Final Report for Cowan/Sinko wetland restoration monitoring (204-288)

August 10, 2006

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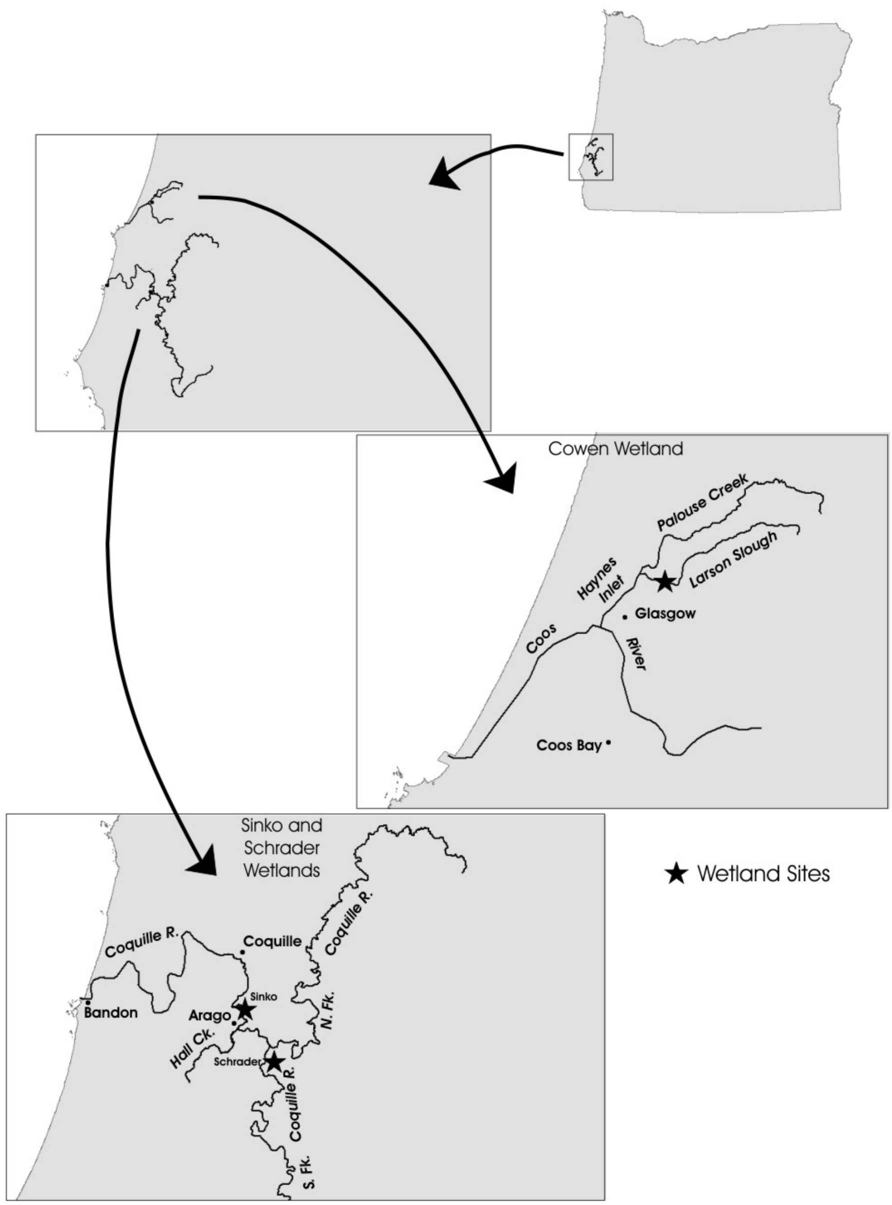
Introduction

The primary objective of the work funded by Oregon Watershed Enhancement Board (204-288) was to monitor project effectiveness of two wetland restoration projects in the Coos/Coquille area, Cowan and Sinko wetlands (Figure 1). Monitoring centered on juvenile salmon habitat use and passage capability through water-control structures used in the projects. These are case studies, which will provide useful examples to evaluate future restoration projects that are similar in physical and biological characteristics. The wetland restoration sites Cowan and Sinko are part of a larger monitoring effort undertaken by Ducks Unlimited to characterize regional patterns of fish community structure in seasonal floodplain wetlands and determine which environmental factors influence that structure.

Figure 1. Vicinity map of Cowan and Sinko wetland restoration projects.



Cowan and Sinko wetlands are unique among other study sites in the Ducks Unlimited Fish Monitoring Program because they are wetland restoration sites behind tide gates. Ducks Unlimited's approach to wetland restoration on the Oregon and Washington Coast and the Columbia River Estuary where the historic hydrologic regime is largely intact and where tide gates have been used to keep tidewater off of land used for agricultural production has been to remove tide gates, breach dikes and let the site recover without active management of water levels. This approach is not possible for wetland restoration sites behind tide gates where there are multiple landowners, some of whom do not want tide gates removed or dikes breached. Yet, many opportunities for wetland restoration exist under these conditions.

Site Description

Cowan wetland restoration project was completed in the fall of 2002. The project is on private land located north east of North Bend, Oregon, along the east side of Haynes Inlet on the south bank of Larson Slough (Figure 2). It restored 80 acres of formerly tidal marsh on Larson Slough. At the mouth of Larson Slough is a recently replaced tide-gate, which is intended to allow the watershed to drain and keep out tidewater. Chinook, coho and steelhead are present in Larson Slough (www.streamnet.org). A pool-weir-chute fish ladder (Figure 3) was installed in the dike to control water elevation in the wetland and allow fish passage into and out of the wetland. Swale enhancement in the wetland connected existing ditches and provided areas of deeper water and drainage toward the structure to reduce fish stranding as the wetland draws down in the summer.

Figure 2. Cowan wetland restoration project.

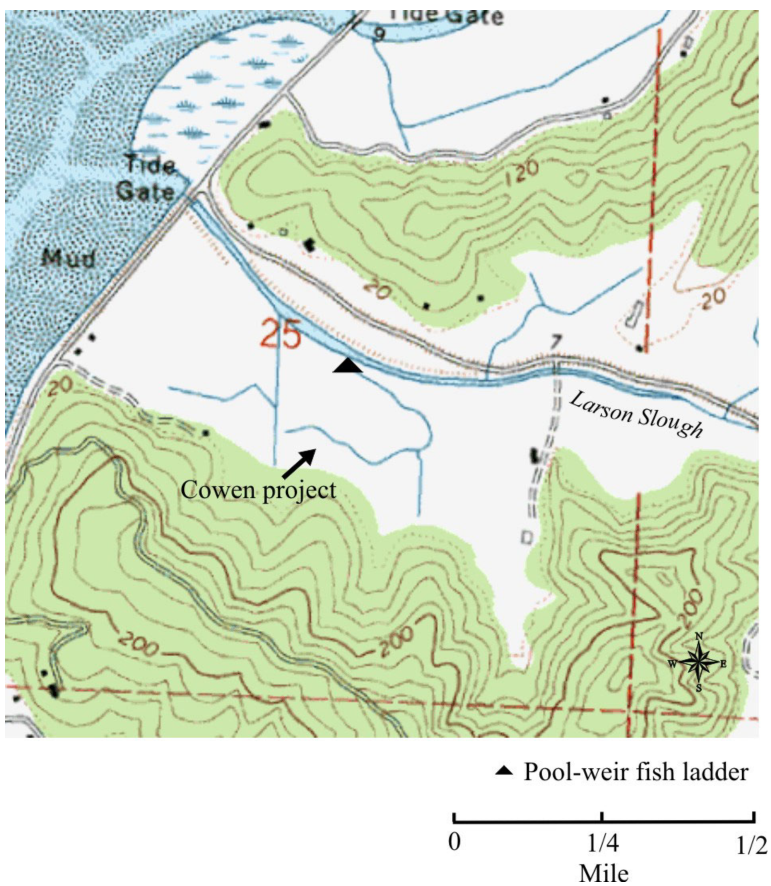
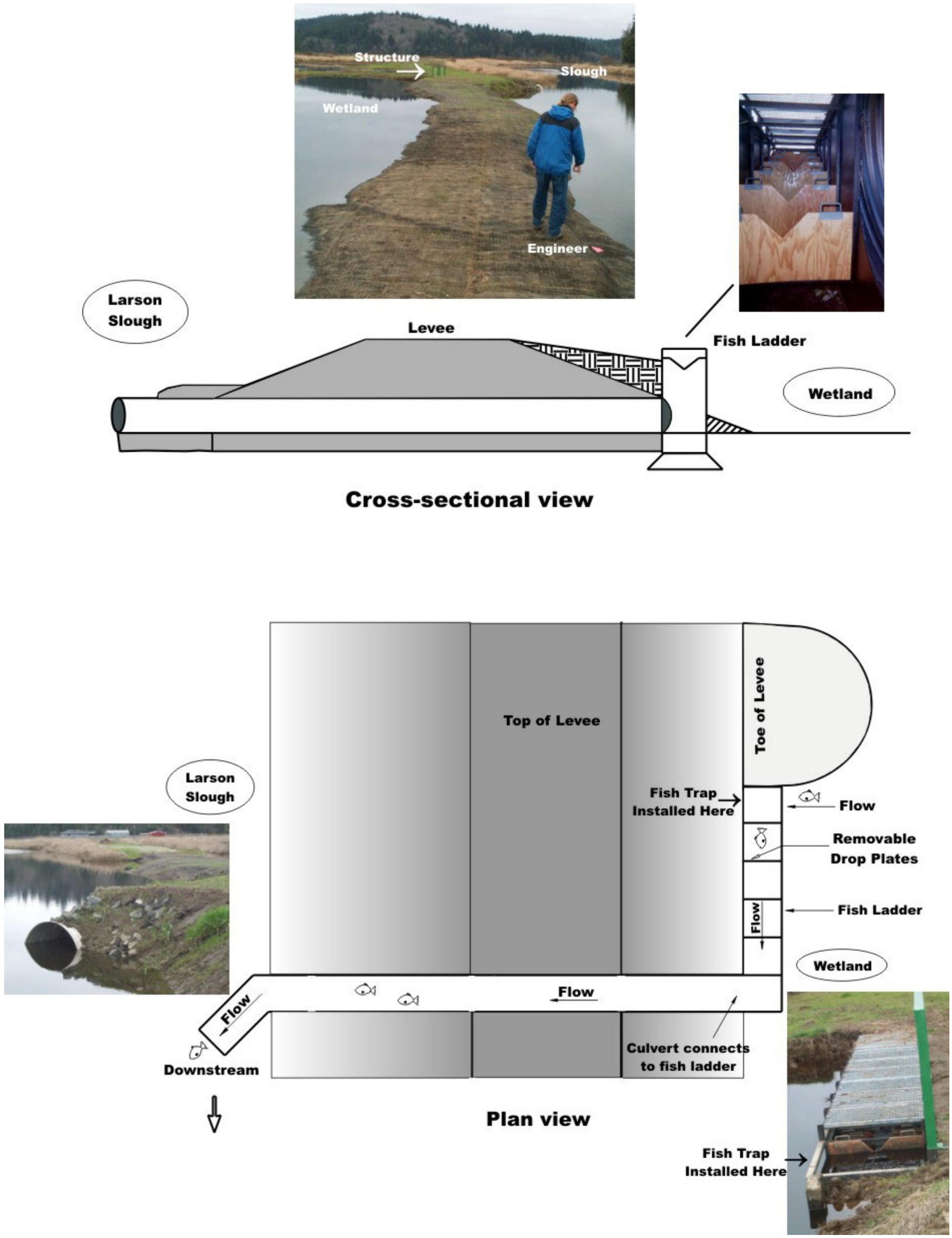


Figure 3. Pool-weir-chute water-control structure at Cowan.



Sinko wetland restoration project (Figure 4) was completed during the summer of 2004. This project restored about 200 acres of wetland habitat that had recently been used for dairy cattle pasture. The restoration project involved filling linear drainage ditches, restoring sinuous channels by reconnecting existing channel fragments, enhancing higher ground, and planting native, woody vegetation, creating wetland micro-topography, and installing a half-round riser water control structure (Figure 5) to prolong water retention in the wetland. Presence of salmonids in the Coquille River includes coho, spring and fall Chinook salmon and winter steelhead (www.streamnet.org).

Figure 4. Sinko wetland restoration project.

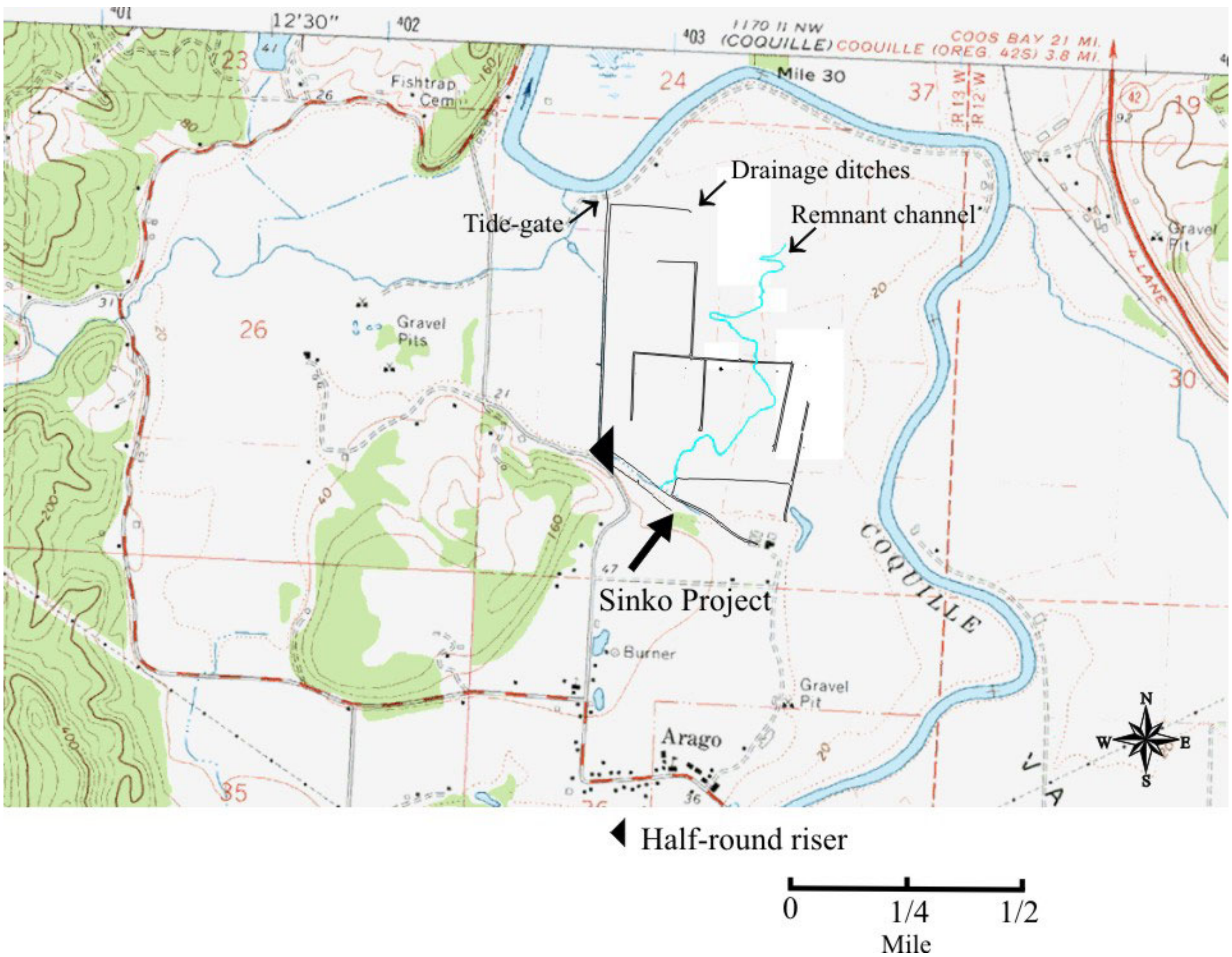
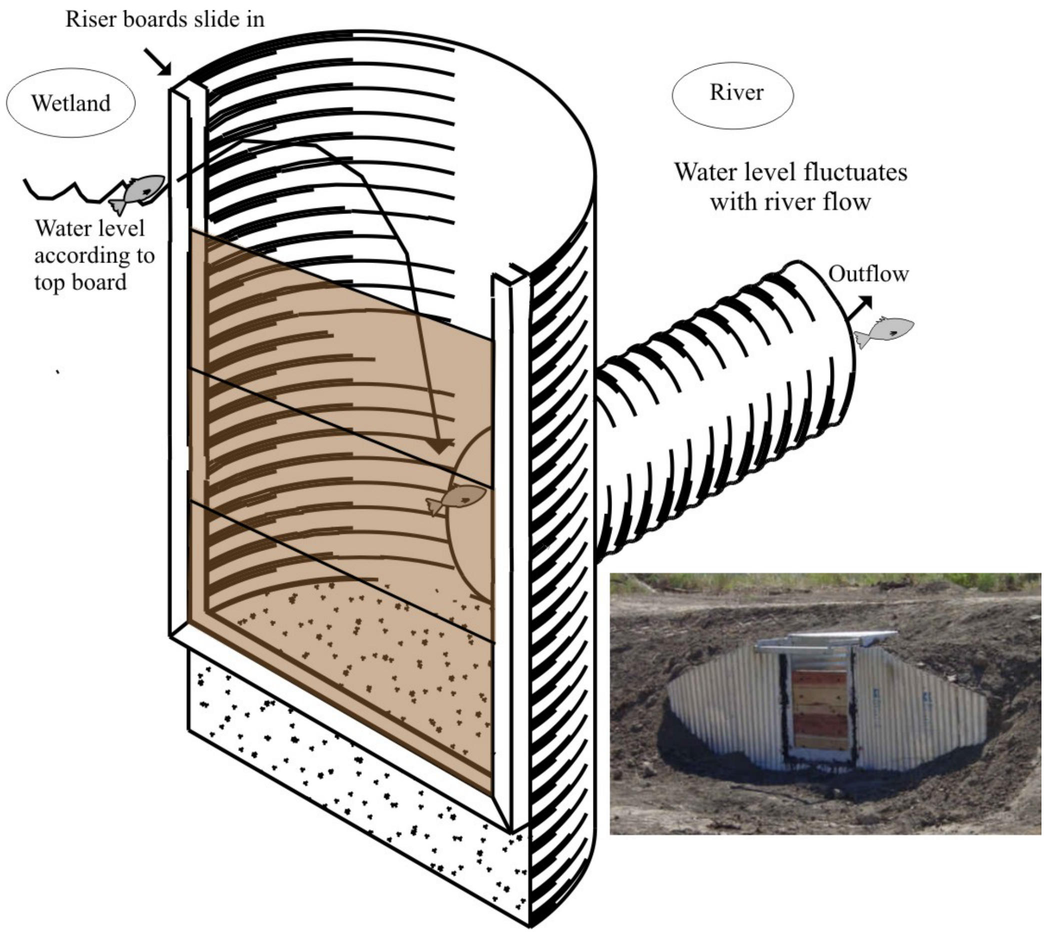


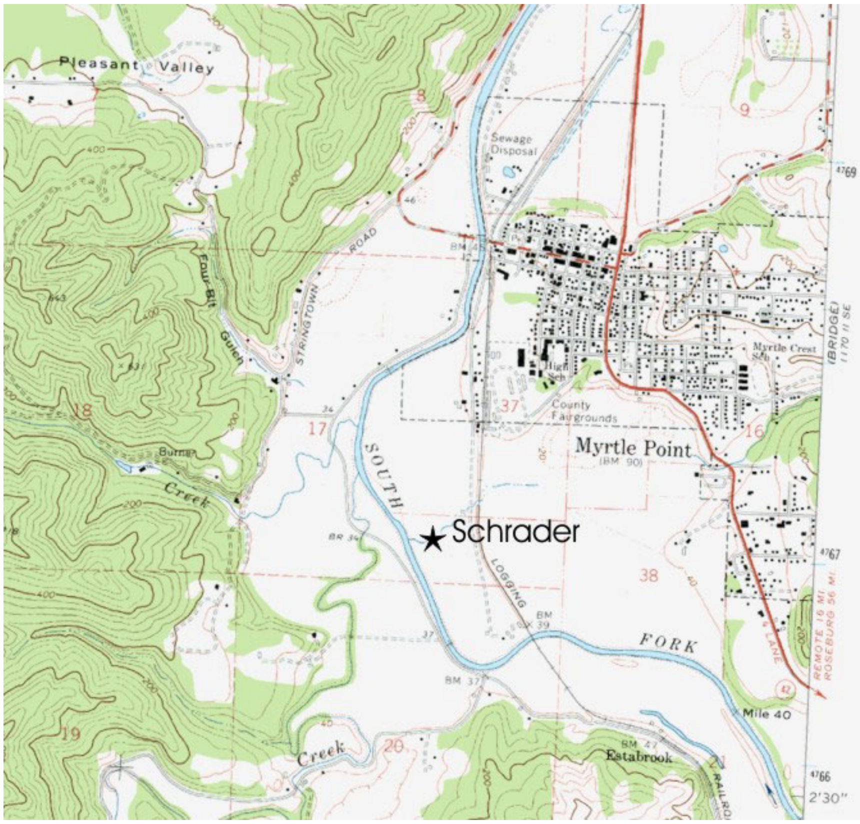
Figure 5. Half-round riser water-control structure.



In addition to Cowan and Sinko wetlands, fish in a floodplain wetland reference site near Myrtle Point, Schrader wetland (Figure 6), was sampled. The purpose of this site was to compare whether juvenile salmon were present in a wetland with no water-control structure, dike or tide-gate during the same period that Sinko wetlands was sampled. No suitable reference site was found near Cowan wetland. Initially, Beaver Slough (near Sinko wetland) was to be used as a reference site but further inquiry found that there is a salmon spawning population in a tributary that runs through Beaver Slough and into the Coquille River. This would have confounded the comparison between juvenile salmon presence at the reference site and Sinko wetland. Neither Cowan nor Sinko wetlands have perennial creeks that flow into the wetlands during the winter and spring from the uplands and do not support salmon spawning populations. Water fills the wetlands from rain, runoff and groundwater from adjacent hills.

Schrader wetland is located at river mile 38.5 on the South Fork Coquille River, about 9 miles upstream from Sinko wetland. It was historically a seasonal floodplain wetland. It is accessible to fishes from the S. Fork Coquille River during the winter and spring when high water inundates the floodplain. There is a strip of riparian brush between the river and wetland. There are no dikes or water-control structures affecting surface-water connectivity between the floodplain and river. Currently, the seasonal floodplain wetland and adjacent upland is used for hay production and as pasture for beef cattle.

Figure 6. Schrader wetland.



Methods

Fish monitoring began at both Cowan and Sinko in January 2004. Fish sampling in Cowan wetland was all done post-project. There was one year of pre-project monitoring at Sinko wetland. Fish monitoring at Schrader wetland began in December 2004. Wetlands were sampled periodically in the winter and spring between January 2004 and June 2006 (Table 1) with a standard fleet of passive trap nets (Figure 7) including two box traps, two fyke nets and one Oneida Lake trap. Nets were set in the daytime and pulled the following morning. Trap type, location, fish species, fork length (to nearest mm) and wet weight (nearest 0.1g, salmonids only) were recorded.

Trap nets to monitor fish movement through water-control structures at Cowan and Sinko wetlands were also used. At Cowan wetland, a two-way vertical-slot trap (Figure 8) was fitted onto the entrance of the fish ladder on the wetland side of the water-control structure. The trap was fished from mid-January through early June in 2004. The trap was checked three times per week. Fish were removed by a dip net. Trap direction (inbound or outbound), fish species, fork length (to nearest mm) and wet weight (nearest 0.1g, salmonids only) were recorded. Fishes were released in the wetland or slough in their original direction of travel. At Sinko wetland, a modified box trap was used to catch fish that passed out through the water-control structure (Figure 9). The one-way trap was fished from December 28, 2004 through May 9, 2005. The trap was checked three times per week and fish were handled in the same manner as the two-way trap at Cowan wetland.

Figure 7. Trap nets used in within-wetland sampling.

Box trap: 0.6m tall, 0.9m wide, 1.5m long with a 7.6m lead net, 4.8mm mesh

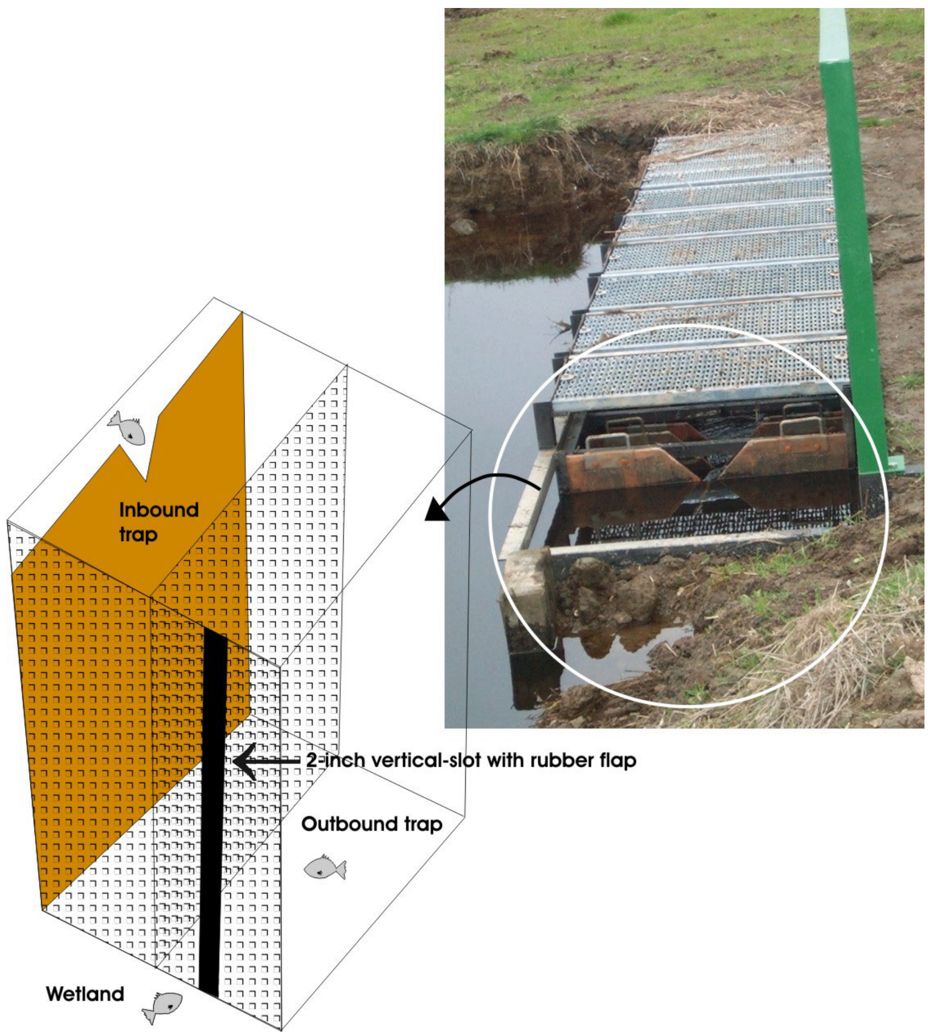
Fyke net: 0.9m tall, 1.2m wide, 0.8m rings, 7.6m wings, 4.8mm mesh

Oneida Lake Trap: 1.2m at mouth of trap, 7.6m wings, 38m lead connects to trap at mouth, 4.8mm mesh

Table 1. Wetland sampling dates at Cowan, Sinko and Schrader wetlands.

	WY 2004[1]		WY 2005		WY 2006
Cowan	1/13/2004	Cowan	12/16/2004	Cowan	1/17/2006
	2/24/04		2/3/2005		3/9/2006
	4/13/2004		3/18/2005		4/15/2006
	6/2/2004		4/27/2005		5/26/2006
Sinko	1/14/2004		6/22/2005	Sinko	1/18/2006
	2/25/2004	Sinko	12/15/2004		3/7/2006
			2/1/2005		4/13/2006
			3/16/2005		5/25/2006
			4/26/2005	Schrader	1/19/2006
			6/21/2005		3/8/2006
		Schrader	12/14/2004		4/14/2006
			2/2/2005		
			3/17/2005		

Figure 8. Two-way vertical-slot trap at Cowan wetland.



[1] In hydrologist's terms, the water year (WY) begins on October 1 and ends September 30.

Figure 9. One-way trap at the outflow culvert of the half-round riser water-control structure at Sinko wetland.

In addition to relative fish abundance data in the wetlands, water depths, water temperatures, dissolved oxygen, conductivity and pH were measured. Global® water-level loggers were used to record water depths at Cowan and Sinko wetlands. These pressure transducers were set to record water depths hourly. Water depths were converted to water-surface elevations by relating the position of the sensor with a nearby known elevation (*i.e.* temporary benchmark or top of water-control structure). Hobo® water-temperature loggers from Onset Computer Corporation were used to record water temperatures on an hourly basis. Dissolved oxygen concentrations of water in the wetlands were measured with a YSI 200 meter beginning in 2005. Water temperature and dissolved oxygen profiles of the water column were recorded every foot. Conductivity and pH were recorded during the last sampling trip, May 2006. A YSI conductivity meter was used to measure specific conductance. The meter was dropped from one to two feet under the water surface and conductivity was recorded. Strips for measuring pH by comparing watercolor after submersion were used during the May 2006 sampling period to get an estimate (± 0.5 pH unit, approximately).

Fish sampling results, including water depth and temperature and other water-quality measurements that were recorded were reported annually. These results are found in the appendix of this document. The following results and discussion are based on those results.

Results and Discussion

Fish use of floodplain wetland habitat

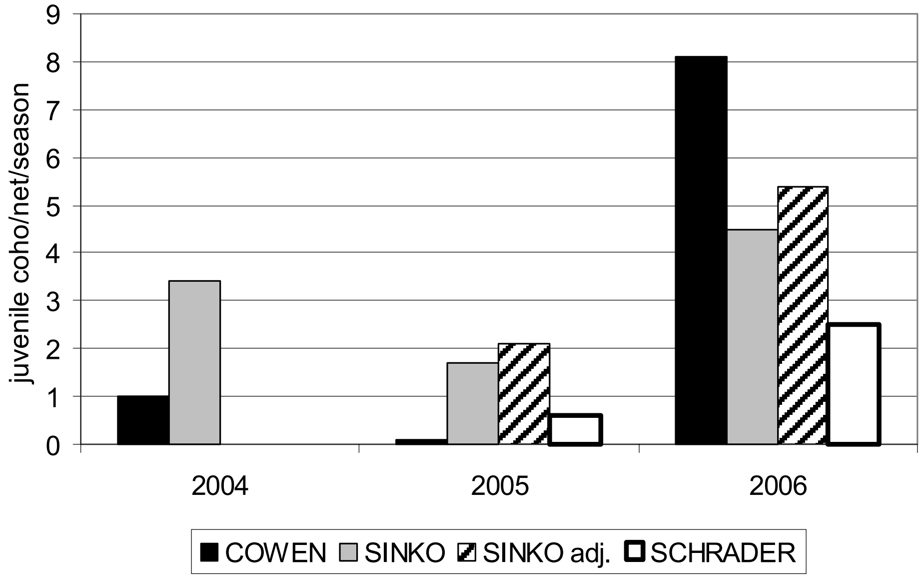
Juvenile coho salmon were found to use both Cowan and Sinko wetlands after completion of restoration work, which included, but were not limited to, the installation of water-control structures. Sinko wetland was sampled prior to the completion of wetland restoration work in January and February 2004 and after completion of the project in 2005 and 2006. Juvenile coho were present in Cowan and Sinko wetland at every sampling occasion in water-year (WY) 2004 (Table 2). Our sampling seasons (November through June) and fish access to the wetlands correspond more with the hydrologist's water year (October through September) and when coho begin moving back into the wetlands than the calendar year, so are described by water year. In WY2005, we began sampling fish in Schrader wetland. A total of 35 were caught during the winter in Sinko wetland and 7 during the same period at Schrader wetland. Only two coho were caught in Cowan wetland in February 2005. Winter 2005 began typically, with a peak in the hydrograph around December 10, 2004 but precipitation declined through the winter until a heavy rain storm on March 27, 2005 brought river levels up overtopping the dike at Cowan wetland, the water-control structure at Sinko wetland and connecting the river and floodplain at Schrader wetland. Coho likely came into the wetlands during the December 2004 freshet but had more limited opportunity until March 2005. There were more water in the rivers and greater surface water connection during the winter and spring of 2006 and also greater catch of coho in the wetlands. Coho were caught at all sampling occasions at all sites in 2006.

Table 2. Juvenile coho salmon catch in Cowan, Sinko and Schrader wetlands (shaded by WY).

Sample Month/Year	Cowan	Sinko	Schrader
January 2004	13	8	not sampled
February 2004	3	23	not sampled
April 2004	2	not sampled	not sampled
June 2004	1	not sampled	not sampled
December 2004	0	1	3
February 2005	2	20	3
March 2005	0	14	1
April 2005	0	0	not sampled
June 2005	0	0	not sampled
January 2006	37	1	8
March 2006	34	53	17
April 2006	82	11	3
May 2006	1	7	not sampled

Catch of juvenile coho in the wetlands can be compared by standardizing catch to the number of nets set per sampling occasion or season. Figure 10 shows catch between sites standardized to number of coho caught in nets per site per season. There are two bars representing Sinko wetland. In order to make a fair comparison with Schrader wetland where late spring sampling was not permitted because of potential damage to the hay crop from crossing the field to get to the wetland, those fish and net sets were omitted from the calculation of coho per net per season in the "adjusted Sinko bar." The graph indicates lower relative abundance of coho in Cowan wetland in 2004 and 2005 than Sinko and Schrader wetlands. There was greater relative abundance of coho in Sinko wetland (including the adjusted value) than in Schrader wetland in both 2005 and 2006. Relative abundance of coho in Cowan wetland in 2006 was twice as great as in Sinko wetland and three times that caught in Schrader wetland. Water from Larson Slough was observed spilling over the dike on two sampling occasions. Sampling during periods of connectivity may elevate abundance of coho in the catch. Coho catch in 2006 was greater overall than in 2004 or 2005.

Figure 10. Comparison of coho catch standardized to fish/net/season, 2004-2006*.



*Sinko adjusted bar includes only data that corresponds to the same period when Schrader wetland was sampled. It does not include June 2005 or May 2006 data (coho numbers and nets set) at Sinko wetland because we were not able to sample Schrader at those times.

Coho catch was greater in the wetland restoration site, Sinko wetland, than in Schrader wetland, the reference site. Coho presence in Sinko wetland, however, is not determined by the water-control structure, the filling of the ditches that drained the wetland, or re-meandering of a swale through the wetland. Juvenile coho are known to move downstream in the fall with freshets (Brown and Hartman 1988, Peterson 1982, Skeesick 1970) and move into off-channel habitats (Peterson 1982, Nickleson et al. 1992, Swales and Leving 1989). Water-control structures are intended to be overtopped occasionally by high water. The half-round riser style of water-control structure at Sinko wetland was not meant for fish passage into the wetland as the fish ladder is at Cowan wetland. It is understood that the Coquille River frequently and predictably inundates the floodplain in the winter and spring and would overtop the structure allowing ingress. It was expected that juvenile coho would have access into the wetland periodically throughout the winter and spring. Presence of coho in the wetlands and the 2005 and 2006 hydrographs indicate that that expectation was met (Figures A8 and A14).

In some respects, the half-round riser water-control structure operates somewhat like a beaver dam in that it holds water at a certain elevation determined by the height of the structure and it sometimes impedes fish movement but it is typically overtopped during high-water events allowing juvenile coho to enter and rear. The advantage of the water-control structure over the beaver dam is the ability to manage water levels. Seasonal wetlands, those that dry up in the summer, are more productive for waterfowl. These wetlands are not suitable for coho summer habitat because any remaining water becomes isolated from the river, too warm and low in oxygen. Wetlands managed by water-control structures are drawn down in the summer by removing boards. The boards are replaced in the fall to hold water.

The critical element to the half-round structure at Sinko wetland or the pool-weir-chute structure at Cowan wetland, where there is no positive source of water, is to ensure that fish have passage opportunity out of the wetland via water spilling over the top riser board in the spring to allow egress. The benefit of the water-control structure is that once the wetland is filled in the fall or winter, it provides a predictable level of water, thus rearing habitat for juvenile coho, through the winter and spring. Prior to the structure at Sinko wetland, sampling could not be accomplished in the spring due to low water where it was two feet lower than it would have been had the structure been installed (compare Figure A8 with 10ft. elevation of the riser board). After the structure was installed, the wetland had enough water to set nets until it was drawn down.

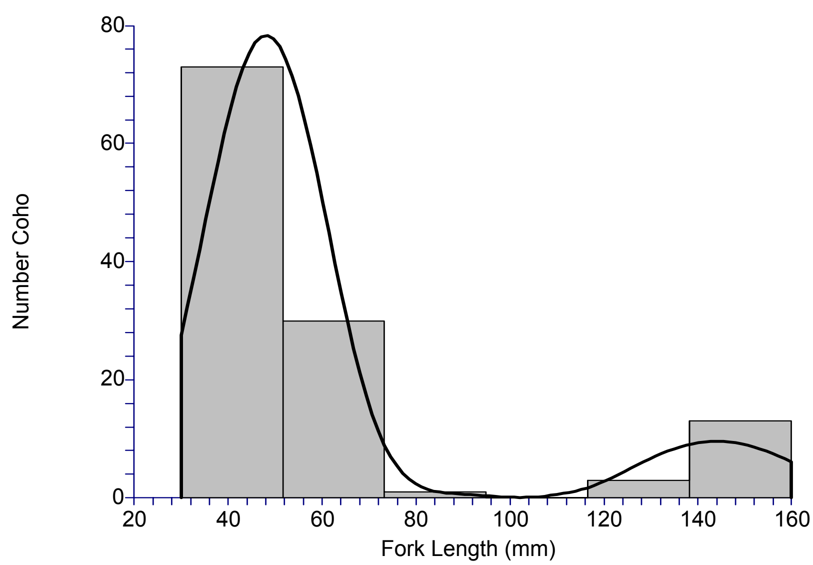
Fish monitoring data indicate that juvenile coho salmon enter wetlands and can be present during the winter and spring. These data reflect year-to-year and site-to-site variability in fish use. Within-wetland sampling provides a periodic snapshot of fish use and relative abundance in the wetlands. We have no estimate of the efficiency of our sampling fleet and cannot estimate fish abundance. Catch of coho may seem insignificant compared to the thousands of threespine stickleback caught but they are not permanent residents of the wetlands and perform a different ecological role than do the threespine stickleback. Despite the low relative abundance of coho in our catch, access to these wetlands may provide benefits such as resting and feeding habitat, which may confer survival benefits as long as coho have passage opportunity out of the wetlands when life-history cues and/or deteriorating water-quality signal their departure.

Relatively few introduced fishes were caught in these wetlands. Introduced fish contributed to less than one percent of the total number of fishes caught and about 33% of the fish biomass in the catch. The most abundant fish species was the native threespine stickleback. This fish is known to occupy low-velocity streams and ponds on the west side of the Cascade Range (Wydoski and Whitney 2003). They are likely an important part of the food web because they are abundant and provide food for a large variety of wetland inhabitants including dragonfly larvae, cutthroat trout, kingfisher, loon, grebe, merganser, and river otter (Reimchen 1994). The large proportion of native threespine stickleback, juvenile coho use of the wetlands, and few introduced species is also typical fish monitoring data from two wetland restoration sites with pool-weir-chute structures at Willapa Bay National Wildlife Refuge on the southern Washington coast (Baker and Miranda 2002, 2003, 2004, 2005). Threespine stickleback were the most abundant fish species in freshwater seasonal floodplain wetlands on the Chehalis River, followed by coho salmon and native Olympic mudminnow (Henning et. al 2006). At fish monitoring sites further inland on the East Fork Lewis River and Lower Willamette River, the proportion of introduced species is much higher, especially in the spring as the water temperatures increase and young-of-the-year begin to hatch (Baker and Miranda 2002, 2003, 2004, 2005).

Miller and Sadro (2003) studied coho use of the South Slough estuary, an arm of Coos Bay where West Fork Winchester Creek enters. They found that juvenile coho movement into the stream-estuary ecotone corresponded with freshet events in the fall and winter and used main channel, adjacent salt marshes and tributary channels in this reach. They estimated that between one-quarter and one-third of the 1998 and 1999 brood entered the lower river above the estuary during the fall and winter and some of them resided for a significant time. Juvenile coho that entered one saltwater marsh resided up to 98 days after capture but the mean residence time was 49.1d ± 2.8d. They found that coho that entered the stream-estuary ecotone before March 1 had a longer residence time than those that entered after that date, 64.4d ± 6.8 d (1998) and 48.3d ± 8.6d (1999) [before 3/1] and 17.5d ± 2.2d (1998) and 18.0 d ± 1.5d (1999) [after 3/1]. They operated a rotary screw trap near the head of tidewater in 1998 and 1999 and found that catch increased substantially in early March as yearling coho moved downstream.

Similar patterns of habitat use of coho in Cowan, Sinko and Schrader wetlands correspond with coho in the Sough Slough study. We observed presence of coho in the wetlands after freshets and the relative abundance seemed to increase after high-water events, especially when there was connectivity with the river. Coho were caught as early as December and as late as June, although we were not able to document individual residence times. Water temperatures in the restored saltwater marshes ranged between 6-22°C annually (Miller and Sadro 2000). The one-way trap at Sinko wetland documented a spring migration of coho out of the wetland in 2005 (Figure A10). These outmigrants were mostly (87%) fry between 30 and 80mm fork length and would likely spend another year in freshwater before migrating to the sea (Figure 11). Outmigrants that were between 125 and 160mm fork length were likely ocean-bound smolts.

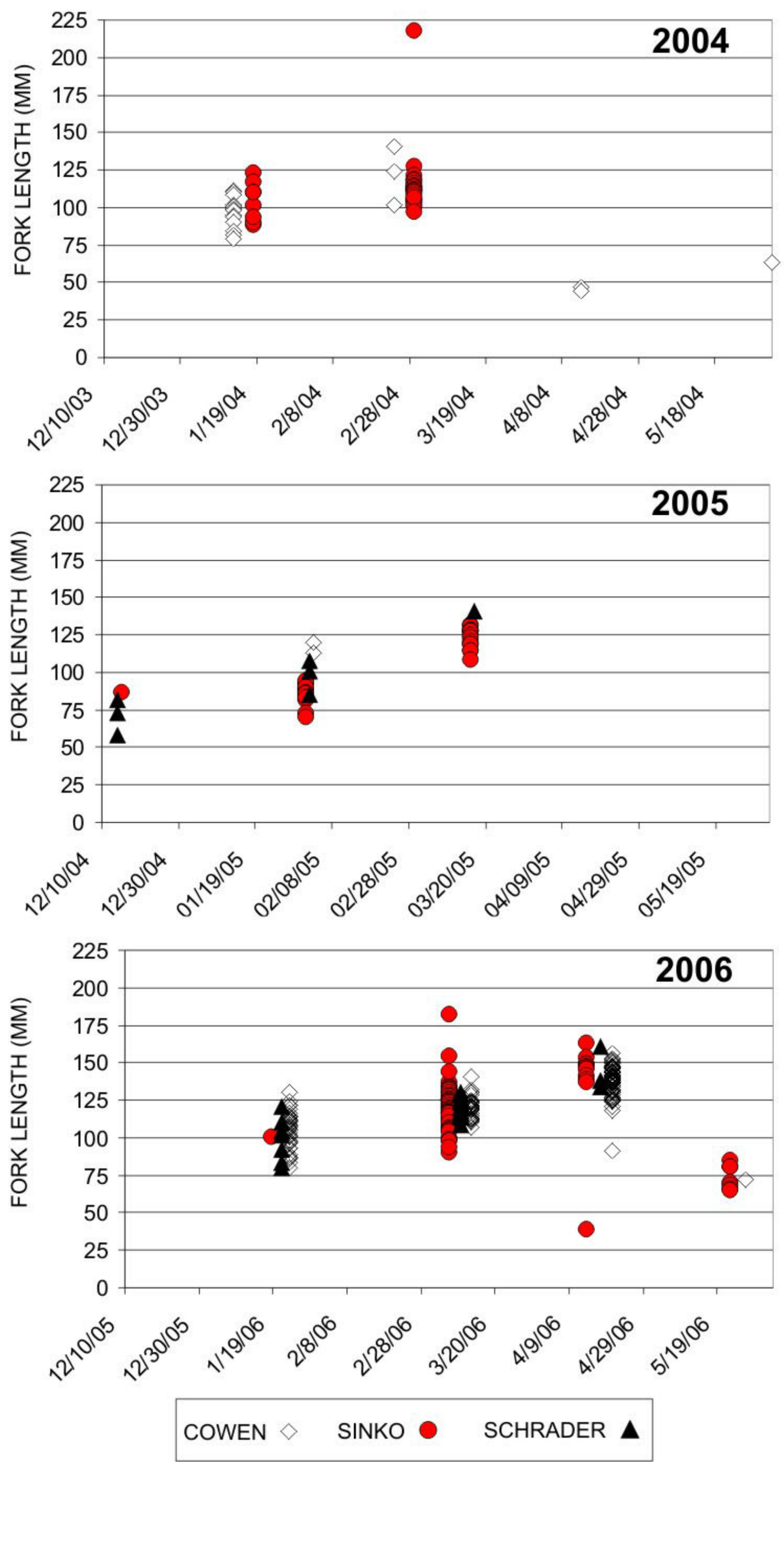
Figure 11. Length-frequency of coho caught outbound in the one-way trap at Sinko wetland, spring 2005.



Sub-yearling coho in the Sough Slough had higher growth rates in the floodplain habitat than in the main stem West Fork Winchester Creek (Miller and Sadro 2003). In Dalton Marsh growth rates of coho were 0.44mm/d (70mm fork length by spring). Coho were no longer present in the catch by mid-June. Coho growth rates in Cox Pond average 0.30mm/d between December 1999 and May 2000. In Kunz Marsh, growth rates were 0.26mm/d between November 1999 and May 2000. These growth rates were higher than for coho rearing in upper West Fork Winchester Creek, which averaged 0.16mm/d in the winter and 0.25mm/d in the spring 2000.

We were able to show an increase in fork length of coho caught during subsequent sampling events in the wetlands (Figure 12) but have no data from coho in the main stem from which to compare. Growth rates ranged broadly from 0.15 to 0.84mm/day for 1+ coho (Table 3). There was one 218mm coho caught in Sinko wetland February 2004 that was probably in the 2+ age class, which was not included in the growth comparison. Fry caught during the spring of 2004 and 2005 in Cowan and Sinko wetlands were also not included in the growth comparison.

Figure 12. Coho fork length (mm) at Cowan, Sinko and Schrader wetlands 2004-2006.



It appears that mostly coho in the 1+ age class were caught during our wetland sampling (Figure 12), while most of the coho caught in the outbound trap at Sinko wetland in 2005 were fry (Figure 11). This may be due to timing of wetland sampling relative to hydrologic conditions. Nearly all of the coho fry caught in the outbound trap were caught on the falling limb of the hydrograph following a high-water event in the spring. Salmon fry are caught regularly in nets used for wetland sampling at other sites so gear selection is not a likely explanation.

Table 3. Increase in fork length (mm/day) for 1+ coho.

Year	Cowan	Sinko	Schrader
2004	0.62 (1/13 to 2/24)	0.15 (1/14 to 2/25)	
2005		0.84 (2/1 to 3/16)	0.54 (12/14 to 2/2)
2006	0.32 (1/17 to 4/15)	0.72 (3/7 to 4/13)	0.52 (1/19 to 4/14)

Use of off-channel habitats by coho in the wintertime is well documented (Bustard and Narvar 1975, Cederholm and Peterson 1988, Peterson 1982, Swales et al. 1986, Swales and Levings 1989). Nickleson et al. (1992) suggests that availability of adequate winter habitat on the Oregon Coast may limit coho production if spawning escapement is adequate. A great many acres of wetlands in the riverine lowlands once accessible to rearing salmon are now gone. Forty-two percent of the coastal wetlands in the Pacific Northwest and 86% of the wetlands in the Coos Watershed have been lost (Miller and Sadro 2000). If a large proportion of the coho brood in Larson Slough and the Coquille River move downstream to reside in the lower reaches of these rivers during the winter and spring like they do in the South Slough, then increasing access to floodplain wetlands may benefit rearing coho.

Water quality and fish passage opportunity at wetland restoration sites

In the winter and early spring when there is fish passage opportunity into and out of the wetlands, water temperatures are cool, dissolved oxygen concentrations are adequate and invertebrates are plentiful[2], floodplain wetlands provide good rearing habitat for coho. In the late spring when water temperatures become warm and dissolved oxygen concentrations fall to critical levels, these wetlands quickly loose their appeal for rearing coho and passage opportunity out of the wetlands is important to maintain to avoid mortality.

Laboratory-determined optimal temperatures for growth of juvenile coho are reported to be between 11.8 and 14.6^{o}C (Brett 1952). Water temperatures in restored wetlands were typically in this range from March through mid-April. In April, water temperatures generally increased sharply. The maximum annual daily average temperatures in Cowan and Sinko wetlands were typically below 18^{o}C annually but 20.7^{o}C was recorded in Cowan wetland late-May 2005. While the late-spring water temperatures are above the upper range of the optimum, the upper limit for positive growth for juvenile Chinook is 19.1^{o}C (Armour 1999). These temperatures are well below incipient lethal threshold for coho salmon of 25^{o}C (Brett 1952).

[2] Field notes at Cowan wetland February 2004 indicate an abundance of caddis fly cases on the fish nets.

Dissolved oxygen levels in the wetlands were generally lower in 2005 than in 2006, especially during the low water period winter 2005. Dissolved oxygen concentration in Cowan wetland was 4.1mg/l at the surface in February 2005 and dropped to below 2mg/l for three subsequent sampling trips. Dissolved oxygen concentrations in Sinko wetland dropped to 3.7mg/l at the surface in February 2005 but increased to more than 5mg/l the rest of the sampling trips that year. In 2006, dissolved oxygen concentrations dropped sharply between the March and May sampling period to less than 1.5mg/l in Cowan and Sinko wetlands. A dissolved oxygen concentration of 4mg/l will not limit survival of salmon but at less than 1mg/l they are likely to die (Diana 1995). Juvenile rainbow trout died 48h after exposure to 1mg/l oxygen at 15^{o}C (Dean and Richarson 1999). At both Cowan and Sinko wetlands critical dissolved oxygen levels were reached by late spring during one or both years. When coho were no longer present in the catch and dissolved oxygen levels in the wetlands fell to very low levels in late spring, threespine stickleback were abundant in the catches at Cowan and Sinko wetlands in 2005 and 2006. Threespine stickleback can tolerate very low oxygen levels by seeking the partly oxygenated surface layer of the wetland (FitzGereld and Wooton 1993).

Low springtime dissolved oxygen concentrations were also recorded in floodplain wetlands on the lower Chehalis River. Henning et al. (2006) found coho emigration patterns to coincide with diminishing dissolved oxygen concentrations (<0.8mg/l by June) in floodplain wetlands. They suspected that oxygen was probably a more significant limiting factor than temperature in the wetlands.

At Cowan wetland in 2004 there were periodic overtopping of the dike and water spilled through the fish ladder most of the winter and spring. But water levels in the wetland slowly dropped in May and water no longer ran through the ladder. The water level logger failed in 2005 but field notes indicate that water did not consistently flow through the fish ladder. Winter 2005 was unusually dry and only two coho were caught in the wetland the entire season, which may indicate the lack of connection between Larson Slough and Cowan wetland. In water-year 2006, water began flowing through the fish ladder November 27, 2005. There appeared to be continuous flow through the ladder until the water level logger failed March 18, 2006. Field notes report that water was not flowing over all of the weirs in the ladder in mid-April and late May 2006. During three years of monitoring this site water flow through the fish ladder during the spring was not adequate to provide fish egress. The structure was designed such that if water no longer flowed through the structure weir panels (Figure 3) would be removed, beginning with the tallest panel, until egress was restored.

Before the water-control structure in Sinko wetland was installed in 2004, fish could enter the wetland area when water overtopped the low point in the dike, which occurred in mid-December. When water levels dropped to below this point, then fish would not have passage opportunity out of the wetland and there was risk of stranding. Before any restoration activity took place on this site coho could become stranded in the drainage ditches once water in the wetland/pasture became disconnected from the ditch running out to the Coquille River. Oregon Department of Fish and Wildlife had documented coho stranding in wetland ditches prior to the installation of the water-control structure (Alan Ritchy, ODFW fish biologist, pers. comm.). Water in the wetland fell below the point of connection with the Coquille River after April 28, 2004. At this time one of the old drainage ditches remained in the wetland but was not yet connected to the ditch leading to the Coquille River. This connection was made after installation of the structure.

After installation of the water-control structure at the Sinko wetland the water level could be held at a minimum of 10 feet elevation (NAVD 1988) through the spring until the wetland was drawn down. The re-contouring of the wetland was designed to drain all of the water (and fish) down to the ditch that runs to the northwest towards the structure. When the boards are pulled and water is draining out of the wetland, the lowest point is immediately in front of the structure so that fish will not become stranded in the wetland after drawdown. In 2005, after the land owner had became familiar with operating the structure, it held water at its designed elevation and fish passage was provided out of the wetland through June. During spring 2005, the wetland held an additional two feet of water that would have drained without the structure. In 2006, the water-control structure spilled through the winter and spring, providing egress until April 20.

Fish passage was restricted at both wetlands for a brief time each spring. This was the result of improper management of the structures, not the design. It is critical to manage the structures so that coho have passage opportunity out of the wetlands as water temperatures increase and dissolved oxygen concentrations diminish. Seasonal floodplain wetlands have been found to have great invertebrate productivity (Gladden and Smock 1990, Krull 1970, Murkin 2000, Smock et al. 1992). It has been demonstrated through these case studies that coho using floodplain wetlands grow during the winter and spring and can pass out through the structures if water flow is maintained by manipulating riser boards and weir panels. Other examples from Ducks Unlimited Fish Monitoring Program demonstrate the benefits of wetland restoration to juvenile salmon where structures were managed carefully. Most notably is LaCenter Bottoms, where the pool-weir-chute water-control structure has been managed so that water continuously flowed through the ladder. The two-way trap in the ladder at LaCenter Bottoms recorded both coho and Chinook fry and yearlings passing into and out of the wetland until drawdown.

Conclusions

These are case studies, which will provide useful examples to help evaluate future restoration projects that are similar in physical and biological characteristics. The objectives of the wetland restoration projects at Cowan and Sinko wetlands were to provide winter habitat for waterfowl. Because the sites are adjacent to salmon-bearing streams that annually inundate the floodplain, a concern by fisheries managers was that juvenile coho would enter the seasonal floodplain wetlands and become stranded by the water-control structures. Through monitoring fish use and passage capability at these restoration sites and comparing coho catch at Sinko wetland with the reference site, Schrader wetland, we have demonstrated that juvenile coho use floodplain habitats during the winter and spring, they grow during their stay in the wetlands and they can pass out of the wetlands through the structures if passage opportunity is maintained.

Historically, these floodplain habitats were accessible to coho and were likely inhabited by coho for part of the year. Some may have become stranded under natural conditions. The use of dikes and tide gates to restrict water from inundating the floodplain, now used for agricultural production, seem to be more common than not, judging by the difficulty in finding a reference site that represented a more natural condition. Both Cowan and Sinko wetland restoration projects employed the use of water-control structures to maintain a design water-surface elevation through the spring. In late spring, water levels were to be drawn down by removing panels in the fish ladder or riser boards in the half-round structure and maintaining fish passage.

Wetland sampling indicated that juvenile coho entered the floodplain wetlands during the winter and spring when surface water connections allowed passage. Positive growth rates of coho using these wetlands were documented. It is not known what proportion of the cohort migrating downstream benefited by these habitats but coho entered when connectivity allowed passage opportunity. Comparing total annual catch in 2005 and 2006 at Sinko and Schrader wetlands, catch of coho in the reference site, Schrader wetland, was not greater than that of Sinko wetland. Not only has juvenile coho use of these floodplain wetlands been recorded but these habitats also support other native fishes and amphibians. Sampling also indicates that relatively few introduced species are harbored in wetlands in the Coos Bay/Coquille area.

Monitoring coho use and passage into and out of the wetlands has revealed the need for closer attention to management of the structures in the springtime to assure coho egress.
Ducks Unlimited has contacted local watershed councils to assist in the on-site management of our restored/enhanced wetlands. With the improved guidance to landowners and more reliable flows through the structures in the spring, these wetland restoration sites will continue to provide beneficial rearing habitat for juvenile coho.

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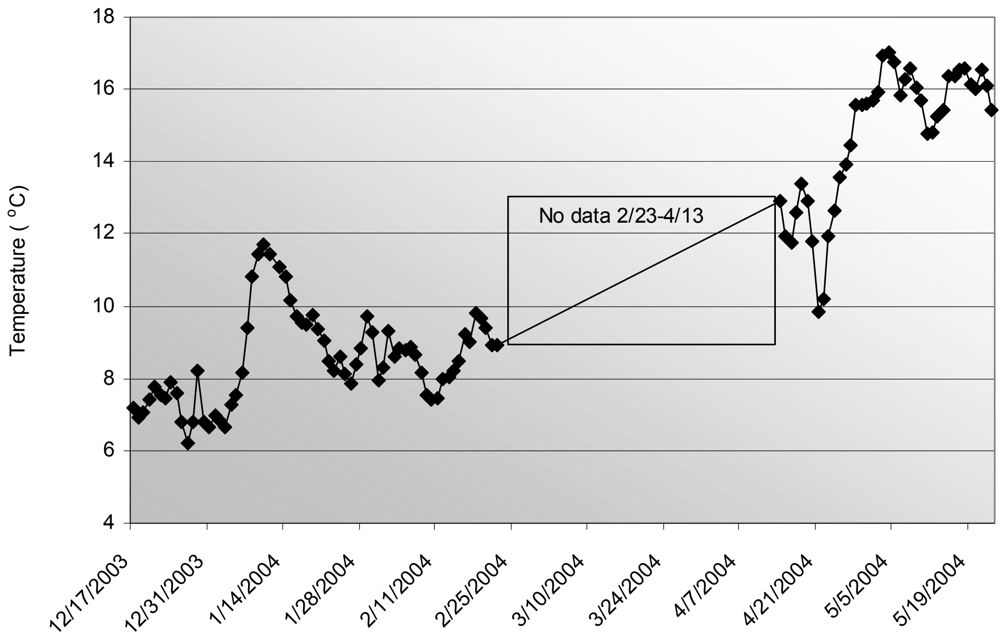
Appendix A - 2004 through 2006 Annual Reports

Cowan wetland 2004

Cowan temperature and hydrology 2004

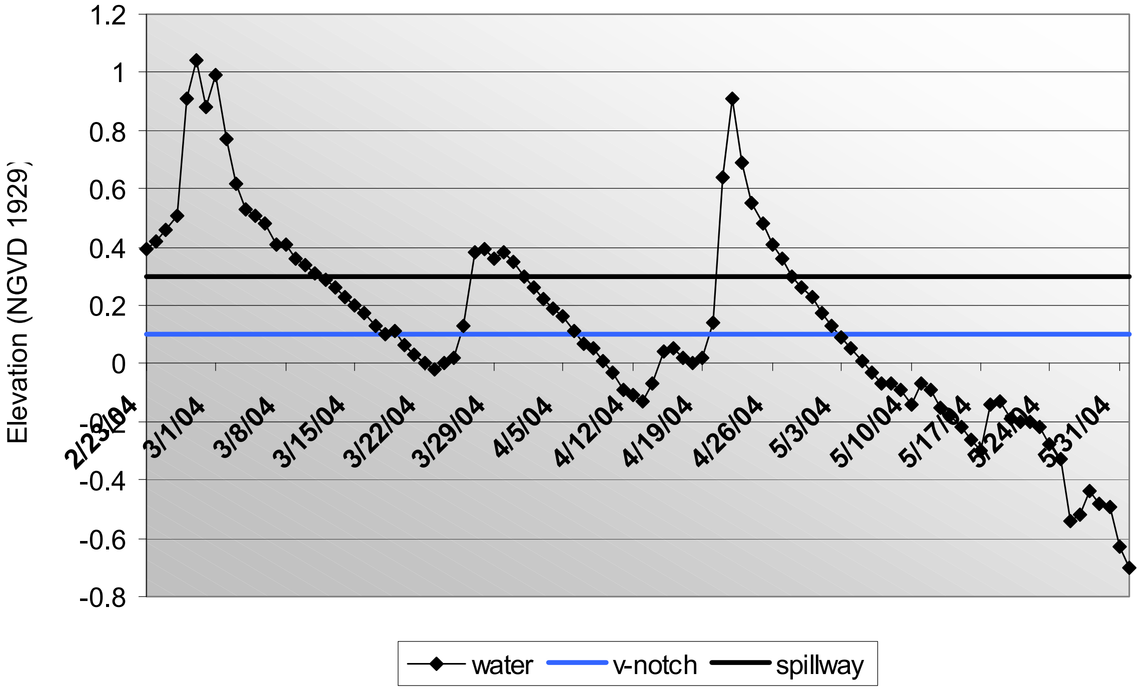
Daily average water temperature from December 17, 2003 to May 23, 2004 in Cowan wetland is shown in Figure A1. The logger failed to record water temperatures between February 23 and April 13, 2004. The lowest daily average water temperature recorded was 6.2 °C on December 23, 2003. Water temperatures quickly began to rise in May reaching a daily average temperature of 17.0 °C May 4, 2004.

Figure A 1. Daily average water temperature at Cowan wetland, December 17, 2003 to May 23, 2004.



A pressure transducer with data logger was used to record water depth in the wetland. Data were recorded from February 23 to June 1, 2004. These depths were converted to water-surface elevation to compare with the elevation of the spillway (0.3 ft. NGVD 1929) and the bottom of the notch in the top board of the fish ladder (0.1 ft. NGVD 1929). A v-notch in the top board of the weir nearest the wetland maintains that elevation in the wetland. Figure A2 shows that water-surface elevation in the wetland increased in early march and late April from heavy rain events. When the line representing the water in the wetland is above the v-notch then water is flowing out through the fish ladder. Water flowed through the fish ladder 61% of the time between February 23 and June 1, 2004. When the line representing the water in the wetland is above the spillway then Larson Slough is connected to the wetland. Larson Slough was connected to the wetland over the dike 29% of the time during this period.

Figure A 2. Water-surface elevation in Cowan wetland with respect to v-notch controlling the water elevation in the wetland and the low point on the spillway.



Cowan two-way trap results 2004

A two-way fish trap was fitted onto the entrance of the fish ladder on the wetland side of the water management structure. The trap was fished from mid-January through early June in 2004. There were almost no fish caught during this period through the two-way traps. The trapper reported only two juvenile coho entering the wetland from the fish ladder. Both of these fish entered after heavy rain events, one coho in mid-January and one in early-March. Since the trap was not part of the original design it was not an optimal design. The trap entrance was flat with a three-inch vertical slot and rubber flap covering part of that opening. There was no "lead" encouraging the fish to swim into the trap. On the slough side of the water management structure, fish would enter through a 48-inch diameter culvert, turn 90 degrees then swim down through the ladder. Since there was a greater catch in the wetland than what came through the fish ladder and into the inbound trap, we presume that fish either entered the wetland before the trap was operational or more likely, entered the wetland during high water over the spillway on the dike.

Cowan wetland fish sampling results 2004

Standard seasonal wetland sampling of Cowan wetland was done January 13, February 24, April 13, and June 2, 2004. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap) with exception to the June sampling when the Oneida Lake trap was not used. The water level was low in June making access to the wetland too difficult to set the Oneida Lake trap. Traps were set for 24-hours during each sampling period.
A total of 11,423 fish were captured in Cowan wetland (Table A1). The majority of these were threespine stickleback caught in June (84% of total fish caught). All fish caught were native

species. Stickleback were the most abundant fish species (99.8% catch by number, 95% catch by weight) followed by coho salmon and river lamprey each comprising less than 1% of the total fish caught.

Coho salmon were captured during each of the 4 sampling periods. Thirteen coho salmon were caught in January (79-111mm), 3 were caught in February (102-141mm), 2 were caught in April (44-47mm), and 1 was caught in June (63mm).

A total of 1,779 amphibians were captured in Cowan wetland. The majority on these were red-legged frog tadpoles (1,192) caught in April and June. Other amphibians caught include red-legged adults (200), Pacific tree frog adults (4), northwestern salamanders (50, including 25 neotenes), and rough-skinned newts (333).

Table A 1. Within-wetland catch at Cowan.

MoYr	Common Name	Family	NatInt	Number	Min_FL	Max_FL	Wt (g)
Jan-04	Threespine stickleback	Gasterosteidae	N	485	29	59	322.3
Jan-04	Coho salmon	Salmonidae	N	13	79	111	186.4
	January Total		**N**	**498**			**508.7**
Feb-04	Threespine stickleback	Gasterosteidae	N	598	42	73	767.5
Feb-04	Coho salmon	Salmonidae	N	3	102	141	81.5
	February Total		**N**	**601**			**849**
Apr-04	Threespine stickleback	Gasterosteidae	N	761	24	68	900.7
Apr-04	River lamprey	Petromyzontidae	N	2	150	150	11.6
Apr-04	Coho salmon	Salmonidae	N	2	44	47	3.8
	April Total		**N**	**765**			**916.1**
Jun-04	Threespine stickleback	Gasterosteidae	N	9558	21	68	3206.8
Jun-04	Coho salmon	Salmonidae	N	1	63	63	4.6
	June Total		**N**	**9559**			**3211.4**
	Grand Total		**N**	**11423**			**5485.2**

<u>Cowan data summary 2004</u>

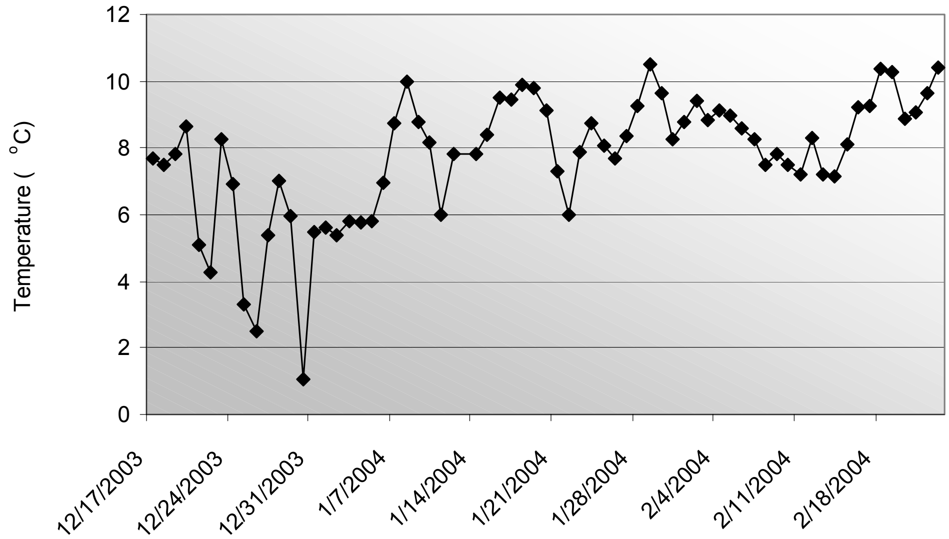
All of the catch, fish and amphibian, were native species. Threespine stickleback and red-legged frog tadpoles dominated the catch. Not many coho salmon were caught in Cowan wetland. A total of 19 coho were caught in four sampling occasions. This catch was lower than expected since the run of coho in Larson Slough is believed to be substantial (Jon Souder, Coos Watershed Association, personnal communication, fall 2003) and connectivity did not limit entry. Since few fish were caught with the two-way trap in the fish ladder, coho likely entered the wetland over the dike.

Sinko wetland 2004

<u>Sinko temperature and hydrology 2004</u>

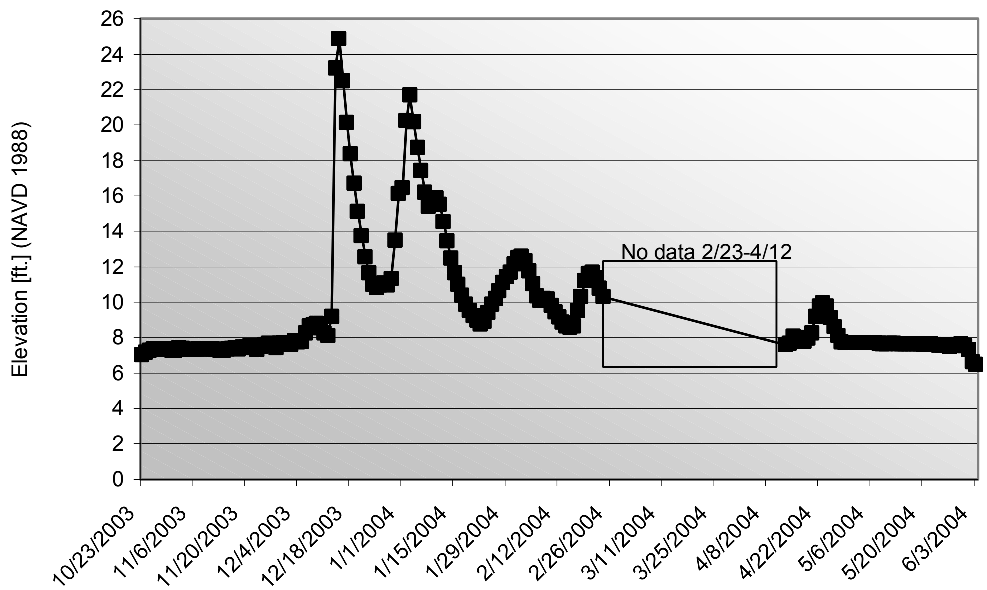
Water temperatures were recorded from December 17, 2003 to February 23, 2004 (Figure A3). Further data collection was hampered by an equipment malfunction. The water temperature dipped down to 1.1^{o}C December 30, 2003 and fluctuated between 8 and 10^{o}C during January and February.

Figure A 3. Daily average water temperature at Sinko wetland, Dec. 17, 2003 to Feb. 23, 2004.



A high-water event raised the Coquille River over 16 feet on December 12, peaking at 24.9 feet (NAVD 1988) on December 15 (Figure A4). Water elevation in the wetland was typically near 8 feet (NAVD 1988) most of the winter and spring. The water-control structure had not yet been installed in 2004 but the first phase of the restoration project had been completed, in which drainage ditches in the wetland were filled with dirt and an old remnant channel had been re-contoured. The lowermost ditch in Figure 4 was the only one in the wetland that was not filled in with dirt. It runs northwest toward the location where the structure would be installed. Throughout the winter and spring there was always water in the northwest-running ditch but it did not connect to the ditch running north out to the tide-gate at the Coquille River. The low-point between the two ditches was 8 feet (NAVD 1988). This was also the elevation in which water to begin spilling into the wetland from the northwest-running ditch. The bottom elevation of this ditch was 4 feet (NAVD 1988). During the January sample period, there was adequate water to inundate the wetland (12.48 feet NAVD 1988). Water in the wetland was low during the February sampling visit but nets were set in the northwest-running ditch where it was deep enough for most nets. During subsequent visits in mid-April and early June water was too low in the northwest-running ditch for any of our nets.

Figure A 4. Daily average stage in Sinko wetland, October 23, 2003 to June 3, 2004.



<u>Sinko wetland fish sampling results 2004</u>

Sampling of Sinko wetland was completed January 14 and February 25, 2004. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap) with exception to the February sampling when the Oneida Lake trap was not used. The water level was too low in February to set the Oneida Lake trap. Traps were set for 24-hours during each sampling period. Sampling was not conducted in April and June due to a lack of water in the wetland.

A total of 1,377 fish were captured in Sinko wetland (Table A2). Five different fish species were identified, including 2 native species and 3 introduced species. Native fish dominated the catch by number (86% of total fish caught) while introduced fish dominated in biomass (79% of the total weight). Threespine stickleback (97% catch by number) and coho salmon (3% catch by number) were the two native fish caught. Brown bullhead was the most abundant of the introduced fish (98% catch by number, 99% catch by weight). Fifty-one amphibians were caught in Sinko wetland, including bullfrogs, red-legged frogs, northwestern salamanders and rough-skinned newts.

Coho salmon were caught during both sampling periods. Eight coho salmon (89-123mm) were caught in January. Twenty-three coho were caught in February, including 22 fish between 97mm and 128mm and one at 218mm.

Table A 2. Within-wetland catch at Sinko wetland.

MoYr	Common Name	Family	NatInt	Number	Min_FL	Max_FL	Wt (g)
Jan-04	Threespine stickleback	Gasterosteidae	N	147	27	67	118.9
Jan-04	Coho salmon	Salmonidae	N	8	89	123	141.8
Jan-04	**Total Native**		**N**	**155**			**260.7**
Jan-04	Bluegill	Centrarchidae	I	3	56	99	43.3
Jan-04	Crappie spp.	Centrarchidae	I	1	30	30	0.1
Jan-04	Brown bullhead	Ictaluridae	I	185	48	215	6550.9
Jan-04	**Total Introduced**		**I**	**189**			**6594.3**
	January Total			**344**			**6855**
Feb-04	Threespine stickleback	Gasterosteidae	N	1002	35	70	1070
Feb-04	Coho salmon	Salmonidae	N	23	97	218	567.5
Feb-04	**Total Native**		**N**	**1025**			**1637.5**
Feb-04	Brown bullhead	Ictaluridae	I	8	50	225	440.6
Feb-04	**Total Introduced**		**I**	**8**			**440.6**
	February Total			**1033**			**2078.1**
	Grand Total			**1377**			**8933.1**

Sinko data summary 2004

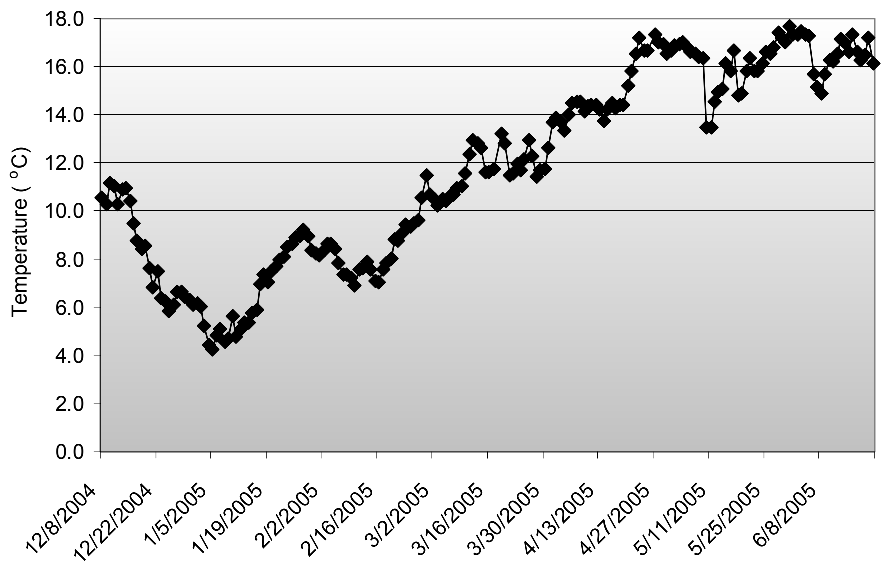
Fish sampling in Sinko wetland in January and February documented the presence of native threespine stickleback and coho salmon. Introduced brown bullhead, black crappie and bluegill and introduced bullfrog tadpoles were also caught. After high water from the Coquille River inundating the wetland in December and January, water in the wetland dropped to a depth too low to sample during April and June.

Cowan wetland 2005

Cowan temperature and hydrology 2005

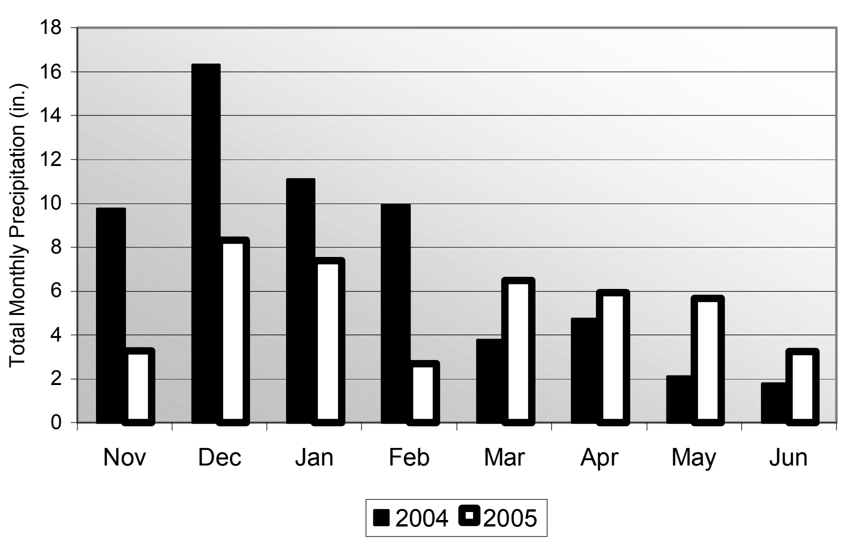
Water temperatures were recorded from December 8, 2004 to June 21, 2005 (Figure A5). The lowest daily average water temperature, 4.2^{o}C, was recorded January 5, 2005 and the highest daily average water temperature, 17.7^{o}C, was recorded May 31, 2005.

Figure A 5. Daily average water temperature at Cowan wetland December 8, 2004 to June 21, 2005.



Water level data in Larson Slough and Cowan wetland are limited. Pressure transducer malfunctions prevented recording water levels in the wetland in 2004 and 2005. Because Larson Slough watershed is predominantly a ground water driven system, precipitation data from North Bend may be used as an indicator of the hydrologic condition of the slough. Total monthly precipitation at nearby North Bend Airport was between 3.7 and 8 inches per month greater in the winter 2004 than winter 2005 (Figure 15). Spring 2005 total monthly precipitation was between 1.2 and 3.6 inches per month greater than spring 2004. Connectivity through the fish ladder in WY 2005 was periodically interrupted by the low water according to field notes taken during fish sampling in the wetland.

Figure A 6. Total monthly precipitation at North Bend Airport in 2004 and 2005.



Dissolved oxygen concentrations and water clarity (secchi depths) were very low in Cowan wetland during the 2005 sampling season (Table A3). Oxygen levels in the water column decreased steadily throughout the sampling season. Even during the winter and spring when water temperatures were cool the water column had low oxygen saturation.

Table A 3. Dissolved oxygen concentrations (mg/l and % saturation) in Cowan wetland WY2005.

	12/15/2004 16:25	2/3/2005 9:30	3/18/2005 8:45	4/27/2005 10:25	6/22/2005 11:15
DEPTH (FT)	DO (%sat)	DO (%sat)	DO (%sat)	DO (%sat)	DO (%sat)
1.0	6.2 (57.4)	4.1 (35.2)	1.8 (16.2)	1.5 (15.1)	0.3 (2.7)
2.0	2.9 (25.6)	3.4 (28.6)	1.6 (15.2)	1.4 (13.6)	0.2 (2.1)
3.0	0.6 (5.6)	1.2 (10.0)	1.3 (11.8)	0.7 (7.3)	0.2 (2.1)
4.0	0.5 (4.8)	0.5 (4.7)	1.0 (9.5)	0.3 (2.7)	0.2 (2.3)
4.5		1.4 (11.8)			0.2 (2.4)
5.0	1.1 (9.5)				
5.5	1.3 (12.1)				
max depth		4.8	4.3	5.0	5.0
secchi depth		1.3	1.0	1.0	2.0

Cowan wetland fish sampling results 2005

Cowan wetland was sampled December 16, 2004, February 3, March 18, April 27, and June 22, 2004. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap). Traps were fished for 24-hours during each sampling period.

A total of 1,048 fish were captured in Cowan wetland (Table A4). Only two different fish species were captured. Threespine stickleback made up the majority of the fishes caught (99.8%). Only two coho salmon were caught. They were both captured during the February sampling period and were presumably in the 1+ age class (113mm and 120mm).

Table A 4. Within-wetland catch at Cowan.

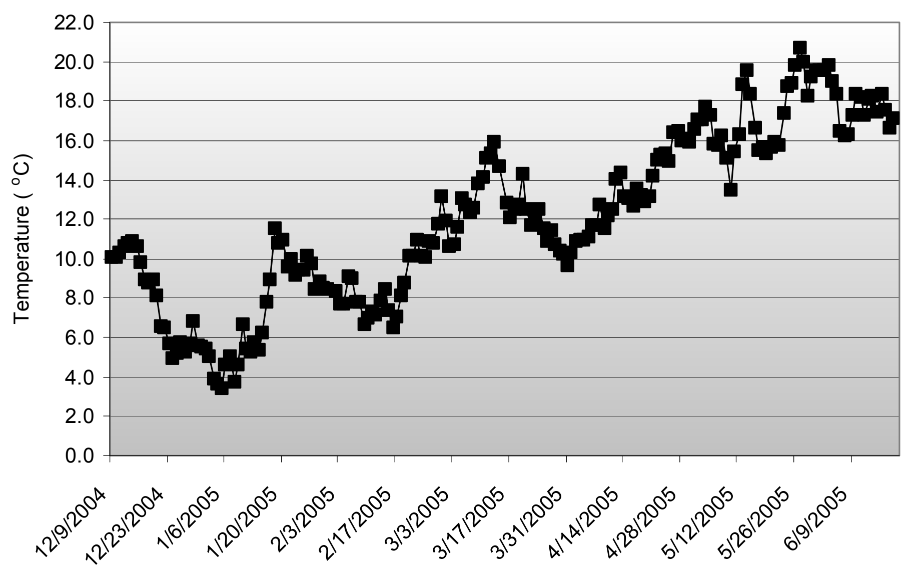
MoYr	Common Name	Family	NatInt	Number	Min_FL	Max_FL	Wt (g)
Dec-04	Threespined stickleback	Gasterosteidae	N	7	27	60	4
	December Total			**7**			**4**
Feb-05	Threespined stickleback	Gasterosteidae	N	36	29	68	37
Feb-05	Coho salmon	Salmonidae	N	2	113	120	46
	February Total			**38**			**84**
Mar-05	Threespined stickleback	Gasterosteidae	N	72	37	74	103
	March Total			**72**			**103**
Apr-05	Threespined stickleback	Gasterosteidae	N	276	23	72	186
	April Total			**276**			**186**
Jun-05	Threespined stickleback	Gasterosteidae	N	655	17	80	343
	June Total			**655**			**343**
	Grand Total			**1048**			**719**

A total of 1,547 amphibians were captured at Cowan wetland. Ninety percent were red-legged frog tadpoles (1,397) caught during the March, April, and June sampling period. Other amphibians include red-legged frog adults (30), northwestern salamanders (2), pacific tree frog tadpoles (8), and rough-skinned newts (110).

<u>Cowan data summary 2005</u>
Cowan wetland seems to be suitable habitat for native threespine stickleback and red-legged frogs. Low water in the slough and lack of connectivity may partially explain the low numbers of coho in the wetland. Another reason for low coho numbers may have been low dissolved oxygen in the wetland. Dissolved oxygen concentration below 50% saturation can limit a fish's standard metabolic rate (Wooton 1998). When a fish becomes stressed by low oxygen concentrations they must work harder to increase ventilation or move to more oxygenated waters. At oxygen concentrations less than one, a salmonid is likely to die. As dissolved oxygen increases, survival time increases until a concentration of 4 mg/l is reached, at which point a salmonid is no longer limited by oxygen (Diana 1995). Threespine stickleback, however, can exist in warm hypoxic waters by using surface respiration where they can exploit the thin oxygen-rich later at the air/water interface (FitzGereld and Wooton 1993). Lack of precipitation in the winter and low water levels in Larson Slough limited connectivity with Cowan wetland.

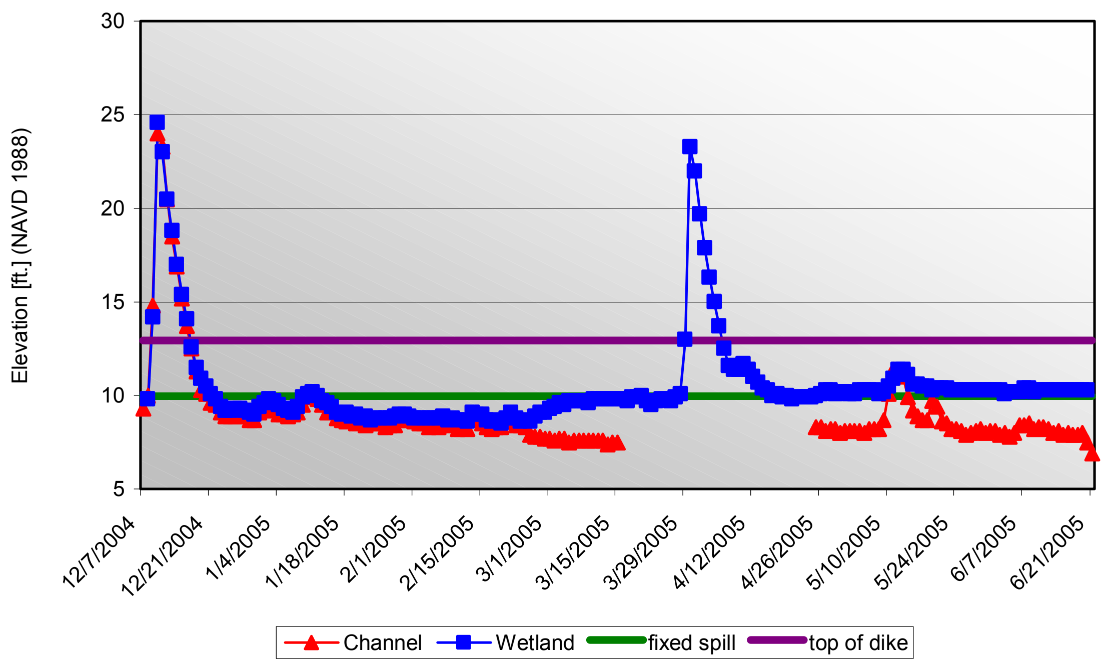
Sinko wetland 2005
<u>Sinko temperature and hydrology 2005</u>
Daily average water temperatures in Sinko wetland between December 9, 2004 and June 30, 2005 are shown in Figure A7. The lowest daily average temperature in the wetland was 3.4°C on January 5, 2005. The highest daily average temperature was 20.7°C on May 27, 2005.

Figure A 7. Daily average water temperature at Sinko wetland December 9, 2004 to June 20, 2005.



A water level logger was placed in Sinko wetland on either side of the water-control structure to determine elevation of water in the wetland and the drainage ditch running out to the Coquille River. Figure A8 describes the surface elevation of the channel immediately below the water-management structure (red diamonds) and the surface elevation of the wetland (blue squares), and compares these elevations with the elevation of the top of the dike (13 ft. NAVD 1988) and the top board controlling water-surface elevation in the wetland (10 ft. NAVD 1988). Data from the water level logger in the channel is missing from April 24 to May 16, 2005. The dike was overtopped twice, first on December 10, 2004 and again March 30, 2005. The riser boards were installed in the structure in late November but they were not secure and floated away during the high flow event December 10, 2004. The riser boards were re-installed around February 24, 2005. Water did not reach the design elevation of 10 feet until March 20. From February 24 until March 20 there was no connectivity between the wetland and the channel. Once the design elevation was reached the structure held the water-surface elevation at a minimum of 10 feet. From March 20 through the end of the sampling season (June 21, 2005) there was continuous fish passage opportunity out of the wetland because water flowed out of the wetland over the top riser board. Fish passage into the wetland is permitted when the dike is overtopped or when water from the Coquille River is backing up into the wetland such that the water-surface elevation in the channel opposite the wetland is greater than the elevation of the top riser board.

Figure A 8. Daily average water-surface elevation in Sinko wetland and the channel below the water-management structure with respect to the spillway and the top of the dike.



Dissolved oxygen levels became low during the dry winter and again in the spring below the surface (Table A5). Low water in February also resulted in low dissolved oxygen levels. Water became more oxygenated as the wetland filled again with precipitation and floodwater. Phytoplankton activity in June caused the surface to become supersaturated (greater than 100% saturation of dissolved oxygen) in the daytime. Respiration by the phytoplankton at nighttime during June likely resulted in early morning low oxygen concentration in the wetland.

Table A 5. Dissolved oxygen (mg/l) and % saturation of Sinko wetland.

	12/15/2004 12:25	2/1/2005 9:45	3/16/2005 11:00	4/25/2005 15:00	6/21/2005 11:00
DEPTH (FT)	DO (%sat)	DO (%sat)	DO (%sat)	DO (%sat)	DO (%sat)
1.0	5.94 (53.3)	3.67 (30.0)	5.71 (52.5)	7.73 (83.7)	7.2 (128)
2.0	5.91 (52.9)	3.57 (29.7)	6 (44.9)	4.79 (48.7)	0.2 (2.1)
3.0	5.79 (52.4)		5.81 (53.0)	2.18 (21.7)	0.2 (2.1)
4.0	5.5 (49.6)				
5.0	5.26 (47.5)				
6.0	4.92 (44.7)				
7.0	4.97 (44.7)				
8.0	3.82 (34.3)				
9.0	1.75 (15.7)				
max depth		2.2	3.5	3.5	2.8
secchi depth		2	2.5	1	2.5

Sinko outbound trap results 2005

A modified box trap was used to catch fish that passed out through the water management structure at Sinko wetland. The trap was fished from December 28, 2004 to May 9, 2005. A high flow event resulted in the trap being underwater between March 29 and April 13, 2005. Consequently the trap was not checked during that time period. A total of 597 fish were caught in the outbound trap (Table A6, Figures A9 and A10). Threespine stickleback was the most abundant fish species caught (60% catch by number). Followed by coho salmon (20% catch by number) and mosquito fish (12% catch by number). All but one of the 121 coho left the wetland between April 15 and May 6, 2005. No water was flowing over the riser boards between February 24 and March 20, 2005 and fish did not have access out of the wetland. Ten threespine stickleback were caught during this period. No length measurements were taken of these fish but presumably they were small enough to fit through the mesh of the trap and entered the trap that way.

Table A 6. Sinko outbound trap data, WY 2005.

Family	Common Name	Number	Min_FL(mm)	Max_FL (mm)
Catostomidae	Largescale sucker	3	20	32
Gasterosteidae	Threespined stickleback	357	20	71
Petromyzontidae	Pacific lamprey	3	150	180
Salmonidae	Coho salmon	121	30	160
Total Native		**484**		
Centrarchidae	Bluegill	40	15	51
Ictaluridae	Brown bullhead	4	254	356
Poeciliidae	Mosquitofish	69	12	47
Total Introduced		**113**		
Grand Total		**597**		

Figure A 9. Catch (abundance) summarized by week in outbound trap at Sinko, WY 2005.

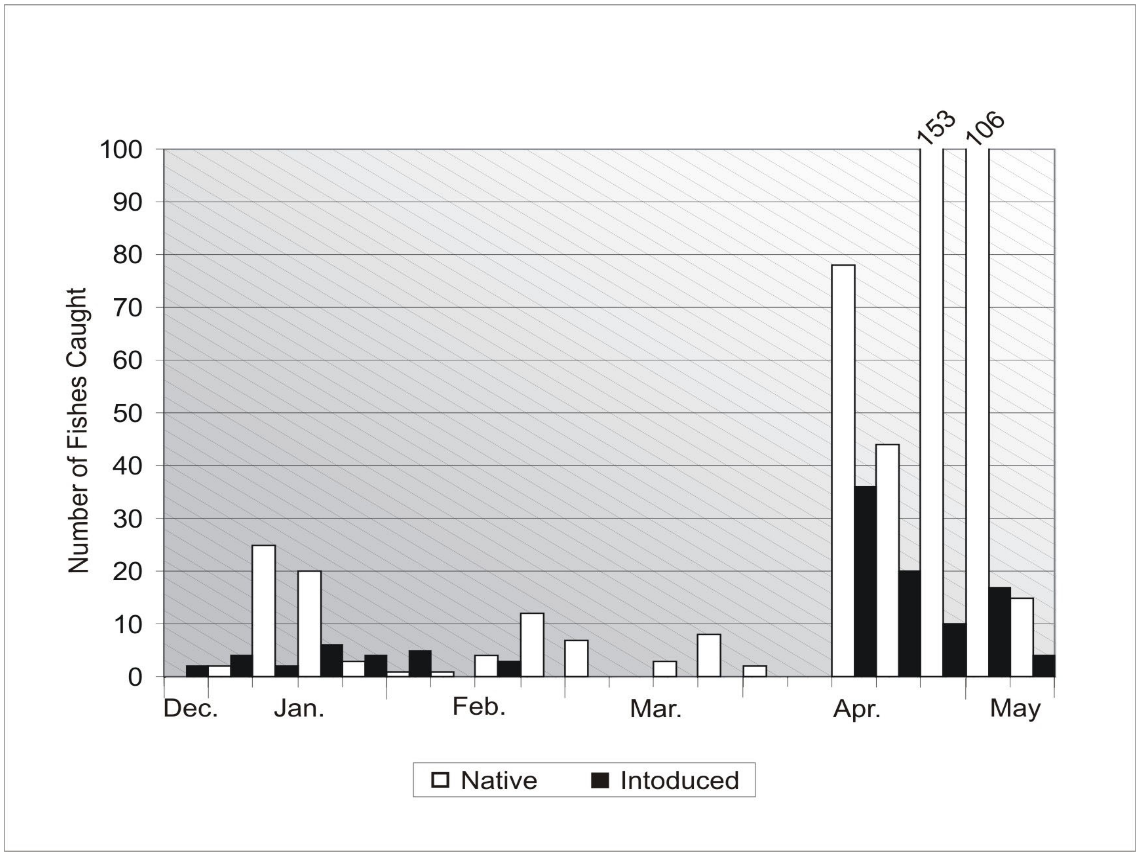
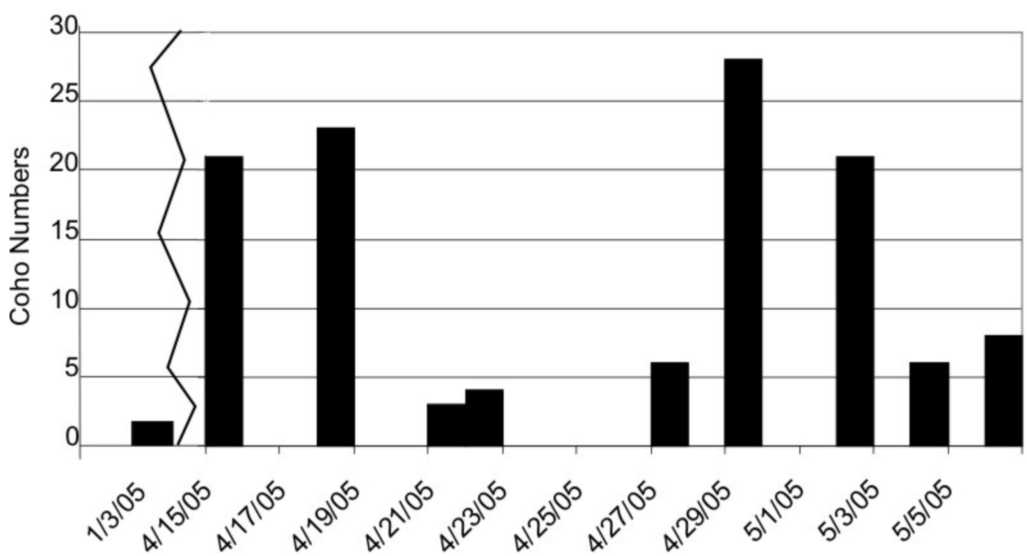


Figure A 10. Coho catch in the outbound one-way trap at Sinko wetland 2005.



Sinko wetland fish sampling results 2005

Standard seasonal wetland sampling of Sinko wetland was done December 15, 2004, February 1, March 16, April 26, and June 21, 2005. Fishes were sampled using the standard gear (2 box traps, 2 fyke nets). The Oneida Lake trap was only fished in December due to shallow water all other sample periods. Traps were fished for 24-hours during each sampling period.

A total of 5,087 fish were caught in Sinko wetland (Table A7). Eight different fish species were captured, including 4 native species and 4 introduced species. Native fish dominated the catch by number (97% of total fish caught) while introduced fish dominated in biomass (62% of the total weight). Threespine stickleback was the most abundant of the native species (99% catch by number, 81% catch by weight) followed by coho salmon (<1% catch by number, 18% catch by weight). Brown bullhead dominated the introduced species in both catch by number (66%) and biomass (99%). One hundred seven amphibians were caught in Sinko wetland, including 1 pacific tree frog, 44 red-legged frogs, 24 bullfrogs, 16 northwestern salamanders, and 7 rough-skinned newts.

A total of 35 coho salmon were caught in Sinko wetland during the December, February, and March sampling periods. One coho salmon, probably in the 1+ age class (87mm), was captured in December. Twenty coho salmon, probably in the 1+ age class (70-95mm), were captured in February. Fourteen coho salmon, probably in the 1+ age class (109-132mm), were captured in March.

Table A 7. Within-wetland catch at Sinko.

MoYr	Common Name	Family	NatInt	Number	Min_FL	Max_FL	Wt (g)
Dec-04	Largescale sucker	Catostomidae	N	3	61	110	21
Dec-04	Threespined stickleback	Gasterosteidae	N	47	29	66	29
Dec-04	Coho salmon	Salmonidae	N	1	87	87	11
Dec-04	**Total Native**			**51**			**60**
Dec-04	Bluegill	Centrarchidae	I	8	20	28	2
Dec-04	Brown bullhead	Ictaluridae	I	36	35	212	1580
Dec-04	Mosquitofish	Poeciliidae	I	25	24	45	5
Dec-04	**Total Introduced**			**69**			**1588**
	December Total			**120**			**1648**
Feb-05	Threespined stickleback	Gasterosteidae	N	95	40	60	93
Feb-05	Coho salmon	Salmonidae	N	20	70	95	216
Feb-05	**Total Native**			**115**			**309**
Feb-05	Brown bullhead	Ictaluridae	I	1	147	147	43
Feb-05	**Total Introduced**			**1**			**43**
	February Total			**116**			**352**
Mar-05	Threespined stickleback	Gasterosteidae	N	291	39	65	341
Mar-05	Unidentified lamprey	Petromyzontidae	N	1	120	120	3
Mar-05	Coho salmon	Salmonidae	N	14	109	132	375
Mar-05	**Total Native**			**306**			**718**
Mar-05	Pumpkinseed	Centrarchidae	I	2	24	24	0
Mar-05	Mosquitofish	Poeciliidae	I	1	43	43	1
Mar-05	**Total Introduced**			**3**			**1**
	March Total			**309**			**719**
Apr-05	Threespined stickleback	Gasterosteidae	N	2287	15	72	387
Apr-05	**Total Native**			**2287**			**387**
Apr-05	Pumpkinseed	Centrarchidae	I	1	27	27	0
Apr-05	Brown bullhead	Ictaluridae	I	45	85	255	3221
Apr-05	Mosquitofish	Poeciliidae	I	1	30	30	0
Apr-05	**Total Introduced**			**47**			**3221**
	April Total			**2334**			**3608**
Jun-05	Threespined stickleback	Gasterosteidae	N	2198	26	71	1808
Jun-05	**Total Native**			**2198**			**1808**
Jun-05	Bluegill	Centrarchidae	I	6	46	66	20
Jun-05	Brown bullhead	Ictaluridae	I	4	98	260	446
Jun-05	**Total Introduced**			**10**			**466**
	June Total			**2208**			**2274**
	Grand Total			**5087**			**8600**

Sinko data summary 2005

Despite the boards floating out of the water-control structure in early winter, once the riser boards were securely installed Sinko wetland held water 2 to 2.5 feet higher than what it could have without the structure during much of the spring. The outbound trap confirmed fish passage capability through the structure. During the unusually dry period this winter, fish passage opportunity out of Sinko wetland was limited for about one month. After boards were replaced in the water-control in February until the end of March when another heavy rain event brought water levels in the Coquille River up, fish had no passage opportunity out of the wetland. Fish access was restored in late March and access was uninterrupted throughout the remainder of the sampling season. Some coho mortality occurred in the one-way trap during the high water events so we discontinued fishing the trap. Coho that entered the wetland with the high-water event that peaked on March 30, 2005 appeared to leave on the falling limb of the hydrograph; 99% of the coho that were caught exiting the wetland did so during this period. Native threespine stickleback was by far the dominant species in this wetland.

Schrader wetland 2005

Water depths were not recorded at Schrader wetland. Water temperature data were recorded along with dissolved oxygen profiles only (Tables A8 and A9). Dissolved oxygen concentrations were low throughout the winter but above lethal levels.

Table A 8. Surface water temperatures (^{o}C) at Schrader wetland.

12/14/2004 12:00	12.0
2/2/2005 10:10	9.1
3/17/2005 10:30	13.1

Table A 9. Dissolved oxygen (mg/l) and % saturation at Schrader wetland.

	12/14/2004 12:00	2/2/2005 10:10	3/17/2005 10:30
DEPTH (FT)	DO (%sat)	DO (%sat)	DO (%sat)
1.0	4.73 (43.2)	3.26 (27.8)	3.35 (32.0)
2.0	4.01 (37.5)	3.11 (27.0)	2.83 (27.0)
3.0	3.63 (33.1)	1.8 (15.8)	2.76 (26.1)
4.0	3.25 (29.8)		2.67 (25.1)
5.0	0.26 (2.2)		
max depth		3	4
secchi depth		3	>4.1

<u>Schrader wetland fish sampling results 2005</u>

Schrader wetland was sampled December 14, 2004, February 2, and March 17, 2004. Fishes were sampled using 2 box traps and 2 fyke nets. The Oneida Lake trap was not used due to difficulty accessing the wetland. Traps were fished for 24-hours during each sampling period. The wetland was not accessible in April and June and therefore sampling did not take place in the spring.

A total of 441 fish were caught in Schrader wetland (Table A10). Eight different fish species were identified, including 4 native species and 4 introduced species. Native fish dominated the catch in total number of fish (95%) while introduced fish dominated in total biomass (53%). Threespine stickleback was the most abundant of the native fish species (94% catch by number, 83% catch by weight). Brown bullhead was the most abundant of the introduced fish (58% catch by number, 90% catch by weight). Five hundred twenty amphibians were caught in Schrader wetland, including 10 northwestern salamanders, 11 red-legged frog tadpoles, 1 red-legged frog adult, 46 rough-skinned newts, and 452 bullfrog tadpoles.

Seven coho salmon were caught in Schrader wetland. Salmon were caught in each of the 3 sampling periods. Three coho salmon, probably in the 1+ age class (58-82mm), were caught in December. Three coho salmon (85-108mm) were caught in February. One coho salmon (141mm) was caught in March.

Table A 10. Within-wetland catch at Schrader wetland.

MoYr	Common Name	Family	NatInt	Number	Min_FL	Max_FL	Wt (g)
Dec-04	Largescale sucker	Catostomidae	N	1	57	57	2
Dec-04	Speckled dace	Cyprinidae	N	2	37	37	1
Dec-04	Threespined stickleback	Gasterosteidae	N	93	40	65	98
Dec-04	Coho salmon	Salmonidae	N	3	58	82	20
Dec-04	**Total Native**			**99**			**120**
Dec-04	Goldfish	Cyprinidae	I	3	51	86	11
Dec-04	Brown bullhead	Ictaluridae	I	9	72	300	634
Dec-04	**Total Introduced**			**12**			**645**
	December Total			**111**			**765**
Feb-05	Threespined stickleback	Gasterosteidae	N	27	48	64	40
Feb-05	Coho salmon	Salmonidae	N	3	85	108	45
Feb-05	**Total Native**			**30**			**85**
Feb-05	Black crappie	Centrarchidae	I	2	90	130	47
Feb-05	Common carp	Cyprinidae	I	1	66	66	3
Feb-05	**Total Introduced**			**3**			**50**
	February Total			**33**			**135**
Mar-05	Largescale sucker	Catostomidae	N	1	83	83	6
Mar-05	Speckled dace	Cyprinidae	N	15	33	58	15
Mar-05	Threespined stickleback	Gasterosteidae	N	271	50	68	466
Mar-05	Coho salmon	Salmonidae	N	1	141	141	38
Mar-05	**Total Native**			**288**			**524**
Mar-05	Goldfish	Cyprinidae	I	4	72	91	22
Mar-05	Brown bullhead	Ictaluridae	I	5	82	156	107
Mar-05	**Total Introduced**			**9**			**128**
	March Total			**297**			**653**
	Grand Total			**441**			**1552**

Schrader data summary 2005

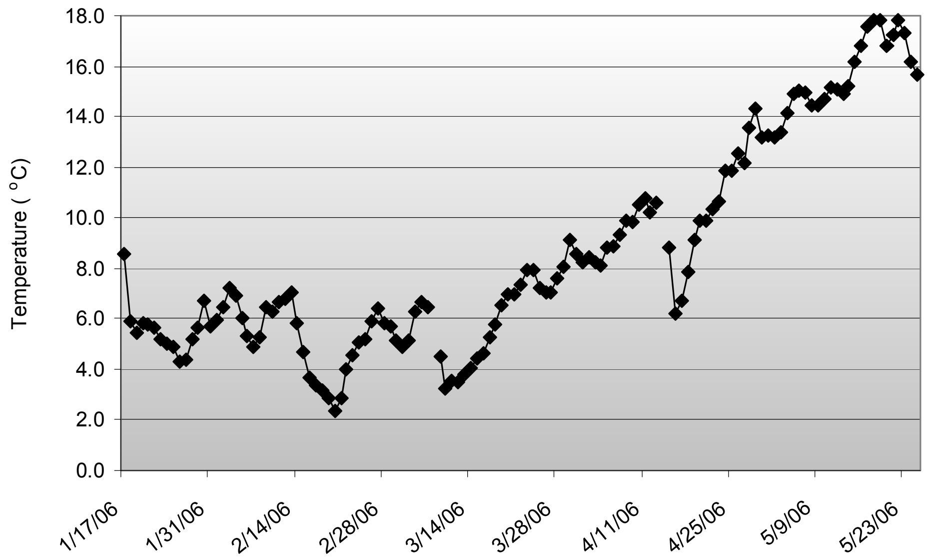
Coho were caught during all sampling periods during the winter at Schrader wetland. Spring sampling was hindered by access through the mud in April and hay in the field in June. At Sinko wetland, coho were caught during the same months as at Schrader. Sampling continued at Sinko wetland through June, though. Coho were caught at Sinko in the one-way trap through May 6, 2005 but none were caught in the spring during wetland sampling in April and June. Fish species present at Schrader that were not caught in Sinko were carp, goldfish and speckled dace. Bluegill, lamprey, mosquitofish, pumpkinseed and Pacific tree frog were present at Sinko but not caught at Schrader. Species common to both were brown bullhead, coho, largescale sucker, threespine stickleback, bullfrog, northwestern salamander, red-legged frog, and rough skinned newt. There were fewer threespine stickleback at Schrader than Sinko wetland either before installation of the water-control structure in 2004 or after the water-control structure was in place in 2005. Standardizing catch to net-days/sampling season, there were 32.6 threespine stickleback (TSS) caught per net at Schrader and 234.2 TSS per net at Sinko in 2005.

Cowan wetland 2006

Cowan temperature and hydrology 2006

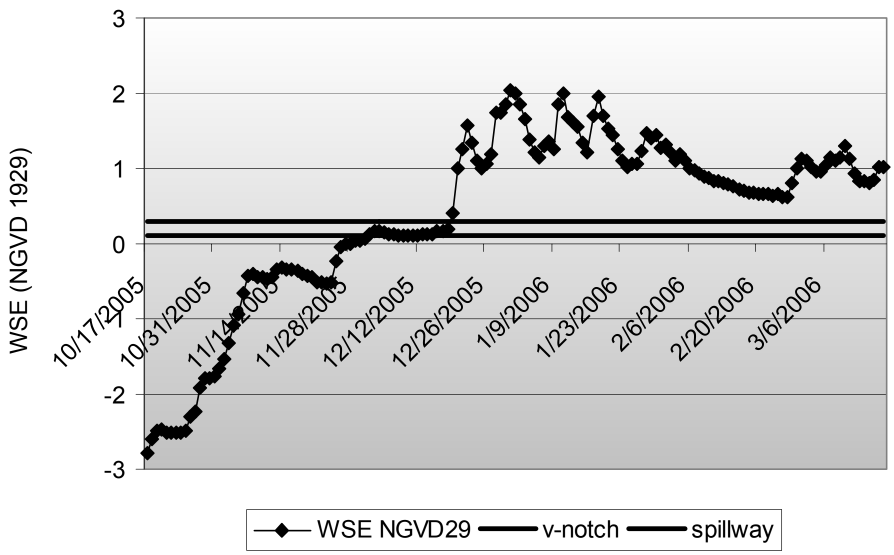
Water temperatures were recorded in Cowan wetland from January 17 to May 25, 2006 (Figure A11). The lowest daily average temperature recorded was 2.4°C on February 20 and the highest daily average temperature recorded was 17.8°C on May 18, 2005.

Figure A 11. Daily average water temperature at Cowan wetland 1/17/06 to 5/25/06.



Cowan wetland began filling with rainwater in late-October. The wetland was full, according to the elevation of the top riser board in the water-control structure, around December 1, 2005 (Figure A12). High water connected Larson Slough and Cowan wetland over the dike beginning December 19, 2005. The water-level logger failed March 19, 2006. The field crew noted that water was not flowing through the fish ladder during the mid-April and late-May wetland sampling trips but it is not known whether there was periodic connectivity during the spring.

Figure A 12. Water-surface elevation in Cowan wetland 10/17/05 to 3/18/06.



Dissolved oxygen concentrations were high (8-9 mg/l) during the January and March sampling trips (Table A11). No dissolved oxygen profiles were recorded during April because the sensor was broken. Dissolved oxygen concentrations were very low (<1mg/l) during the May sampling trip.

Table A 11. Dissolved oxygen concentrations (mg/l) and % saturation at Cowan wetland 2006.

	1/17/2006 11:45	3/8/2006 13:20	5/25/2006 15:10
DEPTH (FT)	DO (%sat)	DO (%sat)	DO (%sat)
1	9.35 (86.8)	8.33 (76.4)	0.75 (7.8)
2	9.38 (85.3)	8.33 (76.5)	0.72 (7.3)
3	9.35 (85.2)	8.31 (76.2)	0.58 (6.4)
4	9.32 (84.5)	8.33 (76.4)	0.49 (5.1)
5	9.25 (84.4)	8.31 (76.4)	0.19 (1.9)
5.5	9.29 (84.7)		
6			0.19
max depth	6	5.5	6.5
secchi depth		3.3	1

<u>Cowan wetland fish sampling results 2006</u>

Sampling fish in Cowan wetland was done on January 17, March 9, April 15 and May 26, 2006. Fishes were sampled with the standard gear (two box traps, two fyke nets, one Oneida Lake trap) except for the May sampling period when the Oneida Lake trap was not used. A total of 38,089 fishes and 3,774 amphibians were caught at Cowan wetland in 2006 (Table A12). The majority of the fish catch (91%) were native threespine stickleback caught in May. Other native fish species included coho salmon (154) and lamprey (3). No introduced fishes were caught.

A total of 3,774 amphibians were caught at Cowan wetland. The majority of the amphibian catch (91%) were red-legged frog tadpoles caught in April and May. Other amphibians included rough-skinned newts (6%), northwestern salamanders, and Pacific tree frogs.

Table A 12. Within-wetland catch at Cowan wetland.

Date	Common Name	Family	NatInt	Number	Min FL (mm)	Max FL (mm)	Weight (g)
1/17/2006	Threespined stickleback	Gasterosteidae	N	160	30	68	157.3
1/17/2006	Coho salmon	Salmonidae	N	37	80	130	665.8
1/17/2006	**Total Native**			**197**			**823.1**
1/17/2006	Long toed salamander	Ambystomatidae	N	1			
1/17/2006	Northwestern salamander	Ambystomatidae	N	61			
1/17/2006	Red-legged frog	Ranidae	N	156			
1/17/2006	Rough-skinned newt	Salamandridae	N	27			
1/17/2006	**Total Amphibian/Other**			**245**			
3/9/2006	Threespined stickleback	Gasterosteidae		829	44	68	1197.8
3/9/2006	Coho salmon	Salmonidae	N	34	107	141	856.8
3/9/2006	**Total Native**			**863**			**2054.6**
3/9/2006	Northwestern salamander	Ambystomatidae	N	11			
3/9/2006	Red-legged frog	Ranidae	N	16			
3/9/2006	Rough-skinned newt	Salamandridae	N	76			
3/9/2006	Unknown frog	Ranidae	?	2			
3/9/2006	**Total Amphibian/Other**			**105**			
4/15/2006	Threespined stickleback	Gasterosteidae	N	2392	34	73	4266
4/15/2006	Unidentified lamprey	Petromyzontidae	N	2	130	140	8.4
4/15/2006	Coho salmon	Salmonidae	N	82	91	156	2952
4/15/2006	**Total Native**			**2476**			**7226.4**
4/15/2006	Northwestern salamander	Ambystomatidae	N	1			
4/15/2006	Pacific tree frog	Hylidae	N	1			
4/15/2006	Red-legged frog	Ranidae	N	994			
4/15/2006	Rough-skinned newt	Salamandridae	N	44			
4/15/2006	**Total Amphibian/Other**			**1040**			
5/26/2006	Threespined stickleback	Gasterosteidae	N	34551	26	69	12765.5
5/26/2006	Unidentified lamprey	Petromyzontidae	N	1	140	140	4.7
5/26/2006	Coho salmon	Salmonidae	N	1	72	72	6.5
5/26/2006	**Total Native**			**34553**			**12776.7**
5/26/2006	Northwestern salamander	Ambystomatidae	N	2			
5/26/2006	Pacific tree frog	Hylidae	N	1			
5/26/2006	Red-legged frog	Ranidae	N	2283			
5/26/2006	Rough-skinned newt	Salamandridae	N	79			
5/26/2006	Unknown salamander		?	19			
5/26/2006	**Total Amphibian/Other**			**2384**			

Cowan data summary 2006

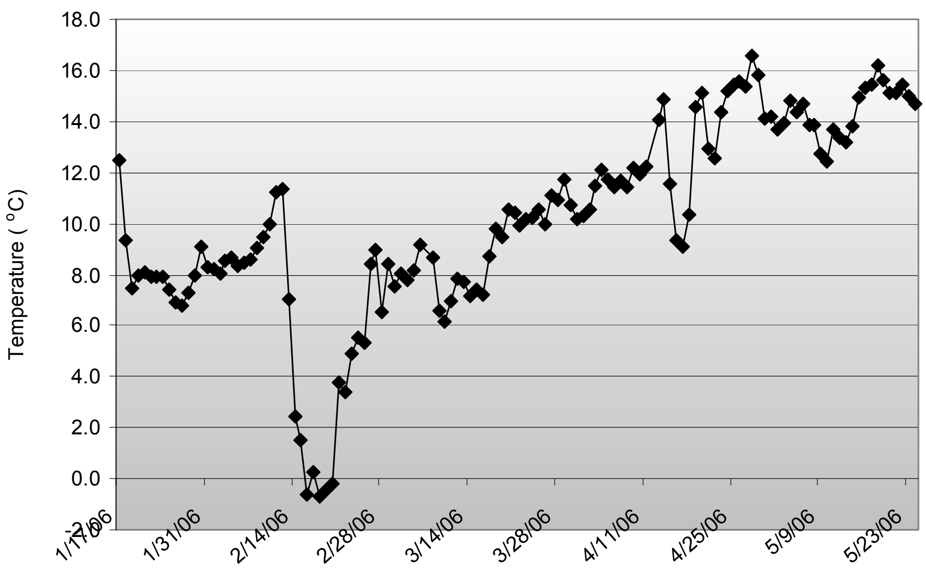
Fish sampling in Cowan wetland has documented habitat use by native fish and amphibian species. Coho salmon were found using the wetland on all four sampling occasions. Water overtopped the dike December 19, 2005. Coho had access into the wetland through the fish ladder or over the dike for most of the winter. Had the pressure transducer continued to function during the spring, we could have better documented whether fish had become stranded during that period or whether water continued to flow through the fish ladder. Coho catch peaked (82 juvenile coho) during the April sampling trip and dropped to one coho in late May. This pattern corresponds with juvenile salmonid outmigration data from two-way traps in wetlands in the Lower Willamette River where the majority of outmigrants are caught in April and May when water temperatures rise sharply and water levels fluctuate with spring run-off (Baker and Miranda 2003, 2004, 2005). While there is no spring run-off in this groundwater-fed, rain-driven system, water levels recede with declining rainfall in the late spring. Water temperatures in Cowan wetland also increased sharply between the April and May sampling periods, 9.8 ^{o}C to 16.4^{o}C average daily temperature, respectively, which may have acted as a signal for coho to depart. Dissolved oxygen levels were very low in late-May (<1mg/l) but threespine stickleback were abundant. Since juvenile coho were caught as late as May when water no longer flowed through the ladder to provide egress, greater attention to management of the water-control structure to provide passage opportunity should be given.

Sinko wetland 2006

<u>Sinko temperature and hydrology 2006</u>

Water temperatures in Sinko wetland were recorded from January 17 to May 24, 2006 (Figure A13). Daily average water temperatures fell below 0^{o}C for three days between February 16 and 20, 2006. The highest recorded daily average water temperature was 16.6^{o}C on April 28, 2006.

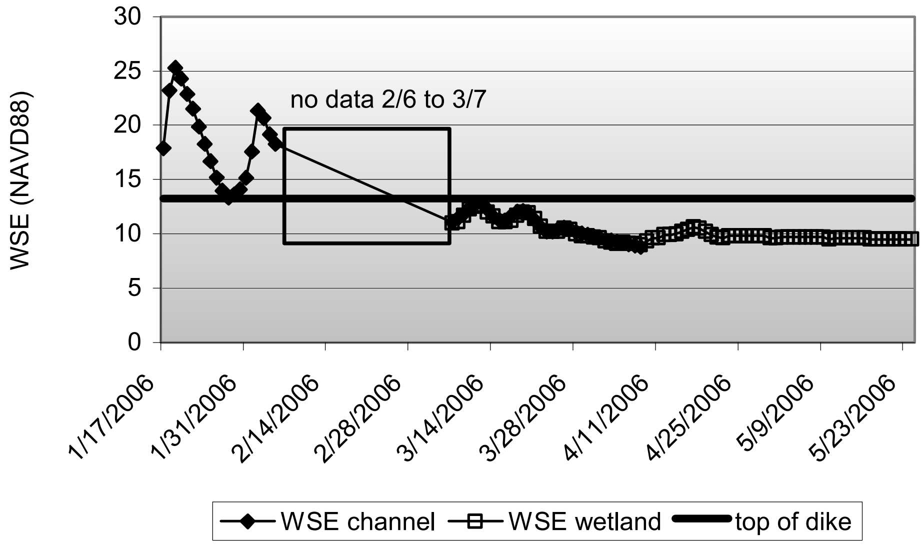
Figure A 13. Daily average water temperature at Sinko wetland 1/17/06 to 5/24/06.



Data from the pressure transducer were recorded January 17 to May 24, 2006 (Figure A14). Water depths were converted to water-surface elevation (NAVD 1988 datum). The pressure transducer in the egress channel failed April 9, 2006. The pressure transducer in the wetland was not functioning initially and was reinstalled March 7, 2006 and ran until May 24, 2006. Water-surface elevations were the same from March 7 until April 8. After that, water in the wetland held at about 10 feet, which was the elevation of the riser board in the water-control structure.

Field notes indicate that water flowed over the riser boards during mid-April wetland sampling but by late May the water level dropped to just below the top riser board preventing fish egress.

Figure A 14. Water-surface elevation at Sinko wetland and in the egress channel 1/17/06 to 5/24/06.



Dissolved oxygen concentrations in Sinko wetland were above 9mg/l in January and March (Table A13). During the March sampling trip water near the surface was supersaturated indicating photosynthesis by phytoplankton. In May, dissolved oxygen concentrations dropped below 1.5mg/l.

Table A 13. Dissolved oxygen (mg/l) and % saturation at Sinko wetland.

	1/18/2006 13:00	3/7/2006 11:45	5/25/2006 12:15
DEPTH (FT)	DO (%sat)	DO (%sat)	DO (%sat)
1	9.74 (87.7)	12.84 (120)	1.38 (13.8)
2	9.74 (87.7)	11.59 (107.3)	0.35 (3.4)
2.5			0.35 (3.5)
3	9.74 (87.7)	10.66 (99.4)	
4	9.74 (87.7)		
5	9.73 (87.6)		
6	9.74 (87.7)		
7	9.73 (87.6)		
8	9.71 (87.5)		
9	9.71 (87.5)		
10	9.61 (87.5)		
10.5	9.58 (87.2)		
max depth	11	3.5	3
secchi depth	1	2	1

Sinko wetland fish sampling results 2006

Standard seasonal wetland sampling of Sinko wetland was done January 18, March 7, April 13, and May 25, 2006. Fishes were sampled using the standard gear (2 box traps, 2 fyke nets). The Oneida Lake trap was only fished in January due to shallow water all other sample periods. During the January sampling trip one of the fyke nets could not be retrieved due to rising water overnight. Traps were fished for 24-hours during each sampling period.

A total of 7,177 fish were caught in Sinko wetland (Table A14). Eight different fish species were captured, including 5 native species and 3 introduced species. Native fish dominated the catch by number (97% of total fish caught) and by biomass (52% of the total weight). Threespine stickleback was the most abundant (6875) of the native species (98% catch by number, 70% catch by weight) followed by coho salmon (<1% catch by number [72 coho], 27% catch by weight). Other native species included lamprey, largescale sucker, and speckled dace. Brown bullhead dominated the introduced species in both catch by number (48%) and biomass (84%). Other introduced species included bluegill and mosquitofish. Six hundred and one amphibians were caught in Sinko wetland and four crawfish. Introduced bullfrog (mostly tadpoles) were the dominant amphibian species (61%) followed by northwestern salamanders (18%), rough-skinned newts (10%), red-legged frogs (6%), and pacific tree frogs (5%).

A total of 72 coho salmon were caught in Sinko wetland during all four sampling periods. In January one coho (101mm fork length) was caught. In March, sizes ranged between 94 and 137mm for 53 coho. In April, ten coho were between 137 and 163mm and one 39mm fry was caught. In May, seven coho ranged between 65 and 85mm.

Table A 14. Within-wetland catch at Sinko wetland.

Date	Common Name	Family	NatInt	Number	Min FL (mm)	Max FL (mm)	Weight (g)
1/18/2006	Speckled dace	Cyprinidae	N	1	40	40	0.7
1/18/2006	Threespined stickleback	Gasterosteidae	N	77	29	66	62.4
1/18/2006	Coho salmon	Salmonidae	N	1	101	101	15.8
1/18/2006	**Total Native**			**79**			**78.9**
1/18/2006	Bluegill	Centrarchidae	I	4	62	130	88.6
1/18/2006	Brown bullhead	Ictaluridae	I	7	51	245	573.2
1/18/2006	Mosquitofish	Poeciliidae	I	1	30	30	0.2
1/18/2006	**Total Introduced**			**12**			**662**
1/18/2006	Northwestern salamander	Ambystomatidae	N	82			
1/18/2006	Red-legged frog	Ranidae	N	16			
1/18/2006	Rough-skinned newt	Salamandridae	N	2			
1/18/2006	Bullfrog	Ranidae	I	1			
1/18/2006	**Total Amphibian/Other**			**101**			
3/7/2006	Largescale sucker	Catostomidae	N	15	54	94	75.5
3/7/2006	Speckled dace	Cyprinidae	N	2	38	45	1.7
3/7/2006	Threespined stickleback	Gasterosteidae	N	1395	38	59	1156.8
3/7/2006	Unidentified lamprey	Petromyzontidae	N	18	80	170	53.7
3/7/2006	Coho salmon	Salmonidae	N	53	90	182	1388.6
3/7/2006	**Total Native**			**1483**			**2676.3**

Table A14 (cont.) Within-wetland catch at Sinko wetland.

Date	Common Name	Family	NatInt	Number	Min FL (mm)	Max FL (mm)	Weight (g)
3/7/2006	Bluegill	Centrarchidae	I	22	27	176	358.1
3/7/2006	Brown bullhead	Ictaluridae	I	11	54	215	510.7
3/7/2006	**Total Introduced**			**33**			**868.8**
3/7/2006	Northwestern salamander	Ambystomatidae	N	24			
3/7/2006	Pacific tree frog	Hylidae	N	7			
3/7/2006	Red-legged frog	Ranidae	N	18			
3/7/2006	Rough-skinned newt	Salamandridae	N	15			
3/7/2006	Bullfrog	Ranidae	I	55			
3/7/2006	**Total Amphibian/Other**			**119**			
4/13/2006	Largescale sucker	Catostomidae	N	3	72	82	14.6
4/13/2006	Speckled dace	Cyprinidae	N	1	44	44	1
4/13/2006	Threespined stickleback	Gasterosteidae	N	337	37	77	556.7
4/13/2006	Unidentified lamprey	Petromyzontidae	N	1	170	170	8.5
4/13/2006	Coho salmon	Salmonidae	N	11	39	163	431.2
4/13/2006	**Total Native**			**353**			**1012**
4/13/2006	Bluegill	Centrarchidae	I	4	49	140	94.7
4/13/2006	Brown bullhead	Ictaluridae	I	17	44	237	845.3
4/13/2006	Mosquitofish	Poeciliidae	I	43	26	55	18.2
4/13/2006	**Total Introduced**			**64**			**958.2**
4/13/2006	Northwestern salamander	Ambystomatidae	N	2			
4/13/2006	Pacific tree frog	Hylidae	N	26			
4/13/2006	Red-legged frog	Ranidae	N	2			
4/13/2006	Rough-skinned newt	Salamandridae	N	19			
4/13/2006	Bullfrog	Ranidae	I	153			
4/13/2006	**Total Amphibian/Other**			**202**			
5/25/2006	Largescale sucker	Catostomidae	N	1	65	65	3
5/25/2006	Threespined stickleback	Gasterosteidae	N	5066	18	73	3107.8
5/25/2006	Coho salmon	Salmonidae	N	7	65	85	49.8
5/25/2006	**Total Native**			**5074**			**3160.6**
5/25/2006	Bluegill	Centrarchidae	I	12	62	160	444.5
5/25/2006	Brown bullhead	Ictaluridae	I	56	45	241	3275.9
5/25/2006	Mosquitofish	Poeciliidae	I	11	29	47	6.3
5/25/2006	**Total Introduced**			**79**			**3726.7**
5/25/2006	Red-legged frog	Ranidae	N	1			
5/25/2006	Rough-skinned newt	Salamandridae	N	23			
5/25/2006	Bullfrog	Ranidae	I	155			
5/25/2006	Crawfish	Palinuridae	?	4			
5/25/2006	**Total Amphibian/Other**			**183**			

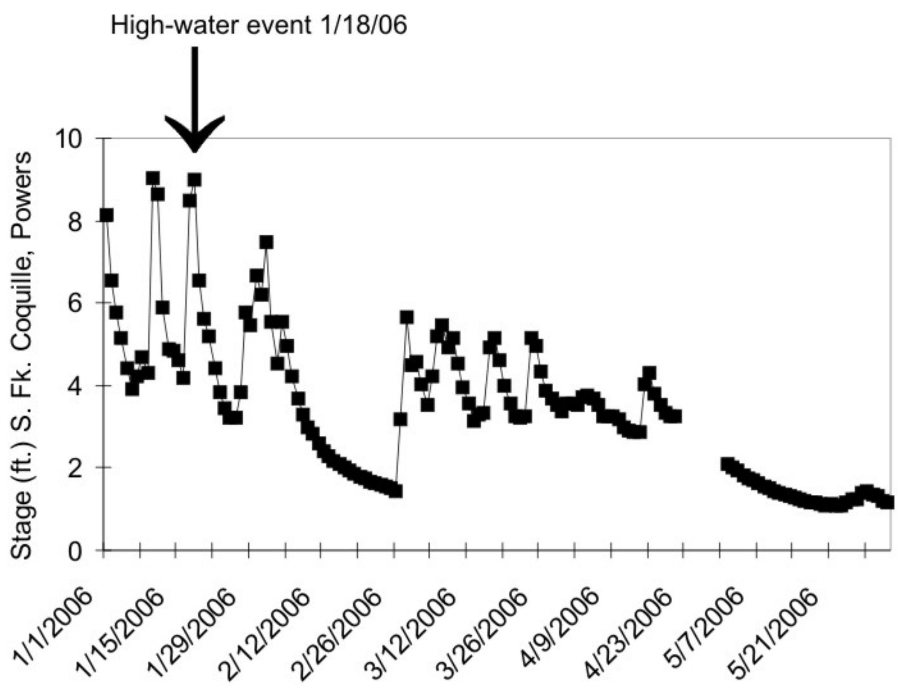
Sinko data summary 2006

Native threespine stickleback again dominated the catch at Sinko wetland. More juvenile coho were caught in the wetland sampling at Sinko wetland in 2006 compared with 2005, 72 and 35, respectively. This is probably due to a more typical wet winter in 2006 than 2005. Coho were present from January through late-May, even when dissolved oxygen levels were low (<1.5mg/l) and water temperatures became warm (reaching 18°C). Fish had access out of the wetland up until the last sampling occasion on May 25, 2006 when the water level dropped below the top riser board. With dissolved oxygen levels so low in late May and egress out of the wetland prevented there is concern that if water levels remained low in the wetland and passage opportunity not restored that coho had become stranded where poor water quality conditions threatened survival. It is possible that fish may find areas of higher oxygen concentrations and lower water temperatures near a seep. During the late spring extra effort needs to be extended to assure that passage opportunity is available for coho to escape deteriorating water quality conditions in the wetland.

Schrader wetland 2006

Fish passage opportunity at Schrader wetland is not as easy to determine as Cowan and Sinko wetlands. Schrader wetland has not been surveyed so the elevation of the point at which limits the connection between the river and wetland is not known and cannot be compared with the water-surface elevation of the South Fork Coquille River. There is a strip of trees and brush along the bank of the river limiting visibility. We know that the surface-water is intermittently connected to the river during the winter and spring. We only know when there is a connection during periods of flooding when it is obvious. There was a high-water event that connected the river and floodplain January 18, 2006 the day before wetland sampling began at Schrader wetland (Figure A15).

Figure A 15. Stage of the South Fork Coquille River at Powers, about 20miles upstream of Schrader wetland.



Data for dissolved oxygen and temperature is limited. During the March sampling period dissolved oxygen concentration in Schrader wetland was greater than 8mg/l (Table A15) and the surface water temperature was 10.5°C.

Table A 15. Dissolved oxygen (mg/l) and % saturation of Schrader wetland.

	3/8/2006 10:00
DEPTH (FT)	DO (%sat)
1	8.43 (75.6)
2	8.45 (75.9)
2.5	8.42 (75.3)
max depth	3
secchi depth	1

Schrader wetland fish sampling results 2006

Schrader wetland was sampled Janary 19, March 8, and April 14, 2006. Fishes were sampled using 2 box traps and 2 fyke nets, except during January when only one fyke net was used. Traps were fished for 24-hours during each sampling period. Access to the wetland was not permitted in late-May due to hay in the field that must be crossed before arriving at the wetland.

A total of 515 fish were caught in Schrader wetland (Table A16). Eight different fish species were identified, including 4 native species and 4 introduced species. Native fish dominated the catch in total number of fish (96%) while introduced fish dominated in total biomass (57%). Threespine stickleback was the most abundant (440) of the native fish species (89% catch by number, 47% catch by weight). Other native fishes included coho (28), largescale sucker (19), speckled dace (7). Brown bullhead was the most abundant (11) of the introduced fish (52% catch by number, 91% catch by weight). Other introduced fishes included black crappie (7), goldfish (2) and largemouth bass (1). Five hundred fifty-four amphibians were caught in Schrader wetland, including one northwestern salamander, 5 red-legged frog adults, 81 rough-skinned newts, and 467 bullfrog tadpoles.

Twenty-eight juvenile coho salmon were caught in Schrader wetland. Salmon were caught during each of the three sampling trips. Eight coho between 80 and 121mm fork length were caught during January. In March, 17 coho (109-130mm) were caught and three coho (134-161mm) were caught mid-April.

Table A 16. Within-wetland catch at Schrader wetland.

Date Lift	Common Name	Family	NatInt	Number	Min FL (mm)	Max FL (mm)	Weight (g)
1/19/2006	Speckled dace	Cyprinidae	N	2	35	38	1.1
1/19/2006	Threespined stickleback	Gasterosteidae	N	9	30	63	7.7
1/19/2006	Coho salmon	Salmonidae	N	8	80	121	126.1
1/19/2006	**Total Native**			**19**			**134.9**
3/8/2006	Largescale sucker	Catostomidae	N	12	47	74	33.9
3/8/2006	Speckled dace	Cyprinidae	N	1	41	41	0.8
3/8/2006	Threespined stickleback	Gasterosteidae	N	196	41	68	242.4
3/8/2006	Coho salmon	Salmonidae	N	17	109	130	416.6
3/8/2006	**Total Native**			**226**			**693.7**
3/8/2006	Goldfish	Cyprinidae	I	2	109	119	30.3
3/8/2006	Brown bullhead	Ictaluridae	I	5	165	262	977.1
3/8/2006	**Total Introduced**			**7**			**1007.4**
3/8/2006	Northwestern salamander	Ambystomatidae	N	1			
3/8/2006	Red-legged frog	Ranidae	N	5			
3/8/2006	Rough-skinned newt	Salamandridae	N	7			
3/8/2006	Bullfrog	Ranidae	I	28			
3/8/2006	**Total Amphibian/Other**			**41**			
4/14/2006	Largescale sucker	Catostomidae	N	7	52	119	35.3
4/14/2006	Speckled dace	Cyprinidae	N	4	35	58	5.6
4/14/2006	Threespined stickleback	Gasterosteidae	N	235	53	69	416.3
4/14/2006	Coho salmon	Salmonidae	N	3	134	161	123.2
4/14/2006	**Total Native**			**249**			**580.4**
4/14/2006	Black crappie	Centrarchidae	I	7	72	115	99.3
4/14/2006	Largemouth bass	Centrarchidae	I	1	130	130	28.5
4/14/2006	Brown bullhead	Ictaluridae	I	6	180	250	714.5
4/14/2006	**Total Introduced**			**14**			**842.3**
4/14/2006	Rough-skinned newt	Salamandridae	N	74			
4/14/2006	Bullfrog	Ranidae	I	439			
4/14/2006	**Total Amphibian/Other**			**513**			

Schrader data summary 2006

Catch of fish and amphibians at Schrader wetland was very similar in 2006 as they were in 2005. The same four species of native fishes were caught. Threespine stickleback were the most abundant fish species. Three of the four introduced species were the same, except largemouth bass were not caught in 2005 but instead one carp (66mm) was caught in 2005. The carp and goldfish ranged in size from 51 to 91mm in 2005. The only distinguishing characteristic is that carp have small mouth barbels and goldfish do not. Ecologically, they are very similar (Wydowski and Whitney 2005). In 2005, seven juvenile coho were caught in Schrader wetland and 28 were caught in 2006. The same species of amphibian were caught both years. Bullfrog tadpoles were most the abundant species.

Comparing Sinko and Schrader wetlands in 2006, threespine stickleback were the most abundant fish species in the catch. Common species to both wetlands also included coho, largescale sucker, speckled dace, and brown bullhead. Sinko wetland had lamprey, bluegill and mosquitofish, which were not present in the catch at Schrader wetland. Schrader wetland had black crappie, goldfish, and largemouth bass, which were not present in the catch at Sinko wetland. Standardizing catch to net-days/sampling season, there were 40 threespine stickleback (TSS) caught per net at Schrader wetland in 2006 and 429.7 TSS/net at Sinko wetland in 2006. In 2005, there were 32.6 and 234.2 TSS/net at Schrader and Sinko wetlands, respectively. Comparing coho catch in the same manner there were 2.5 coho/net at Schrader wetland and 4.5 coho/net in Sinko wetland in 2006. In 2005, there were 0.6 and 1.7 coho/net at Schrader and Sinko wetlands, respectively. For both threespine stickleback and coho, we had greater catch in Sinko wetland for two years of post-project monitoring than our reference site, Schrader wetland. This may be due to more constant water levels at Sinko wetland and perhaps a more steady and predictable egress to the Coquille River.