1.7 CONCLUSIONS**

The Umpqua River historically supported more salmonids and lamprey than it currently does. Current freshwater limitations to salmonid sustainability identified in this study include: high summer water temperatures, non-native species (smallmouth bass), migration barriers and habitat fragmentation from dams. Focusing on restoration of degraded salmonid habitat and conservation of high quality salmonid habitat could mitigate losses of wild salmonids compared to historic baseline numbers in the Umpqua River Basin. Given the legacy of overharvest of

wild fish in the basin, and to protect the remaining wild, native salmonids in the Umpqua watershed, natural reproduction of wild populations is necessary. In addition, careful examination of the impact of increasing the limit of wild salmon and steelhead harvest to various stocks is also necessary. Hatchery fish have been planted in the Umpqua River for over 100 years, and problems associated with hatchery fish including mixing with wild stock and subsequent decreases in the fitness of future generations (Waples 1999, Chilcote et al. 2010) have the potential to affect wild salmonids. Research should be conducted to determine if there are deleterious effects from hatchery fish on wild fish in the Umpqua. Increasing the numbers of returning wild adult salmonids and lamprey will increase the amount of marine derived nutrients throughout the river system, and increase productivity of the river and riparian zone, in turn leading to more high quality spawning and rearing habitat from stream shading, and large woody debris loading (Helfield and Naiman 2001). The Umpqua Basin currently lacks a comprehensive basin-wide, landscape scale restoration and conservation plan that includes both public and private lands. Such a plan is needed that addresses the underlying problems of habitat fragmentation and degradation, and high water temperatures. Addressing these issues will inform restoration possibilities for related habitat concerns including the amount of available spawning habitat, available gravel for spawning and proper incubation and growing conditions for juvenile salmonids and lamprey. Large scale watershed conservation and restoration projects have a better chance of succeeding than small scale site specific restoration projects (Roper et. al 1997). Most small-scale restoration projects do not include long-term post restoration monitoring, and yet monitoring is the key to long term restoration success, and has the capability to inform managers which activities are accomplishing restoration goals in the long term (Kondolf and Micheli 1999, Bernhardt et. al, 2005). Many smaller scale restoration projects have been implemented in the Umpqua Basin with localized success. However, according to the Oregon Coastal coho status review (Stout et al. 2011) coho salmon are still in decline in the Umpqua River and habitat complexity and summer and winter juvenile rearing capacity is declining.

This study gives broad scale ecological information for salmonid production that is linked to site specific and landscape scale metrics. This information can be used to inform future restoration and conservation work in the Umpqua. Expanding on the landscape scale ecological assessment that was presented in this study will aid in the development and implementation of a

long-term, basin-wide restoration and conservation program that address the underlying causes of salmonid and lamprey declines in the Umpqua Basin.

Table 1-1 Fish of the Umpqua River (ODFW 1992).

Species	Location	Abundance	Status
Fall Chinook salmon	North Umpqua	Few	Native
<i>Oncorhynchus tshawytscha</i>	South Umpqua	Abundant	Native
	Smith River	Common	Native
Spring Chinook salmon	Umpqua River	Abundant	Native
<i>Oncorhynchus tshawytscha</i>	North Umpqua	Abundant	Native
	Smith River	Abundant	Native
Coho salmon	Umpqua River	Abundant	Native
<i>Oncorhynchus kisutch</i>	South Umpqua	Abundant	Native
	North Umpqua	Abundant	Native
	Smith River	Abundant	Native
Chum salmon	Umpqua River	Few	Native
<i>Oncorhynchus keta</i>			
Pink salmon	Umpqua River	Few	Native
<i>Oncorhynchus gorbuscha</i>			
Sockeye salmon	Umpqua River	Few	Native
<i>Oncorhynchus nerka</i>			
Kokanee	Lemolo Lake	Common	Non-Native
<i>Oncorhynchus nerka</i>	Hemlock Lake		
Winter steelhead trout	Smith River	Abundant	Native
<i>Oncorhynchus mykiss</i>	Umpqua River	Abundant	Native
	North Umpqua	Abundant	Native
	South Umpqua	Abundant	Native
Summer steelhead trout	Umpqua River	Abundant	Native
<i>Oncorhynchus mykiss</i>	North Umpqua	Abundant	Native
Brown trout	Upper North Umpqua	Abundant	Non-Native
<i>Salmo trutta</i>	North Umpqua Lakes	Abundant	Non-Native
	and reservoirs	Abundant	Non-Native
Cutthroat trout	Most streams	Abundant	Native
<i>Oncorhynchus clarki clarki</i>			
(resident and anadromous)	Some lakes and reservoirs	Abundant	Native
Eastern brook trout	Upper North Umpqua	Abundant	Non-Native
<i>Salvelinus fontinalis</i>	Cascade high lakes	Abundant	Non-Native
Rainbow trout	Most Streams	Abundant	Native
<i>Oncorhynchus mykiss</i>	Some lakes and reservoirs	Abundant	Native
Largemouth bass	Umpqua River	Abundant	Non-Native
<i>Micropterus salmoides</i>	Lakes, Ponds, sloughs	Abundant	Non-Native
Smallmouth bass	Umpqua River	Abundant	Non-Native
<i>Micropterus dolomieu</i>	South Umpqua River	Abundant	Non-Native



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	Cow Creek	Abundant	Non-Native
Bluegill	Umpqua River	Abundant	Non-Native
<i>Lepomis macrochirus</i>	Some lakes and ponds	Abundant	Non-Native
Brown bullhead	Umpqua River	Abundant	Non-Native
<i>Ameiurus nebulosus</i>	South Umpqua River	Abundant	Non-Native
	Smith River	Abundant	Non-Native
	Lakes and sloughs	Abundant	Non-Native
Yellow bullhead	Umpqua River	Few	Non-Native
<i>Ameiurus natalis</i>	South Umpqua River	Few	Non-Native
	Some lakes and sloughs	Few	Non-Native
Black crappie	Umpqua River	Abundant	Non-Native
<i>Pomoxis nigromaculatus</i>	South Umpqua River	Abundant	Non-Native
	Some lakes and sloughs	Abundant	Non-Native
Green sunfish	Umpqua River	Common	Non-Native
<i>Lepomis cyanellus</i>	South Umpqua River	Common	Non-Native
	Some lakes and sloughs	Common	Non-Native
Yellow perch	Some lakes and sloughs	Common	Non-Native
<i>Perca flavescens</i>			
Pumpkinseed	Some lakes and ponds	Few	Non-Native
<i>Lepomis gibbosus</i>			
Warmouth	Some lakes and ponds	Few	Non-Native
<i>Lepomis gulosus</i>			
American shad	Umpqua River	Abundant	Non-Native
<i>Alosa sapidissima</i>	South Umpqua	Abundant	Non-Native
	Smith River	Abundant	Non-Native
Eulachon (smelt)	Umpqua River	Common	Native
<i>Thaleichthys pacificus</i>			
White sturgeon	Umpqua River	Common	Native
<i>Acipenser transmontanus</i>	Smith River	Common	Native
Green sturgeon	Umpqua River	Common	Native
<i>Acipenser medirostris</i>	Smith River	Common	Native
Striped bass	Umpqua River	Abundant	Non-Native
<i>Morone saxatilis</i>	Smith River	Abundant	Non-Native
Cottids	Most Streams, some lakes	Abundant	Native
<i>Cottus sp.</i>			
Dace	Most streams	Abundant	Native
<i>Rhinichthys sp.</i>			
Goldfish	Some lakes and sloughs	Abundant	Non-Native
<i>Carassius auratus</i>			
Pacific lamprey	Most Streams	Abundant	Native
<i>Entosphenus tridentatus</i>			

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Northern pikeminnow <i>Ptychocheilus oregonensis</i>	Most Streams	Abundant	Native
Redside shiner <i>Richardsonius balteatus</i>	Most streams Some lakes and sloughs	Abundant	Non-native
Largescale sucker <i>Catostomus latipinnis</i>	Most streams Some lakes and sloughs	Abundant	Native
Threespine stickleback <i>Gasterosteusaculeatus</i>	Most streams	Common	Native
Tui chub <i>Gila bicolor</i>	Upper North Umpqua reservoirs	Common	Native
Umpqua chub <i>Oregonichthys kalawatseti</i>	Umpqua River Elk Creek Calapooya Creek	Common Common Common	Native Native Native

Table 1-2. Water Chemistry Results for 2008 and 2009 by river fork. The averages are listed with standard deviations and sample numbers in parenthesis. Available OWEB and ODEQ standards are listed for comparison.

	ODEQ/ OWEB	(2008) South Umpqua	North Umpqua	Main Umpqua	(2009 )South Umpqua	North Umpqua	Main Umpqua
Temperature (max) deg C		28.4	23.22	26.42	28.67	22.59	28.34
Nitrate and Nitrite ( $\mu\text{g L}^{-1}$ )		5.36 +/- 4.18 (7) 2.272-14.296	6.71 +/-10.11 (7) 1.57-29.55 13.22+/-	8.55+/-9.53 (5) 2.67-25.48	2.89+/-2.89(12) 1.06-10.78	2.69+/-2.36(12) 0.4-9.67	12.68+/- 14.22(9) 1.61-44.12 14.00+/-
Ammonium ( $\mu\text{g L}^{-1}$ )		12.53+/-3.52 (7) 7.78-17.482	1.61(7) 11.78-16.58	13.08+/-1.83(5) 11.62-15.45	11.02+/-5.68(12) 5.84-20.53	14.29+/-8.05(12) 4.79-27.71	7.18(9) 6.53-25.97 17.85+/-
Soluble Reactive Phosphorus( $\mu\text{L}^{-1}$ )		4.99+/-3.81 (7) 0.92-11.90	39.43+/-11.02 (7) 23.68-58.80	20.51+/-7.24 (5) 12.54-32.30	5.15+/-3.03(12) 1.06-9.33	32.30+/-7.69(12) 20.06-43.56	7.54(9) 7.43-39.30
Total Persulfate Nitrogen ( $\mu\text{g L}^{-1}$ )	300ug/L TN(OWEB)	98.45+/-33.32 (7) 50.02-134.06	92.92+/-58.01 (7) 47.66-210.54	145.39+/- 32.00(5)	125.36+/- 35.60(12)	36.25+/-7.88(12) 71.27-178.42	184.77+/- 31.78(9) 134.05-223.74
Total Phosphorus ( $\mu\text{g L}^{-1}$ )	50ug/L (OWEB)	6.89+/-2.08(7) 5.06-10.31	34.73+/-6.70 (7) 27.10-45.30	22.65+/-6.17 (5) 15.44-32.35	9.45+/-2.59(12) 6.05-13.03	32.96(12) 23.61-49.07	6.56(9) 18.96-39.30
Dissolved Organic Carbon( $\text{mg L}^{-1}$ )		1.25+/-0.40 (7) 0.74-1.94	0.59+/-0.15 (7) 0.40-0.79	1.11+/-0.24 (5) 0.92-1.47	2.87+/-2.60(12) 0.62-7.29	1.98+/-2.24(12) 0.52-5.80	2.32+/-2.46(9) 0.94-1.32
Total organic Carbon ( $\text{mg L}^{-1}$ )		1.30+/-0.40 (7) 0.81-1.96	0.65+/-0.15 (7) 0.44-0.88	1.25+/-0.25 (5) 0.98-1.63	4.07+/-3.76(12) 0.82-10.27	2.68+/-2.34(12) 0.74-6.62	2.58+/-2.57(9) 1.06-7.16
Specific Conductance ( $\mu\text{S}$ )		116.55 $\pm$ 7.88 (4)	59.2 $\pm$ 1.98 (4)	83.4 $\pm$ 3.02 (3)	42.48(12)	64.63+/- 13.85(12)	85.41+/- 27.08(9)
pH	6.5-8.5 (ODEQ)	8.13 $\pm$ 0.14 (4)	7.92 $\pm$ 0.29 (4)	8.06 $\pm$ 0.10(3)	7.83+/-0.30(12)	7.67+/-0.32(12)	7.66+/-0.15(9)
Dissolved O <sub>2</sub> ( $\text{mg L}^{-1}$ )	8.0mg/L (OWEB)	10.06 $\pm$ 0.54 (7)	10.92 $\pm$ 0.43 (7)	9.508 $\pm$ 0.77 (5)	9.78+/-1.16(12)	11.31+/-0.43(12)	1.101(9)
Dissolved O <sub>2</sub> (% saturation)		100.71 $\pm$ 3.41 (7)	99.87 $\pm$ 0.63 (7)	96.18 $\pm$ 5.79 (5)	99.33+/-12.12(12)	106.2+/-8.14(12)	96.078+/- 7.41(9)

Table 1-3. Aufwuchs average grams of Carbon and Nitrogen and molar C:N ratio results with standard deviations in parenthesis.

	<b>g N m<sup>-2</sup></b>	<b>g C m<sup>-2</sup></b>	<b>Molar C:N Ratio</b>	<b>N</b>
Summer North				
AVG	0.32 (0.31)	2.88 (2.50)	11.30 (2.37)	15
Fall North				
AVG	0.46 (0.39)	3.80 (3.13)	9.94 (1.53)	20
all season Avg.	0.40 (0.36)	3.40 (2.87)	10.52 (2.02)	35
Summer South				
AVG	0.29 (0.34)	3.09 (3.42)	13.67 (4.05)	15
Fall South				
AVG	0.34 (0.24)	2.83 (1.83)	10.08 (1.20)	20
all season Avg.	0.32 (0.28)	2.94 (2.59)	11.62 (3.29)	35
Summer Main				
AVG	0.36 (0.33)	3.21 (2.80)	10.60 (3.39)	10
Fall Main				
AVG	0.58 (0.46)	4.89 (3.85)	9.82 (0.91)	14
all season Avg.	0.38 (0.43)	3.30 (3.54)	10.95 (3.30)	24

Table 1- 4. Benthic Invertebrate Densities

	<b>North 2008</b>	<b>South 2008</b>	<b>Main 2008</b>	<b>North 2009</b>	<b>South 2009</b>	<b>Main 2009</b>
Average	315.62	430.4	282.588	313.45	359.89	305.85
Standard Deviation	103.92	196.951	115.01	109.97	200.61	185.01
Standard error	22.678	44.04	27.89	19.14	32.98	34.96
(N)	21	20	17	33	37	28

Table 1-5. (RAP, 2010) Measures of habitat complexity, water quality, fish density, and marine derived nutrients for five Pacific Rim sites in the Salmonid Rivers Observatory Network. Water chemistry values are means  $\pm$  standard deviation, with range below. Bracketed values are sample sizes. Vegetation species/types sampled: Co = cottonwood (*Populus* spp.); W = willow (*Salix* spp.); D = red osier dogwood (*Cornus sericea*); F = *Filipendula kamtschatica*; Bl = blackberry (*Rubus arcticus*); Bi = birch (*Betula papyrifera*); G = grass (*Poaceae*); Sa = *Rubus spectabilis*; E = elderberry (*Sambucus* spp.); Se = *Senecio cannabifolius*; Ch = *Chosenia arbutifolia*; N = stinging nettle (*Urtica gracilis*); S = sedge (*Cyperaceae* family); R= blackberry (*Rubus* genus) . All data from SaRON 2004-2006, except for Skeena River (data from 2005-2006), Umpqua River (data from 2008-2009) and: \* Riverscape Analysis Project (<http://rap.ntsg.umt.edu/>); Table modified from Hill et al. 2010.

	Umpqua	Kitlope	Skeena	Kwethluk	Kol
Latitude	43° 16' N	53° 15' N	54° 12' N	60° 49' N	53° 49' N
Longitude	123° 8' W	127° 54' W	129° 35' W	116° 24' W	155° 57' E
Catchment Area (sq km)	12084	3206	51383	3787	1502
Temperature (max) deg C	28.67	13.5	16.8	16.8	15.1
Nitrate and nitrite (ug L <sup>-1</sup> )	12.99 $\pm$ 5.70(52) 4.79-27.3	21.9 $\pm$ 19.5 (26) 4.7 – 96.3	26.1 $\pm$ 16.1 (52) 7.5 – 74.1	15.2 $\pm$ 11.0 (78) 0.8 – 81.7	165.2 $\pm$ 126.6 (33) 8.8– 591.0
Ammonium (ug L <sup>-1</sup> )	5.93 $\pm$ 8.33(52) 0.4-44.12	20.4 $\pm$ 42.8 (26) 2.2– 206.6	13.6 $\pm$ 13.4 (52) 2.4 – 67.4	14.3 $\pm$ 14.5 (78) 1.2-65.3	67.7 $\pm$ 105.3 (33) 9.4 – 545.2
Soluble reactive Phosphorous (ug L <sup>-1</sup> )	19.68 $\pm$ 14.65(52) 0.92-58.80	4.1 $\pm$ 5.1 (26) 0.4 – 19.3	3.3 $\pm$ 2.6 (52) 0.40 – 13.9	3.1 $\pm$ 1.5 (78) 0.4 – 6.5	14.2 $\pm$ 13.8 (234) 4.6 – 77.4
Total organic Carbon (mg L <sup>-1</sup> )	2.36 $\pm$ 2.57 (52) 0.44-10.27	0.76 $\pm$ 0.57 (22) 0.04 – 1.90	1.54 $\pm$ 0.99 (24) 0.56 – 4.98	2.20 $\pm$ 1.54 (77) 0.57 – 6.98	1.54 $\pm$ 0.55 (7) 1.02 – 2.39
Dissolved organic Carbon (mg L <sup>-1</sup> )	1.86 $\pm$ 2.01(52) 0.40-7.79	0.42 $\pm$ 0.39 (23) 0.04 – 1.49	1.11 $\pm$ 0.64 (24) 0.26 – 2.69	1.92 $\pm$ 1.42 (77) 0.36 – 6.49	1.84 $\pm$ 0.84 (7) 1.03 – 3.56
Specific Conductance ( $\mu$ S)	89.72 $\pm$ 35.67(44)	15.8 $\pm$ 2.1 (22)	68.9 $\pm$ 5.9 (28)	105.8 $\pm$ 7.7 (87)	54.7 $\pm$ 6.9 (129)
Juvenile salmonid density	0.29 $\pm$ 0.31(48)	0.14 $\pm$ 0.08 (19)	0.20 $\pm$ 0.10 (11)	2.59 $\pm$ 5.70 (16)	3.71 $\pm$ 3.13 (16)
Riparian plant foliar $\delta^{15}$ N (‰)	0.72 $\pm$ 2.45(128) -3.39 – -6.65	-4.11 $\pm$ 1.94 (74) -5.83 – -3.73	-1.36 $\pm$ 1.05 (54) -2.47 – 0.06	-0.56 $\pm$ 1.48 (57) -2.70 – 1.55	3.32 $\pm$ 1.52 (74) 3.29 - 4.43
Plants sampled for $\delta^{15}$ N	S,C,R,P	Co, E, G, D, Sa, W	Co, G, D, W	Bi, G, Bl, 3-W, Co	Ch, G, F, Se, N, W

**Figure 1-1.** Map of Umpqua River Basin, Oregon. Dotted Line indicates the division between the physiographic provinces of the Cascade and the Coast Range Mountains. Black open squares indicate the metropolitan areas of Reedsport (at the mouth of the Umpqua River) and Roseburg (at the confluence of the North and South Umpqua Rivers). Red chevrons indicate areas of traditional use by the Cow Creek Tribe (South Umpqua River) and the Mollala Umpqua (North Umpqua River) Native Americans.

**Figure 1-2.** Approximate run timings for North Umpqua River salmonids and lamprey at Winchester Dam (see Fig 1). Arrows indicate peak spawning times. (lamprey data from Beamish 1980, cutthroat after Johnson et. al, 1994, all other data from ODFW 2009).

**Figure 1-3.** Salmonid density in number of salmonids/m<sup>2</sup>, with standard error bars, by river fork for the 2008 and 2009 sampling seasons. Black bars indicate the North Umpqua, gray bars indicate the South Umpqua and white bars indicate the Main Umpqua.

**Figure 1-4.** Salmonid density in salmonids/m<sup>2</sup> by species for each river fork. Black bars indicate Chinook salmon, gray bars indicate coho salmon, and white bars indicate trout fry (rainbow or cutthroat).

**Figure 1-5.** A. Main Umpqua River temperatures, B. North Umpqua temperatures, C. South Umpqua temperatures. ODEQ temperature thresholds are given. The black bar above the graph indicates spring Chinook, Pacific lamprey, summer steelhead and coastal cutthroat run times. Cutthroat trout spawn in July (Johnson, 1994). Numbered lines correspond to the location of the temperature loggers within the watershed (Figure 1).

**Figure 1-6.** Benthic invertebrate ash free dry mass in mg/m<sup>2</sup> for sampling season and river fork. Black Bars indicate the North Umpqua, Gray bars indicate the South Umpqua, and white bars indicate the Main Umpqua.

**Figure 1-7.** Ephemeroptera, Plecoptera, Trichoptera (EPT) Test by River fork for the 2009 sampling season, with standard error bars. The black bar indicates the North Umpqua, the gray bar indicates the South Umpqua and the white bar indicates the Main Umpqua.

**Figure 1-8.** Average stable isotopes of  $\delta C^{13}$  and  $\delta N^{15}$  from riparian vegetation in 2008 (A.) and 2009 (B.) by river fork. The white triangle indicates the Main Umpqua, the Black diamond indicates the North Umpqua, and the gray square indicates the South Umpqua.

**Figure 1-9.** Average stable isotope results of  $\delta C^{13}$  and  $\delta N^{15}$  for juvenile trout fry (rainbow or cutthroat trout) for 2008 (A.) and 2009 (B.) by river fork. The white triangle indicates the Main Umpqua, the Black diamond indicates the North Umpqua, and the gray square indicates the South Umpqua.

**Figure 1-10.** Log plot showing the saturation of MDN at around 500 kg of salmon nitrogen per km. Points are SaRON rivers. G is the Kwethluk, C is the Kol, E is the Kitlope, and the North Umpqua is represented by the black oval. Reference rivers without salmon are shown as diamonds. Modified from Morris et al. 2011 (manuscript)

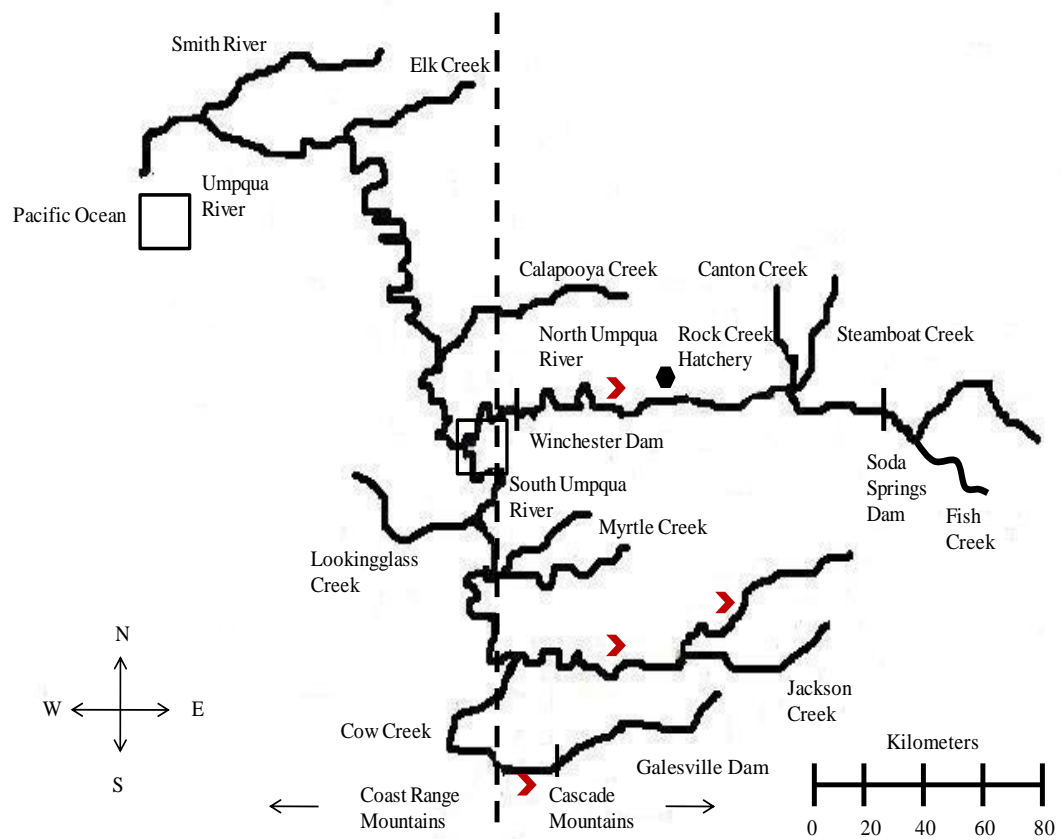


Figure 1-1.



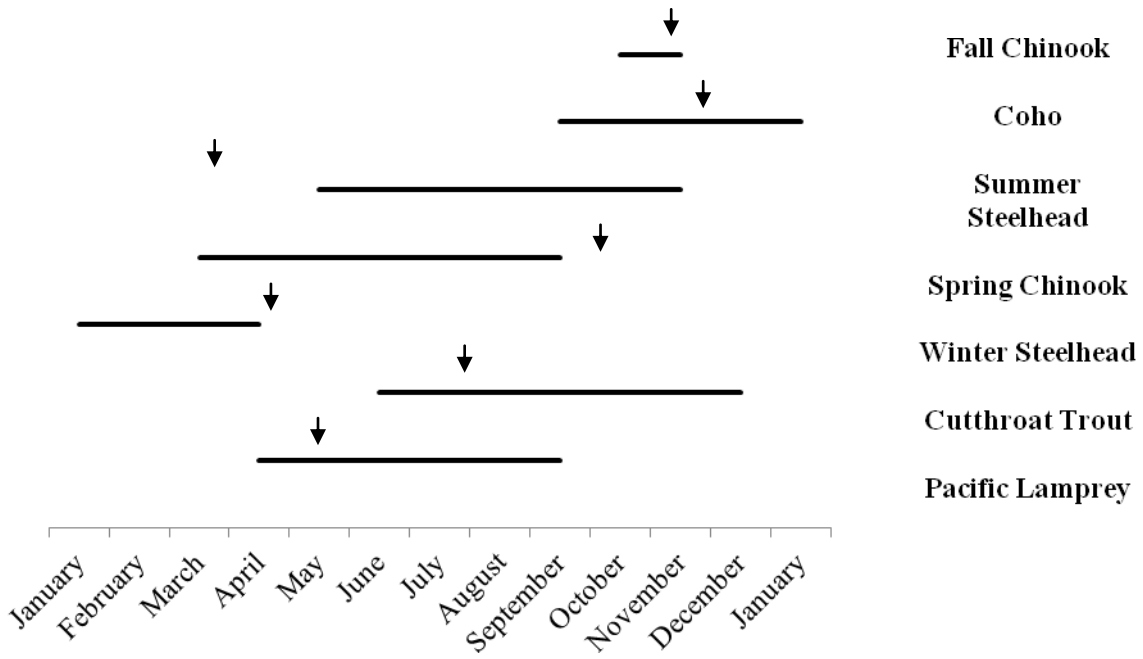


Figure 1-2

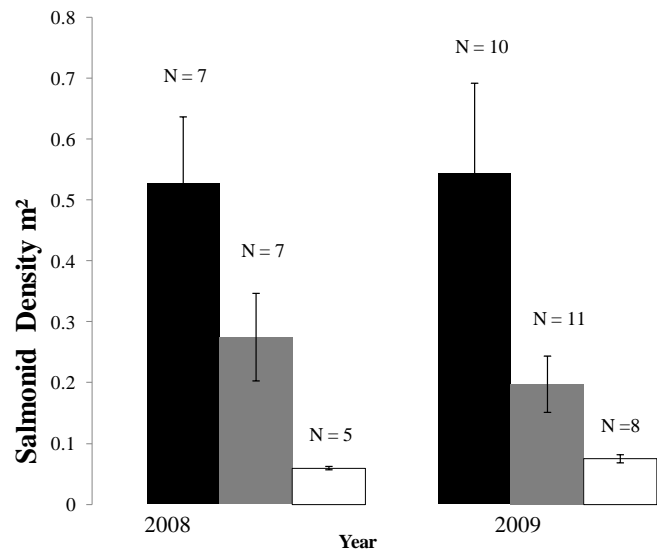


Figure 1-3.

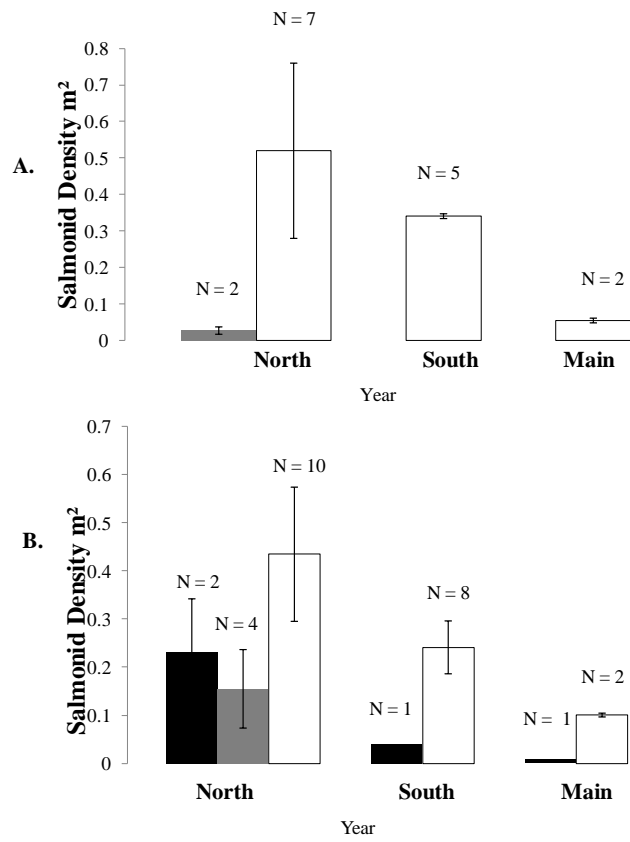
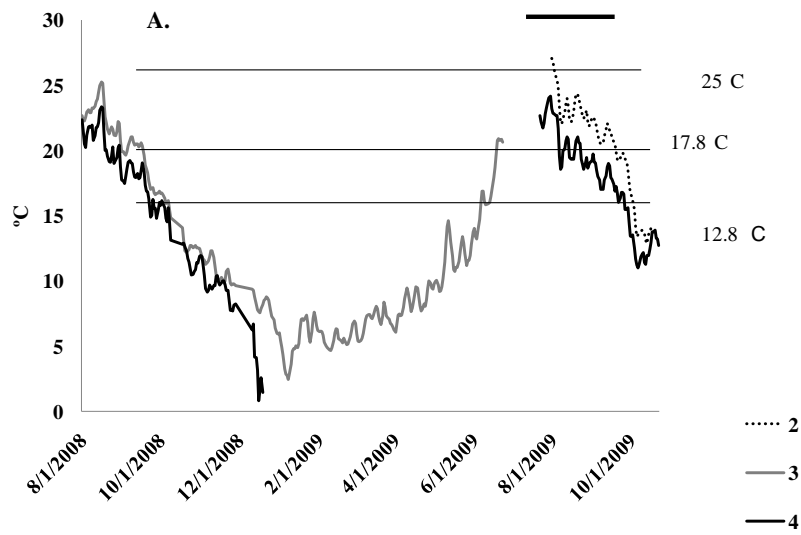
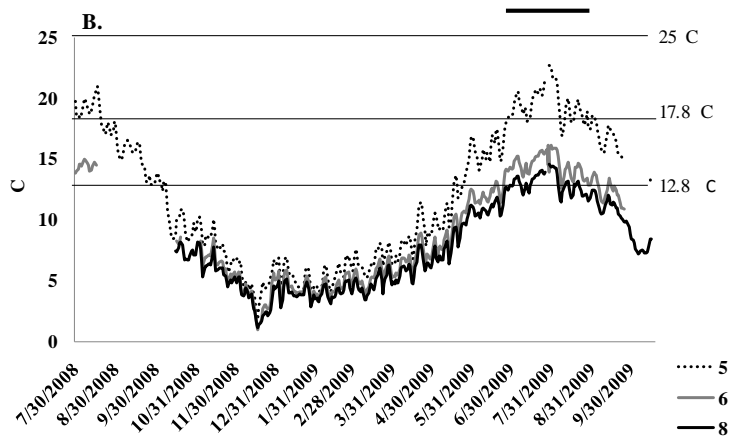


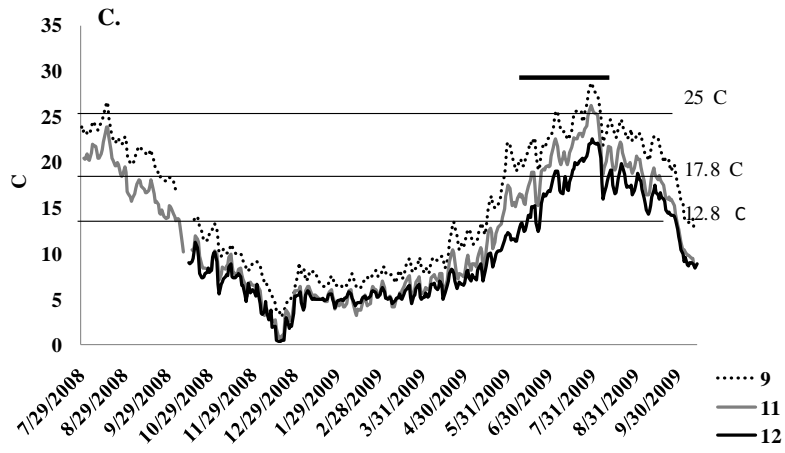
Figure 1-4.



A.



B.  
Figure 1-5.



C.  
Figure 1-5. continued

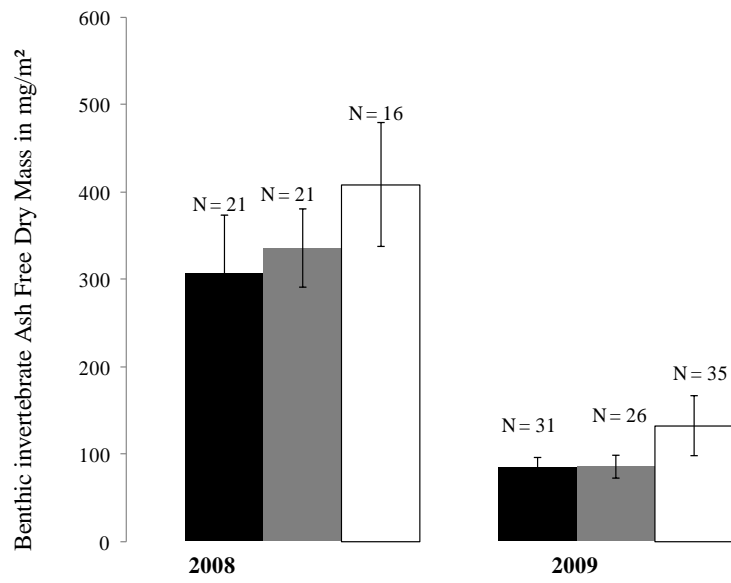


Figure 1-6.

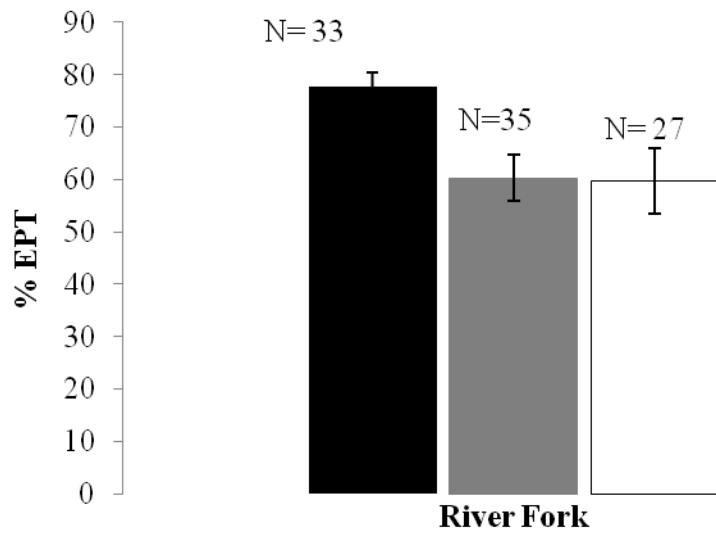
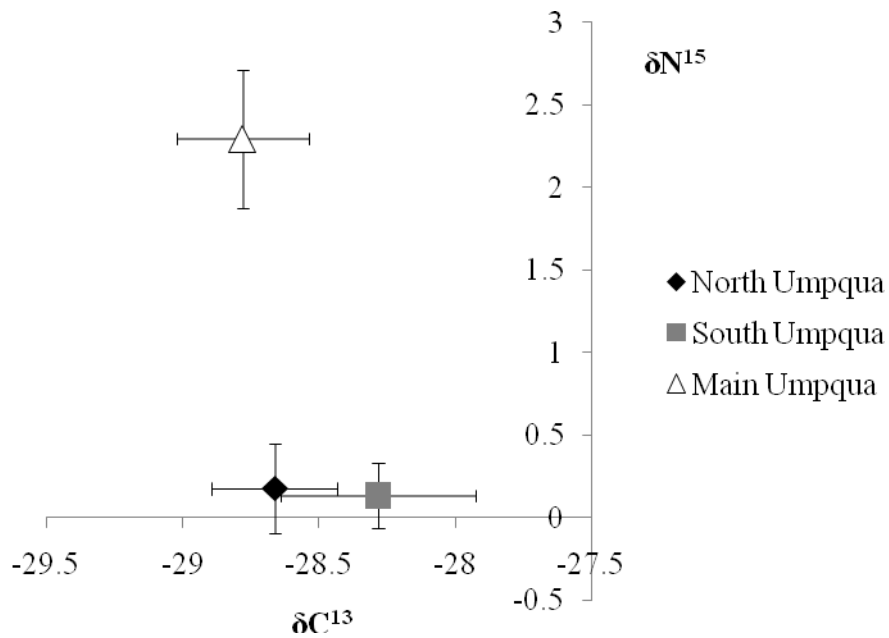
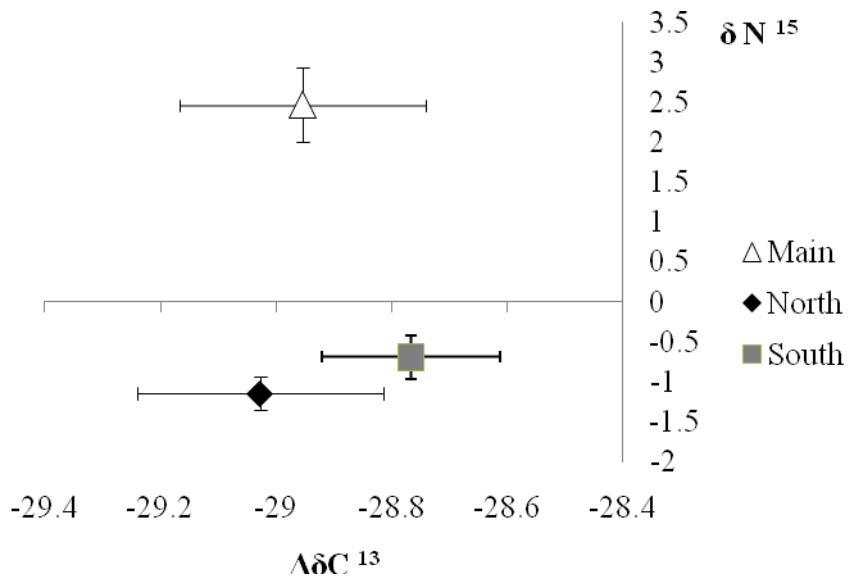


Figure 1-7.



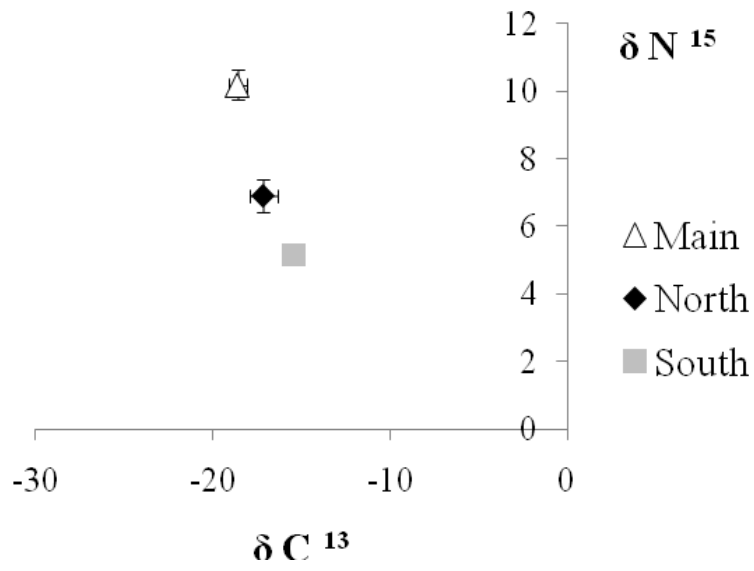
A.



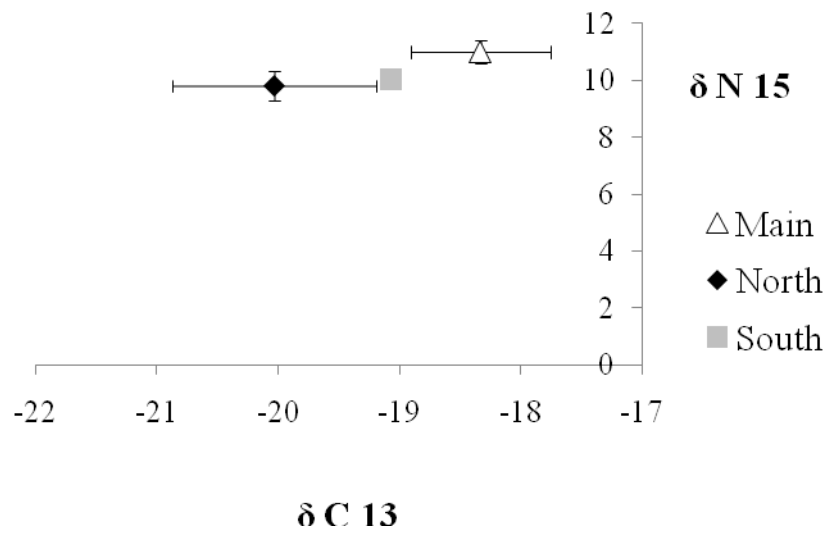
B.

Figure 1-8.





A.



B.  
Figure 1-9.

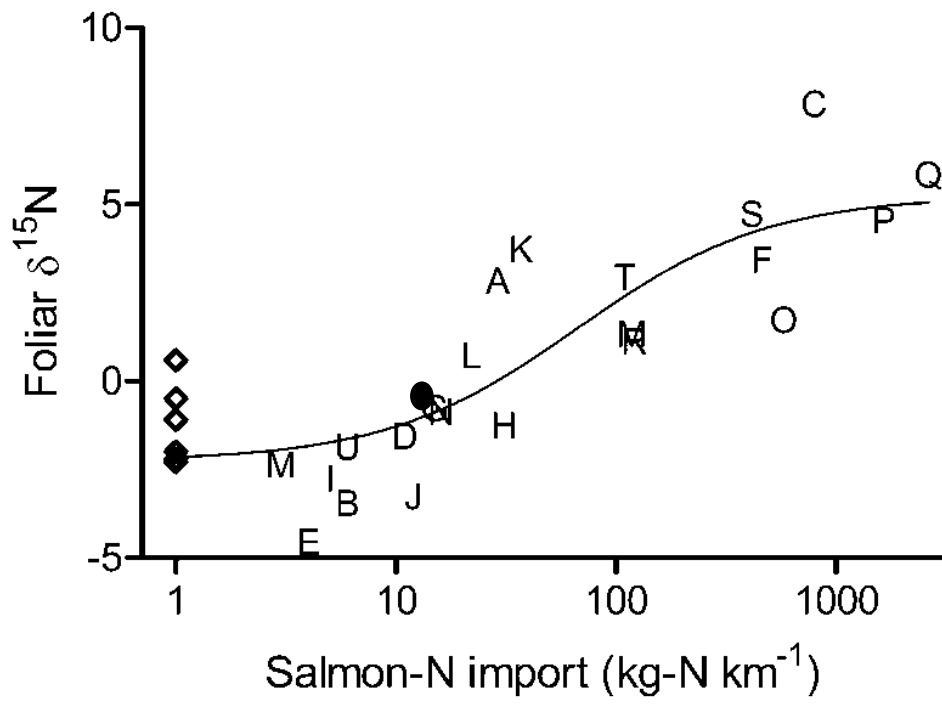


Figure 1-10.

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## **Appendix A.**

### **TEK and LEK Questions and Answers**

TEK and LEK interviewees were given a number in order to maintain anonymity, and adhere to ethical standards. The questions are correlated with answers, and respondent (interviewee) number that was assigned

#### **How long have you been fishing on the Umpqua? Can you tell me a little bit about your fishing experience on the river?**

Tribal members

**Respondent 1:** 60+ years not a fisherman but lived here most of her life

**Respondent 2:** 60+ years

**Respondent:** 50+ years

Local Residents

**Respondent 4:** 50+

**Respondent 5:** 50+

**Respondent 6:** 50+

#### **2. What kinds of fish have you caught in the past while fishing on the Umpqua? When were you catching these fish? How did you catch them? Where did you catch them? (Remember to please specify if it was in the North Umpqua, South Umpqua or Mainstem Umpqua)**

**Respondent 4:** In the Main I have caught shad, striped bass and smallmouth bass, largescale suckers bullhead, smallmouth bass, spring Chinook, fall Chinook, coho, American shad, pikeminnow, sea run cutthroat trout ( were abundant in the late 1960's) and white sturgeon in tidewater. In the North I have caught cutthroat trout, resident rainbow, spring Chinook, fall Chinook, coho salmon, summer and winter steelhead, large scale suckers brook trout (reservoirs), smallmouth bass (below Winchester) and brown trout. In the South I have caught brown bullhead, smallmouth bass, sturgeon (below Canyonville), winter steelhead, chum, and pikeminnows; I used a pole or a fly rod.

**Respondent 2:** I used to catch 3-4, sometimes 10-12 a day (rainbows) at the Ranch (mainstem South Umpqua) I would fish it once or twice a week. There were trout in the South. Joe Hall Creek had coho, and Brownie creek had coho. I used to see sea run cutthroats, steelhead, and rainbows. Chinook never run up Elk Creek that I remember. Chinook run up Jackson Creek, and Beaver Creek, but not far up Beaver Creek. Lamprey used to go up Elk Creek. Up at the falls water used to run over the falls year round, and the hole below the falls was deeper. In the North Umpqua, I was building roads at Steamboat Creek. I caught fish (salmon and steelhead) while I was working up there. I would get half a dozen or so.

**Respondent 5:** I would catch coho in the fall on the Main and South Umpqua. Chinook in the spring on the lower North Umpqua and Main Umpqua, trout on the North, South and Main Umpqua Rivers in the Spring Summer and Fall. I would and still can catch steelhead year round in the North Umpqua, and I would catch steelhead on the Main in the winter. I caught bass on the Main during the summer, and there was a superb run of cutthroat trout on the Main as well. On the Main I used to hook 15-16 coho in a morning. We used to see a lot more fish on the spawning bars then we do now, and more gravel then we do now, but because of the dam (Soda Springs) holding the gravel back, we don't see as much gravel. There is more algae and turbidity in the river. We saw very few coho up here on the North in the upper river, especially up here, but we saw a lot of salmon, most of those spawned in the main river, there were a few that spawned in Steamboat Creek, and I don't think I saw any up Canton Creek. Rock Creek was heavily logged; the kids would call it chocolate milk creek.

**Respondent 1:** People used to talk about the Spring Chinook runs on the South Umpqua.

**Respondent 3:** (fishing gear used included) spears to pitchforks and eventually fishing poles and some of them would make weirs and sort of pick through the salmon and everything to make sure they were good and right let the others go. The numbers started going down then started changing for everybody in the 1960s, there was a lot of change from there until about the early 1970's. The numbers of fish really dropped after BLM started using that spray. Nobody noticed at first because nobody said anything to anybody but people noticed numbers started to drop quite a bit and then when you would go back on the ridges and hunt after they would spray, the deer were scorched and burnt on their back and we couldn't figure out at first what was going on with that, and then we noticed the quail and the grouse and the fan tailed pigeons numbers dropped way down, and the cottontail. We noticed in the creeks there would be dead fish after they would spray and frogs, even crawdads and salamanders, because they were spraying really hard and real heavy. It was all over western Oregon.

**3. Have you specifically caught any Salmon or Steelhead on the Umpqua? When did you catch salmon? When did you catch steelhead? How did you catch them? Where did you catch them?**

**Respondent 4:** I caught winter steelhead (Dec-March) south of Canyonville, and in the Main from river forks down to James Wood, and in the North from Colliding Rivers to Whistlers Bend. I would fish for spring Chinook in the North below Winchester Dam, and in the Swiftwater, Rock Creek area. The timing was May-June. I caught summer steelhead July-Nov. in the fly water above Rock Creek, and on the lower North below Winchester. I would catch fall Chinook Aug-Sept. at Reedsport, and coho on the lower Main in Oct.

**Respondent 2:** Yes, on the South, trout

**Respondent 5:** I would catch Chinook in the spring, coho in the fall, steelhead in the Main during the winter, and steelhead year round in the north Umpqua.

**Respondent 3:** You could catch different size trout you know just the fry from steelhead and the salmon before they would make a run down to the ocean. You could catch suckers, you could eat those too, and when the run of summer steelhead and the dif runs of salmon would come up too, Chinook and coho. There was quite a few fish and everything used to make it up over South Umpqua Falls, historically before the Forest Service blasted that out, and made those fish ladders, there had always been fish that went up over the falls. When they would get up to a certain point, everybody understood that you just didn't go get a bunch and put in your smoker and canner, to dry or anything like that. You would just eat one or two here and there and leave the rest alone because they had to spawn. That only stands to reason, and everybody, even way back they didn't go up there and go get 100's or 1,000's they just left it alone, it was an area where you just picked one or two to eat, if you was going hunting or gathering or just going up there camping or whatever, picking berries, you didn't hurt them, you didn't bother them too much. Above the falls were spawning grounds, real thick spawning grounds. Damage that too much and then you start affecting everything else. We fished the Main River and then we fished side streams. At Days Creek, they used to come up there just thick and even those little narrow creeks that come through there, there were runs of fish in there and in the mainstem, just all of those creeks and you could catch them at the mouth of the creeks and there was all kinds of banks, and holes where it would narrow up and make it easier to get them. I can hardly remember a time when we went out, and we didn't bring something back. The lampreys are just about gone here and the North Umpqua too with all it's a cooler and clearer water they were having a tough time in this whole system but on the South Umpqua and Cow Creek and all those tributaries their just about gone. There are just a few here and there and in the hot water I found some little guys, but they were already dead. The little lamprey and salmon depend on root wads, and all of those are almost gone. All of that has been logged out and sort of ruined it for that. Some salmon would be 2 to 2 ½ - 3' long, you know some of them would be pretty good size. Summer steelhead It seems like there numbers have dropped a lot and there used to be certain times they would go through in the summer and when they would first start coming up, and you would try to catch them as soon as we could when they would come up because the quality of the meat, you know the oil and everything in the fish is better when they are fresh. There were spring and fall Chinook in the river.

**4. Do you remember seeing any areas of the river that had a lot of salmon or steelhead spawning? Do you still see mass numbers of salmon in these areas? If so, where and when did you see these large numbers?**

**Respondent 4:** Fall Chinook from Roseburg-Canyonville were abundant, but the numbers from year to year were variable. There used to be a tremendous population of wild coho up cow creek that has been lost completely to Galesville dam, which has no fish passage. Spring Chinook were prevalent in the upper North Umpqua from Horseshoe bend to Soda Springs dam. 70-80%. Of the spring Chinook spawn there around September. The number one site for spring Chinook is at Marster's Bridge. Also, the mouth of Boulder Creek had Spring Chinook spawning. For a mile above and below South Umpqua falls, Spring Chinook would spawn. The coho are primarily

hatchery coho in the North Umpqua fly water. Oak Creek may have a wild coho run. South Umpqua coho are wild, so are Smith River coho. Dumont and Boulder Creek are coho spawning areas. Steelhead spawn in Steamboat Creek. I suspect fall Chinook spawn in portions of the Main on gravel bars.

**Respondent 2:** Spring Chinook used to spawn all along the main South Umpqua River. Spring Chinook got up over South Umpqua Falls. At Mule Bridge near Camp Comfort, there was a hole, and you could look down, and you could not jump in that hole without hitting a fish. As a kid I would catch big rainbows at Fish Lake. I would not keep anything unless it was over 12 inches long. You could see all kinds of fish, steelhead and Chinook. Any hole on South Umpqua River with gravel would have fish spawning. The salmon and steelhead have declined.

**Respondent 5:** according to what I have heard from some of the biologists, Canton Creek doesn't have anywhere near the run of steelhead in it that it used to have, the summer steelhead that is. We used to be able to find them in every pool from the mouth up into Steamboat Creek. We used to hike the creek just to see if we could find fish, and every pool would have fish in it, and a couple of them, well like the two main ones were right where the scared man road comes down, and the next one was right where the scared man camp was. Those two pools used to be loaded with fish and one pool down there would probably have a couple hundred steelhead in it, some of the others would not be much different than that, then there was a big pool up a mile and ½ above the scared man campground that had a ton of fish in it, and there were some huge fish there, I don't know why but the big ones used to like to hold there. Canton Creek used to have a lot more fish in it than it does now. Regarding steamboat falls, there was a jump pool there at the falls that they would jump up into, about a 6ft jump, then they had access to try to get over the next jump and at the right flow they could go over there, and I would find fish in early July up in Cedar Creek which is quite a ways above there. The winter fish spawn most of them in the main stem up here now, just in the upper end here, although Copeland (Creek) might have some summers (steelhead) go up there, I don't know what some of the research has shown, but I do know that Copeland had fish go up it over the falls, and make it up in all the small creeks, including Fairy Creek and Apple Creek they go up those, fish do utilize those, a lot of winter fish will slide up into those streams. One race of winter fish that I'm sure was wiped out was one that would come in right at the bottom of Steamboat Creek, right by the Canton Creek campground there, in June and spawn in there in June. Down below the campground and they would spawn in that area a couple three places above the bridge, where the bridge goes across Steamboat Creek from there on up to Canton Creek campground there was a race that would come up and spawn in there in June, and when they started logging in there, really extensively logging (I think Steamboat Creek has always been warm in the summer) but it reached a point when it actually pushed it over the top and the eggs probably wouldn't develop in the warmer water. It didn't take many years to wipe them out, they had been in the river every year, for several years and then they were not there.

**Respondent 3:** A lot of times in these different places it seems like there were always some fish spawning somewhere you know but now its “fallowed” out there are a few here and there that are making it back and still spawning in the same areas. Stanton Park has always had fish spawning; all of those strips and then down at the hole on K-bar Ranch and all around on the riffles there used to be spanners. On the gravelly riffles the fish used to spawn, and you can still find maybe one or two and if you can’t see them you can come through and find the bones. In the old spots there is always one or two. There were Chinook and steelhead and also other species like the reds (coho) they would come through they wouldn’t always hit the creeks. You could spot the reds pretty good in those riffles and the water, whereas the Chinook and the steelhead you would have a little trouble spotting them unless you could hear them, or see them, you could smell them in there but you don’t always get a chance to see them. You could see them when there were working those beds and cleaning those beds out getting ready to spawn, but those coho you could see those pretty good just like on the upper parts of the creek and stuff it was just like long ribbons in the water you know it would just be red. There were a few chum salmon as well, but they were not sought after for fishing. I heard my great uncles talking about going down river to get some chum, but they mostly waited on things like the Chinooks to come through and the coho that’s mainly what they were after. There were several runs of different kinds of salmon and, but that is pretty well wasted right now, if the weather ever turns around there is a good opportunity that this river could pop right back but it’s so dependent on the rain and snowpack because we are cut off from the mainstem of the cascades on the upper end of the south It’s not open like the North Umpqua where it goes further back up to the cascades we are cut off and it is real dependent on the rain and snowpack so we haven’t had that kind of water, but my dad use to tell me stories and I used to listen to the older guys they could remember when the south Umpqua was down to just puddles in the main part of the river. There were droughts here before, but the fish came back. It is very weather dependent.

**Respondent 1:** I remember on the South Umpqua, the eels used to be by the big rocks.

## **5. How has the fishery changed over the years?**

**Respondent 4:** Most have declined, other than winter steelhead it has gotten worse. Summer steelhead and spring Chinook are not good, fall Chinook are ok, coho have declined, winter steelhead are ok, and sea run cutthroat have declined. We used to fish for sea run cutthroat specifically because they were so abundant.

**Respondent 2:** Where did they go? Creeks are not running the water that they used to. At Drew we used to drive along the road and there was a place we could dive in the river. Now we can’t even get our feet wet there, and it used to be a deep hole. I could see to the bottom of the river most everywhere. Agriculture below Canyonville has increased.

**Respondent 5:** Pressure had multiplied by a hundred fold. There are more people, and more disturbances.

**Respondent 3:** It’s changed so much; you used go out, and at different times of year, like April, waiting for those young salmon and steelhead starting to head back down to the ocean. When those eels would they would spawn out and die out you know they would be all white and the

color of the water and everything would be white. You could see sturgeon coming from way down there, they would come up and you could see them in the water over those eels and that's when you could hook those or spear them too. Lamprey would come up in May or early June, it seemed like there were just bunches of them we would catch those too. Every once in a while we used to get a sturgeon too, then there used to be these trout that were all speckled, I haven't caught one of those for a while. There were sea run cutthroat, but there was another one that had speckles all over it and they used to stay here year round even up to some of the creeks up to the beaver dams and everything even the steelhead couldn't make it over the beaver dams, but those little trout could. They would only be like 5-8 inches would be a big one. They had little tiny skirts of eggs, because they would do their spawning up there in the creeks, but they were in the mainstem too, but they aren't around anymore. In late April and May we would see coastal cutthroat, we would get good runs of them. And then those little jacks, they would all come up together. And of course those trout were eating up the spawn for those guys in redds, that was a good place to get those because you could see them flashing around.

**Respondent 5:** There are several factors, there wasn't that extensive of a fishery until they got up here to steamboat, then they had a fishing lodge here, and at Susan creek, the circle H lodge there at Susan creek then Gordon's lodge, the North Umpqua lodge at steamboat. Regarding Winchester dam counts: during high water years I used to go out to the dam and watch them, and early in the summer and during the high water years the fish would come up through the ladder, swim out into the raceway above the ladder and swim back out into the current and drop back over, so it doesn't take many like that to make an erroneous count, high water it was more apt to happen than in lower water, but the main thing is most of the pools, and I mean MOST of them were not bothered, from the summer steelhead, or very little all year, there would be a few fisherman up here at Steamboat and that would be it. It used to be a long way from the highway to the old road, which is it right here, this is the old highway coming up here, and that's how you would get down to the pools off of that road. There used to be steelhead and lots of salmon, but You didn't see any coho up here; coho were put up in here by hatchery boxes basically when They wanted to get coho back up in the counts. They put out a bunch of hatch boxes in every stream here, and coho may be taking over steelhead habitat. I used to catch someone every summer poaching at steamboat. I caught a couple people one time that had 75 in the back of their pick up and a whole bunch more dead in the bottom of the pool from dynamite. There had to be 150 dead. People would come over from Cottage Grove and poach at scared man. There were sea run cutthroat and resident cutthroat –both fluvial and resident. There were a lot of trout in the upper river. There used to be more trout in the North Umpqua. Today there is not enough fine spawning gravel, because of the dam. There used to be more lamprey in the North. I saw one Lamprey in the camp water this spring and that is the first one I have seen in years. You would find them dead all over the river. You would find a lot of them dead at Steamboat.

**Respondent 6:** we used to stand on the river bank and look down and see lamprey spawning, but we have not seen that in many years. They are a part of the ecosystem that is now gone. There



are so many more people, and fish are disturbed. People swim in the holding pools in the tributaries at Steamboat.

**6. How have the areas where you fished for salmon and steelhead changed? Has there been development or degradation to the area?**

**Respondent 1:** There was very little logging when I was little, so the logging has increased, and the roads were not paved- only gravel that was sometimes graded. During WWII and the 40's logging started to increase and there were a number of little mills, run by a few people. I also think the water temperature may have gotten warmer since I was younger.

**Respondent 4:** Logging had a huge effect throughout the entire basin after WWII. Private land has been clear cut over last 40 years. Some areas are on a second round of clear cutting. On public lands forest practices have changed for the better.

**Respondent 2:** More homes, more agriculture, less vegetation streamside, heavy logging and clear cuts.

**Respondent 5:** Warmer temps, more cobble or large rock, year round discoloration from decayed algae from reservoirs-decayed algae on rocks and stream bottom. Soda Springs and other dams, the Flood of 1964 changed things. Road building, culverts, the numbers of salmon and steelhead have changed in the pools-due to fishing pressure. I have caught hatchery fish up here during spawning. The runs are supposedly holding steady, but in the upper river from Steamboat up to the dam over the last 20 years or so there are a lot less steelhead going up the mainstem, then there were historically. When they put Soda Springs in I had no idea what the ramifications would be. I remember watching them clean the channel out before they put in Soda Springs in the 1950's. We used to see a lot more salmon spawning, and a lot more winter steelhead. The winter steelhead run, if you go back 30 years, the best fishing was around the 5<sup>th</sup> of Feb-March 1<sup>st</sup>. Now it's going into the best is the 15<sup>th</sup> of March-April 30<sup>th</sup>. I have caught summer steelhead up at Copeland creek, immature summer steelhead in middle of May. You would find them up Canton Creek early in the year. The Canton Creek run is gone completely now-at least that is what Loomis would tell me. June 1<sup>st</sup>-14<sup>th</sup> was excellent fishing for steelhead, but now the summer run is 15<sup>th</sup> of July-Aug 15<sup>th</sup>. The river was closed above Mott bridge at the end of October and opened in April 15 around the 1950's-1960. The fishing was also closed above rock creek for a period of time, but it has been a lot of years since it was closed. In the 60's, 70's and 80's the North Umpqua was heavily logged. With regards to Pass Creek- They heavily logged Pass Creek. The destruction of Pass Creek was documented in the Film Pass Creek in 1968. I noticed below some of these logging units you would not find juveniles, and we started keeping a diary of water temps in the summer of the Main River, and the tributaries up Steamboat and Canton Creeks. The average temp would be 57-60°- when they logged Cedar Creek, in one year it went from 60° up to 84°, and Steamboat Creek was the same way, it would be in the mid 80's. You can't see the bottom of the river-we used to be able to see the bottom in 20' of water-it's the algae. Road Building-every road went right by a creek, and the culverts would fail. The runoff from heavy storms would come into the stream instead of into the ground.

There was increased runoff in many streams, and streams were narrow, 6-7ft wide, and after the first time they would put a road in, the stream bottom width would almost double from erosion. Any time you add silt or get gravel moving there is more erosion. The road would destroy the gravel bars; it would be down to bedrock, so the habitat would be gone. They would put the rip-rap in and channelize the river. Floodplains in the tributaries and main river were messed up. There used to be several flat spots along the river.

**Respondent 6:** some hatchery fish in past years will stray up the river. The side streams are healing, but there isn't much gravel in the mainstem for spawning, where we see salmon spawning it's in small gravel. there used to be steelhead that came at different time, and they don't show up in the numbers they used to. Tokatee Village is supposed to have put in a treatment plant to keep out herbicides and that sort of thing out of the water. The reservoirs act like a nursery for algae. The USFS has left a buffer now on the streams-their forest practices have gotten better. We had shiners and dace move in when the tributary water temperatures got warm. The Dace were not up the tributaries like they are now, not as many, but they moved up there as soon as the water warmed up. The 1964 flood was so damaging because it scoured out the streams to bedrock, then the bedrock would get hot during the summer. The 1964 flood did the most damage-so many streams, because they had been logged right to the stream and when the flood came the water just poured through and every one of those streams had huge blockages of logs that when they would break loose would tear everything out of the stream beds. The streams were widened as soon as they logged them. The damage from all the debris was really something. It was not just the river level; it was that there was nothing to hold the river.

**Respondent 5:** the flood of 1996 did not stay up as long as the 1964 flood and the stream practices had improved so much that a lot of those streams did not have the debris to get pushed down the river. Because of Pass Creek, the film, we have what we have today in the Oregon Forest practices act. The BLM logged Pass Creek. They took gravel out of the gravel bar at Steamboat. On the South Umpqua there is so much water taken out of it, it is overly appropriated. The South has always been a slower moving river. There is cattle grazing on the Mott Meadows up on top. They are open to grazing, there used to be sheep too- but there is not the amount that there used to be. They were up at the headwaters of Fish Creek and they would tromp through the streams. Winchester dam has been a barrier to the bass. My husband has been down on the Main and seen Bass eat salmon smolts.

**Respondent 3:** There used to be great big root wads and it would be whole fir, pine, cedar trees or cottonwoods they would make a big log jam, they were natural what fell in and came from the floods we had good high water and big heavy floods and everything was dependent on it, little fish even the older ones you could watch and they would hang around and you could spear them or net them out, or you could take a big pole and a piece of twine and make a big hook and hook them , we did that with the eels. Eels were real dependent on the log jams too big root wads and all the side creeks that brought the water and kept a steady flow it took care of those gravel beds it was a good place for them to hide out there was plenty of food for them. The water temp. fluctuates here but everything really changed from the 70s. There used to be very big snowdrifts up on Canyon mountain and sometimes they would be there all summer long. The water would just be clear and cold and be enough if you got a cup drink it out of that melt you know it would hurt your teeth you would just have to sip real slow the water was real good and clean but we just

haven't had the weather, the snowpack and the rain. It seems like the rains would just start up in Sept. and Oct. and just rain real steady and then we had plenty of snow and ice, but we just haven't had that so the temps have been real bad. I've noticed that other years down the creeks the temp would be up and those trout and the different fish would find those springs and stuff that were leaking out into the river, water was a little cooler and shaded you could drift over there and catch those guys by hand. The fish had sores from the warm water; you would look at them and let them go. It just seems like the water quality is just shot if they would just change that around, it's bad enough for humans but anything in the river even the animals and stuff I am just surprised, the fish that are still here must be pretty hardy, even the crawfish, the water quality is really bad here, for the last twenty years here the water quality has just shot down hill and that's from development and sewage and probably the compounds like overflow from washing dishes and clothes laundry detergent and other things, it's really sad, and why they haven't done something to slow that down or put a stop to it.

**7. Do you remember any major events that have influenced the river? Dam construction? Major flooding events? Introduction of non native fish species? Agriculture? Cattle grazing? Development? How did these events influence the river?**

**Respondent 4:** 1964 flood of record. Soda Springs Dam had cut off 7-8 miles of the main stem North Umpqua, and 30-40 miles of Fish creek has been cut off. Spring Chinook used to spawn in the area where Soda Springs Reservoir is now. There were- 3 large gravel bars w/ side channels and sinuosity in Soda Springs reservoir. That was historically a hot spot. Galesville dam cut off an exceptional run of Coho that are extinct now. Smallmouth bass and striped bass in the estuary eat salmon smolts and lamprey.

**Respondent 3:** It has been everything from human to cattle because they don't fence them back and like in other areas that they work with like in the Umatilla they fenced different areas and they worked with private landowners and cattle operations you know even the farming they worked with everybody and its improved the fishing. Nothing has been done here. if it weren't for the North Umpqua being scenic it would have probably been all logged out and tore out too, but for ours, the South Umpqua and the Cow Creek it was just whatever you wanted to do. They first started logging in the late 60s and the early 70s those guys used to just run up and down in the creeks and they even used to push fish out of the water and everything with the logging. Upper Middle Creek up on Cow Creek was logged, and it was just section after section and it didn't matter you could just watch those creeks just went straight down hill just washed out and heated up nothing to hold back the heat, nothing to hold back the water to control it. They sent us up and down the creeks just whatever you wanted to do and that's just how everybody logged. Instead of having everybody take care of their sewage its everything from all these little towns if it over flows it gets to full they can't afford it, they just dump it in the river. Those smallmouth and they are pretty territorial anyway they would just about wipe out whole strips up and down the river. They had pretty good little schools and they would congregate and stay out of the other fishes way and these guys would come in and just eat them, and suckers there were whole strips of them. There is still mercury seepage you can go up to some of those old places where they weren't actually mining for mercury but there are mercury deposits there you can still pick some up. They actually mined for mercury here too.

**Respondent 5:** There are not the bug hatches that there used to be. For a lot of years the river fluctuations would strand bugs them on the river edges. I have seen juvenile salmon get trapped too; I have seen thousands of them trapped. That is regulation from Soda Springs. They filled in the jump pool at Steamboat falls so the fish have to use the ladder, but historically they could get up over the falls-I would see fish over the falls in July. Historically apparently the South Umpqua was a far greater producer of salmonids than the North Umpqua. Historically fish got up Fish Creek. There is evidence of steelhead caught behind Big Camas Creek ranger station in Fish Creek- it was in some forest service diary, and we are trying to find it. The first bass in the River occurred in the 1950's- during floods farmers ponds that were stocked with bass would get flooded into the river. I caught a sockeye salmon here at steamboat-I think it washed over the dam. I had a biologist with me and he said where did that come from? That's a sockeye. I have heard of one or two strays coming over Winchester dam. And they planted Kokanee in Lemolo lake. Apparently, historically there was good fishing at the base of Tokatee Falls

**Respondent 6:** every so now often you have an "event" when they have a problem and the power plant shuts down and the water spills over the top of the dm and the river levels go up.

**Respondent 5:** for a long time it was every day the river fluctuated

**Respondent 1:** Coffee creek was quite a famous mining town in the 1800's they had a mining camp up Coffee Creek and brought in Chinese laborers and had a real you know mining camp up there...so it was famous for its gold. When I was little there were very few homes, but there has been subdividing and ranches have broken up and people have come to live. There are more people living here now. I think the biggest impact has been the logging. Unquestionably that, and then for awhile a lot of cows...it was open range for people who had cows and everything and that's bound to have an impact as well.

## **8. Can you think of any other changes to the river system or to Salmon and Steelhead habitat over the years?**

**Respondent 4:** Ongoing gravel mining operation in the estuary for over 100 years. Scottsburg to the Mouth of the Umpqua has been dredged and deepened. At one time it would have been a nursery area for juveniles.

**Respondent 2:** lots of changes over the years. The fishing isn't there like it used to be, not like when I was a kid. If the fish was not big enough we would throw it back and let it grow up! There used to be a creek across from the old Thomason home stead filled with trout-no salmon or steelhead. You could fish it once a year, using an old willow pole with a string, and you could catch 1 in a hole, but I could catch 20-30 of them in the creek. Rainbow or cutthroat trout. I used a gray fly or grasshoppers. Seems like there was more water in the South Umpqua historically

There used to be a gravel bar at South Umpqua Falls, and it was a channel all the way down to the next hole. When we were kids used to go swimming in there, and you could grab onto the salmon and try to hold them. When they blasted the falls the gravel bar moved out, and the channel filled up, and now it's bare rock. I worked with the fisheries people at Tiller and we put logs in the channel. The smolts cannot get through the lower South Umpqua. The water is luke warm and the bass will eat them. Canyonville to the confluence with the North needs help. It only took fish a year to start using the areas we put the logs into. I used to clean creeks out with Cats, then I started putting the logs back in. Joe Hall Creek, just up from the mouth. They built a mill and pond. After the mill went out, they never took the dam out. I was hunting one time up there down the old Joe Hall creek trail. There are these steelhead trying to get through the hole in the dam. I was working up Savage Creek and I saw steelhead. I doubt there has been a fish up there in years. There were lamprey in Elk Creek and the Main South Umpqua. In upper Cow Creek, near red cloud mine, we used to catch little trout 6-8" long and I would catch a bunch of them. They spawned up there. Did not see coho up there, I don't think they could get above the falls.

#### **9. How and what did you use salmon and steelhead for traditionally and culturally?**

**Respondent 4:** Recreation and food

**Respondent 2:** I know one time when I was a kid we had a scaffold on the creek and we had fish we dried and smoked. I have heard that salmon and steelhead were a big part of the Cow Creek way of life, I think they canned it.

**Respondent 3:** It was subsistence, and you would give fish away and but in times past, it was traded and there was commodity when you had an overage you would use it for trade for different things to keep you and your family going and like when I was small if anybody had anything over they would make sure somebody had something to eat too. You could make powdered fish it wasn't just the flesh that you make the powder fish too you use the bones too. And then you could use the oil out of them you could use all of that.

**Respondent 5:** Food and recreation, and business.

**Respondent 1:** we used salmon for food and also freshwater mussels that were at the ranch. I heard stories of using lamprey oil for rendering and tanning (of hides).

#### **10. How do you value salmon and steelhead in a traditional and cultural sense?**

**Respondent 4:** They are a big part of my life-professionally, and recreationally

**Respondent 2:** I would like to see them come back. I won't ever live to see it like it was when I was a kid. Those sea run cutthroat used to be 16-18" long. I used to catch them on Joe hall Creek.

**Respondent 3:** Its right up there, just like the plains tribe have buffalo, we have salmon that's the one. they respected and they were part of the creation story here for this land and for our people and there was for a salmon ceremony and an eel ceremony all of those respected, highly respected, Salmon was number 1 and suckers and eels too they were highly respected and they were just like us and they were all named in creation stories here for this land for our people and for Indian law to be able to follow and to be respected and as long we respected them they respected us and vice versa and we took care of ourselves and those old folks never thought any other way then being like one of them and it was like they were the elders. Even though we take those that was a covenant if you want to put it that way as long as we took care of them and honored it and respected it paid attention with it and done right with it they would always be here and return.

**Respondent 5:** They are part of our heritage.

**Respondent 6:** We should be good stewards of the river

#### **11. Did you use other non salmonid fish, such as lamprey, traditionally? If so how?**

**Respondent 4:** Smallmouth bass good food, recreation, American shad are fun to catch and are good crab bait

**Respondent 3:** Caught adult lamprey for food, and used the oil.

#### **12. What kind of restoration would you like to see on the Umpqua? Who should decide how the river is restored? How should the tribe be involved?**

**Respondent 4:** Seriously address the causes of degradation, not just the symptoms of degradation. It will take a fundamental societal change regarding land use. It will be expensive, and populations are increasing.

**Respondent 2:** I would like to see what you are doing. And bring the tribe in to it.

**Respondent 3:** The tribe should be directly involved, no matter how big or how small they should move forward and spear point it they have already made moves on it like what they have been doing with the steelhead spawn they are raising, they should broaden it out to the whole range home range and the traditional range. Whether we have our fishing rights or not it's an enhancement for everything its part of the stewardship it's not so much what we receive ourselves but it would be an enhancement to the water and the water quality and all the aquatic life and to the rest of the community as a whole too and I think there would be enough help and support from everybody else if the tribe would be involved.

**Respondent 5:** Remove Soda Springs Dam and I'm not sure if it will happen in my life. It would set a precedent of what we set our values at. There is more fishing pressure now, but you can't really change that. Hatchery fish will not bring back the fish runs. It is an immediate gain for future losses; it does not pan out financially either. There is so much that happens when you are out fishing, it's not just what happens on the end of the line. Road removals are important too, and if the schools of forestry and schools of fisheries would teach students how to protect things.

**Respondent 6:** In 1910-1925-28 they destroyed the runs on this river- the commercial fisheries wiped out the in river fisheries. They had canneries at Reedsport, they had nets up and down the river in the North, South and Main, and they put racks across the river to block fish movement put in by ODFW for their hatchery program. It was called the game commission. In the Winterbotham book, there are statistics that say when the fish catches just dropped out, and it never came back because they took them down so far. Science should be used to determine restoration, ideally through the management agencies. We have a had a problem with fires here in the clear cut areas that they have re-planted with even aged stands, and you get a fire in an even aged stand and it goes up quick. Like up at Apple Creek, those went up quick. In the 50's the clear cuts were huge, and on south facing slopes, they could not get good re-growth. They would plant and spray and plant and spray.

**Respondent 1:** Put money into the river- cleaning it up and helping it. And what's unique about it, the Umpqua River is in one county in Oregon. The headwaters to the ocean and that's kind of unique itself. I would appropriate money for a study, but only if money was also appropriated at the same time for implementing it, not just for the study. On Road removal: If there isn't any need why are they there? What could be done in the forest, is planting of natural forest products. What would be the matter with planting huckleberries? With planting hazelnuts which are the wild you know, there are areas that wonderful for planting wild strawberries which have such a distinctive flavor. There was heavy agriculture before there was logging. the thing is fish require deep pools and shade and a lot of the shade has been cut away from the banks of the river. I'm sure when you worked with ODFW they explained to you about putting logs back in the river to create a semblance of the habitat. Another factor is the low summer flows and the temperature it gets warmer and warmer, the water does, and all those things factor in. Now there is more human habitat more cutting away of the trees that provide shade in the river.