Restoring Willanch Creek

Fifteen Years of Cooperation Benefiting Salmon

Coos Watershed Association

The Oregon Plan for Salmon and Watersheds

Willow wall construction helped to shade the stream and lower the water temperature. (Photo taken in 1997.)

Riparian vegetation growing in Lower Valley assisted the greater than 10^{O}F drop in stream temperature. (Photo taken in 2004.)

Large wood placed in Willanch Creek in 2004 aided in enhancing stream complexity.

Introduction

The Coos Watershed Association's vision for a healthy Willanch Creek was put into action in 1995. After 15 years of perseverance in building strong partnerships, and completing a wide range of projects, we've been able to demonstrate that the habitat for fish and other wildlife is improved: today the water is 10^{O}F cooler, and water flowing through the creek and the surrounding floodplain takes a more natural path. This improvement relied on the cooperation and collaboration of five private landowners, three timber companies, four benefactors, the Coos County Road Department, and four different Coos Watershed Association project managers. Our work includes:

- planting trees, building willow walls, and building livestock exclusion fences along stream banks to reduce erosion and to filter runoff from adjacent pastures;
- replacing culverts with bridges at four sites to permit fish to pass and to allow gravels to move downstream;
- replacing the tide gate at the mouth of Willanch Creek with an improved design to allow juvenile fish access to the estuary during critical times;
- putting large wood in the stream to provide cover, collect gravels, and scour pools;
- blocking and removing unneeded logging roads to reduce soil erosion and prevent illegal garbage dumping.

This report is the story of how we've made a difference in Willanch Creek—our vision, our work, and our data.

Setting

Although the Willanch Creek sub-basin (Figure 5, page 6-7) is a small part of the Coos watershed, it embodies a wide range of ecosystems and land uses. These conditions in a relatively small area make it a good place to evaluate watershed improvement projects and their affect on coho salmon habitat.

Salmon Life Cycle and Habitat Needs

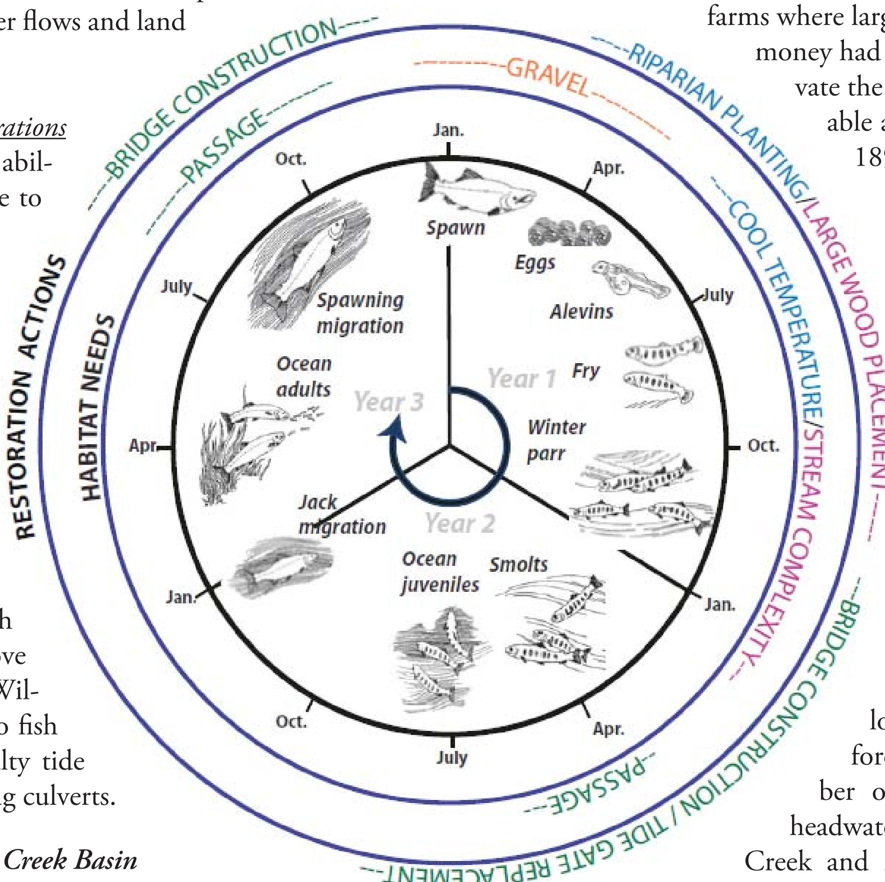
As shown in Figure 1, the coho salmon life cycle generally takes three years. Throughout the life cycle different habitat requirements play important roles in salmon survival and habitat requirements at different life cycle stages are often interrelated. Further, because fish have little physiological control over their body temperature, they regulate it primarily by moving to a place in the river with a suitable temperature. These prime temperature places, or access to them, are often limited—in turn limiting the number of salmon that can inhabit that stretch of stream. Further, as water warms it loses oxygen, which places additional stress on fish.

<u>Spawning and Eggs</u> require pea- to marble-sized gravel. The spaces between these rocks, where the eggs and emerging young live, need to have clear, clean, flowing water with plenty of oxygen; fine sediments, such as silt, can fill the spaces and suffocate the eggs. Flowing water, or riffles, deliver oxygen to eggs; riffles are usually rapid structures with a choppy surface that incorporates oxygen into the water. This oxygen-

ation benefit continues downstream in systems that stay cool enough for the water to retain the oxygen.

Alevins, fry, and parr require a complex stream system with a variety of habitats for summer and winter rearing. Summer rearing habitat consists of pools and in-stream wood that can provide food sources and refuges for the growing fish. Winter rearing habitat, which was especially limiting in Willanch Creek, consists of off-channel alcoves, pools, and beaver ponds where juveniles can find protection from high winter flows and land predators.

Smolt and adult migrations can be limited by their ability to successfully move to and from the ocean. Smolts must be able to acclimate to the salt water in phases, which requires considerable freedom of movement at the transition between salt and freshwater. A number of human-made structures can interfere with the ability of fish to move between habitats. In Willanch Creek, barriers to fish passage included a faulty tide gate and malfunctioning culverts.



Landform in Willanch Creek Basin

Willanch Creek has many branching tributaries that flow into the main channel. Draining a total of 5,369 acres (8.4 square miles), this east-west oriented basin encompasses elevations up to 1209 feet above sea level and contains ecosystems from estuarine to forested uplands. The Willanch sub-basin has 33.8 miles of stream that eventually drains into the northeast side of Coos Bay (Figure 5). Willanch Creek's main tributary, Johnson Creek, converges with Willanch Creek approximately 3.5 miles upstream from the mouth. East Bay Drive, a county road, crosses Willanch Creek near where it empties into Coos Bay; a tide gate at this crossing has reduced tidal inundation upstream since 1947.

Land Use Over Time

Living along the shores of Coos Bay long before Euro-American settlement, Native Americans used the lowland flats of the Willanch sub-basin for smoking fish caught in weirs (Coyote, 2010). Euro-American settlement of the Coos Bay area began in 1852. Coal mining was the first industry to take hold in the area, but lumber soon surpassed coal mining in importance; the first Coos Bay lumber shipments were made to California as early as 1854 (Case, 1983). Early settlers worked hard to cultivate the land for agriculture, dairy farming, and cattle grazing. Nineteenth century historical documents describe Willanch Slough as having well established farms where large amounts of labor and money had been expended to cultivate the land and make it habitable and productive (Dodge, 1898).

The 1930 census indicates that there were 40 individuals living in 16 households along Willanch Creek who were engaged primarily in farming, ranching, and logging.

Today, 76% of the Willanch sub-basin is managed for timber. Although small woodlot owners manage some forestlands, industrial timber operators dominate the headwater areas of Willanch Creek and its tributaries. Agricultural land uses, primarily grazing and hay cropping, make up 20% of the sub-basin and are concentrated in the lower-gradient bottomlands. Rural residential land use comprises 4% of the sub-basin and is concentrated along Coos Bay.

Land Use Effects

As Euro-Americans began to settle and farm in the Willanch Creek sub-basin, they cleared forests for timber, diked wetlands for pasture, and dredged and channelized streams to control their flow. Wetland draining of the area in the 1940s

Figure 1 (above): Coho life cycle showing habitat needs and restoration actions taken to address those needs. (Adapted from Lawson, et al, 2007).

and 1950s included the placement of a tide gate at the mouth of Willanch Creek to prevent saltwater inundation in the bottomlands (CoosWA, 2006). Agricultural development eliminated much of the riparian vegetation, decreased channel complexity, and interrupted the natural cycle of sediment flushing. These activities led to increased stream temperature and sediment load, which reduced spawning and rearing habitat for salmon.

Restoration Efforts, 1995-2010

Restoration of Willanch Creek was aimed at improving habitat conditions for salmon by addressing four main building blocks: fish passage; stream temperature; sediment inputs; and general spawning, rearing, and migratory habitat. These restoration objectives are based on the necessary habitat conditions for salmon reproduction and survival. In many cases the efforts used to address these objectives are interrelated and improve multiple habitat conditions (Figure 1, page 3). Salmon play a vital role in evaluating restoration efforts because they are good overall indicators of watershed health.

Improve Fish Passage

Four malfunctioning culverts were replaced with bridges to allow both adult and juvenile fish to move freely under these road crossings. The tide gate at the outlet of Willanch Creek was replaced in the summer of 2010.

Improve Stream Complexity

The aquatic habitat inventories (AHI) conducted in 2001 and 2003 identified the need for improving the stream complexity. Specifically, pools and alcoves to provide fish with resting spots and refuge from higher flows, and riffles to incorporate oxygen into the water. Complexity was increased by adding eighteen large wood placements in the upper section of the creek. Large wood placement is known to improve summer rearing habitat by creating pools, increasing pool depth by scour action, trapping and sorting spawning gravel, enhancing channel sinuosity, and by generally adding complexity to the stream.

Control Sediment Inputs

The *Coos Bay Lowlands Assessment and Restoration Plan* (CoosWA, 2006) showed that the Willanch sub-basin naturally had high levels of sediment. However, road-related erosion, improperly functioning culverts, and certain land-use practices added fine sediment to the system. In addition, the tide gate prevented the sediment from being flushed out naturally. A variety of restoration activities addressed this condition: native trees were planted along the creek, 1.5 miles of road were removed, and four culverts were replaced with bridges. It should be noted that in winter 2006/2007 a landslide in the Upper Wood Treatment Reach deposited a large amount of sediment into Willanch Creek that affected habitat conditions in the Upper Wood Treatment Reach (photo in Figure 5).

Reduce Stream Temperature

Temperature is often considered an easy first-glance indicator of salmon habitat quality. The Oregon Department of Environmental Quality has established that salmon require a seven-day average temperature of 64^{O}F or below. (ODEQ, 2009). Reducing the temperature of Willanch Creek was addressed through riparian planting and by allowing the creek to spread out and meander across its floodplain. Allowing the stream to easily flow into the floodplain causes water to infiltrate into the groundwater; this cooler water is then released back into the stream during lower flows in the summer months.

Restoration Results

The effectiveness of the restoration program was gauged by evaluating fish passage, habitat diversity, stream temperature, and fish populations. This data was used to determine how well the restoration efforts improved salmon habitat by addressing the objectives discussed above: improving fish passage, improving aquatic habitat diversity and complexity, reducing sediment, and decreasing temperature.

Increased Fish Passage

Replacing four malfunctioning culverts with bridges greatly increased the flow capacity of the stream. On average, flow increased over 20%, and at one crossing (that was completely blocked) flow increased 100%. These bridges also improved fish access to a total of 5.9 miles of stream with spawning and

Salmon spawning in Willanch Creek where the gravel streambed is ideal for spawning. (Photo taken in 2009.)

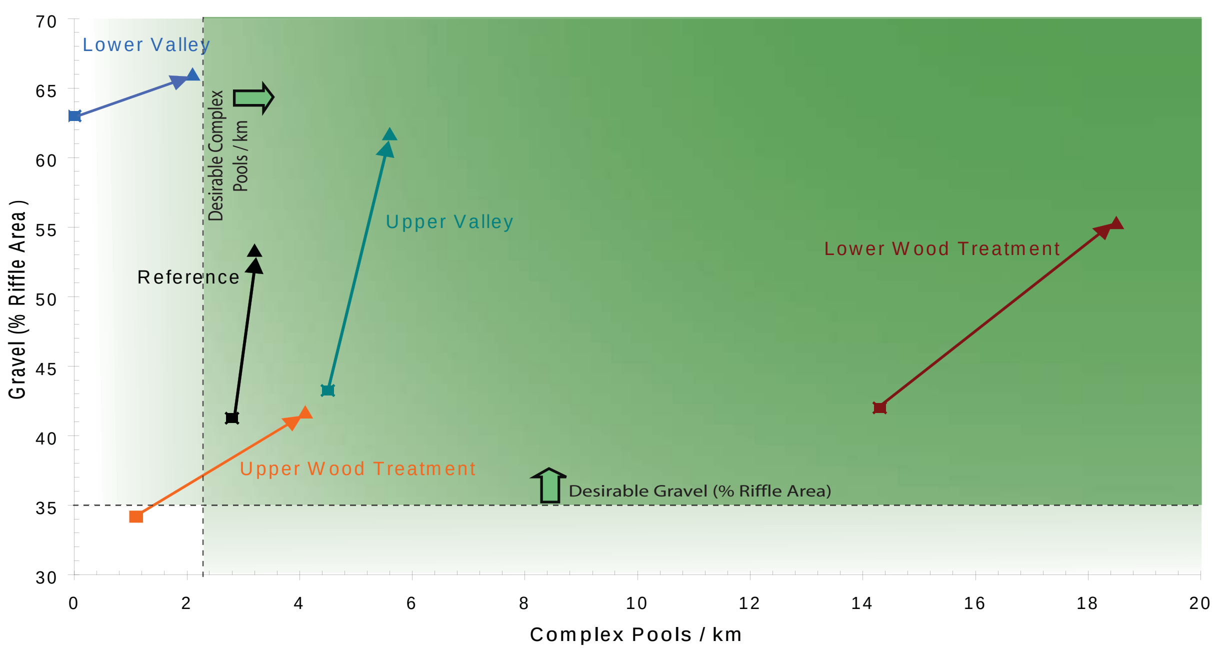


Figure 2: All reaches showed improvement in the percent of gravel and the complexity of pools. In 2009 all reaches except the Lower Valley met these benchmarks.

rearing habitat, and released stored gravel.

Improved Aquatic Habitat Diversity

The aquatic habitat inventories (AHI) focused on parameters that are key habitat features for salmon: large wood, pool area, residual pool depth, riffle area, width to depth ratio, and entrenchment ratio of the stream. It is vital for salmon to have this diversity of habitat types available in a stream. Our data was compared to the benchmarks established by the Oregon Department of Fish and Wildlife (Moore, 1997). Figure 5 shows the AHI reach locations on Willanch Creek.

Large wood placement in streams is an effective way to initiate natural habitat formation and create diversity in key habitat types. By returning large wood to the system, several salmon habitat factors are improved: pool area, residual pool depth, riffle area, width to depth ratio, and entrenchment ratio. (Dredging and other outdated management techniques had

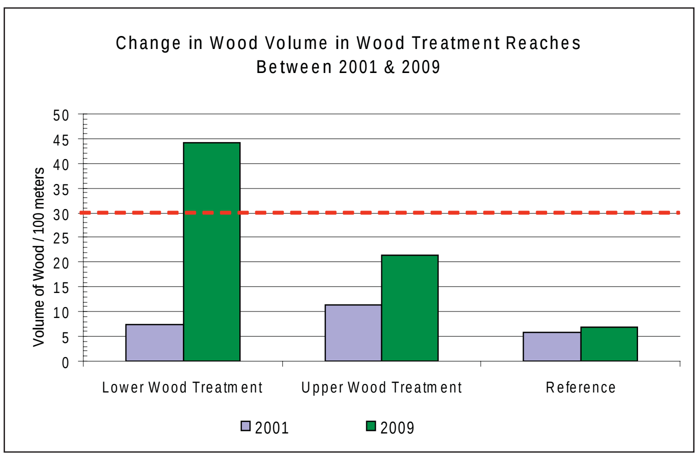


Figure 3: Increase in wood volume in the reaches where large wood was added to the stream. The Lower Wood Treatment Reach met the ODFW benchmark in 2009. (Lower Valley and Upper Valley Reaches not shown since they were not treated with wood.)

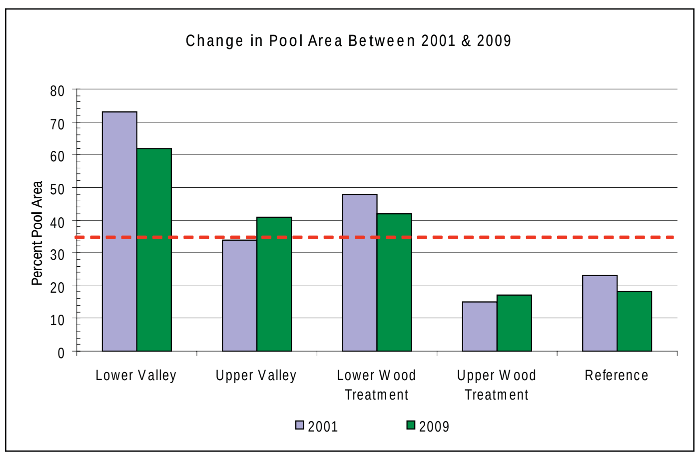
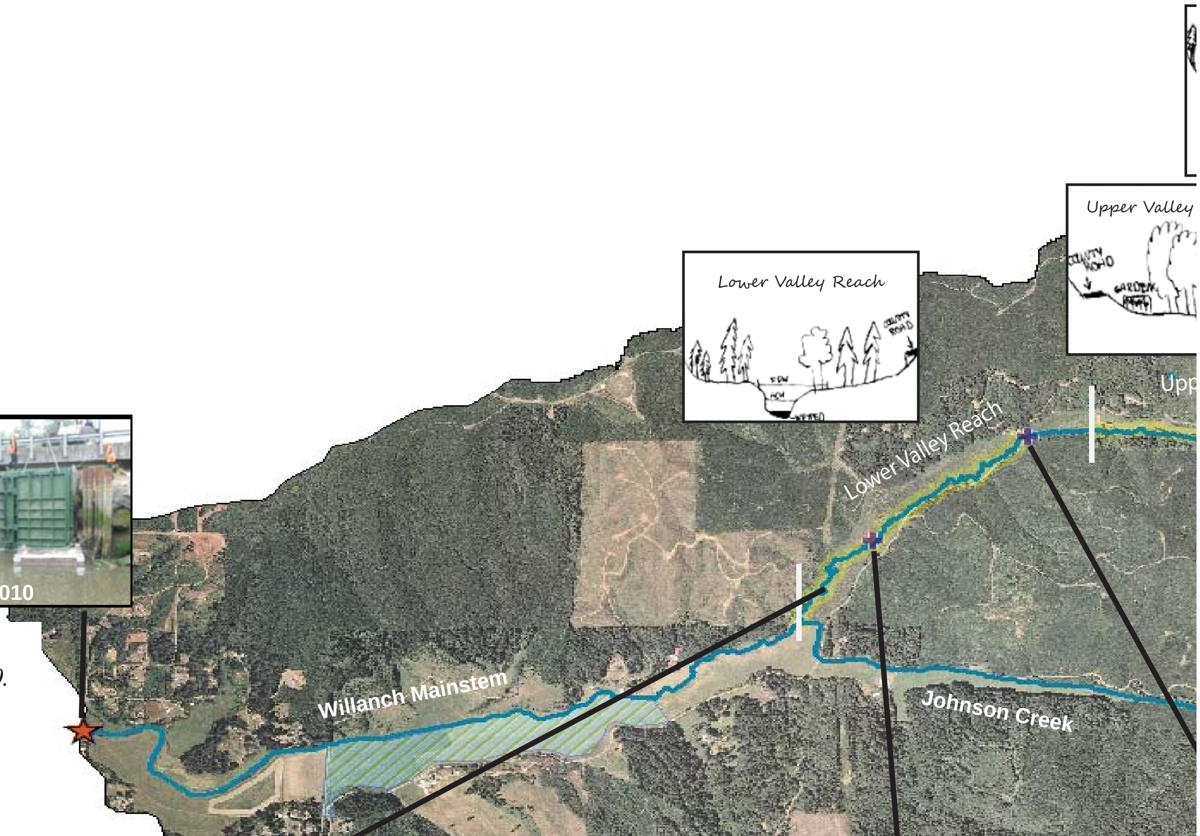


Figure 4: Three of the five reaches met the ODFW benchmark in 2009. Those that did not meet this benchmark also lacked large wood, which can contribute to pool area of a stream.

Figure 5: Willanch Creek Watershed Restoration

New tide gate at the mouth of Willanch Creek, summer 2010.



Riparian planting along the Lower Valley Reach.

Blocked culverts replaced with a railcar bridge to allow water to flow freely.

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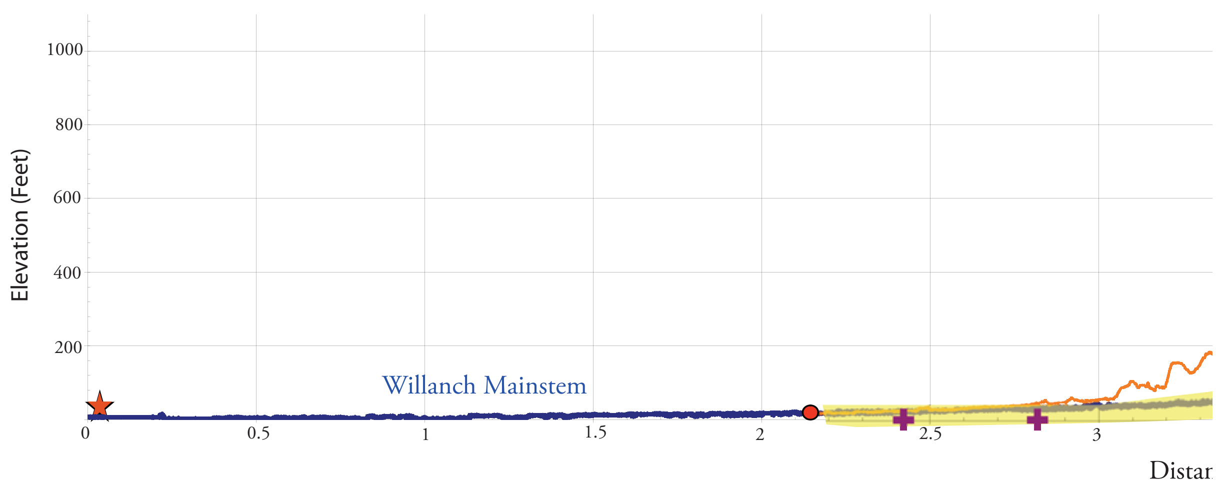
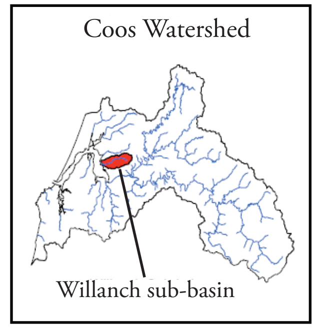
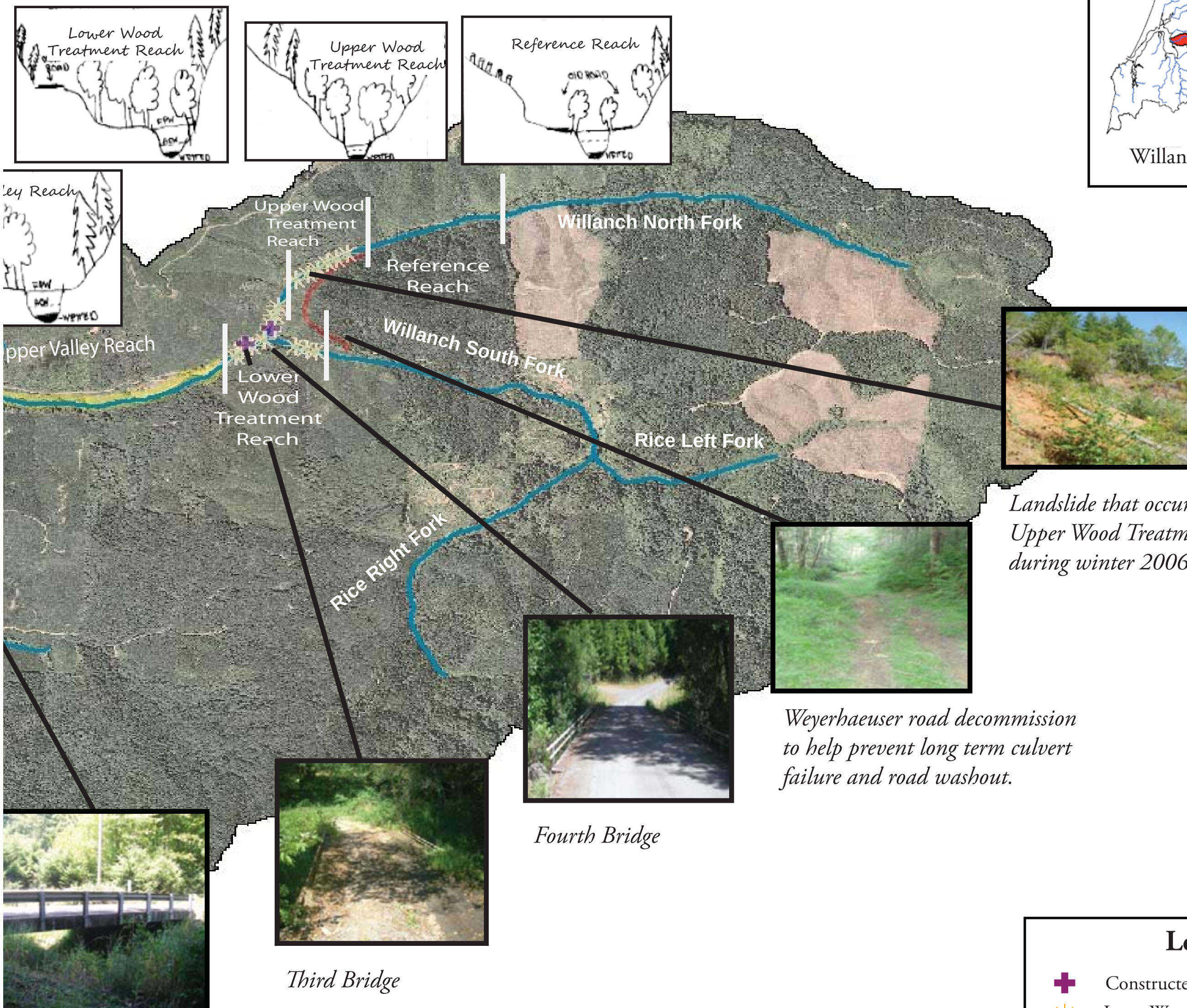






Landslide that occurred in the Upper Wood Treatment reach during winter 2006 / 2007.

Weyerhaeuser road decommission to help prevent long term culvert failure and road washout.

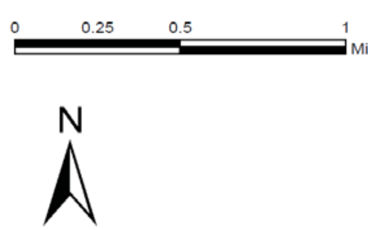
Fourth Bridge

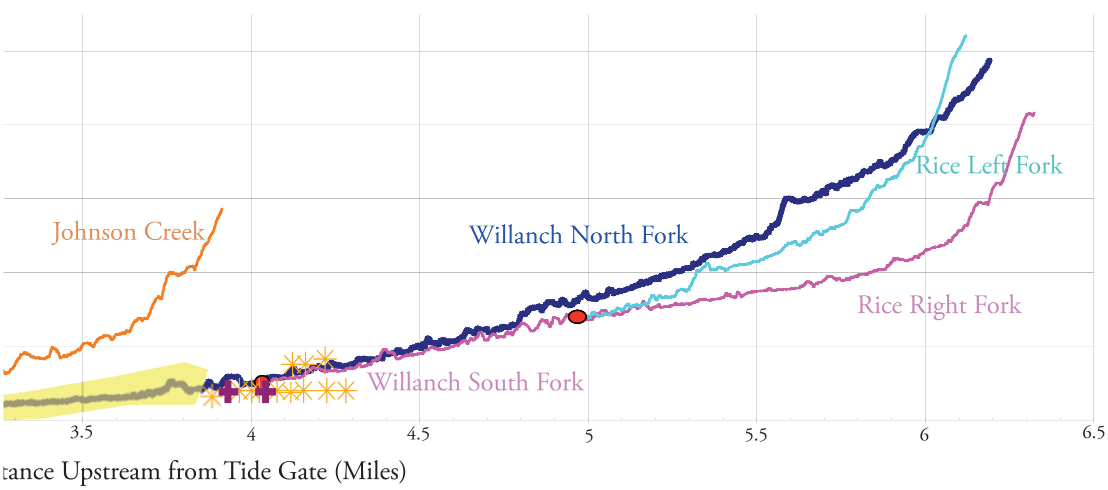
Third Bridge

cond Bridge

Legend

- Constructed Bridges
- Large Wood Placements
- Weyerhaeuser Road Decommission
- Riparian Planting
- Tide Gate Replacement
- Possible Wetland Mitigation Bank
- Tributary Intersection





removed large woody debris.) The Upper and Lower Wood Treatment sites were treated with large wood in 2005. The 2009 AHI showed that the Lower Wood Treatment site attained a desirable level of large wood (according to the ODFW benchmarks), but the Upper Wood Treatment site still lacked key pieces (Figure 3, page 5).

Pool area is important because pools provide refuge from higher flows during the rainy season and provide deeper water during drought. In Willanch Creek, pools were created by the placement of large wood, which enhanced the scour action of the stream. According to ODFW, pool area should comprise 35% of the habitat in streams like Willanch Creek. In the 2001 and 2009 AHI surveys, three of the five reaches met this benchmark (Figure 4, page 5). The landslide in 2007 may have prevented the Upper Wood Treatment Reach from meeting the desirable benchmark.

Residual pool depth, as described by Thomas Lisle (1987), is "the depth that, if flow were reduced to zero, water would fill pools just up to their lips." This is an unbiased, quantitative way to measure change in pool size. The ODFW benchmark for medium streams, such as Willanch Creek, states that residual pool depths should be greater than 0.6 meters (2 feet). The 2001 AHI survey showed that no reach met this benchmark; the 2009 AHI survey showed one of the five reaches had met this desirable level and all reaches showed moderate improvement (Figure 6).

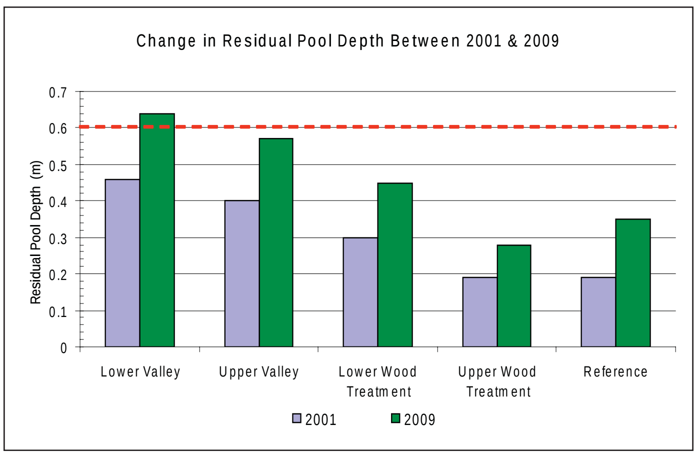


Figure 6: All reaches showed improvement and the Lower Valley Reach met the ODFW benchmark in 2009.

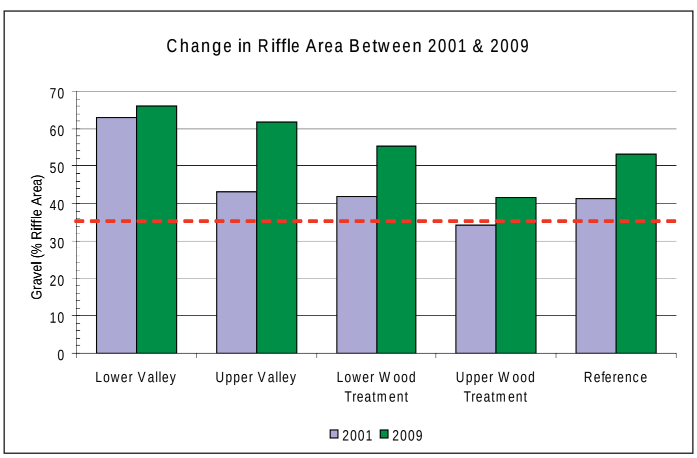


Figure 7: All reaches met the ODFW benchmark in 2009 for gravel (% riffle area).

Riffle areas in a stream have fast water with a choppy surfaces that provide oxygen for young salmon and riffles usually have a gravel substrate that provides salmon spawning habitat. The 2001 AHI survey indicated that four of the five reaches met the ODFW benchmark; all five reaches surveyed during the 2009 AHI had a desirable amount of riffle area (Figure 7). Improvements were greatest in the Lower Wood Treatment Reach where gravel was captured when the Upper County Road Bridge replaced a perched culvert.

Width to depth ratio, shown in Figure 8, indicates the shape of the channel. Some streams are wide and shallow (high ratio), while others are deep and narrow (low ratio). The width to depth ratio was reduced in Willanch Creek through riparian planting and large wood placement. A desirable width to depth ratio, according to ODFW standards, is less than 15 for streams on the western side of the Cascades. Although four of the five reaches in the study had a desirable width to depth ratio in 2001, the 2009 AHI survey showed that all five reaches met this benchmark and four out of five improved (Figure 9).

Entrenchment ratio is a measure of the ability of a channel to expand into its floodplain: some channels have steep banks that keep the stream confined, while other channels have banks that allow floodwaters to easily spill into the floodplain (Figure 8). Increasing entrenchment ratio—floodplain connectivity—helps replenish groundwater during the wet season; this cooler water is then released during the dryer,

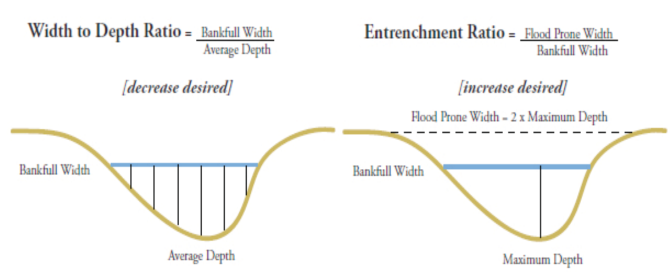


Figure 8: Diagrams showing how width to depth ratio and entrenchment ratio are calculated.

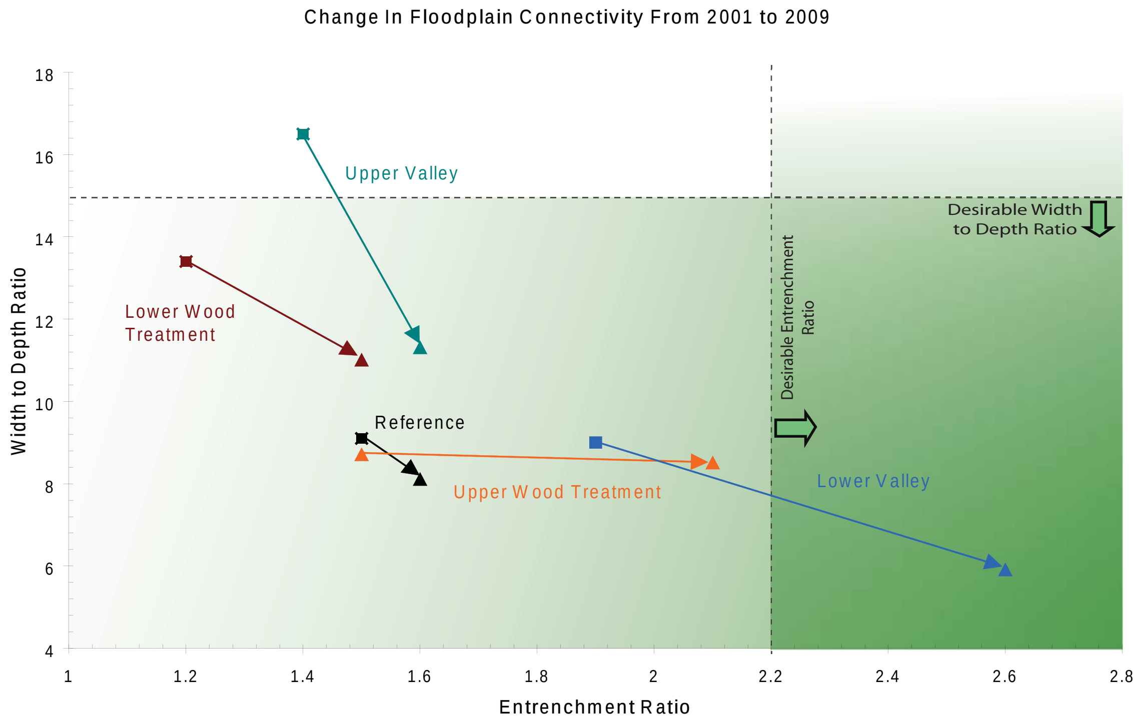


Figure 9: Comparison between width to depth ratio and entrenchment ratio in Willanch Creek from 2001 to 2009. A decrease in width to depth ratio and an increase in entrenchment ratio is the desirable trend. The Lower Valley reach met both these benchmarks.

warmer months. According to Rosgen (1996), an entrenchment ratio greater than 2.2 indicates a well-developed floodplain. The 2009 AHI survey showed that only one reach had a desirable entrenchment ratio; however, the remaining four showed improvement (Figure 9). Over time, gravels deposited at the large wood placement sites will improve entrenchment ratios.

Reduced Sediment Inputs

Bank stability is affected by land use practices, riparian vegetation, soil type, flow volume, and velocity. Bank stability is an important concern for salmon habitat and water quality because unstable, eroding banks deliver fine sediment to the stream. Bank stability was improved at Willanch Creek through riparian planting, willow wall construction, and fencing that kept livestock off the banks and out of the stream. The National Marine Fisheries Service guidelines suggest that banks with more than 90% vegetation cover have the best stream habitat (1996). In both the 2001 and 2009 AHI surveys, four of the five reaches met this benchmark. The Lower Valley showed improvement (from 81.4% covered to 89.4% covered). As shown in the photo in Figure 4, prior to the riparian planting projects the stream banks were relatively unstable in the Lower Valley Reach. Note that in 1996 a natural landslide in the Upper Wood Treatment Reach contributed a large amount of sediment into the stream.

Decreased Stream Temperature

Lowering stream temperature is an important goal in many stream restoration projects because water temperature (and related dissolved oxygen) is critical to salmon survival. Each summer, from 1997 to 2010, temperature recorders were placed throughout Willanch Creek to measure maximum stream temperature. Water temperature generally increases as water travels downstream, an effect heavily influenced by the

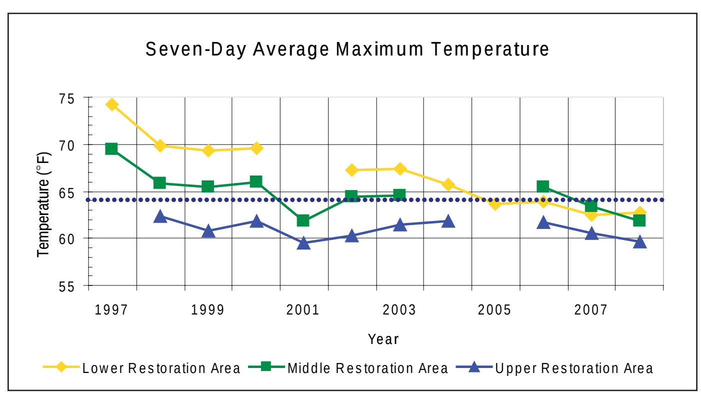


Figure 10: Temperature data collected on Willanch Creek from 1997 to 2008 in the lower restoration, middle restoration, and upper restoration areas. In 2007 all areas were below the salmon temperature threshold of 64°F.

amount of shade from riparian vegetation. The relationship between shade and temperature is illustrated in Figures 10-12. Our main objective was to reduce stream temperatures to below 64°F. Over the twelve years of temperature data collection, the lower site showed a decrease in temperature from 74.2°F to 61.9°F—a 12.3°F reduction that satisfied the standard well; all sites met the DEQ temperature standard in the last four years of data collection. We hypothesize that the initial cooling was due to shading by riparian vegetation planted in 1997. The second period of cooling was likely due to improved channel entrenchment ratio that resulted in more floodplain connectivity. (A "well connected" floodplain allows flood water to soak into the banks; this cool water is later released to the stream.) Additionally, the planted trees apparently lured beavers into the area. Beaver ponds have naturally slowed the stream, further increasing floodplain connectivity and the stored water that is released into the stream during the summer.

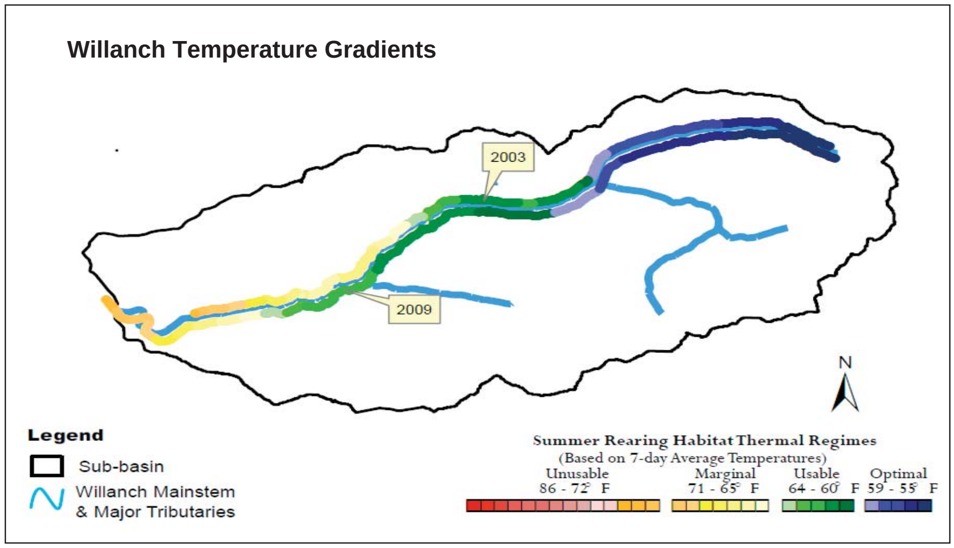


Figure 11: Temperature data gathered on Willanch Creek in 2003 (top line) and 2009 (bottom line). As a result of riparian planting and increased floodplain connectivity, cooler water reached lower in the stream in 2009 than in 2003.

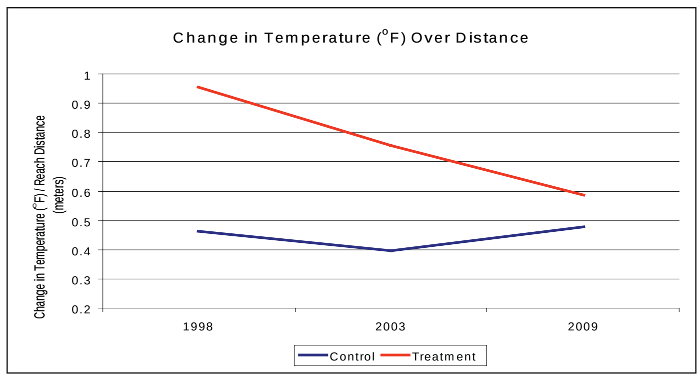


Figure 12: The treatment area where riparian planting took place showed a steady decrease in temperature from 1998 to 2009. This was attributed to shading and increased floodplain connectivity in that area. The control area from the upper to middle restoration area remained relatively stable during this time.

So What's This All Mean For Fish … ?

The cumulative effects of our restoration efforts in Willanch Creek increased physical habitat needed by salmon, restored adult access to spawning grounds and juvenile access to the estuary, and reduced summer water temperatures to optimal conditions for juvenile coho. The inevitable next question is, "How many fish have been produced as a result of these actions?" Unfortunately, this is one of the most difficult questions to answer.

First, salmon populations naturally rise and fall largely due to conditions in the ocean that are driven by the "El Niño, Southern Oscillation" (ENSO) and Pacific Decadal Oscillation (PDO) cycles. The ENSO cycles through about every 18 months, while the PDO cycles every 20 - 30 years. The effects of these cycles can be seen in population trends for coho salmon on the Oregon Coast and in the Coos Basin (Figure 13). On top of these climatic cycles there are periodic natural disturbances to Willanch Creek; noteworthy examples were the complete blockage of the culvert (that was later replaced by the "Third Bridge") which interrupted spawning migrations in 2001, and the landslide in the Upper Wood Treatment area in 2007 that dumped thousands of cubic yards of earth into the North Fork. Recall, also, that there is a three year cycle from spawning to return of adults (Figure 1). All of this means that we would not expect to see a continuing and uninterrupted rise in spawning salmon in Willanch Creek over the short-term (i.e., fewer than 30 years).

Spawner surveys do indicate that some Willanch Creek coho populations track fairly well with the numbers of coho that come into the Coos watershed. Figure 14 shows this relationship for two areas of Willanch Creek where sufficient years of surveys have been conducted. Between 1992 and 2008, the Upper Valley and Lower Wood produced about 20% more coho than the basin average, while the Lower Valley Reach produced about 40% fewer coho

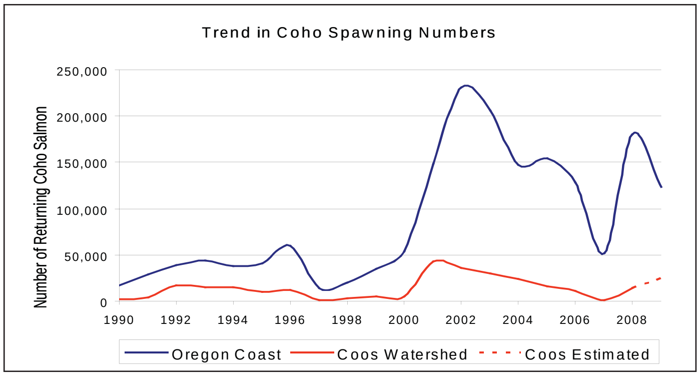


Figure 13: On average, one-fifth of coho salmon on the Oregon Coast pass through the Coos Watershed. (ODFW, 2007)

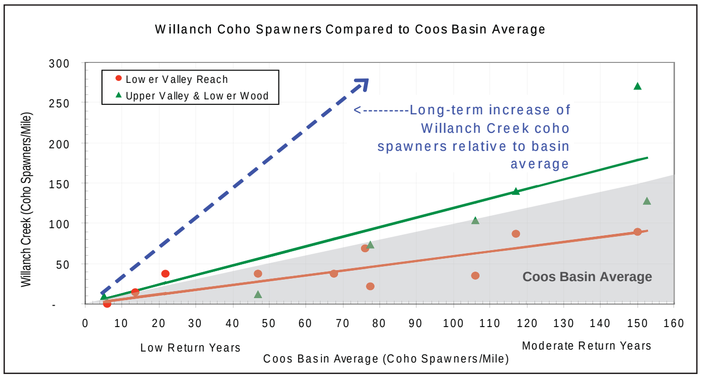


Figure 14: The number of coho spawners in Willanch Creek are expected to increase.

than of the basin average. Now that restoration efforts have been largely completed, we would expect to see steeper lines in future years compared to the recent past as habitat and populations continue to recover.

Conclusion

Restoration efforts in the Willanch sub-basin demonstrate how an integrated, watershed-scale approach to restoration can produce measurable improvements in salmon habitat. Again, the ecological roles and needs of salmon make them an excellent choice to guide habitat management. In addition to being indicators of watershed health, healthy salmon populations are essential to both the ecology and economy of the Coos watershed. The success of the restoration and monitoring efforts on Willanch Creek are greatly attributed to the involvement of cooperative landowners.

Acknowledgements

Many CoosWA project managers and monitoring technicians, both past and present, have worked on restoration projects in the Willanch Creek sub-basin since 1995. We would like to thank all project partners: Oregon Watershed Enhancement Board, Coos County Road Department, U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, Lone Rock Timber Company, Weyerhaeuser Timber Company, Menasha Forest Products Corporation, Oregon Department of Environmental Quality, the Coos Bay-North Bend Water Board, and the Laird Norton Family Foundation. Most importantly, we would like to acknowledge the cooperation of all the private landowners in the Willanch Creek sub-basin, especially: Frank & Linda Babcock, Donald & Ruby Gray, Mark & Alanna Johnson, Frank & Mavis Rood, and Jackie & Belinda Shaw.

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Coos Watershed Association

Please contact us to learn more about the Coos Watershed Association. Whether you are a landowner with a potential restoration project or seeking assistance on ways that you can better manage your land, or you would just like to know more about who we are and where we work, we would love to hear from you.

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LAIRD NORTON FAMILY FOUNDATION

Cover Photo: Alders planted in 1995 grew quickly, shading and cooling the stream. (Photo taken in 2004.)

Coos Watershed Association

Timeline of Willanch Creek
Post-Settlement

- **1850** – Euro-American settlement of Coos Bay area.
- **1908–1939** – Town of Cooston existed independently at the mouth of Willanch Creek.
- **1940–1950** – Landowner draining of Willanch Creek bottom lands.
- **1947** – Tide gate installed at East Bay Drive bridge at the mouth of Willanch Creek.
- **1995** – Riparian restoration projects began: planting of big leaf maple, elderberry, fir, alder, spruce, and willow. Governor Kitzhaber assists with first planting and fencing project.
- **1996** – Clearing of invasive blackberry began.
- **1997** – Temperature recorders placed in Willanch Creek: 990 ft. of willow wall constructed and 1800 ft. of existing stream-side fence was replaced.
- **1998** – 2100 ft. of stream-side fenced off from livestock.
- **2001** – First Aquatic Habitat Inventory Survey conducted; three 48-inch culverts replaced with a 57 ft. railcar bridge.
- **2004** – Two 5 ft. culverts replaced with a concrete slab bridge and a perched 48-inch culvert replaced with a steel I-beam and poured concrete bridge; 3100 ft of stream was treated with large wood.
- **2009** – Most recent Aquatic Habitat Inventory conducted.
- **2010** – Tide gate replaced with a side-hinged and top-hinged design to be more fish-friendly.

Spacing not to scale.

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