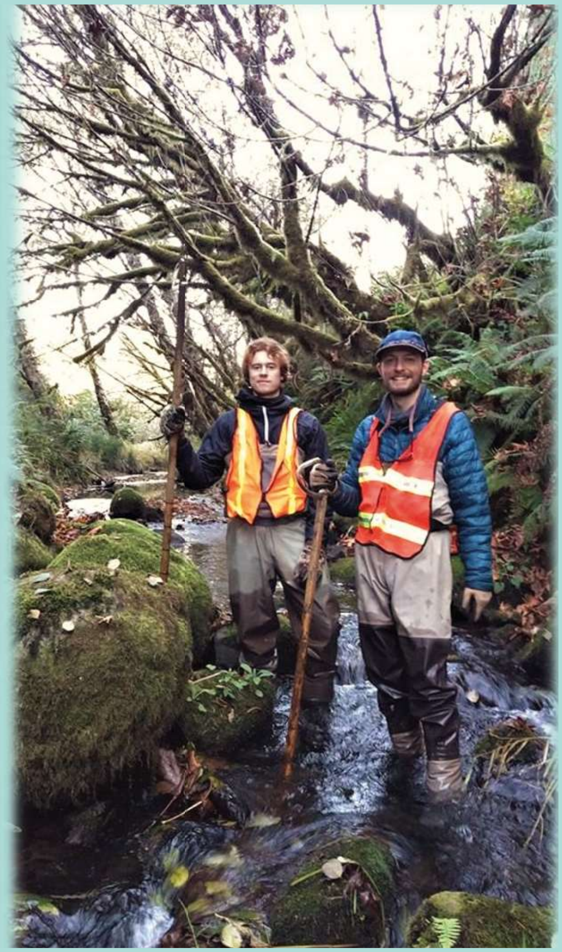
Restoring Willanch Creek



25 Years of Cooperation Benefiting Salmon

COOS Watershed Association
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OWEB

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 10°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 25 years of perseverance in building strong partnerships, and completing a wide range of restoration projects, we've been able to demonstrate that the habitat for fish and other wildlife is improved: today the water is 10˚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:

- planted trees, built willow walls, and built livestock exclusion fences along 1.15 miles of stream banks to reduce erosion and filter runoff from adjacent pastures;
- replaced culverts with bridges at four sites to permit fish to pass and to allow gravels to move downstream to access 5.9 miles of fish habitat;
- replaced the tide gate at the mouth of Willanch Creek with an improved design to allow juvenile fish access to the estuary during critical times;
- placed large wood in 0.86 miles stream to provide cover, collect gravels, and scour pools;
- blocked and removed 1.5 miles of unneeded logging roads to reduce soil erosion and prevent illegal garbage dumping.

Setting

Although the Willanch Creek sub-basin (Figure 6, 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.

Fish have little physiological control over their body temperature, so 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, which limit the number of salmon that can inhabit that stretch of stream. Additionally, as water warms it loses oxygen, which places additional stress on fish.

Spawning and egg incubation require marble to baseball-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 rapid structures with a choppy surface that incorporates oxygen into the water. This oxygenation benefit can continue downstream if water temperatures stay cool -- colder water retains more 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 refuge for 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 undersized 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 many ecosystem types, from estuarine to forested uplands. Lowland flats of the Willanch sub-basin were used by the W'ican Native American settlement 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 sent 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.

During the 10-year restoration period, 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 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.

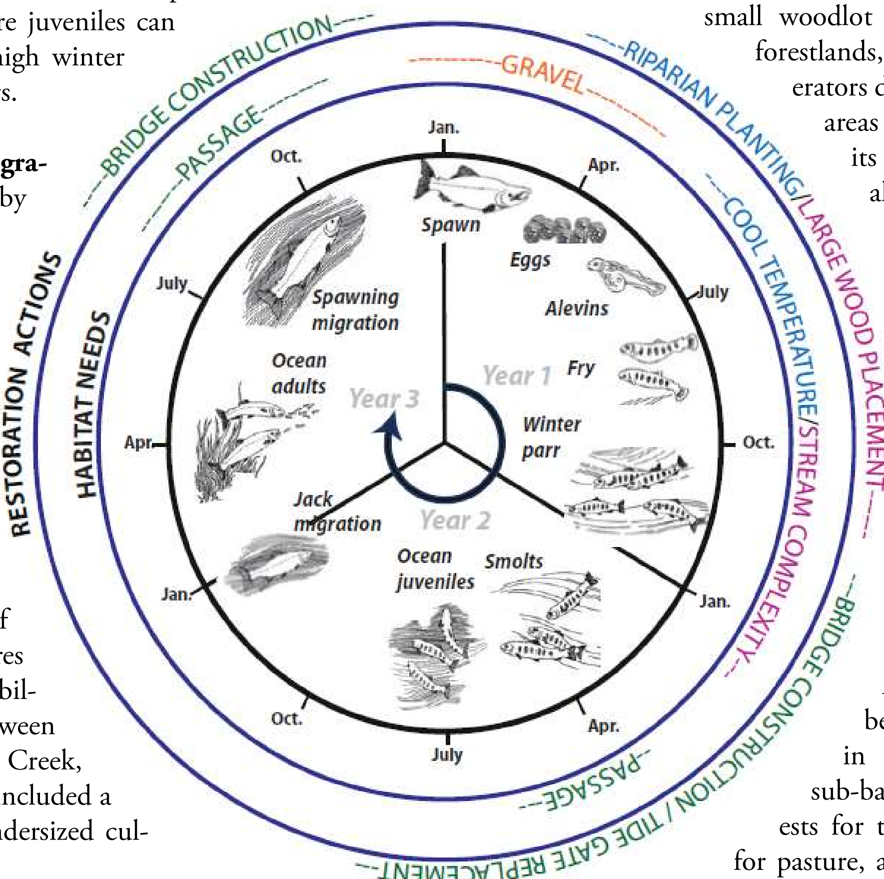

Figure 1 (above): Coho life cycle showing habitat needs and restoration actions taken to address those needs. (Adapted from Lawson, et al, 2007).

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 quality. 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 helping us evaluate 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, opening 5.9 miles of fish habitat. The tide gate at the outlet of Willanch Creek was replaced in the summer of 2010, which increased fish passage and and allowed for more natural tidal fluctuations, etc.

Improve Stream Complexity

The aquatic habitat inventories (AHI) conducted in 2001 and 2003 identified the need for improving stream complexity. Specifically, more pools and alcoves were needed 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 land-use practices added fine sediment to the system. In addition, the tide gate prevented sediment from being flushed out naturally. A variety of restoration activities were employed to address these habitat concerns: riparian plantings were done along approximately 1.5 miles of creek, 1.5 miles of road were removed, and four culverts were replaced with bridges to help improve sediment transport. 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 6).

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°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. Trees planted along the riparian zone provide shade to the stream promoting cooler water.

Restoration Results

The effectiveness of the restoration actions were 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 in upstream spawning habitat reaches 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 rearing habi-

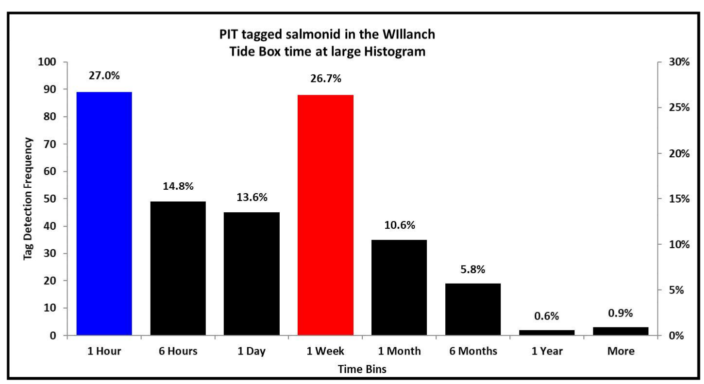

Figure 2: Time at Large (time of final resight minus time of first resight) for 332 PIT tagged salmonids detected at Willanch Creek tide gate PIT antenna array between June 2016 and June 2019. Bars represent number of fish on left axis and labels represent percent on the right axis. Blue bins represent half of all repeat resights. Note: 225 (40%) PIT tagged fish were only detected once and are not included.

tat, and released stored gravel, improving downstream habitat quality.

In 2010 the paired wooden top-hinge tide gate at the confluence of Willanch Creek was replaced with a set of aluminum tide gates, one top door and one side door with a Muted Tide Regulator (MTR). The head wall and gates were recycled from a previous installation and mounted to the existing paired box culvert in an economical compromise that provided a high cost-benefit for the project.

Intensive monitoring at the tide gate began in 2015 with the installation of gate angle sensors and water level loggers upstream and downstream of the gates (Souder et al 2018). These data were networked with a water velocity sensor in 2016 that provides a uniquely rigorous dataset for MTR tide gate modeling that is currently underway. Preliminary analyses have found that the MTR door opens much wider, a bit earlier and stays open significantly longer than the top door gate next to it.

Estuarine fish and plant species are numerous throughout the lower saline tidal reach of Willanch Creek. PIT tag antennas in each side of the Willanch tide box 'resight' tagged fish as they pass through or hold in the tide box. Histograms of 'time at large' (Figure 2) suggest that half of the fish detected pass through the tide gate quickly, detected only once (not included in Figure 2.), in 1 hour or less (blue), or reside in the tidal zone around the tide gate for up to a week (red). The greater than 1-year bin are 4 resights of adult salmon returning to spawn.

Other analyses show that the MTR door is open 56% of the time, twice as much as the top door gate next to it. Inherent variance in the MTR operation across seasonal tidal and flow conditions has been shown to two feet. So, without any adjustments to the MTR setting, tidal inundation varies from 3.6 to 5.2 feet across the seasonal range of river discharge. The Muted Tide Regulator tide gate at Willanch Creek has restored a significant portion of the natural tidal exchange that would be expected with no gates present on the box culvert.

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 these diverse 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 6 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 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 benchmark of 30 cubic meters per 100m of stream), but the Upper Wood Treatment site lacked sufficient key pieces (Figure 4, page 5). Now in 2017, AHI surveys show that

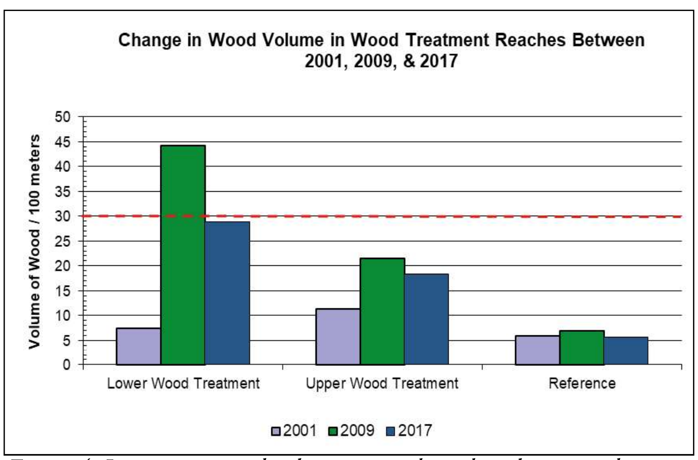

Figure 4: Increase in wood volume in reaches where large wood was added to the stream. The Lower Wood Treatment Reach met the ODFW benchmark in 2009 and fell just below this desirable benchmark in 2017. (Lower Valley and Upper Valley Reaches are not shown since they were not treated with wood.)

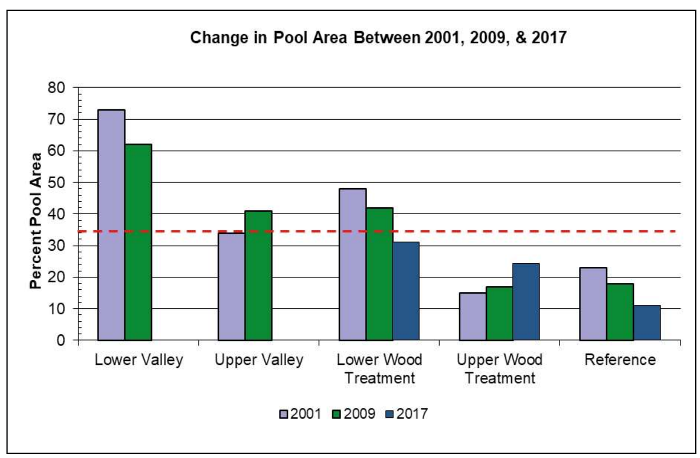

Figure 5: Three of the five reaches met the ODFW benchmark in 2009, yet during 2017 of the 3 reaches inventoried, none met this desirable benchmark. Both the Upper and Lower treatment reaches fall just short of the desirable pool area, and the reference reach is steadily decreasing in adequate pool area

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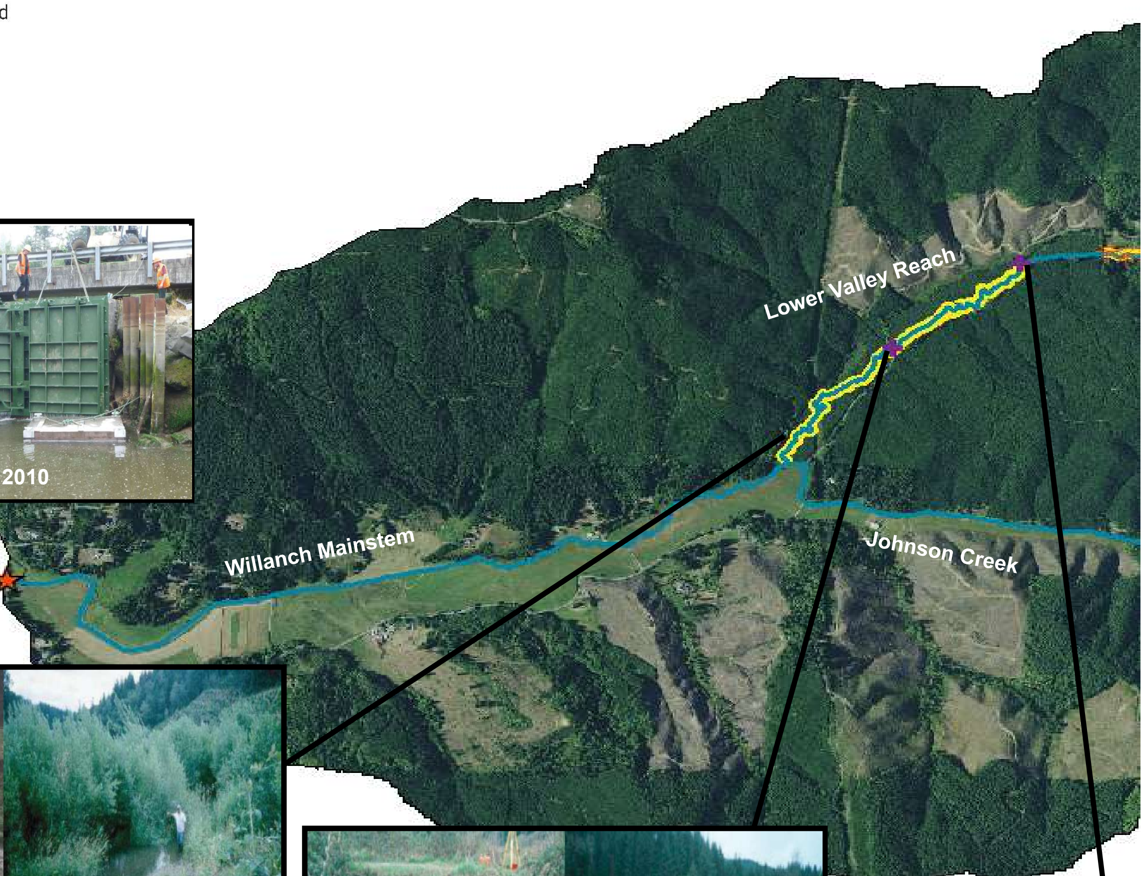
Figure 6: Willanch Creek Watershed Restoration

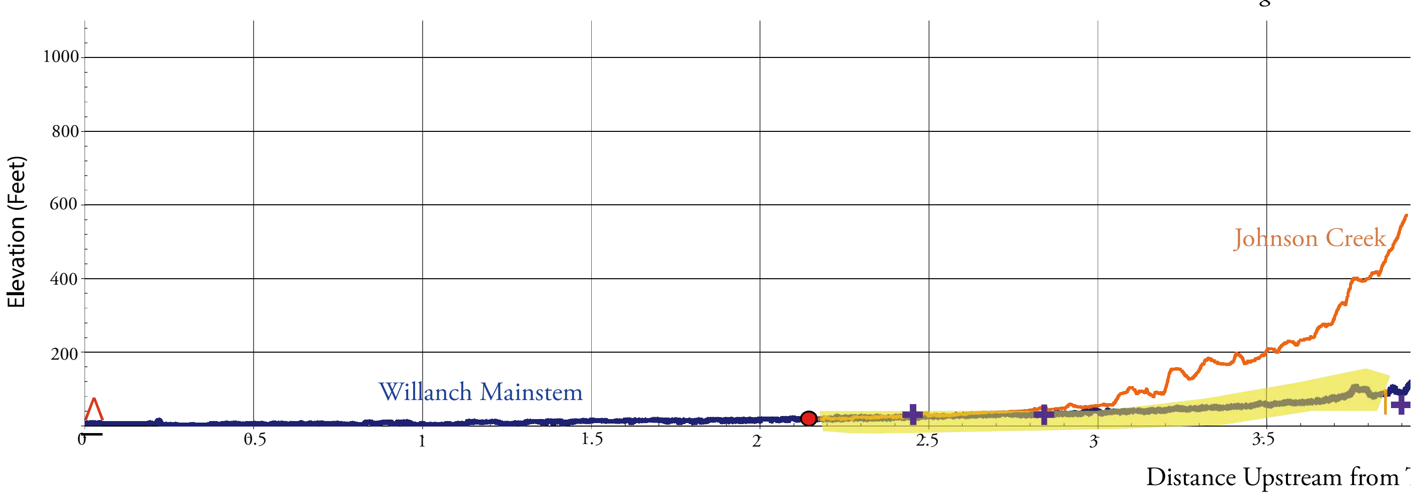
New tide gate at the mouth of Willanch Creek, summer 2010.

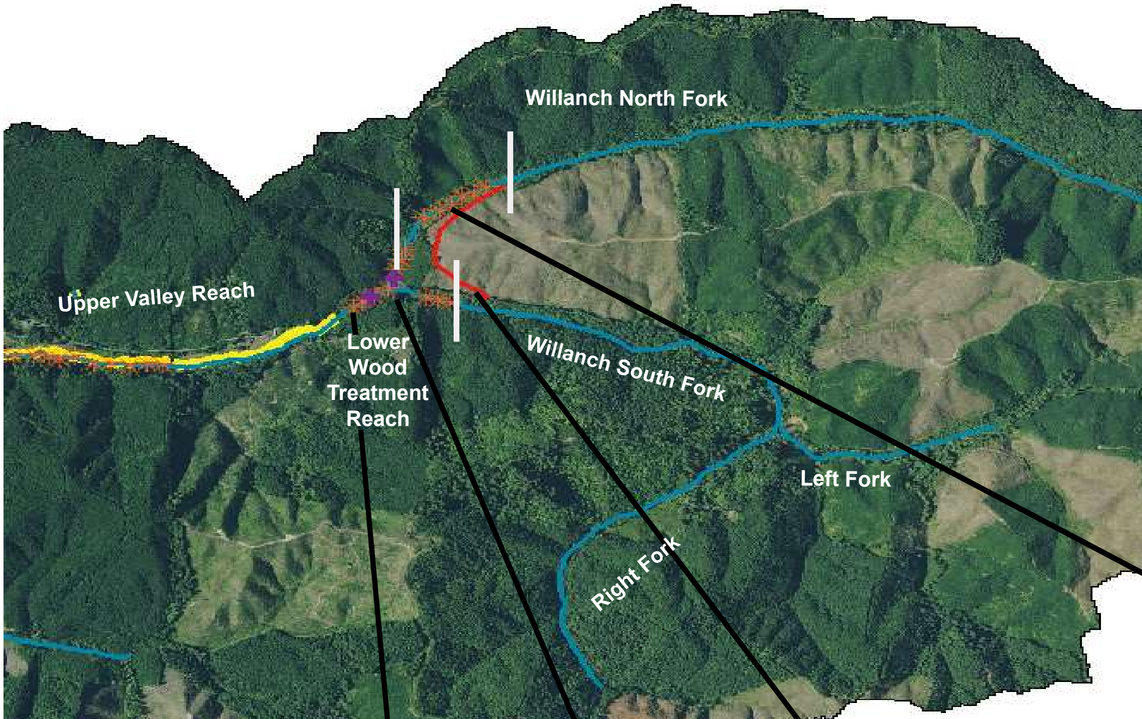


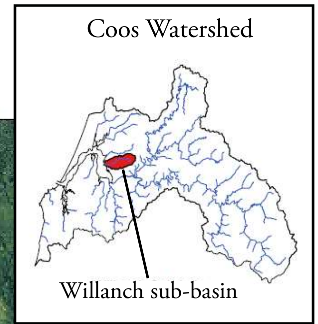
Riparian planting along the Lower Valley Reach.

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

Second Bridge





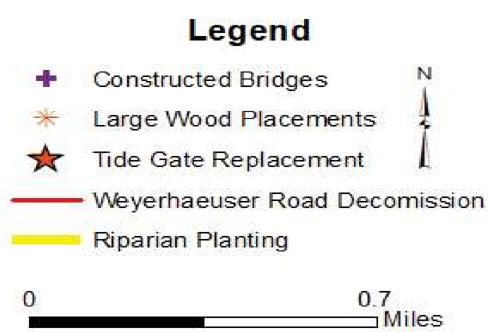


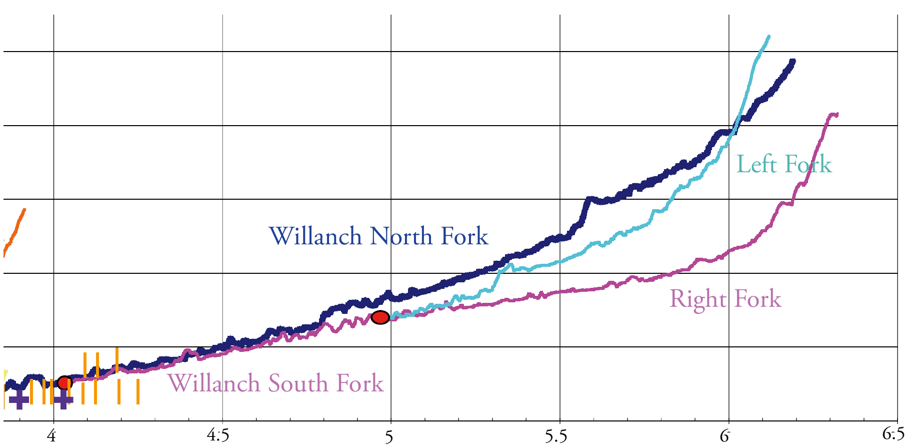
Landslide that occurred in the Upper Wood Treatment reach during winter 2006 / 2007.

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

Fourth Bridge

Third Bridge





the Upper Wood Treatment Reach has retained more than a 50% increase in wood volume from its pre project condition.

Pool area is important because pools provide refuge from higher flows during the rainy season and provide deeper water during droughts. 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 5, page 5). The landslide in 2007 may have prevented the Upper Wood Treatment Reach from meeting the desirable benchmark. Data from the 2017 surveys show that both of the wood treatment reaches are just below the desirable benchmark, while the Reference reach (untreated) is steadily decreasing year after year.

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 re- sidual pool depths should be greater than 0.6 meters (2 feet). The 2001 AHI survey showed that no reach met this bench-mark; the 2009 AHI survey showed one of the five reaches had met this desirable level and all reaches showed moderate improvement from pre project conditions(Figure 7). In 2017, the reaches surveyed (Lower Wood, Upper Wood, and Reference) all hovered near 50% (0.3 meters) of the ODFW desirable benchmark for this variable; less than desirable benchmarks for residual pool depths may indicate that additional restoration is required to attain this critical habitat benchmark.

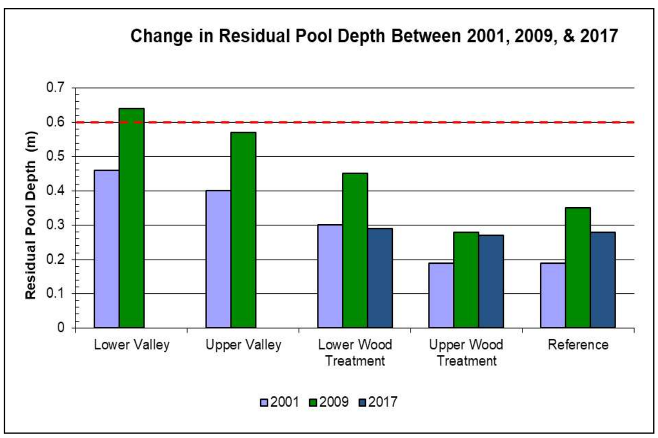


Figure 7: All reaches showed improvements in residual pool depths from 2001 to 2009, yet in 2017 all surveyed reaches fell below the 2009 findings.

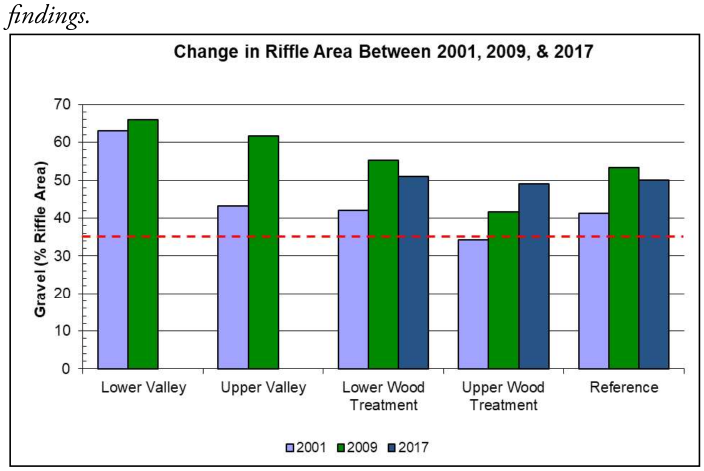


Figure 8: All reaches met the ODFW benchmark in 2009 for gravel (% riffle area).

Riffle areas in a stream have fast water with choppy surfaces that provide oxygen for young salmon and these riffles usually have a gravel substrate that provides adequate salmon spawning habitat. The 2001 AHI survey indicated that four of the five reaches met the ODFW benchmark of 35% gravel in riffle areas. All reaches surveyed in 2009 & 2017 exceeded the desirable amount of riffle area (Figure 8). Improvements to undersized culverts and road decommissioning, coupled with instream habitat structures have helped to promote gravel retention throughout the basin.

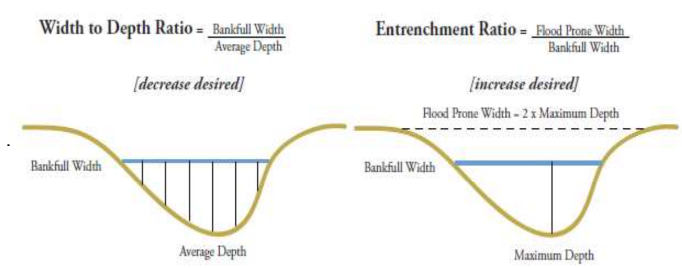


Figure 9: Diagrams showing how width to depth ratio and entrenchment ratio are calculated.

Width to depth ratio, shown in Figure 9, 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 10).

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

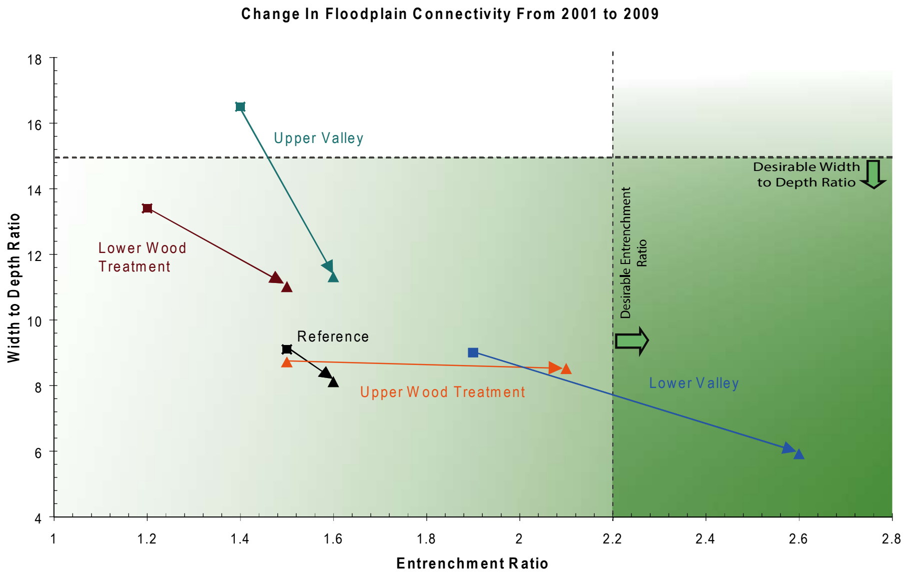


Figure 10: Comparison between width to depth ratio and entrenchment ratio in Willanch Creek from 2001 to 2009. A decrease in width to depth ratio and an increase in entrenchment ratio is the desirable trend. The Lower Valley reach met both these benchmarks . (AHI data for2017 was unavailable for these attributes)

banks that allow floodwaters to easily spill into the floodplain (Figure 9). Increasing entrenchment ratio—floodplain connectivity—helps replenish groundwater during the wet season. This cooler water is then released during the dryer, 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 10). Over time, gravels deposited at the large wood placement sites will improve entrenchment ratios.

Increased Vegetation Cover

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 5, 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 2018, 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 amount of shade from riparian vegetation. Temperature reductions are illustrated in Figures 11-13. Our main objective was to reduce stream temperatures to below 64°F. Over the twenty-one years of temperature data collection, the lower site showed a decrease in temperature from 74.2°F to 64.8°F—a 10°F reduction that satisfied the standard; all sites were under or within 1°F the DEQ temperature standard for over a decade 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 lured beavers into the

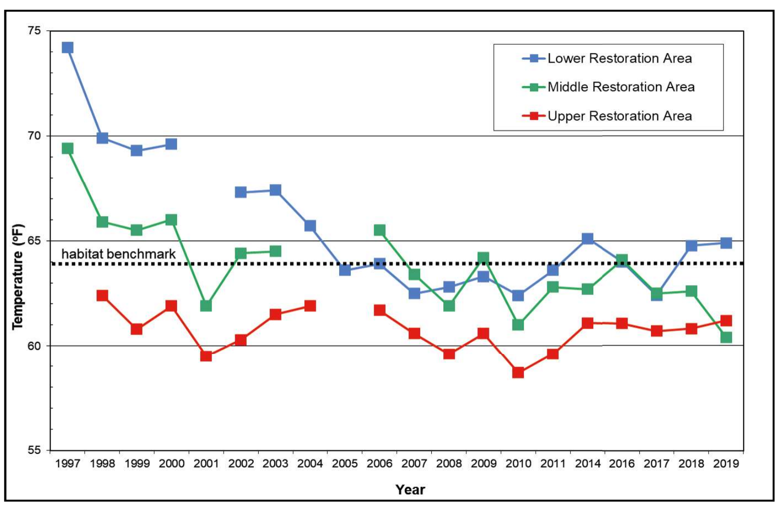


Figure 11: Temperature data collected on Willanch Creek from 1997 to 2018 in the lower restoration, middle restoration, and upper restoration areas. Starting in 2007 all areas were below the salmon temperature threshold of 64°F. This trend has largely continued for over a decade.

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.

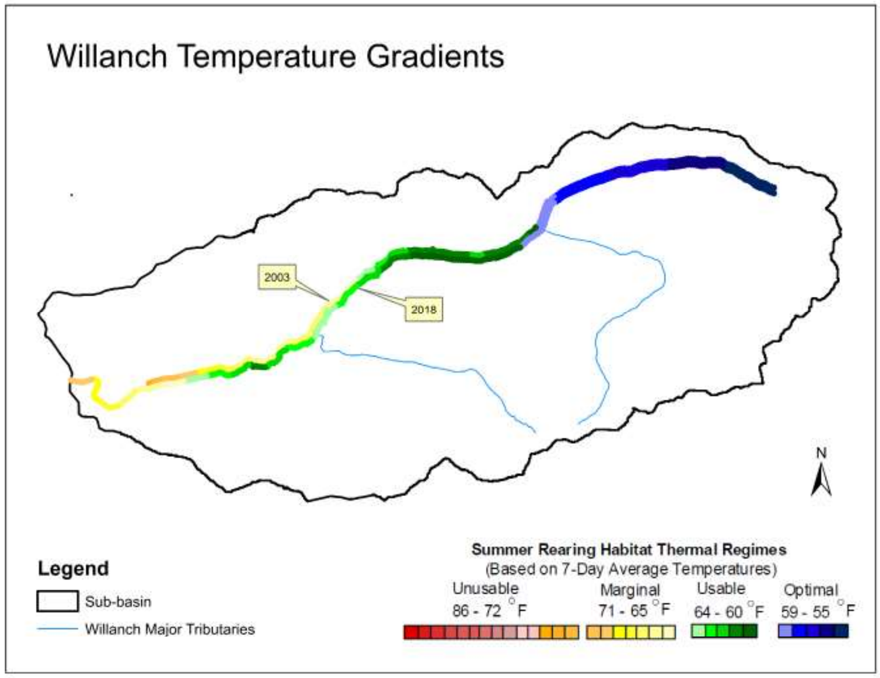


Figure 12: Temperature data gathered on Willanch Creek in 2003 (top line) and 2018 (bottom line). As a result of riparian planting and increased floodplain connectivity, cooler water reached lower in the stream (2.5mi. from the headwaters) in 2018 than in 2003.

So What's This All Mean For Fish?

The cumulative efforts to improve and increase the salmon and steelhead population in Willanch Creek includes all types of restoration activities from the estuary to the headwaters. Restored access to spawning and tidal rearing habitats was complemented by reduced summer water temperatures to optimal conditions for juvenile coho and trout.

The restoration's success has been established as a result of the long term monitoring that has captured the ecological improvements over time.

Regional and coast wide salmon populations naturally rise and fall due to climate patterns in the Pacific Ocean. Rupp et al. (2012) found strong predictive power of annual adult coho recruitment in Pacific Decadal Oscillation (PDO) indices, a component of Sea Surface Temperature (SST) anomalies. Likewise, the North Pacific Gyre Oscillation (NPGO) index, a component of sea surface height, also tracks coho populations (Figure 13). These climatic cycles act on large continental scales but locally, periodic natural disturbances also occur. In 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.

Changes to ocean, estuary and stream habitats can effect multiple cohorts due to the three year coho life cycle (Figure 1). Alignment of climate and local disturbances can interact to significantly reduce coho populations. Yet salmon persist because resiliency is key to thriving salmon and steelhead populations. Places like Willanch Creek, at the nexus of the stream and estuary ecotone, provide critical habitat for salmon to express the full range of life history adaptations.

ODFW and CoosWA spawning surveys indicate that Willanch Creek coho populations track the numbers of coho that return to the Coos watershed and the Oregon coast as a whole. Figure 14 shows this relationship for two areas of Willanch Creek for years when both surveys were conducted. Between 1992 and 2018, 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 than 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, sub-basin watershed scale approach to restoration can produce measurable improvements in salmon habitat. Restoring both habitats and the connectivity across them is essential to function for the interactive environments that salmon inhabit. Ecological, social and economic goals all guide habitat restoration and management. Functional quality habitat and stable fish populations indicate that Willanch Creek is an ecologically functioning subbasin. Restoration in working landscapes is an adaptive process that requires ongoing maintenance as well. Opportunity remains in the Willanch subbasin to further restore connectivity to marsh/pasture platform environments. Adaptive management of the MTR under a collaboratively developed water

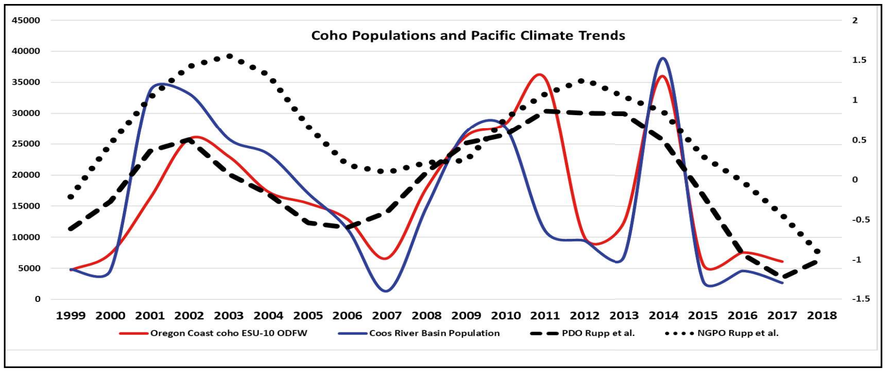


Figure 13. Pacific climate patterns drive coho salmon population trends. OC ESU (red line) and Coos basin (blue line) coho population estimates (ODFW 2019). Spring and summer previous 4-year average of the Pacific Decadal Oscillation (dashed black line) and North Pacific Gyre Oscillation (dotted black line) indices (Rupp et al. 2012).

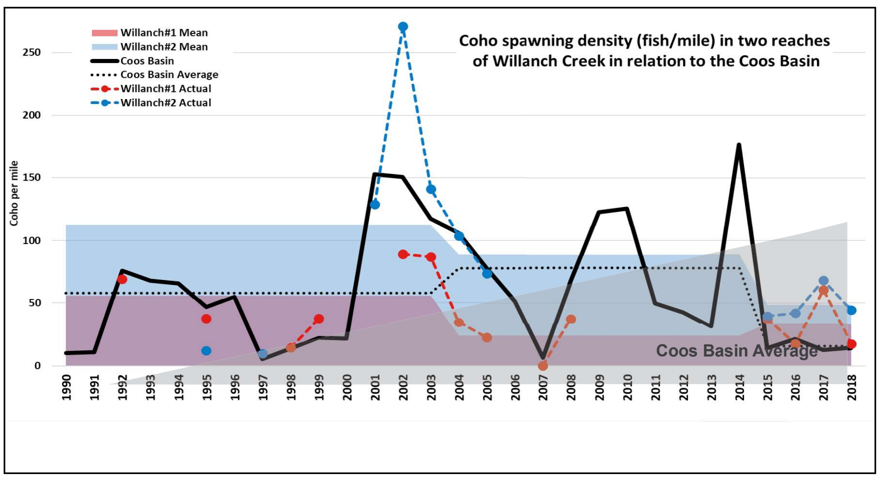


Figure 14. Willanch coho spawner density (fish/mile) tracks the Coos Basin density from the early 1990's to 2018. Between 1992 and 2018, the Upper Valley and Lower Wood produced about 20% more coho than the basin average, while the Lower Valley Reach produced about 40% fewer coho than of the basin average.

management plan that provides for both increased fish habitat and pasture productivity is a relatively new concept that can release additional shared benefits.

Healthy salmon populations in Willanch Creek indicate good watershed health and are essential to both the ecology and economy of the Coos watershed. Being able to "Tell the Story' of the success of restoration and monitoring efforts in Willanch Creek is greatly attributable to the involvement of many very cooperative landowners and funders.

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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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COOS Watershed Association
Improving the Health of Our Watershed

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.
- **2011** Babcock Instream Restoration. 0.27 miles and 11 sites treated
- **2014** Riparian Planting
- **Present** On-going Monitoring