Fish Monitoring at Flood Plain Wetland Restoration Sites in the Pacific Northwest U.S.A.

2003 Annual Report

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This document is a draft, not for citation. All sections are open for feedback, editing, and revision. This is preliminary information, part of an ongoing effort.

Executive Summary

This report summarizes fish monitoring data collected in seasonal, floodplain wetlands in Oregon and Washington in water-year 2003. This work is a continuing effort to document native and introduced fish use of this habitat, including Pacific salmon, and to confirm fish-passage capability through water-control structures used for wetland restoration and enhancement projects.

Juvenile salmon were found to use floodplain wetlands throughout the winter and spring and leave with spring run-off. A pattern of decreasing proportion of native to introduced fishes from west to east was distinguished. Fish-passage capability was demonstrated at three types of water-control structures. Fish had continuous passage opportunity out of wetlands with a positive water source but passage was limited where there were no streams feeding the wetlands.

Water-control structures were shown to increase water-surface elevation, thus surface area of floodplain wetlands, provide productive over-winter habitat for juvenile salmon as well as many other native fishes and animals, and provide a means for managers to control invasive plants like the reed canarygrass and encourage a greater diversity of native plant species in the wetlands.

Acknowlegements

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Introduction

This report summarizes the second year of data collected at various sites across Oregon and Washington to evaluate fish use of floodplain wetlands and fish passage capability through various types of water-control structures at sites with different fish assemblages and hydrologic regimes.

This annual report for water-year (WY) 2003 should be regarded as a brief update, while a more complete analysis of the data will be carried out at the conclusion of the third year, during the summer of 2004. After the WY 2004 sampling season is complete, data from all sites during the past three years will be summarized showing patterns of fish use of floodplain wetlands across the region seasonally, fish passage capability through various water-control structures, patterns of salmon movement in and out of wetlands with respect to water levels and temperatures, and examples of salmonid growth rates and residence times in wetlands.

A complete review of the Ducks Unlimited Fish Monitoring Program will commence with the completion of the 2004 annual report in which the program will likely move into the next phase which will involve greater quantification of benefits that restored and managed wetlands provide to salmonids.

For a discussion on the approach used by Ducks Unlimited to mimic the historic hydrology and restore ecological function to wetlands and a description of water-control structures used at the study sites in this annual report, the reader should refer to the 2002 annual report (Baker and Miranda 2003a,b).

In WY 2003, there were some changes to sites that were selected for monitoring fish use of wetlands and passage capability through water-control structures. General information and objectives about sites sampled in 2002 and 2003 are listed in tables 1 and 2. On the Washington coast, Ducks Unlimited began collecting data at sites on the lower Chehalis River in 2002 before turning that effort over in 2003 to Julie Henning, Washington Department of Fish and Wildlife (WDFW) fish biologist. Ms. Henning is using those sites for her master's thesis. In the Lower Columbia River ,a site was added on the East Fork of the Lewis River. On the Columbia Slough near Portland, Smith and Bybee Lakes were added, the Columbia Slough site was discontinued but the North Columbia Slough sampling site was continued. In the Multnomah Channel, a site just upstream from Multnomah South, referred to as McCarthy, was added. The Tualatin River site was not sampled because water from the river never over-topped the structure. Thus, it was believed that fish never had access into the wetland. In eastern Washington, the Satus Wildlife Refuge site was discontinued. In eastern Oregon, the Ladd Marsh Wildlife area was added.

Project Objectives

The goal of this work is to document floodplain wetland habitat use by salmon and other native and introduced fishes and amphibians; document fish usage patterns of floodplain wetlands across the northwest; and to confirm passage capability of salmon through various types of water control structures.

To accomplish this goal, the following key questions that have been identified:

<u>Habitat Usage</u>

Q1: What is the usage of floodplain wetlands by juvenile salmonids?

- Seasonal use patterns
- Species, age/size classes
- Hatchery and wild salmonids

Q2: What is the usage of floodplain wetlands by native fishes relative to introduced fishes?

- Seasonal use patterns
- Native and introduced fishes as potential predators of salmonids

Q3: What are the characteristics of floodplain wetland habitat that may explain fish use patterns?

- Temperature
- Hydrology
- Season with respect to life-history stage of salmonids
- Food availability

<u>Passage Capability</u>

Q4: What is the fish passage capability through water-control structures?

- Flow characteristics over structures
    - duration of flow through season
    - passage with respect to flow
- Passage limitation
    - absolute or restricted for a period (delay/stranding)

Table 1. Site biography.

Site	Location	Ecoregion	Latitude/Longitude	WY Sampled
Lewis/Porter Pt.	Willapa Bay	OR/WA Coast	46° 22' 30.24" N, 123° 58' 34.32" W	2002, 2003
Greenhead/Hoxit	Chehalis River	OR/WA Coast	46° 58' 19.61" N, 123° 33' 55.16" W	2002, 2003
Ruby Lake	Sauvie Island	Upper CR* Estuary	45° 49' 35.09" N, 122° 58' 9.39" W	2002, 2003
Wigeon Lake	Sauvie Island	Upper CR Estuary	45° 49' 50.85" N, 122° 47' 58.97" W	2002, 2003
Multnomah North	Multnomah Channel	Upper CR Estuary	45° 41' 22.82" N, 122° 52' 6.93" W	2002, 2003
Multnomah South	Multnomah Channel	Upper CR Estuary	45° 40' 18.52" N, 122° 51' 54.23" W	2002, 2003
McCarthy	Multnomah Channel	Upper CR Estuary	45° 39' 27.25" N, 122° 50' 54.65" W	-----, 2003
Columbia Slough	Columbia Slough	Upper CR Estuary	45° 38' 36.54" N, 122° 46' 2.14" W	2002, 2003
Smith and Bybee	Columbia Slough	Upper CR Estuary	45° 36' 54.09" N, 122° 44' 32.94" W	-----, 2003
LaCenter	East Fork Lewis River	Upper CR Estuary	45° 51' 31.65" N, 122° 40' 11.38" W	-----, 2003
Tualatin NWR	Tualatin River	Willamette River	45° 23' 41.36" N, 122° 49' 23.6" W	2002
Satus W.A.	Yakima River	Eastern OR/WA	46° 21' 34.62" N, 120° 12' 57.7" W	2002
Ladd Marsh W.A.	Grande Ronde River	Eastern OR/WA	45° 15' 5.19" N, 117° 57' 13.62" W	-----, 2003

*CR=Columbia River

Table 2. Site objectives.

Site	Objectives
Lewis/Porter Point	fish passage through pool-weir-chute
Greenhead/Hoxit	fish passage through half-round riser;
Ruby Lake	fish passage through full-round riser; seasonal fish movement
Wigeon Lake	control site 2002; fish passage through full-round riser 2003; seasonal fish movement
Multnomah North	control site 2002; fish passage through half-round riser 2003; seasonal fish movement
Multnomah South	limited sampling 2002; fish passage through sloping-weir-fishway 2003
McCarthy	control site 2003; proposed site for pool-weir-chute
Columbia Slough	collect pre-project data, reference site for Smith/Bybee
Smith and Bybee	collect pre-project data
LaCenter	control site 2003; proposed site for passive/active restoration comparison
Tualatin NWR	fish passage through half-round riser
Satus W.A.	fish passage through multiple half-round risers; salmon use and movement
Ladd Marsh W.A.	fish passage through pool-weir-chute; fish movement

Figure 1. Vicinity map of study sites in 2002 and 2003.

Methods

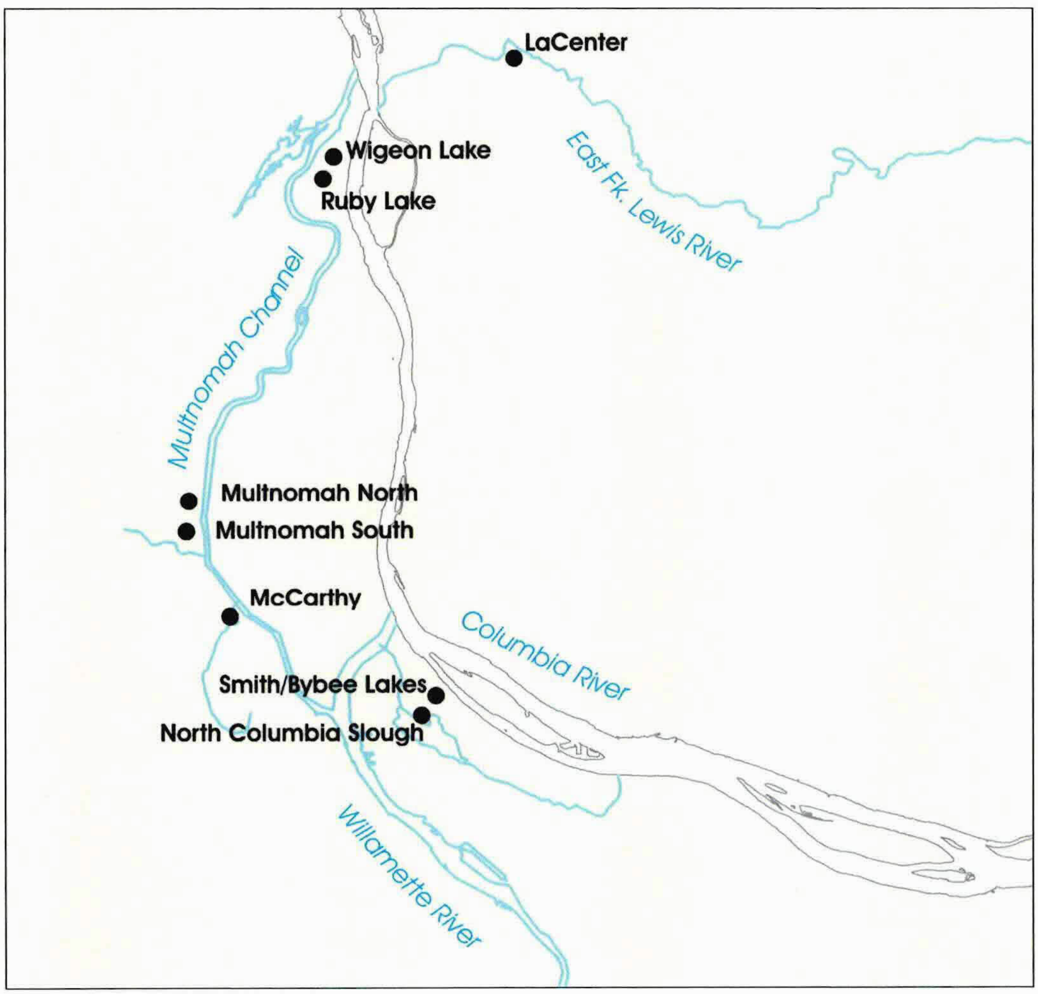
Methods for sampling fishes were the same as in 2002 (see Baker and Miranda 2003a,b for more detail). Passive trap nets were used to sample fishes within wetlands periodically in the winter through spring, referred to as standard seasonal wetland sampling (SSWS). Overnight sets were picked the following morning and fishes were identified, measured and returned to the water body from which they were captured. Salmonids at Ruby and Wigeon Lakes, Multnomah North and McCarthy were tagged with passive integrative transponders (PIT). Two-way vertical slot traps were fished from November 22, 2002 through July 8, 2003 at three sites on the Lower Willamette River and at Ladd Marsh from April 2 to June 30, 2003. Fishes were handled in the same manner as the SSWS.

Results and Discussion

Lower Willamette River/Upper Columbia River Estuary Sites

There were eight sites sampled during the 2003 season in the Lower Willamette River; including sites on Sauvie Island, on the west bank of Multnomah Channel; the Columbia Slough; and near the mouth of the Lewis River (Figure 2).

Figure 2. Vicinity Map for sites in the Lower Willamette River/Upper Columbia River Estuary.



Ruby Lake

Ruby Lake is a seasonal wetland on the north end of Sauvie Island (Figure 3). To get to Ruby Lake from Multnomah Channel, fishes must travel 1.1 miles up Cunningham Slough. Fishes can access the wetland from two channels off of Cunningham Slough; a perennial channel from Cunningham Slough to Ruby Lake on the east side or an intermittent channel on the northwest corner of Ruby Lake when the water surface elevation in Cunningham Slough is 5.2 feet NGVD 1929 or higher (Figure 4,5). There is no positive source of water into Ruby Lake, only rainwater and surface and groundwater flow as determined by low-relief topography.

Figure 3. Vicinity Map for Ruby and Wigeon Lakes.

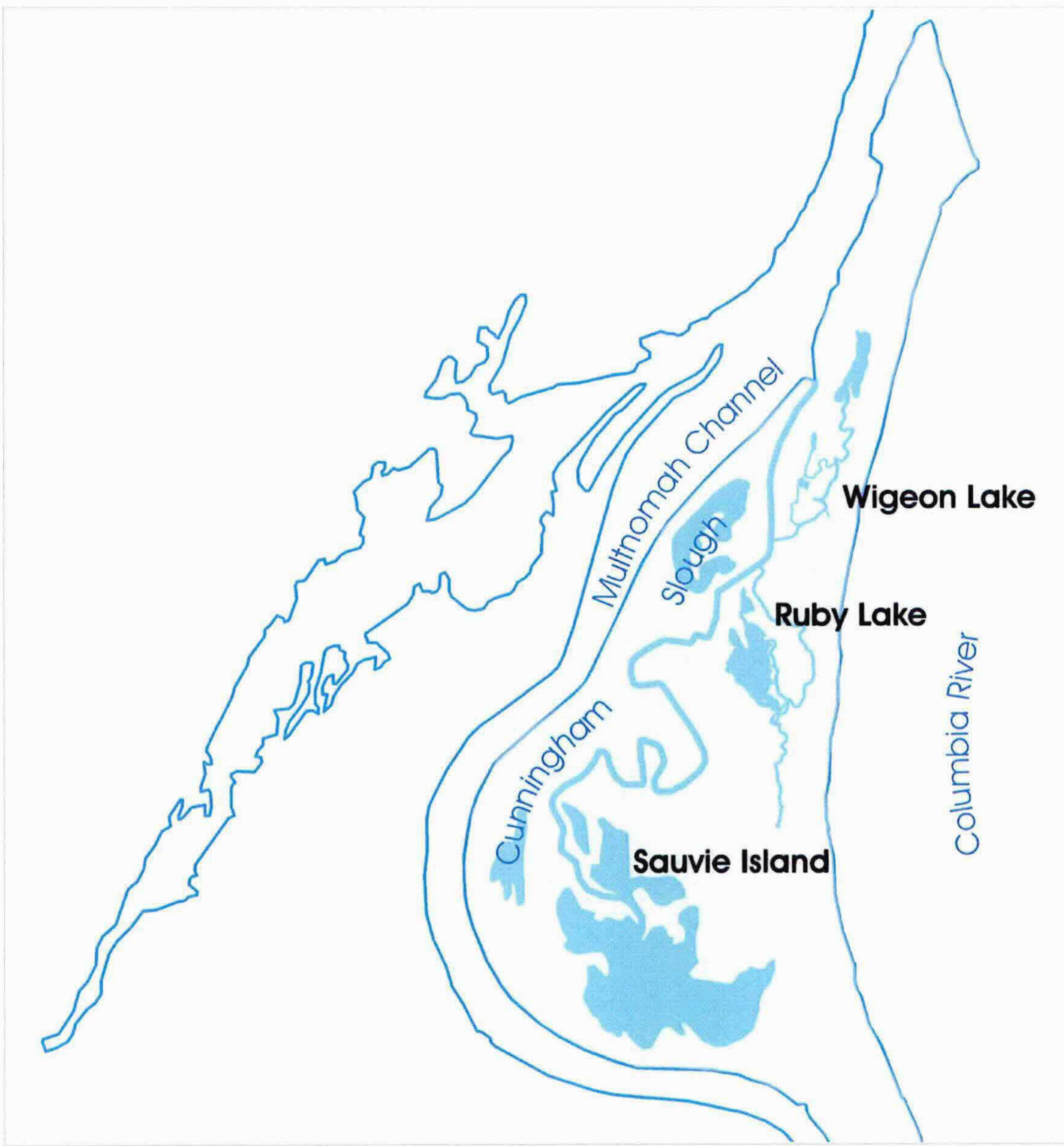
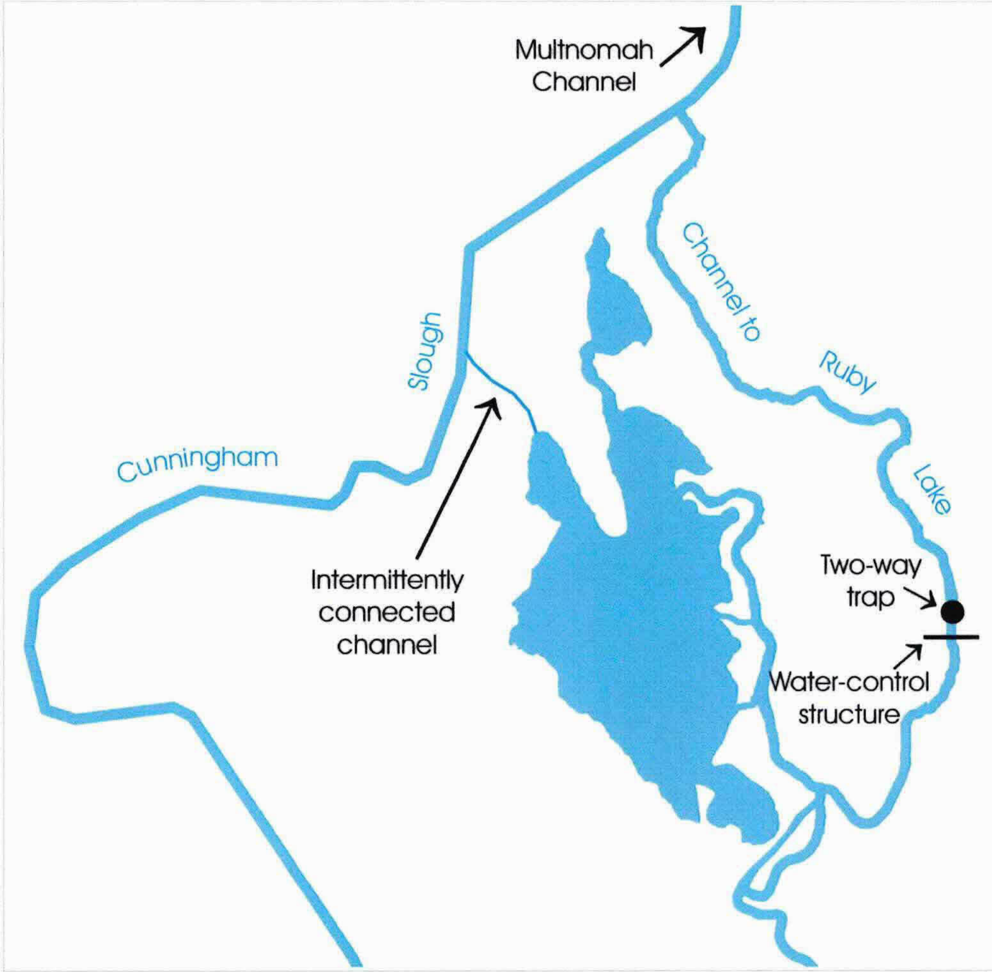


Figure 4. Vicinity map of Ruby Lake.



Ruby Lake temperature and hydrology

Water temperature data were recorded on an hourly basis about two feet below the surface on the wetland side of the water-control structure from November 27, 2002 to July 8, 2003. Figure 5 shows the seven-day average maximum temperature and seven-day average stage in the Columbia River at Vancouver for that period. The Oregon state water quality temperature standard is exceeded when that the seven-day average maximum temperature exceeds 20°C (68°F) for waters of the Columbia River or its associated sloughs and channels (OAR 340-041-0006(54)*ii*). This standard was exceeded May 27, 2003 according to data taken near the surface at Ruby Lake.

Staff-gage data were recorded throughout the period that the two-way trap was fished. These data were related to the USGS stage data for the Columbia River at Vancouver, Washington, which is recorded at 15-minute intervals. A linear regression analysis was done and an equation derived to relate the data sets (r^2=0.76). The equation was used to translate the data from the USGS gage to water-surface elevation data at Ruby Lake (Figure 6). By comparing water-surface elevation to features of the control structure and landscape, a frequency of fish-passage opportunity can be estimated. Between November 22, 2002 and July 8, 2003 water flowed over the top of the dike, the riser board, the top of the two-way trap, and through the egress channel 1.0%, 3.4%, 14.4% and 54.3% of the time, respectively.

Equation 1: μ {RLriver | USGS} = -.0235 + USGS*(0.72)

Figure 5. Seven day average maximum temperature at Ruby Lake and stage, WY 2003.

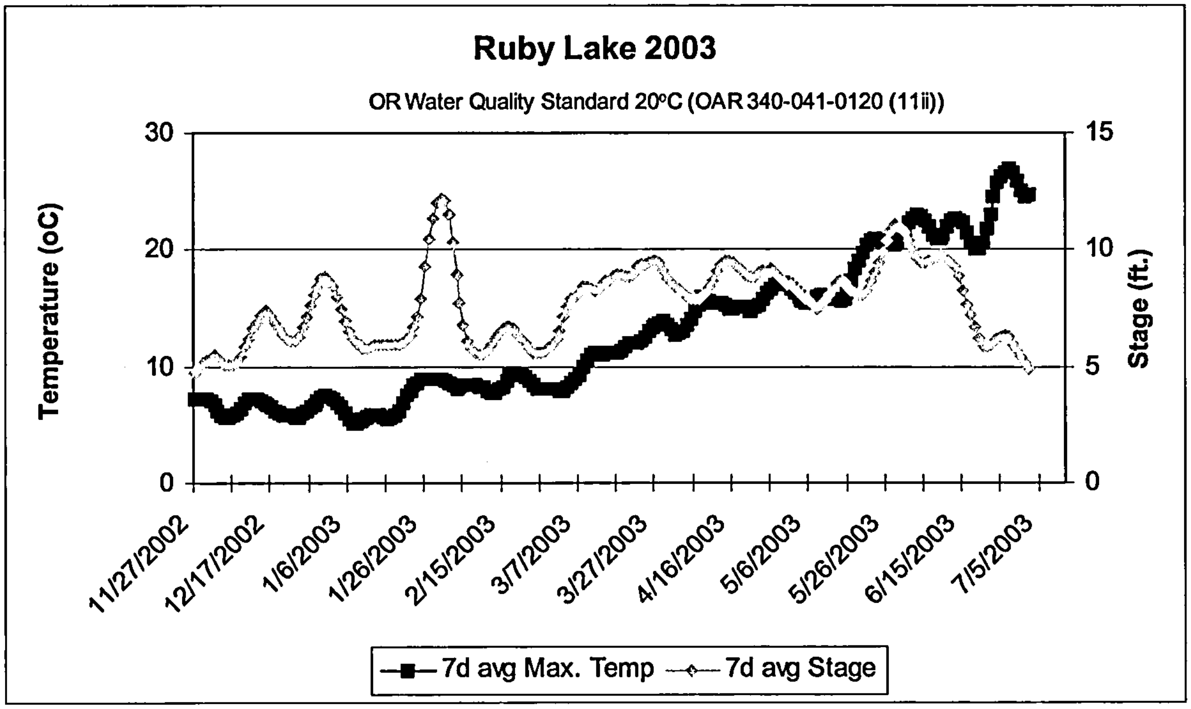
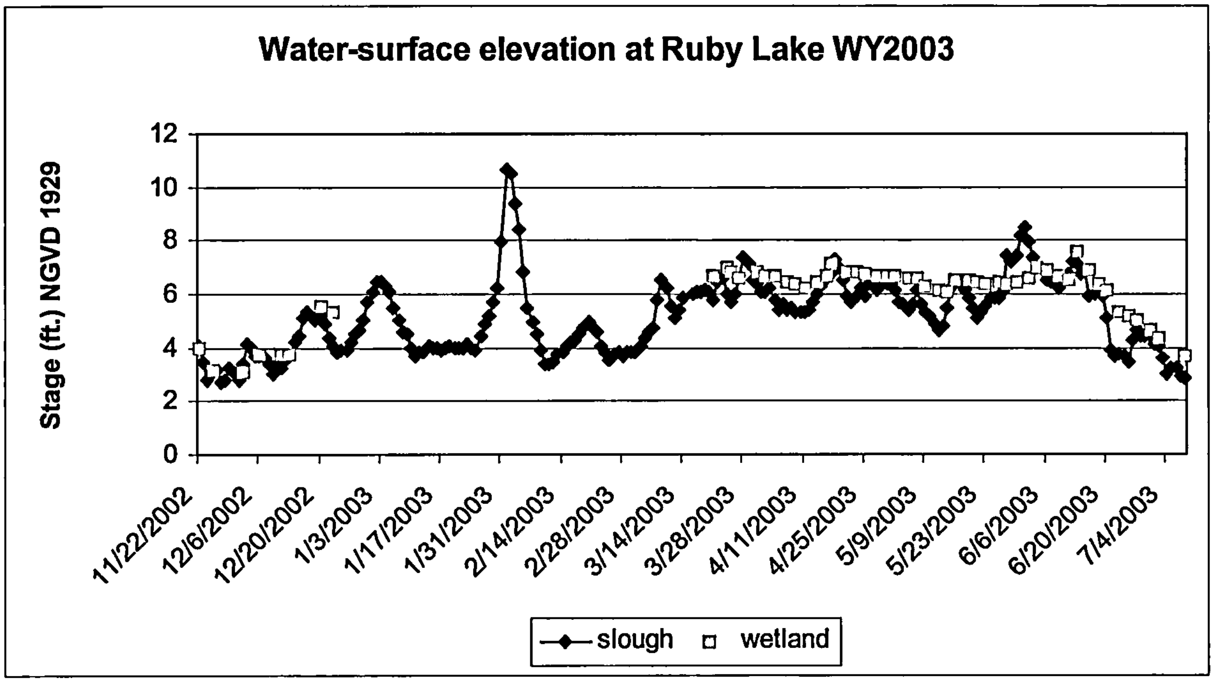


Figure 6. Comparison of water-surface elevation in wetland and slough at Ruby Lake*.



*Dike 9.8 ft. Riser 8.9 ft. (11/22 to 6/11) Riser 6.4 ft. (6/12 to 7/8) Trap 6.6 ft. Egress 5.2 ft.

Water-surface elevation at Ruby Lake was held at a slightly higher level in WY 2003 than if there were no structure (Figure 6). Water in Ruby and Wigeon Lakes were not held at their maximum possibly due to debris lodged in the reverse tide-gate, which let water through the structure. This may have increased fish-passage opportunity if the gap in the reverse tide-gate flap was large enough for fishes to swim through. Fishes did not have passage opportunity over the riser boards as the water level in the wetland was below the boards. This is of little concern with regards to fishes at Ruby Lake because of the frequency of passage opportunity through the egress channel.

Ruby Lake two-way trap results

The two-way trap was fished from November 22, 2002 to July 8, 2003. There were 4,617 fish caught inbound and 3,258 fish caught outbound during this period. Eighty percent of the fish were caught during the winter (Figure 7). Figure 7 summarizes the catch on a weekly basis and shows that there were a greater abundance overall of introduced fish species. Comparing two-way trap catch to the stage in Cunningham Slough, just below the water-control structure, one can see a relationship between catch and the hydrograph (Figure 6), especially the peak in late-January/early February. The trap was overtopped 14.4% of the time, whenever the stage was greater than 6.6 ft NGVD 1929. This is reflected in figure 7, which shows no data during those times.

The most abundant native species in the two-way trap catch was the threespine stickleback (*Gasterosteus aculeatus*) (Tables 4 and 5). The most abundant introduced species in the two-way trap catch was the black crappie (*Pomoxis nigromaculatus*), common carp (*Cyprinus carpio*), brown bullhead (*Ameiurus nebulosus*), and the yellow perch (*Perca flavescens*).

Table 3. Two-way trap catch (% number and biomass) at Ruby Lake WY2003.

			Winter		Spring	
IN	Species		% #	% biomass	% #	% biomass
(4617)	Native (752)	TSS	10.4	1.7	11.3	1.0
		RSS	3.3	3.1	11.1	6.8
	Introduced (3865)	BLC	52.8	31.7	29.6	59.3
		CAP	18.4	21.6	14.3	13.3
		BRB	3.3	24.1	28.9	59.3
OUT (3258)	Native (953)	TSS	27.5	6.6	14.9	2.1
		RSS	1.0	1.2	12.7	9.4
	Introduced (2305)	BLC	51.7	46.4	33.2	27.2
		CAP	5.7	12.3	4.7	3.6
		BRB	1.4	7.7	19.1	45.2
		YEP	10.5	17.8	10.9	6.9

TSS (threespine stickleback); RSS (redside shiner); BLC (black crappie); CAP (carp); BRB (brown bullhead); YEP (yellow perch)

Three coho salmon (*Oncorhynchus kisutch*) were caught in the inbound trap at Ruby Lake from 12/13/02 to 1/15/03. These coho were between 85 and 109mm. One coho salmon was caught in the outbound trap on 11/25/02 and was 103mm. These fish could have entered or left the wetland, bypassing the two-way traps by the egress channel or during the time the trap was overtopped.

Figure 7. Catch (abundance) summarized by week in two-way traps at Ruby Lake, WY 2003.

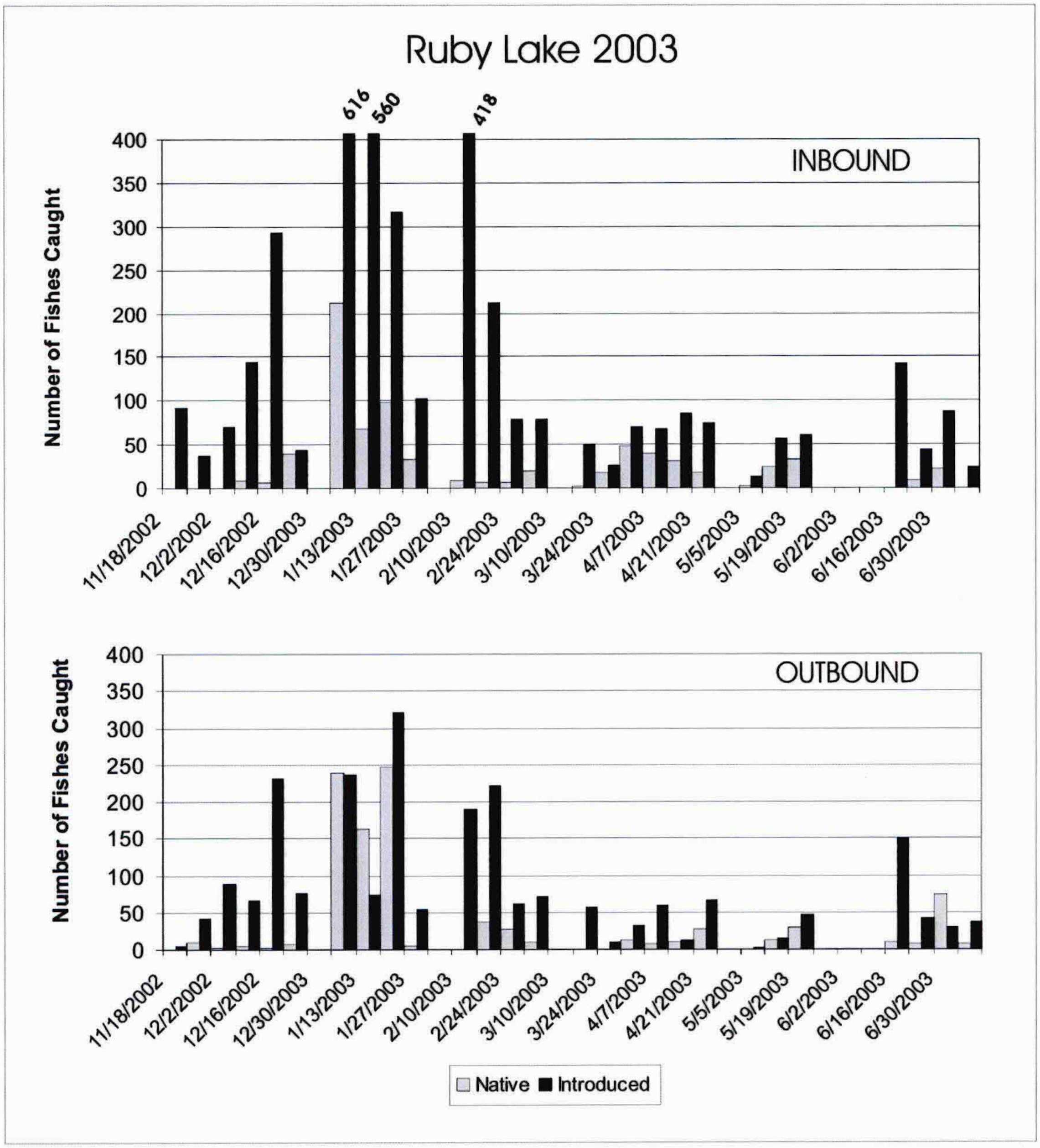


Table 4. Ruby Lake two-way trap data, WY 2003 inbound.

Direction	Season	Species	Nat/Intro	Number	% #	Weight (g)	% wt.
IN	Winter	black crappie	I	1968	52.8	9024.2	31.7
IN	Winter	carp	I	684	18.4	6145.8	21.6
IN	Winter	threespine stickleback	N	388	10.4	493.3	1.7
IN	Winter	yellow perch	I	311	8.4	2630.9	9.2
IN	Winter	brown bullhead	I	124	3.3	6879.1	24.1
IN	Winter	redside shiner	N	124	3.3	884.3	3.1
IN	Winter	banded killifish	I	48	1.3	330.3	1.2
IN	Winter	prickly sculpin	N	31	0.8	610.6	2.1
IN	Winter	oriental weatherfish	I	13	0.3	612.6	2.2
IN	Winter	largemouth bass	I	10	0.3	349.4	1.2
IN	Winter	white crappie	I	9	0.2	222.4	0.8
IN	Winter	bluegill	I	5	0.1	104.7	0.4
IN	Winter	northern pikeminnow	N	5	0.1	155.3	0.5
IN	Winter	coho salmon	N	3	0.1	43.6	0.2
IN	Winter	peamouth	N	1	0.0	6.5	0.0
IN	**Winter**	**IN WINTER TOTAL**		3724		**28493**	
IN	Spring	brown bullhead	I	258	28.9	7585.6	59.3
IN	Spring	black crappie	I	223	25.0	1500.9	11.7
IN	Spring	carp	I	128	14.3	1697	13.3
IN	Spring	threespine stickleback	N	101	11.3	125.2	1.0
IN	Spring	redside shiner	N	99	11.1	867.6	6.8
IN	Spring	yellow perch	I	50	5.6	388.2	3.0
IN	Spring	warmouth	I	20	2.2	325.9	2.5
IN	Spring	pumpkinseed	I	12	1.3	288.3	2.3
IN	Spring	largemouth bass	I	2	0.2	24	0.2
IN	**Spring**	**IN SPRING TOTAL**		**893**		**12802.7**	
IN		**IN TOTAL**		**4617**		**41295.7**	

Table 5. Ruby Lake two-way trap data, WY 2003 outbound.

Direction	Season	Species	Nat/Int	Number	% #	Weight (g)	% wt.
OUT	Winter	black crappie	I	1335.0	51.7	6329.9	46.4
OUT	Winter	threespine stickleback	N	710.0	27.5	906.6	6.6
OUT	Winter	yellow perch	I	271.0	10.5	2425.0	17.8
OUT	Winter	carp	I	148.0	5.7	1684.2	12.3
OUT	Winter	brown bullhead	I	35.0	1.4	1050.7	7.7
OUT	Winter	prickly sculpin	N	27.0	1.0	520.8	3.8
OUT	Winter	redside shiner	N	25.0	1.0	163.1	1.2
OUT	Winter	largemouth bass	I	13.0	0.5	392.5	2.9
OUT	Winter	white crappie	I	7.0	0.3	71.2	0.5
OUT	Winter	banded killifish	I	6.0	0.2	34.4	0.3
OUT	Winter	bluegill	I	2.0	0.1	18.4	0.1
OUT	Winter	coho salmon	N	1.0	0.0	16.7	0.1
OUT	Winter	warmouth	I	1.0	0.0	24.6	0.2
OUT	**Winter**	**OUT WINTER TOTAL**		**2581.0**		**13638.1**	
OUT	Spring	black crappie	I	225.0	33.2	2237.0	27.2
OUT	Spring	brown bullhead	I	129.0	19.1	3717.5	45.2
OUT	Spring	threespine stickleback	N	101.0	14.9	175.0	2.1
OUT	Spring	redside shiner	N	86.0	12.7	770.9	9.4
OUT	Spring	yellow perch	I	74.0	10.9	565.4	6.9
OUT	Spring	carp	I	32.0	4.7	294.4	3.6
OUT	Spring	pumpkinseed	I	11.0	1.6	177.1	2.2
OUT	Spring	warmouth	I	10.0	1.5	134.0	1.6
OUT	Spring	largemouth bass	I	4.0	0.6	50.9	0.6
OUT	Spring	prickly sculpin	N	2.0	0.3	41.1	0.5
OUT	Spring	bluegill	I	1.0	0.1	6.7	0.1
OUT	Spring	goldfish	I	1.0	0.1	12.6	0.2
OUT	Spring	largescale sucker	N	1.0	0.1	40.1	0.5
OUT	**Spring**	**OUT SPRING TOTAL**		**677.0**		**8222.7**	
OUT		**OUT TOTAL**		**3258.0**		**21860.8**	
		GRAND TOTAL		**7875.0**		**63156.5**	

Ruby Lake SSWS results

Standard seasonal wetland sampling of Ruby Lake was done December 3 and 4, 2002, February 20 and 21, April 15 and 16, and June 17 and 18, 2003. Fishes were sampled with two box traps and two fyke nets for two 24-hour sets per sampling period.

A total 15,088 fish were captured in Ruby Lake (Table 6). Four native fish species and 12 introduced species were identified. Native fishes dominated catch by number and biomass comprising 93% and 69% respectively of the total catch. Threespine stickleback were the most abundant of the native fishes (99% catch by number, 69% catch by weight). Crappie spp. (*Pomoxis spp.*) dominated the introduced fish species (54% catch by number, 43% by weight). The majority of the fish were captured during the December and February sampling periods comprising 51% and 45% respectively of the total catch. Catch in April and June was low, possibly due to high water in April, which diluted the density of fish in the wetland, and rising water temperatures in June (Figure 5).

Three coho salmon, probably in the 1+ age class (88-107 mm), and three Chinook salmon, probably in the 0+ age class (42-79 mm), were captured in Ruby Lake. Scale samples have been taken but age-length relationships have not yet been verified. One coho salmon (93 mm) was captured during the December sampling period. Two coho salmon (88 and 107 mm) and two Chinook salmon (42 and 51 mm) were captured during the February sampling period. One Chinook salmon (79 mm) was captured during the April sampling period.

Table 6. SSWS catch at Ruby Lake.

MoYr	Common Name	Family	NatIn	Number	Min F	Max F	WT (g)
Dec-02	Redside shiner	Cyprinidae	N	177	40	100	550
Dec-02	Threespined stickleback	Gasterosteidae	N	6742	45	60	7730
Dec-02	Coho salmon	Salmonidae	N	1	93	93	13
Dec-02	**Total Native**		**N**	**6920**			**8293**
Dec-02	Black crappie	Centrarchidae	I	5	48	182	195
Dec-02	Bluegill	Centrarchidae	I	3	35	70	10
Dec-02	Crappie spp.	Centrarchidae	I	356	47	85	887
Dec-02	Largemouth bass	Centrarchidae	I	3	110	179	147
Dec-02	White crappie	Centrarchidae	I	2	202	215	257
Dec-02	Common carp	Cyprinidae	I	120	53	160	376
Dec-02	Banded killifish	Cyprinodontidae	I	28	55	93	145
Dec-02	Brown bullhead	Ictaluridae	I	267	49	86	735
Dec-02	Yellow perch	Percidae	I	1	90	90	9
Dec-02	**Total Introduced**		**I**	**785**			**2762**
	December Total			**7705**			**11054**
Feb-03	Redside shiner	Cyprinidae	N	4	46	65	9
Feb-03	Threespined stickleback	Gasterosteidae	N	6636	50	60	9014
Feb-03	Chinook salmon	Salmonidae	N	2	42	51	4
Feb-03	Coho salmon	Salmonidae	N	2	88	107	30
Feb-03	**Total Native**		**N**	**6644**			**9057**
Feb-03	Black crappie	Centrarchidae	I	124	13	101	817
Feb-03	Oriental weatherfish	Cobitidae	I	1	80	80	10
Feb-03	Common carp	Cyprinidae	I	12	72	425	823
Feb-03	Goldfish	Cyprinidae	I	1	173	173	49
Feb-03	Brown bullhead	Ictaluridae	I	9	54	75	37
Feb-03	**Total Introduced**		**I**	**147**			**1736**
	February Total			**6791**			**10793**
Apr-03	Threespined stickleback	Gasterosteidae	N	370	52	62	561
Apr-03	Chinook salmon	Salmonidae	N	1	79	79	8
Apr-03	**Total Native**		**N**	**371**			**569**
Apr-03	Black crappie	Centrarchidae	I	16	54	102	131
Apr-03	Bluegill	Centrarchidae	I	3	46	85	20
Apr-03	Warmouth	Centrarchidae	I	1	91	91	21
Apr-03	White crappie	Centrarchidae	I	1	97	97	10
Apr-03	Common carp	Cyprinidae	I	4	89	129	64
Apr-03	Brown bullhead	Ictaluridae	I	4	101	288	709
Apr-03	**Total Introduced**		**I**	**29**			**956**
	April Total			**400**			**1525**
Jun-03	Threespined stickleback	Gasterosteidae	N	110	25	65	23
Jun-03	**Total Native**		**N**	**110**			**23**
Jun-03	Black crappie	Centrarchidae	I	53	95	128	1124
Jun-03	Bluegill	Centrarchidae	I	1	76	76	9
Jun-03	Pumpkinseed	Centrarchidae	I	12	70	128	346
Jun-03	White crappie	Centrarchidae	I	2	119	127	43
Jun-03	Common carp	Cyprinidae	I	4	156	178	189
Jun-03	Goldfish	Cyprinidae	I	2	118	222	117
Jun-03	Banded killifish	Cyprinodontidae	I	1	82	82	6
Jun-03	Brown bullhead	Ictaluridae	I	7	116	330	708
Jun-03	**Total Introduced**		**I**	**82**	**70**	**330**	**2543**
Jun-03	**June Total**			**192**		**330**	**2566**
	Grand Total			**15088**		**425**	**25939**

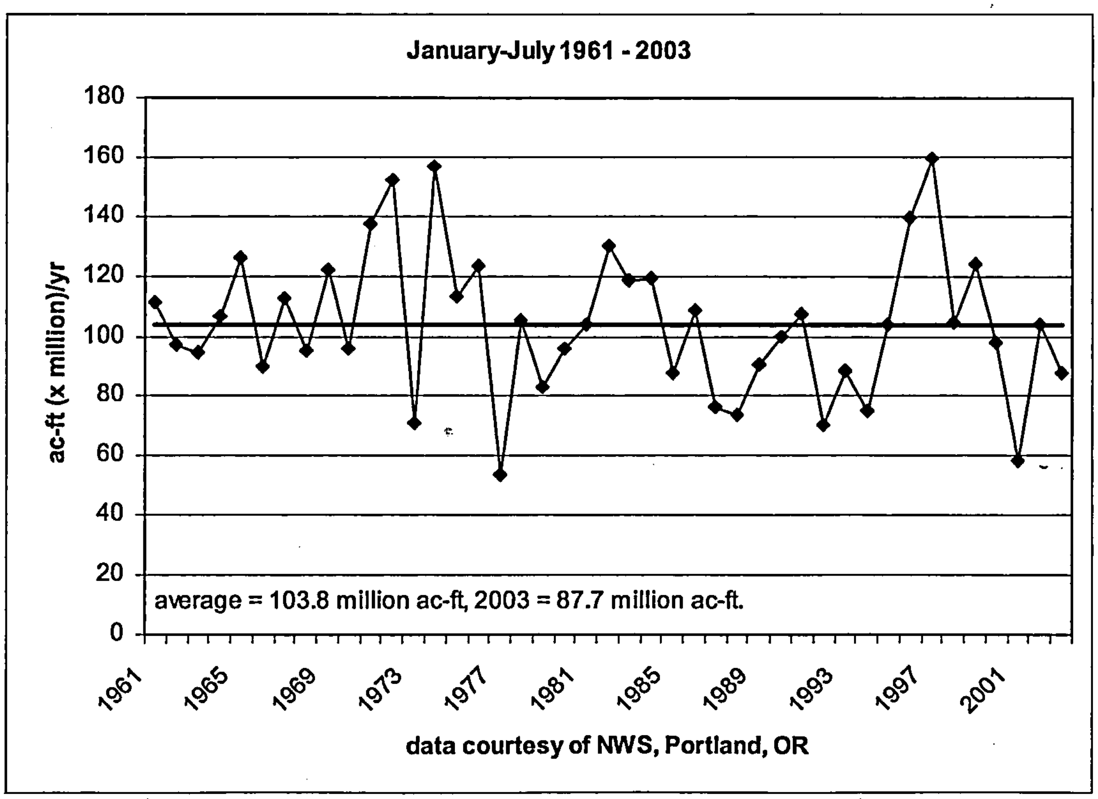
Ruby Lake Amphibians/Invertebrates

Bullfrog tadpoles (*Rana catesbiana*) were the most abundant amphibians; 167 in the SSWS and 1008 in the two-way catch. Bullfrog tadpoles were caught in December and February in the wetland and thorughout the sampling period with the two-way traps. Other invertebrates and amphibians caught were Asian freshwater shrimp (*Exopalaeomon modestus*) (36), red-legged frog tadpoles (*Rana aurora*) (8) and crayfish (Palinuridae) (3).

Ruby Lake data summary

Introduced fishes dominated the two-way trap catch (78% of total abundance) and native fishes dominated the SSWS catch (93% of total abundance). Threespine stickleback was the most numerous native species and black crappie was the most dominant introduced species. Few salmon were caught. Three coho were caught in the inbound trap and one coho was caught in the outbound trap. Two Chinook and four coho were caught during the SSWS. Many more salmon may have used the wetland but had frequent access via the egress channel and also high-water events, which would have allowed them to bypass the two-way trap. Most fishes were caught December through February in the two-way traps and also in the December and February sampling periods during the SSWS. This may be due to a weak spring runoff in WY2003. Figure 8 shows the annual inflow volume of the Columbia River at The Dalles (January-July), which gives a comparison of spring runoff from year to year. Spring runoff in 2003 was 84% of the average from 1961 to 2003.

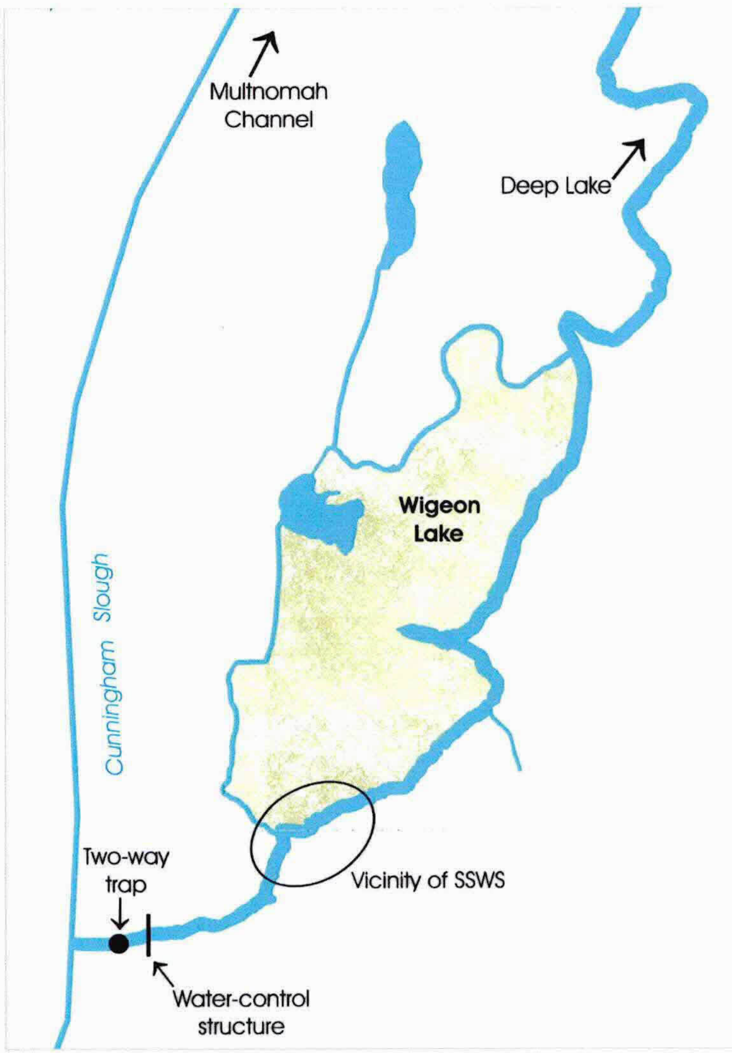
Figure 8. Adjusted inflow volume (million ac-ft/yr) for the Columbia River at The Dalles, OR.



Wigeon Lake

Wigeon Lake is a seasonal wetland on Sauvie Island (Figure 9). In WY 2002 the full-round riser water-control structure at Wigeon Lake was managed to act as a reference site and no riser boards were installed. In WY 2003, the structure was intended to operate as designed. The structure holds water to a maximum of 8.8 ft. NGVD 1929. The design of this project was to take advantage of the natural topography and hold water as high as possible using the water-control structure, without building levees. At this elevation, there is still a large island of ground higher than what can be flooded. This limits sampling areas to within the slough channel.

Figure 9. Wigeon Lake.



Wigeon Lake temperature and hydrology

Water temperature data were recorded on an hourly basis about two feet below the surface on the wetland side of the water-control structure from November 27, 2002 to July 8, 2003. Figure 10 shows the seven-day average maximum temperature and seven-day average stage in the Columbia River at Vancouver for that period. The Oregon state water quality temperature standard is exceeded when that the seven-day average maximum temperature exceeds 20°C (68°F) for waters of the Columbia River or its associated sloughs and channels (OAR 340-041-0006(54)*ii*). This standard was exceeded June 5, 2003 according to data taken near the surface at Wigeon Lake.

Staff-gage data were recorded throughout the period that the two-way trap was fished. These data were related to the USGS stage data for the Columbia River at Vancouver, Washington, which is recorded at 15-minute intervals. A linear regression analysis was done and an equation derived to relate the data sets (r^2=0.81). The equation was used to translate the data from the USGS gage to water-surface elevation data at Wigeon Lake (Figure 11). By comparing water-surface elevation to features of the control structure and landscape, a frequency of fish-passage opportunity can be estimated. Between November 22, 2002 and July 8, 2003 water flowed over the top of the dike, the riser board, and the top of the two-way trap 3.0%, 7.7%, and 21.2% of the time, respectively.

Equation 2: μ {WLriver | USGS} = 1.07 + USGS*(0.76)

Figure 10. Seven day average maximum temperature at Wigeon Lake and stage, WY 2003.

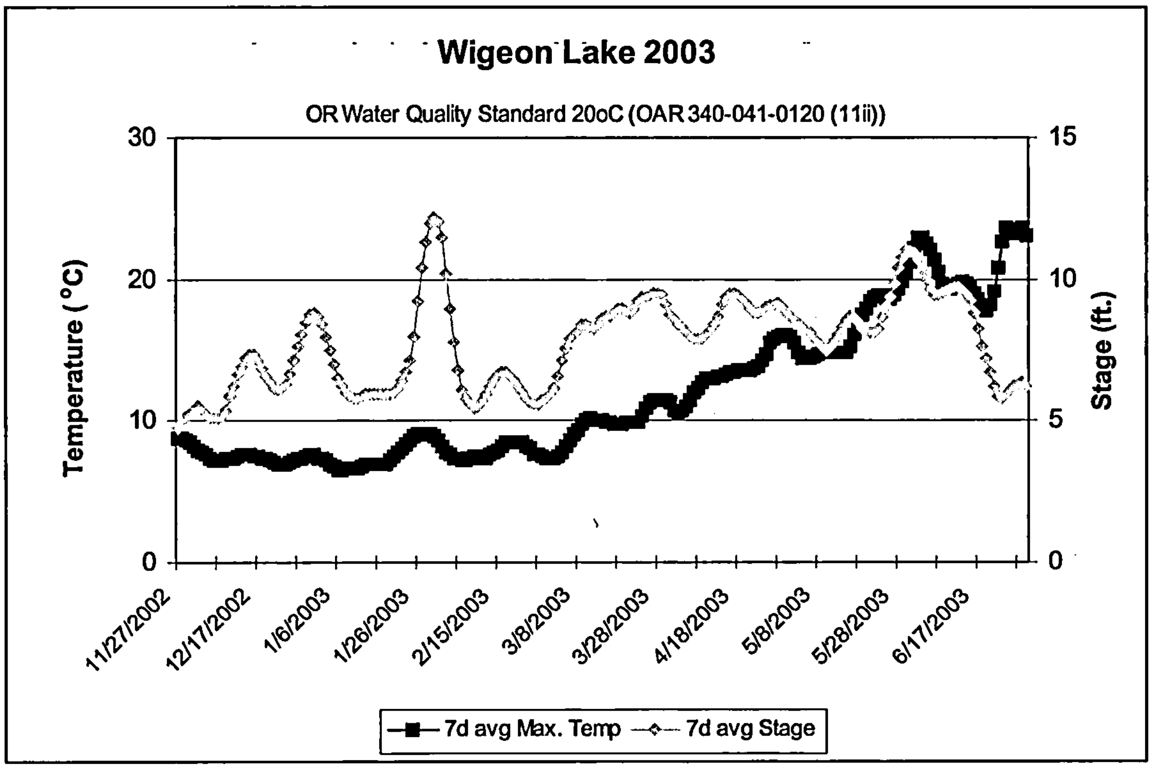
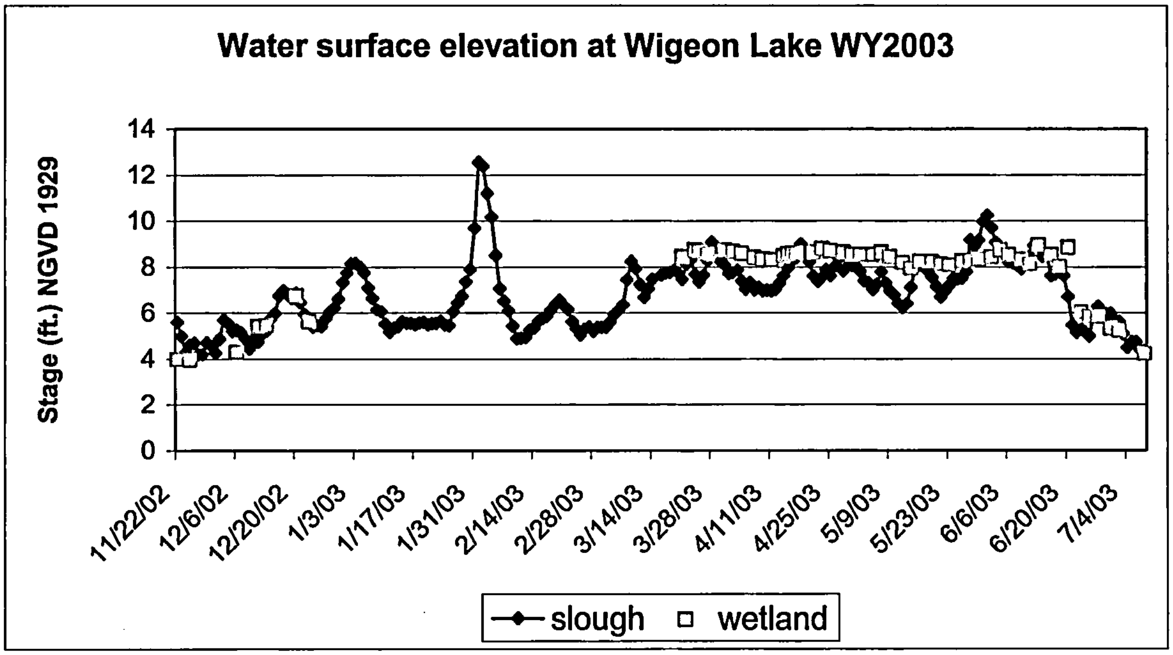


Figure 11. Comparison of water-surface elevation in wetland and slough at Wigeon Lake*.



*Dike 9.8 ft. Riser 8.8 ft. Trap 8.0 ft.

The slide gate on the structure was not screwed down until 1/2/03 and did not function until after that date. Riser boards were held at 8.8 ft. and the average water-surface elevation in the wetland from March through mid-June was 8.5 ft.

Wigeon Lake two-way trap results

The two-way trap was fished from November 22, 2002 to July 8, 2003. There were 4,650 fish caught inbound and 2,332 fish caught in the outbound trap. Figure 12 summarizes the catch on a weekly basis and shows that there were more fishes caught during the winter (81%). Threespine stickleback were the most abundant native species by number and biomass, while black crappie, carp, brown bullhead and yellow perch were the most abundant introduced species in the two-way trap catch (Table 7).

There were 14 coho salmon caught in the inbound trap during the winter between 11/22/02 and 2/24/03. These coho were between 72 and 115mm fork length. There were 13 Chinook salmon caught in the outbound trap in the spring between 5/9/03 and 5/21/03. These Chinook were between 84 and 105mm fork length.

Table 7. Two-way trap catch (% number and biomass) at Wigeon Lake WY2003.

			Winter		Spring	
IN (4650)	Species		% #	% biomass	% #	% biomass
	Native (811)	TSS	13.6	2.9	11.6	1.4
	Introduced (3839)	BLC	42.9	33.2	26.7	17.6
		CAP	24.4	30.4	15.4	9.3
		BRB	1.2	2.0	22.3	33.9
		YEP	10.7	15.4	9.5	9.2
OUT (2332)	Native (268)	TSS	4.9	0.9	10.0	0.6
	Introduced (2064)	BLC	51.9	40.1	36.0	68.2
		CAP	19.1	21.5	7.9	3.3
		BRB	1.6	2.5	10.7	5.8
		YEP	15.6	19.6	19.6	9.7

TSS (threespine stickleback); BLC (black crappie); CAP (carp); BRB (brown bullhead); YEP (yellow perch)

Figure 12. Catch (abundance) summarized by week in two-way traps at Wigeon Lake, WY 2003.

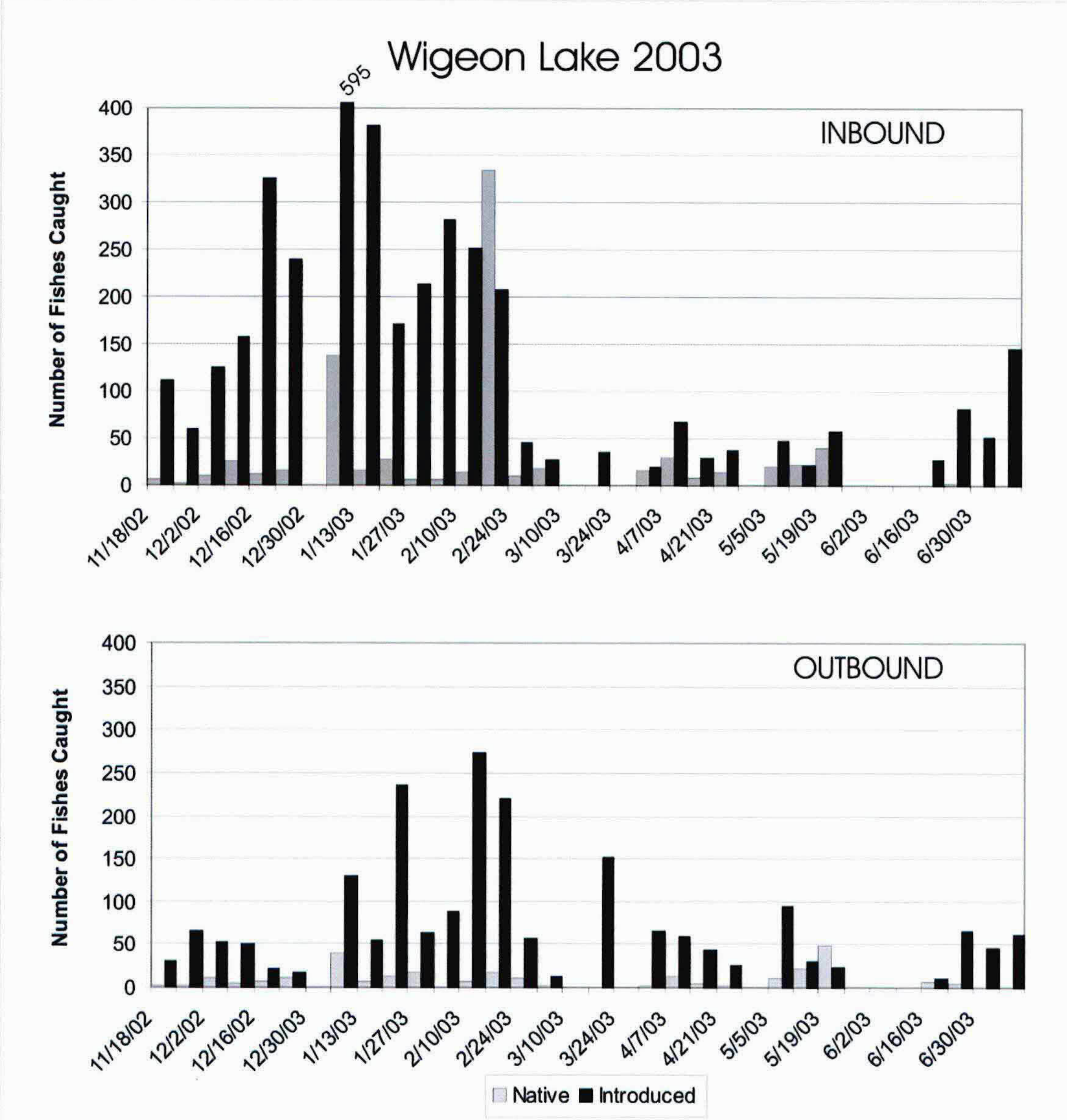


Table 8. Wigeon Lake two-way trap data, WY 2003 inbound.

Gear	Season	Species	Nat/Intro	Number	% #	Weight (g)	% wt
IN	Winter	black crappie	I	1682	43.0	8352.8	33.2
IN	Winter	carp	I	955	24.4	7641.6	30.4
IN	Winter	threespine stickleback	N	532	13.6	734.5	2.9
IN	Winter	yellow perch	I	417	10.7	3865.8	15.4
IN	Winter	prickly sculpin	N	67	1.7	1389.8	5.5
IN	Winter	banded killifish	I	62	1.6	394.9	1.6
IN	Winter	brown bullhead	I	46	1.2	510.4	2.0
IN	Winter	redside shiner	N	43	1.1	371.4	1.5
IN	Winter	largemouth bass	I	32	0.8	583	2.3
IN	Winter	bluegill	I	27	0.7	551	2.2
IN	Winter	warmouth	I	15	0.4	145.5	0.6
IN	Winter	coho	N	14	0.4	201.4	0.8
IN	Winter	pumpkinseed	I	11	0.3	232.7	0.9
IN	Winter	northern pikeminnow	N	8	0.2	118.1	0.5
IN	Winter	peamouth	N	3	0.1	26.5	0.1
IN	Winter	white crappie	I	1	0.0	47	0.2
IN	**Winter**	**IN WINTER TOTAL**		**3915**		**25166.4**	
IN	Spring	black crappie	I	196	26.7	1415	17.6
IN	Spring	brown bullhead	I	164	22.3	2729.7	33.9
IN	Spring	carp	I	113	15.4	747.1	9.3
IN	Spring	threespine stickleback	N	85	11.6	114.9	1.4
IN	Spring	yellow perch	I	70	9.5	741	9.2
IN	Spring	redside shiner	N	33	4.5	286.3	3.6
IN	Spring	prickly sculpin	N	26	3.5	692.1	8.6
IN	Spring	warmouth	I	14	1.9	451.8	5.6
IN	Spring	pumpkinseed	I	13	1.8	327.7	4.1
IN	Spring	largemouth bass	I	8	1.1	153.7	1.9
IN	Spring	bluegill	I	5	0.7	101.7	1.3
IN	Spring	oriental weatherfish	I	5	0.7	261.2	3.2
IN	Spring	banded killifish	I	3	0.4	18.5	0.2
IN	Spring	IN SPRING TOTAL		735		8040.7	
IN		**INBOUND TOTAL**		**4650**		**33207.1**	

Table 9. Wigeon Lake two-way trap data, WY 2003 outbound.

Gear	Season	Species	Nat/Intro	Number	% #	Weight (g)	% wt
OUT	Winter	black crappie	I	890	51.9	4887.9	40.0
OUT	Winter	carp	I	327	19.1	2627.2	21.5
OUT	Winter	yellow perch	I	267	15.6	2391	19.6
OUT	Winter	threespine stickleback	N	84	4.9	106.5	0.9
OUT	Winter	prickly sculpin	N	53	3.1	992.6	8.1
OUT	Winter	brown bullhead	I	28	1.6	307.2	2.5
OUT	Winter	banded killifish	I	17	1.0	116.3	1.0
OUT	Winter	largemouth bass	I	15	0.9	259.9	2.1
OUT	Winter	bluegill	I	10	0.6	136.6	1.1
OUT	Winter	redside shiner	N	10	0.6	120.3	1.0
OUT	Winter	warmouth	I	6	0.3	96.5	0.8
OUT	Winter	pumpkinseed	I	4	0.2	98.1	0.8
OUT	Winter	peamouth	N	3	0.2	47.9	0.4
OUT	Winter	northern pikeminnow	N	1	0.1	18	0.1
OUT	**Winter**	**OUT WINTER TOTAL**		**1715**		**12206**	
OUT	Spring	black crappie	I	222	36.0	9688.3	68.2
OUT	Spring	yellow perch	I	121	19.6	1375	7638.9
OUT	Spring	brown bullhead	I	66	10.7	827	4594.4
OUT	Spring	threespine stickleback	N	62	10.0	87.9	488.3
OUT	Spring	carp	I	49	7.9	464.6	2581.1
OUT	Spring	prickly sculpin	N	24	3.9	563.7	3131.7
OUT	Spring	warmouth	I	22	3.6	452.7	2515.0
OUT	Spring	redside shiner	N	18	2.9	173.3	962.8
OUT	Spring	Chinook	N	13	2.1	181.2	1006.7
OUT	Spring	pumpkinseed	I	9	1.5	186.7	1037.2
OUT	Spring	banded killifish	I	3	0.5	20.7	115.0
OUT	Spring	bluegill	I	3	0.5	57.9	321.7
OUT	Spring	largemouth bass	I	3	0.5	43	238.9
OUT	Spring	oriental weatherfish	I	2	0.3	83.6	464.4
OUT	**Spring**	**OUT SPRING TOTAL**		**617**		**14205.6**	
OUT		**OUTBOUND TOTAL**		**2332**		**26411.6**	
		GRAND TOTAL		**6982**		**59618.7**	

Wigeon Lake SSWS results

Standard Seasonal Wetland Sampling of Wigeon Lake was done January 3, February 25, April 17, and June 19, 2003. Fishes were sampled using two box traps and two fyke nets for a 24-hour period.

A total of 7,802 fish were captured in Wigeon Lake (Table 10). Five native fish species and 9 introduced species were identified. Native fishes dominated in both catch by number and biomass comprising 97% and 76% respectively of the total catch. Threespine stickleback were the most abundant of the native fishes (99% catch by number, 89% by weight). Crappie spp. were the most abundant introduced fish (58% catch by number, 30% by weight) followed by brown bullhead (16% catch by number, 17% by weight). The majority of the fish were caught during the January (23%) and February (66%) sampling periods.

Thirty-seven Chinook salmon, probably in the 0+ age class (40-97 mm), were captured in Wigeon Lake. Thirty-five Chinook salmon (40-59 mm) were captured during the February sampling period. Two Chinook salmon (96 and 97 mm) were captured during the April sampling period.

Table 10. SSWS catch at Wigeon Lake.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Jan-03	Prickly sculpin	Cottidae	N	1	120	120	21
Jan-03	Threespined stickleback	Gasterosteidae	N	1808	48	62	2451
Jan-03	**Total Native**		**N**	**1809**			**2472**
Jan-03	Bluegill	Centrarchidae	I	1	44	44	2
Jan-03	Crappie spp.	Centrarchidae	I	11	55	95	42
Jan-03	Largemouth bass	Centrarchidae	I	1	167	167	64
Jan-03	Common carp	Cyprinidae	I	9	70	90	50
Jan-03	Banded killifish	Cyprinodontidae	I	1	64	64	3
Jan-03	Brown bullhead	Ictaluridae	I	1	70	70	5
Jan-03	**Total Introduced**		**I**	**24**			**165**
	January Total			**1833**			**2637**
Feb-03	Largescale sucker	Catostomidae	N	2	75	77	10
Feb-03	Prickly sculpin	Cottidae	N	1	134	134	30
Feb-03	Redside shiner	Cyprinidae	N	7	54	74	19
Feb-03	Threespined stickleback	Gasterosteidae	N	4992	49	60	6036
Feb-03	Chinook salmon	Salmonidae	N	35	40	59	83
Feb-03	**Total Native**		**N**	**5037**			**6178**
Feb-03	Black crappie	Centrarchidae	I	93	55	92	626
Feb-03	Bluegill	Centrarchidae	I	3	85	110	55
Feb-03	Common carp	Cyprinidae	I	13	69	520	1348
Feb-03	Banded killifish	Cyprinodontidae	I	4	65	80	18
Feb-03	Brown bullhead	Ictaluridae	I	3	66	71	13
Feb-03	Yellow perch	Percidae	I	7	74	106	66
Feb-03	**Total Introduced**		**I**	**123**			**2126**
	February Total			**5160**			**8304**
Apr-03	Largescale sucker	Catostomidae	N	1	435	435	872
Apr-03	Prickly sculpin	Cottidae	N	6	69	104	39
Apr-03	Threespined stickleback	Gasterosteidae	N	396	52	64	633
Apr-03	Chinook salmon	Salmonidae	N	2	96	97	28
Apr-03	**Total Native**		**N**	**405**			**1572**
Apr-03	Black crappie	Centrarchidae	I	2	54	61	6
Apr-03	Largemouth bass	Centrarchidae	I	1	142	142	38
Apr-03	Banded killifish	Cyprinodontidae	I	1	84	84	7
Apr-03	Brown bullhead	Ictaluridae	I	3	67	82	18
Apr-03	Yellow perch	Percidae	I	1	93	93	10
Apr-03	**Total Introduced**		**I**	**8**			**79**
	April Total			**413**			**1651**
Jun-03	Threespined stickleback	Gasterosteidae	N	336	18	75	108
Jun-03	**Total Native**		**N**	**336**			**108**
Jun-03	Black crappie	Centrarchidae	I	18	87	118	323
Jun-03	Pumpkinseed	Centrarchidae	I	1	82	82	13
Jun-03	Goldfish	Cyprinidae	I	8	39	45	7
Jun-03	Banded killifish	Cyprinodontidae	I	6	23	90	39
Jun-03	Brown bullhead	Ictaluridae	I	27	59	153	539
Jun-03	**Total Introduced**		**I**	**60**			**920**
	June Total			**396**			**1029**
	Grand Total			**7802**			**13621**

Wigeon Lake Amphibians/Invertebrates

The most abundant amphibians in Wigeon Lake were bullfrog tadpoles. There were only 8 in the SSWS catch but 295 in the two-way trap catch. Red-legged frog tadpoles were more abundant in the wetland catch, 31, but few in the two-way trap, 5. There were also Asian freshwater shrimp (13), crayfish (10), and Pacific chorus frogs (*Pseudacris regilla*) (15).

Wigeon Lake data summary

A similar pattern of native and introduced fish use between two-way trap data and SSWS data can be seen at Wigeon Lake compared with Ruby Lake. In the two-way trap catch, most fishes were caught during the winter and most of the catch was introduced fishes. Most of the catch during the SSWS was native species, mostly threespine stickleback and the dominant introduced species was black crappie, same as Ruby Lake.

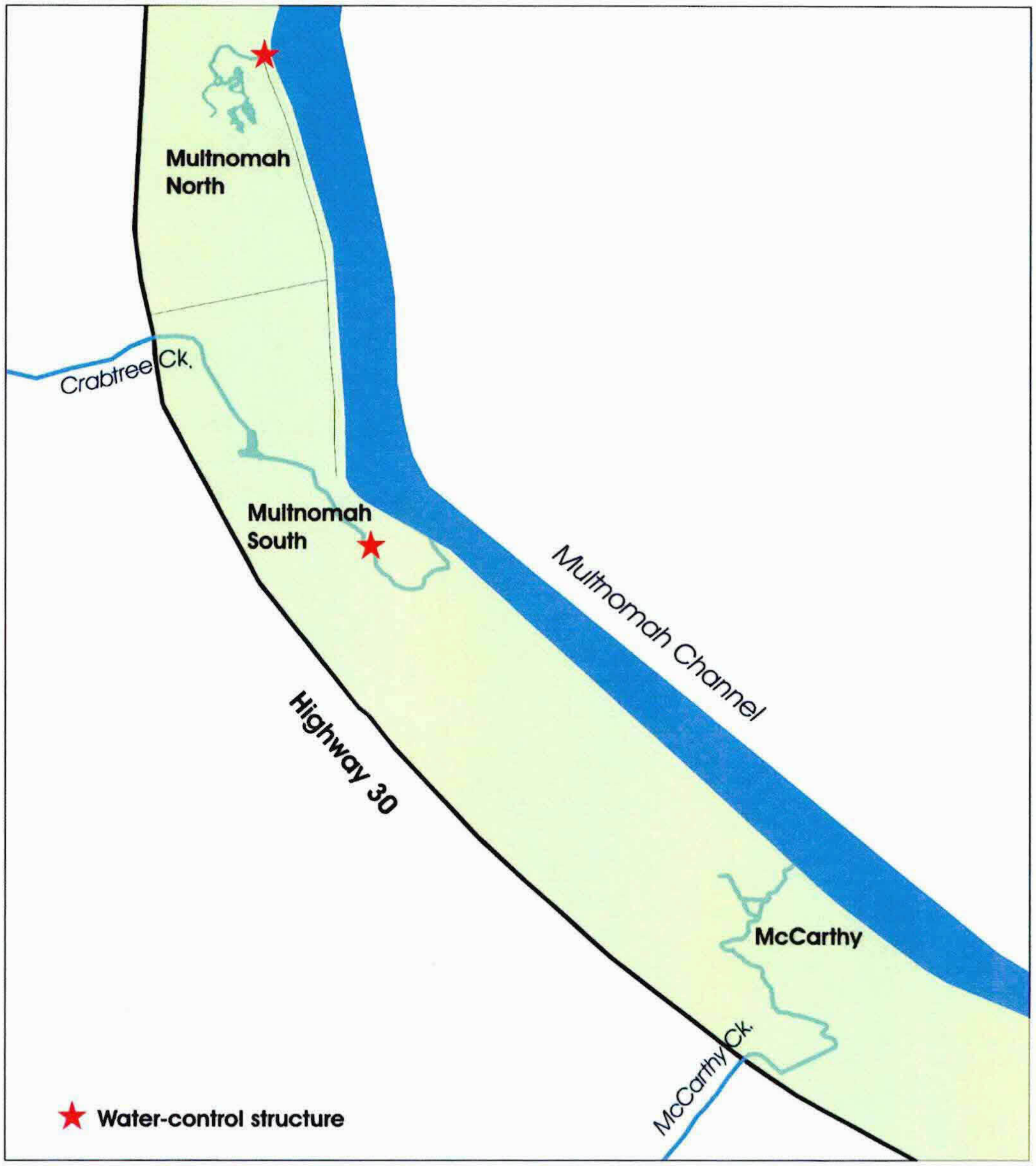
There were more salmon caught at Wigeon Lake compared to Ruby Lake. There were 14 coho caught in the inbound trap; 13 Chinook caught in the outbound trap; and 37 Chinook caught during SSWS. Most (35) of these Chinook caught during the SSWS were young-of-the-year (YOY) and were caught during the February 25th sampling period. These fish likely came in during a high-water event, which peaked February 2, 2003. The Chinook caught in the outbound trap were caught during a short period (May 9-21) that coincided with spring runoff. This exodus preceded the date in which the water-quality standard for temperature was exceeded (June 5).

The structure worked as designed and held water through the spring. Frequency of passage opportunity was less than Ruby Lake because there is no egress channel but a group of Chinook was caught during spring runoff in the outbound trap (May 9-21). Shortly thereafter (June 1), the dike was overtopped. Fish seem to move in response to high-water events and frequency of passage opportunity itself may not be a good measure of whether the structure is preventing fishes from getting out of the wetlands but connectivity between the riverine and floodplain habitats is important for maintaining processes which promote ecological function of floodplain wetlands.

Multnomah North

Multnomah North is a seasonal wetland located on the west side of the Multnomah Channel (Figure 13). In WY 2002, the half-round riser water control structure was in place but riser boards were not installed allowing the site to be used as a reference. The water control structure was fully operational in WY 2003.

Figure 13. Sites on the west bank of Multnomah Channel.



Multnomah North temperature and hydrology

Water temperature data were recorded on an hourly basis about two feet below the surface on the wetland side of the water-control structure from November 27, 2002 to July 8, 2003. Figure 14 shows the seven-day average maximum temperature and seven-day average stage in the Columbia River at Vancouver for that period. The Oregon state water quality temperature standard is exceeded when that the seven-day average maximum temperature exceeds 20°C (68°F) for waters of the Columbia River or its associated sloughs and channels (OAR 340-041-0006(54)*ii*). This standard was exceeded June 6, 2003 according to data taken near the surface at Multnomah North.

Staff-gage data were recorded throughout the period that the two-way trap was fished. These data were related to the USGS stage data for the Columbia River at Vancouver, Washington, which is recorded at 15-minute intervals. A linear regression analysis was done and an equation derived to relate the data sets (r^2=0.81). The equation was used to translate the data from the USGS gage to water-surface elevation data at Multnomah North (Figure 15). By comparing water-surface elevation to features of the control structure and landscape, a frequency of fish-passage opportunity can be estimated. Between November 22, 2002 and July 8, 2003 water flowed over the top of the dike, the riser board, and the top of the two-way trap 1.0%, 1.9% and 16.4% of the time, respectively.

Equation 3: μ {MNriver | USGS} = 0.24 + USGS*(0.88)

Figure 14. Seven day average maximum temperature at Multnomah North and stage, WY 2003.

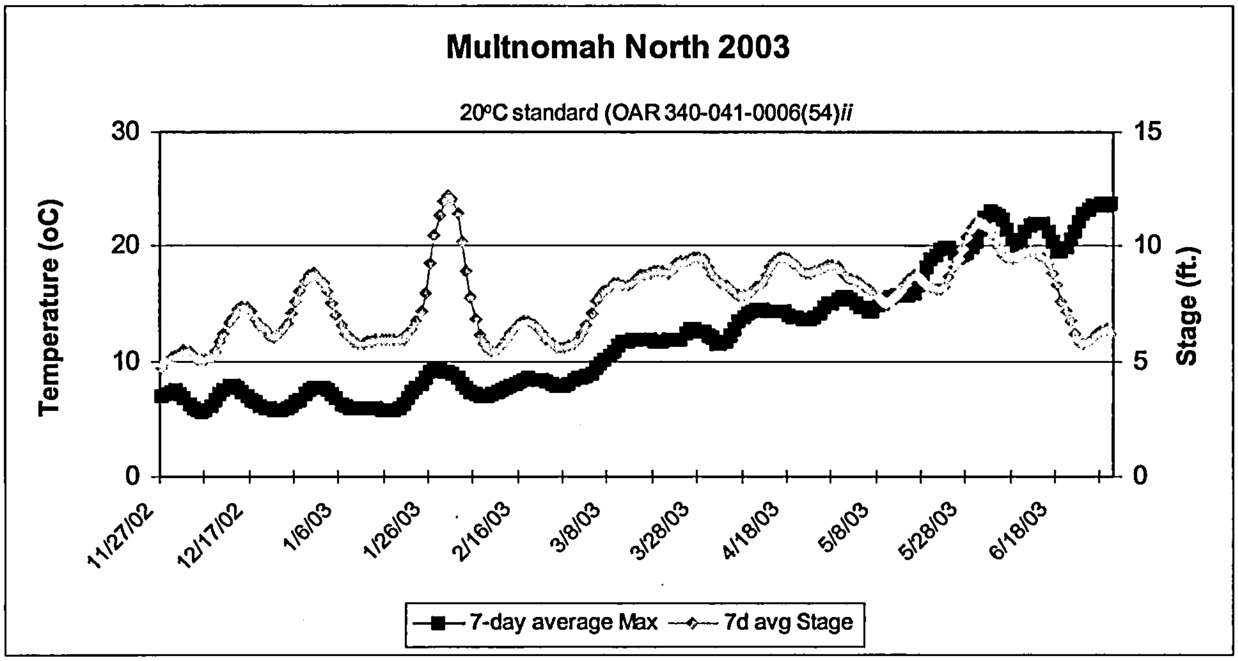
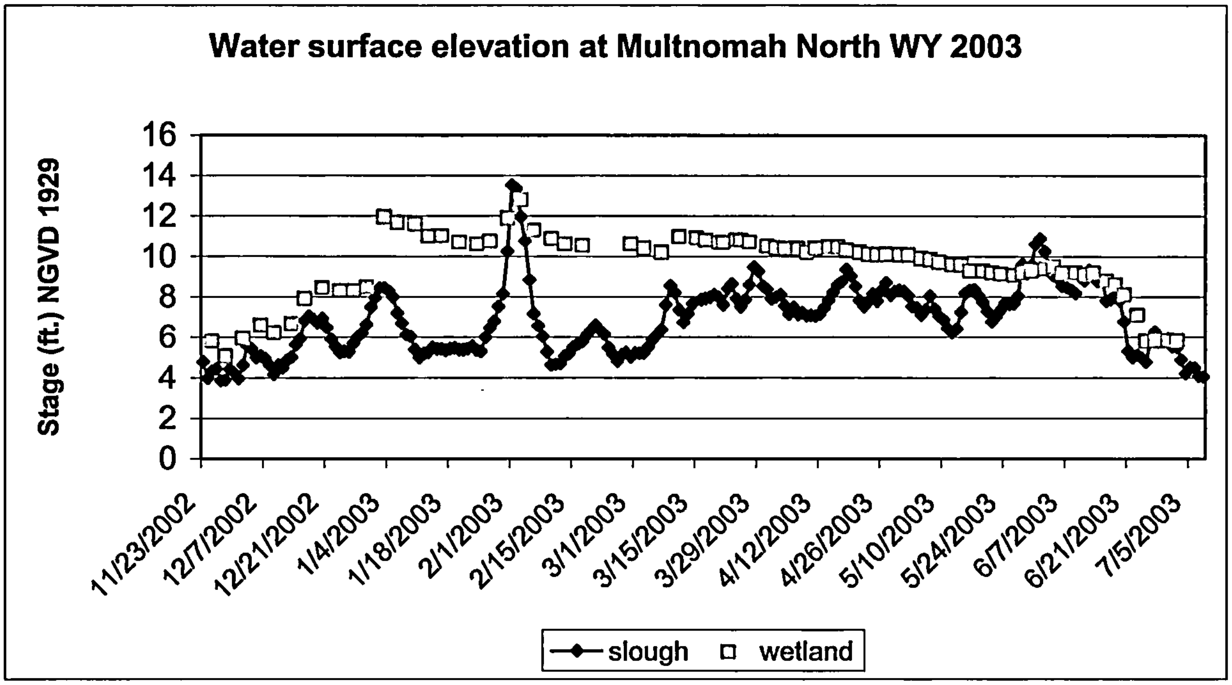


Figure 15 shows the additional storage of water in the wetland achieved by the use of the water-control structure. Water level in the wetland increased from 8.5 feet (NGVD 1929) on 12/30/02 to 11.95 feet on 1/3/03. Water between 12 and 9 feet (NGVD 1929) elevation was held in the wetland from early January through mid June. The invert elevation of the channel at the structure is 3.0 feet (NGVD 1929). So, the water held by the structure was between 9 and 6 feet deep during that time but the actual benefit provided by the water control structure can be seen in figure 15 by the difference between the water-surface elevation of the tidal channel (slough) and wetland. This increase in water-surface elevation translates to an increase in wetland habitat. The wetland was drawn down in mid-June.

Figure 15. Comparison of water-surface elevations in the wetland and the channel at Multnomah North*.



*Elevations: Dike 12.5 ft. Riser 11.0 ft. Trap 8.5 ft. (NGVD 1929)

Multnomah North two-way trap results

The two-way trap was fished from November 22, 2002 to July 8, 2003. There were 8,542 fish caught inbound and 7,280 fish caught in the outbound trap. Figure 16 summarizes the catch on a weekly basis and shows that there were more fishes caught during the winter than spring (82.5% catch in winter).

Threespine stickleback were the most abundant native species by number but prickly sculpin (*Cottus asper*) was most abundant by biomass. Black crappie, yellow perch and carp were the most abundant introduced species in the two-way trap catch (Table 11).

There were ten coho and two Chinook salmon caught in the inbound trap. Nine of the coho were caught between January 15 and February 27, 2003 and were between 74-110mm fork length. Another coho was caught 5/16/03, measuring 110mm. Also, on May 16 two Chinook were caught inbound, measuring 98 and 100mm.

There were 15 coho and 34 Chinook caught in the outbound trap. The coho were caught between February 19 and May 14 and were between 84 -156mm fork length. All of the Chinook were caught in the spring. All but one were caught between May 9 and May 26, 2003 and were between 87-107 mm, presumably YOY. The other Chinook was caught April 2 and was 180mm.

Two adipose-clipped hatchery coho were caught, both in the outbound trap. One was caught March 31, 2003 (139mm fork length) and the other was caught May 9, 2003 (150mm fork length). The first hatchery coho was released back into the wetland and came out two days later.

Table 11. Two-way trap catch (% number and biomass, in vs. out) at Multnomah North WY2003.

			Winter		Spring	
	Species		% #	% biomass	% #	% biomass
IN (8542)	Native (2059)	TSS	22.1	3.8	22.2	2.4
		PRS	1.1	4.2	3.1	6.4
	Introduced (6483)	BLC	47.1	54.7	26.3	13.1
		YEP	20.0	22.2	26.5	20.1
		CAP	6.3	6.7	5.4	10.5
OUT (7280)	Native (1335)	TSS	10.3	2.1	20.1	1.3
		PRS	3.4	16.5	7.4	10.7
	Introduced (5945)	BLC	47.7	28.5	25.6	9.6
		YEP	32.9	41.6	29.2	13.7
		CAP	2.7	3.5	4.4	19.3

TSS (threespine stickleback); PRS (prickly sculpin); BLC (black crappie); CAP (carp); YEP (yellow perch)

Figure 16. Catch (abundance) summarized by week in two-way traps at Multnomah North, WY 2003.

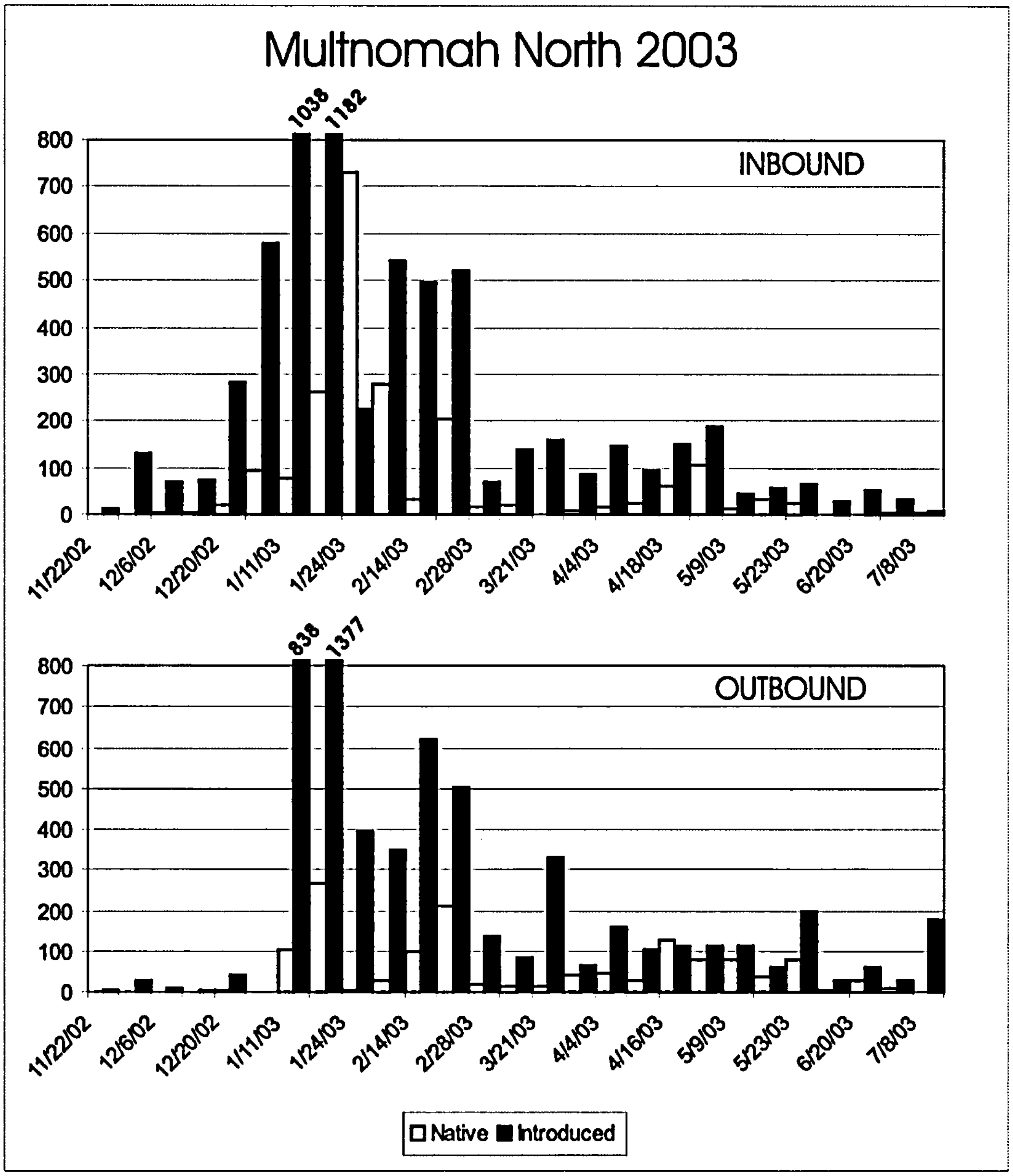


Table 12. All fishes caught in INBOUND 2-way trap at Multnomah North.

Family	Common Name	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Catostomidae	Largescale sucker	4	170	397	1801
Cottidae	Prickly sculpin	116	65	197	3165
Cyprinidae	Northern pikeminnow	15	97	190	344
Cyprinidae	Peamouth	7	85	240	526
Cyprinidae	Redside shiner	15	70	140	156
Gasterosteidae	Threespined stickleback	1890	40	67	2390
Salmonidae	Chinook salmon	2	98	100	30
Salmonidae	Coho salmon	10	74	110	142
Total Native		**2059**			**8554**
Centrarchidae	Black crappie	155	59	152	1242
Centrarchidae	Bluegill	40	50	160	681
Centrarchidae	Crappie spp.	3632	35	700	30009
Centrarchidae	Largemouth bass	79	67	175	1207
Centrarchidae	Pumpkinseed	11	55	125	160
Centrarchidae	Warmouth	175	40	130	2674
Cobitidae	Oriental weatherfish	14	107	160	655
Cyprinidae	Common carp	526	50	310	5085
Cyprinodontidae	Banded killifish	36	75	105	254
Ictaluridae	Brown bullhead	34	55	300	2540
Percidae	Yellow perch	1781	47	190	14783
Total Introduced		**6483**			**59289**
Grand Total		**8542**			**67844**

Table 13. All fishes caught in OUTBOUND 2-way trap at Multnomah North.

Family	Common Name	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Catostomidae	Largescale sucker	22	130	475	11310
Cottidae	Prickly sculpin	312	70	197	9797
Cyprinidae	Northern pikeminnow	1	87	87	7
Cyprinidae	Peamouth	10	70	260	497
Cyprinidae	Redside shiner	29	66	96	211
Gasterosteidae	Threespined stickleback	911	30	67	1206
Salmonidae	Chinook salmon	35	87	180	529
Salmonidae	Coho salmon	15	84	156	446
Total Native		**1335**			**24003**
Centrarchidae	Black crappie	28	65	87	195
Centrarchidae	Bluegill	28	52	145	631
Centrarchidae	Crappie spp.	3083	40	182	13625
Centrarchidae	Largemouth bass	21	75	165	345
Centrarchidae	Pumpkinseed	40	51	112	385
Centrarchidae	Smallmouth bass	2	230	350	0
Centrarchidae	Warmouth	102	50	145	1598
Cobitidae	Oriental weatherfish	16	110	150	744
Cyprinidae	Common carp	226	50	400	8028
Cyprinodontidae	Banded killifish	33	65	102	207
Ictaluridae	Brown bullhead	30	65	285	1900
Percidae	Yellow perch	2336	47	235	20043
Total Introduced		**5945**			**47700**
Grand Total		**7280**			**71703**

Multnomah North SSWS results

Sampling of the Multnomah North wetland was done December 12 and 13, 2002, February 12 and 13, April 8 and 9, and June 3 and 4, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap). Traps were fished for two 24-hour sets per sampling period.

A total of 15,923 fish, representing 21 species, were captured in the Multnomah North wetland (Table 14). Native fishes dominated the catch in both catch by number and biomass, comprising 96% and 53% respectively of the total catch. Threespine stickleback were the most abundant native fish species comprising 99% catch by number and 58% of the total biomass. Largescale suckers contributed significantly to the total biomass of the native fishes with 34% catch by weight, although their catch by number was only 0.2%. Black crappie were the most abundant of the introduced species by number with 64% of the total introduced fishes. Common carp contributed the greatest biomass to the introduced fishes comprising 64% of the total weight. The greatest number of fishes was captured in December (75% of the total fish) with threespine stickleback comprising the bulk of the catch (98% of the December catch).

Eighty-one Chinook salmon were captured in the Multnomah North wetland. Seventy-one Chinook salmon (53-89 mm) were captured during the April sampling and 10 Chinook salmon (79-102 mm) were captured in June. An estimate of growth rates of these Chinook in the Multnomah North wetland can be made by using data of Chinook caught at McCarthy, the reference site just upstream, on February 11, 2003, just after the high-water event that would have brought the Chinook into Multnomah North. The average fork length of the YOY Chinook at McCarthy on Februay 11 was 39mm (n=104). The average fork length of YOY Chinook caught at Multnomah North during the April SSWS was 71mm (range 53-89, n=71) and 88mm for the June SSWS (range 79-102, n=10). This gives an average growth rate of 0.59mm/d for the group caught in April and 0.44mm/d for the group caught in June.

Table 14. SSWS catch at Multnomah North.

MoYr	Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT
Dec-02	Largescale sucker	Catostomidae	N	6	45	65	11
Dec-02	Prickly sculpin	Cottidae	N	2	135	140	65
Dec-02	Redside shiner	Cyprinidae	N	4	73	100	29
Dec-02	Threespined stickleback	Gasterosteidae	N	11800	45	57	12635
	Total Native		N	**11812**			**12740**
Dec-02	Black crappie	Centrarchidae	I	65	55	90	408
Dec-02	Bluegill	Centrarchidae	I	1	66	66	6
Dec-02	Smallmouth bass	Centrarchidae	I	1	100	100	0
Dec-02	Black crappie	Centrarchidae	I	44	55	90	249
Dec-02	Bluegill	Centrarchidae	I	8	40	65	23
Dec-02	Smallmouth bass	Centrarchidae	I	3	52	140	0
Dec-02	Oriental weatherfish	Cobitidae	I	4	77	86	44
Dec-02	Common carp	Cyprinidae	I	52	50	110	281
Dec-02	Brown bullhead	Ictaluridae	I	6	56	150	157
Dec-02	Yellow perch	Percidae	I	1	98	98	12
	Total Introduced		I	**185**			**1179**
	Total December		I	**11997**			**13919**
Feb-03	Largescale sucker	Catostomidae	N	17	120	500	8595
Feb-03	Prickly sculpin	Cottidae	N	14	90	191	503
Feb-03	Redside shiner	Cyprinidae	N	1	82	82	7
Feb-03	Peamouth	Cyprinidae	N	55	72	100	397
Feb-03	Threespined stickleback	Gasterosteidae	N	290	45	61	369
	Total Native		N	**377**			**9871**
Feb-03	Black crappie	Centrarchidae	I	19	64	157	223
Feb-03	Bluegill	Centrarchidae	I	1	60	60	4
Feb-03	Pumpkinseed	Centrarchidae	I	2	85	104	42
Feb-03	Black crappie	Centrarchidae	I	25	58	145	287
Feb-03	Bluegill	Centrarchidae	I	2	49	165	98
Feb-03	Largemouth bass	Centrarchidae	I	1	91	91	9
Feb-03	Common carp	Cyprinidae	I	6	99	149	106
Feb-03	Yellow perch	Percidae	I	59	81	195	900
Feb-03	Mosquitofish	Poeciliidae	I	1	21	21	7
	Total Introduced		I	**116**			**1675**
	Total February			**493**			**11546**
Apr-03	Prickly sculpin	Cottidae	N	5	59	153	125
Apr-03	Peamouth	Cyprinidae	N	1	87	87	8
Apr-03	Northern pikeminnow	Cyprinidae	N	1	120	120	18
Apr-03	Peamouth	Cyprinidae	N	3	91	102	31
Apr-03	Threespined stickleback	Gasterosteidae	N	452	49	65	765
Apr-03	Chinook salmon	Salmonidae	N	71	53	89	457
	Total Native		N	**533**			**1404**

Table 14. Catch from wetland sampling at Multnomah North (Continued).

MoYr	Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT
Apr-03	Black crappie	Centrarchidae	I	23	61	107	219
Apr-03	Pumpkinseed	Centrarchidae	I	1	79	79	11
Apr-03	Black crappie	Centrarchidae	I	40	61	107	368
Apr-03	Oriental weatherfish	Cobitidae	I	2	145	155	133
Apr-03	Banded killifish	Cyprinodontidae	I	2	75	77	10
Apr-03	Brown bullhead	Ictaluridae	I	1	285	285	314
Apr-03	Yellow perch	Percidae	I	47	80	110	473
	Total Introduced		**I**	**116**			**1529**
	Total April			**649**			**2933**
Jun-03	Prickly sculpin	Cottidae	N	11	34	188	254
Jun-03	Threespined stickleback	Gasterosteidae	N	2528	22	68	821
Jun-03	Chinook salmon	Salmonidae	N	10	79	102	113
	Total Native		**N**	**2549**			**1188**
Jun-03	Black crappie	Centrarchidae	I	113	72	170	1803
Jun-03	Largemouth bass	Centrarchidae	I	2	120	226	192
Jun-03	Black crappie	Centrarchidae	I	89	83	118	1374
Jun-03	Bluegill	Centrarchidae	I	1	70	70	7
Jun-03	Pumpkinseed	Centrarchidae	I	4	65	109	56
Jun-03	White crappie	Centrarchidae	I	3	81	95	23
Jun-03	Oriental weatherfish	Cobitidae	I	2	100	128	60
Jun-03	Common carp	Cyprinidae	I	13	347	680	14032
Jun-03	Goldfish	Cyprinidae	I	3	120	150	73
Jun-03	Brown bullhead	Ictaluridae	I	4	105	220	309
Jun-03	Yellow bullhead	Ictaluridae	I	1	285	285	339
	Total Introduced		**I**	**235**			**18269**
	Total June			**2784**			**19457**
	Grand Total			**15923**			**47855**

Multnomah North Amphibians/Invertebrates

The most abundant amphibian in the Multnomah North unit was the bullfrog tadpole. There were 13 in the catch within the wetland and 145 in the two-way traps. Other aquatic organisms in the catch were Asian freshwater shrimp (3), red-legged frogs (3), and one freshwater clam.

Multnomah North data summary

Even though connectivity between the floodplain and river decreased after installation of the water-control structure, YOY Chinook entered the wetland and were caught during April (71) and June (10) during SSWS. The only time they could have entered the wetland without going through the two-way trap was during a high-flow event on February 2 that overtopped the dike. Growth-rate estimates indicate these Chinook grew 1.8 times their fork length by April and 2.2 times their fork length by June. According to our catch data, YOY chinook enter wetlands during high-flows and leave the wetland during a brief period during the spring, as our outbound two-way trap data indicate. However, the trap was overtopped during a flow-event that peaked June 1 so many more Chinook from this group that entered in February may have left without detection. Fewer yearling coho and Chinook were caught, 13 (assuming size at date) ompared with 130 presumed YOY.

A similar pattern at Ruby and Wigeon Lakes was seen at Multnomah North, where there was a greater proportion of introduced species in the two-way trap catch and a greater proportion of native species in SSWS catch.

Multnomah South

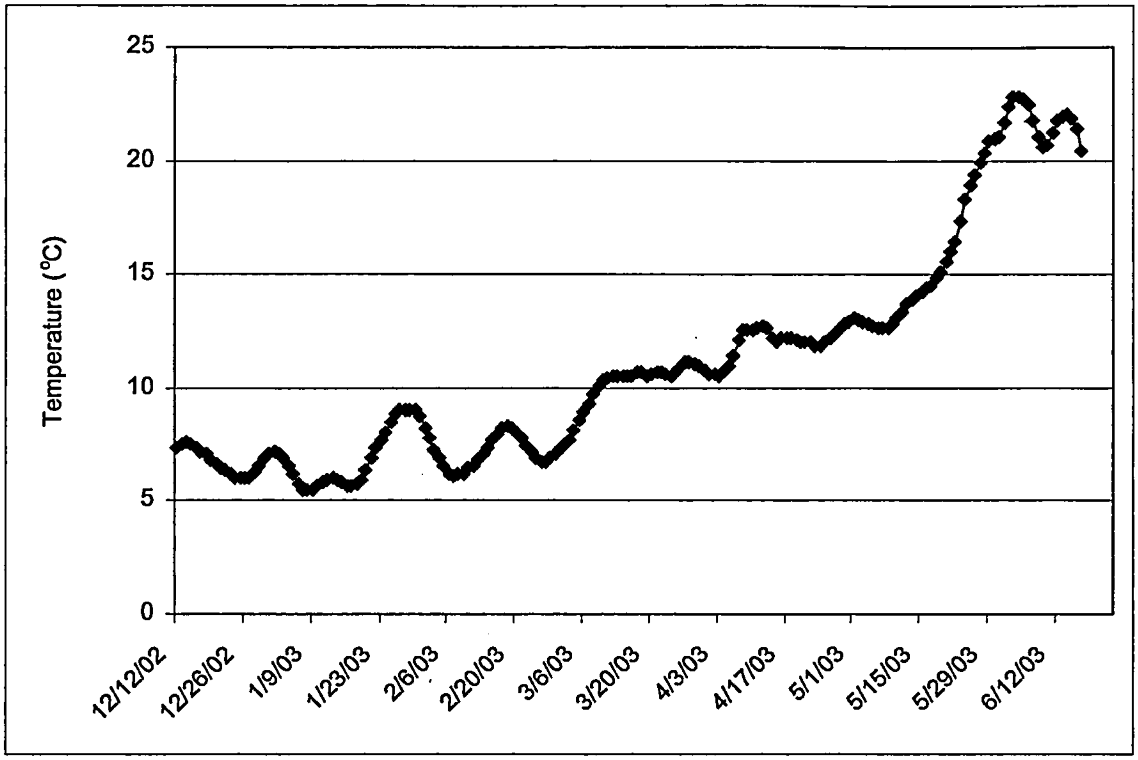
Multnomah South is located on the west side of the Multnomah Channel, just south of Multnomah North (Figure 13). A road prism separates the north and south units on this property and is connected by a culvert (invert elevation of the culvert is about 12 ft. NGVD 1929). Crabtree Creek flows into the wetland throughout the period that water is held by the structure. The half-round riser water-control structure was fully functional during the sampling season. Part of this structure, which is different than others in the fish-monitoring program, is a sloping-weir fishway (similar to a baffled culvert), which was installed to allow passage of salmonids out of the wetland (Figure 17). There are 7 notched baffles in the 37 foot-long sloping-weir fishway. The gradient is 13.5%.

Figure 17. Multnomah South water-control structure and sloping-weir fishway.

Multnomah South temperature and hydrology

Water temperature data were recorded on an hourly basis about two feet below the surface on the wetland side of the water-control structure from December 12, 2002 to June 23, 2003 (data provided by Metro). Figure 18 shows the seven-day average maximum temperature for that period. The Oregon state water quality temperature standard is exceeded when that the seven-day average maximum temperature exceeds 20°C (68°F) for waters of the Columbia River or its associated sloughs and channels (OAR 340-041-0006(54)*ii*). This standard was exceeded June 3, 2003 according to data taken near the surface.

Figure 18. Seven day average maximum temperature at Multnomah South, WY 2003*



*data courtesy of Curt Zonick, Metro Parks and Greenspaces

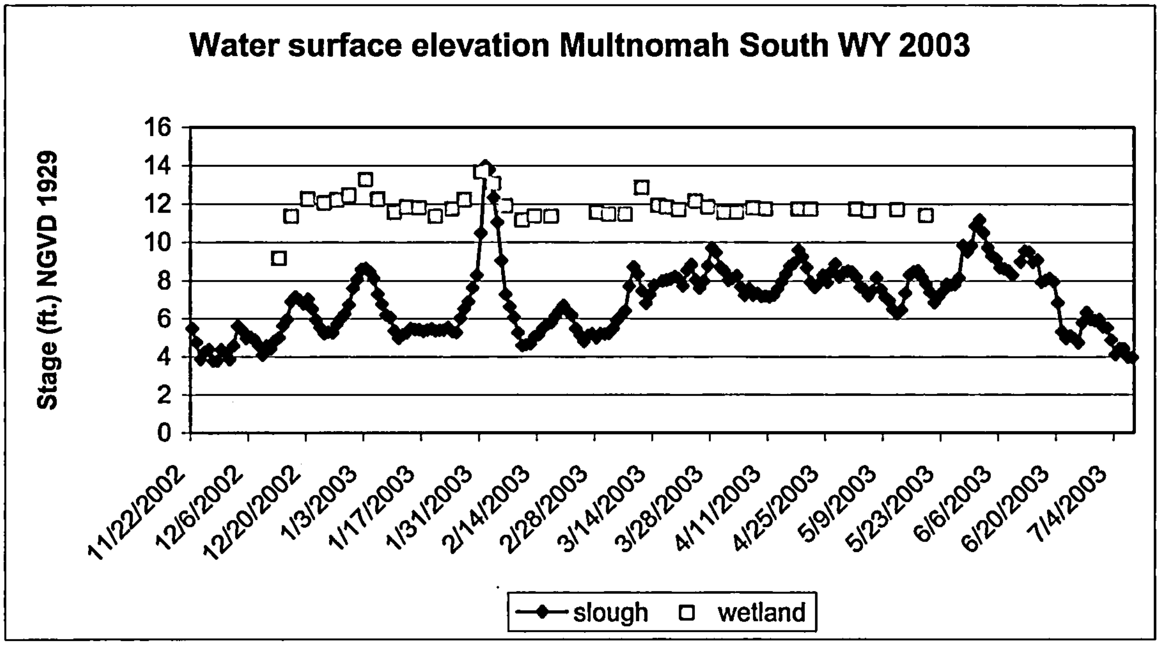
Staff-gage data were recorded throughout the period that the two-way trap was fished. These data were related to the USGS stage data for the Columbia River at Vancouver, Washington, which is recorded at 15-minute intervals. A linear regression analysis was done and an equation derived to relate the data sets (r^2=0.98). The equation was used to translate the data from the USGS gage to water-surface elevation data at Multnomah South (Figure 19). By comparing water-surface elevation to features of the control structure and landscape, a frequency of fish-passage opportunity can be estimated. Between November 22, 2002 and July 8, 2003 the dike was never overtopped. The riser boards were overtopped during the high-flow event February 2 (connectivity for 1.3% of the time Nov-July). At this time, the reverse-tide gate would have also been open while the water-surface elevation of the river was higher than the wetland.

Because of the constant and ample supply of water from Crabtree Creek, water ran over the riser boards and fishway constantly until they were removed in the spring, after the June 1 peak in the hydrograph.

The water-control structure held water during the winter and spring at about 12 ft. NGVD 1929. The structure held as much as 7.5 feet of water beyond what would have been there without the structure. Judging from figure 19, the water-surface elevation in the slough outside of the water-control structure hovered around 8 feet much of the year. The additional four feet of water-surface elevation achieved by use of the water-control structure provided additional wetland habitat.

Equation 4: μ {MSriver | USGS} = -0.065 + USGS*(0.93)

Figure 19. Comparison of water-surface elevation in wetland and slough at Multnomah South*.



*Dike 15.0 ft. Riser 12.0 ft.

Multnomah South SSWS

Sampling of the Multnomah South wetland was done December 17 and 18, 2002, February 18 and 19, April 22 and 23, and June 24 and 25, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap) with one exception. During the June sampling period the Oneida Lake trap was not used due to shallow water depths. Traps were fished for two 24-hour sets per sampling period.

A total of 21,686 fish, represented by 19 species, were captured in the Multnomah South wetland (Table 15). Threespine stickleback dominated the catch in total number (96.7% total catch) and biomass (21.6% of total). There was an especially abundant catch of threespine stickleback in June (20,744). Common carp and mosquitofish were the most abundant introduced fishes by number, 22% and 21%, respectively. Oriental weatherfish contributed the most biomass comprising 38% of the total weight of the introduced fish species, followed by brown bullhead with 11% and pumpkinseeds with 10%.

One Chinook salmon, probably YOY (102 mm), was captured during the April sampling period in the Multnomah South wetland. Pacific lamprey are another species of interest that were captured in Multnomah South. They have been listed by the state of Oregon as a sensitive species since 1993 (Kostow, 2002). Six pacific lamprey ammocetes (110-140 mm) were caught during the December sampling period and 3 ammocetes (125-140 mm) were caught during the February sampling period.

Table 15. SSWS catch at Multnomah South.

MoYr	Common Name	Family	NatInt	Number	MIN_FL (mm)	Max_FL (mm)	WT (g)
Dec-02	Peamouth	Cyprinidae	N	1	271	271	244
Dec-02	Threespined stickleback	Gasterosteidae	N	88	31	60	77
Dec-02	Pacific lamprey	Petromyzontidae	N	6	110	140	20
Dec-02	**Total Native**		**N**	**95**			**341**
Dec-02	Black crappie	Centrarchidae	I	2	66	78	12
Dec-02	Bluegill	Centrarchidae	I	4	34	143	149
Dec-02	Pumpkinseed	Centrarchidae	I	1	122	122	47
Dec-02	Oriental weatherfish	Cobitidae	I	32	52	165	498
Dec-02	Common carp	Cyprinidae	I	5	44	93	15
Dec-02	Brown bullhead	Ictaluridae	I	5	63	170	108
Dec-02	Mosquitofish	Poeciliidae	I	2	25	27	0
Dec-02	**Total Introduced**		**I**	**51**			**829**
	December Total			**146**			**1170**
Feb-03	Prickly sculpin	Cottidae	N	2	90	145	47
Feb-03	Threespined stickleback	Gasterosteidae	N	104	45	63	135
Feb-03	Pacific lamprey	Petromyzontidae	N	3	125	140	12
Feb-03	**Total Native**		**N**	**109**			**193**
Feb-03	Black crappie	Centrarchidae	I	1	97	97	15
Feb-03	Bluegill	Centrarchidae	I	6	107	130	225
Feb-03	Pumpkinseed	Centrarchidae	I	1	115	115	39
Feb-03	Oriental weatherfish	Cobitidae	I	14	65	160	504
Feb-03	Goldfish	Cyprinidae	I	2	49	155	37
Feb-03	Brown bullhead	Ictaluridae	I	7	150	250	771
Feb-03	**Total Introduced**		**I**	**31**			**1592**
	Total February			**140**			**1786**
Apr-03	Prickly sculpin	Cottidae	N	1	85	85	7
Apr-03	Peamouth	Cyprinidae	N	2	170	255	263
Apr-03	Threespined stickleback	Gasterosteidae	N	59	19	72	115
Apr-03	Chinook salmon	Salmonidae	N	1	102	102	16
Apr-03	**Total Native**		**N**	**63**			**401**
Apr-03	Bluegill	Centrarchidae	I	4	58	137	95
Apr-03	Pumpkinseed	Centrarchidae	I	5	63	126	166
Apr-03	Warmouth	Centrarchidae	I	2	130	130	124
Apr-03	Oriental weatherfish	Cobitidae	I	30	74	180	1147
Apr-03	Goldfish	Cyprinidae	I	2	86	240	132
Apr-03	Yellow perch	Percidae	I	3	126	138	83
Apr-03	**Total Introduced**		**I**	**46**			**1747**
	Total April			**109**			**2147**

Table 15. Catch from wetland sampling at Multnomah South (Continued).

MoYr	Common Name	Family	NatInt	Number	MIN_FL (mm)	Max_FL (mm)	WT (g)
Jun-03	Prickly sculpin	Cottidae	N	1	25	25	0
Jun-03	Redside shiner	Cyprinidae	N	32	22	42	15
Jun-03	Threespined stickleback	Gasterosteidae	N	20744	23	60	3768
Jun-03	**Total Native**		**N**	**20777**			**3784**
Jun-03	Black crappie	Centrarchidae	I	15	90	132	310
Jun-03	Bluegill	Centrarchidae	I	4	87	151	209
Jun-03	Crappie spp.	Centrarchidae	I	42	26	39	10
Jun-03	Largemouth bass	Centrarchidae	I	62	32	174	800
Jun-03	Pumpkinseed	Centrarchidae	I	27	77	150	751
Jun-03	Warmouth	Centrarchidae	I	12	87	158	662
Jun-03	Oriental weatherfish	Cobitidae	I	31	95	175	1549
Jun-03	Common carp	Cyprinidae	I	138	54	108	837
Jun-03	Goldfish	Cyprinidae	I	3	34	95	12
Jun-03	Banded killifish	Cyprinodontidae	I	34	22	50	35
Jun-03	Brown bullhead	Ictaluridae	I	7	89	155	176
Jun-03	Yellow perch	Percidae	I	3	32	49	4
Jun-03	Mosquitofish	Poeciliidae	I	135	10	58	152
Jun-03	**Total Introduced**		**I**	**513**			**5506**
	Total June			**21291**			**9438**
	Grand Total			**21686**			**14541**

Multnomah South fish passage monitoring at the sloping-weir fishway

The sloping-weir fishway is a component of the half-round riser water-control at Multnomah South. It has a flashboard riser and slotted weir that controls the water and a baffled culvert that allows fish passage over the water control structure. Fish-passage capability of this fishway was tested during the spring of 2003. The structure was not built with fish monitoring in mind so sampling gear was adapted to fit the need. Fish seemed to go down through the structure without delay or injury but it was not possible to document passage into the wetland via the fishway (Appendix A). A striking result of this monitoring was an estimated 9,200 threespine stickleback left the wetland overnight (May 12 to 13).

Multnomah North Amphibians/Invertebrates

A total of 1,524 amphibians were captured in the Multnomah South wetland. Six amphibian species were observed including bullfrogs, long toed salamanders, northwestern salamanders, pacific tree frogs, red-legged frogs, and some un-identified tadpoles. During the December sampling period red-legged frog tadpoles and bullfrog tadpoles were not differentiated due to difficulty in identifying the tadpoles. During the following sampling periods the field crew learned how to identify the tadpoles and they were not lumped into one group. The majority of the amphibians were captured in June comprising 78% of the total amphibians. Bullfrog tadpoles made up the majority of the amphibians (1,164) followed by red-legged frogs (119). Only 1 long toed salamander, 6 northwestern salamanders, and 4 pacific tree frogs were identified throughout the sampling period.

Multnomah South data summary

Connectivity of this wetland with Multnomah Channel appears to be limited. Exchange from the river to the wetland only occurs during very high flows (when water surface elevation in Multnomah Channel exceeds 12.0 ft. NGVD 1929). Fish and other aquatic organisms can exit through the structure via the sloping-weir fishway or over the riser boards. It is less clear to what extent biota can move in through the sloping-weir fishway. Connectivity in that direction is likely diminished, however.

One YOY Chinook (caught 4/23/03 at 102mm) was caught in the Multnomah South unit. It entered either at the South unit structure while the riser boards were overtopped or the reverse-tide gate was open or from the North unit, through the culvert under the road. Water would have been flowing through that culvert (invert elevation about 12 ft. NGVD 1929) for a brief period during the February 2 high-flow event.

Not surprising is the abundance of threespine stickleback in the SSWS catch (as well as catch out of the sloping-weir fishway). This catch corresponds with that in nearby Multnomah North, Ruby and Wigeon Lake.

McCarthy

The McCarthy site is private property with a tidal channel located on the west side of the Multnomah Channel just upstream of the Multnomah South site (Figure 13). McCarthy Creek flows into the McCarthy site providing a constant positive water source through the winter and spring. There is currently no water-control structure at the site and was thus sampled as a reference site. A pool-weir-chute is planned for installation to begin operation WY2005.

McCarthy temperature and hydrology

Water temperature data were not obtained at this site nor were staff gage data collected to relate to the USGS gaging station in Vancouver. Nearby stage data at Multnomah North or South give an indication of the hydrologic pattern through the winter and spring, though.

McCarthy SSWS results

Sampling of the McCarthy wetland was done December 19, 2002, February 11, April 10, and June 5, 2003. Fishes were sampled with the two box traps and two fyke nets during the December, February, and April sampling periods. The same gear was used for the June sampling with the addition of the Oneida Lake trap. Nets were set for a 24-hour period.

A total of 14,099 fish were captured in the McCarthy wetland (Table 16). Native fish dominated the catch in both total number of fish and biomass, comprising 98% and 91%, respectively, of the total fish captured. Seventeen different fish species were captured including 8 native species and 9 introduced species (Table 16). Threespine stickleback were the most abundant of the native fish species (91% of catch by number, 63% by weight). Black crappie were the most abundant of the introduced fish (85% of the total number of introduced fish and 81% of the total biomass).

A total of 1,086 salmon were caught in the McCarthy wetland. Three coho salmon, probably in the 1+ age class (93-104 mm), were captured during the December sampling period. One thousand and twelve Chinook salmon (that's 1,012!), probably in the 0+ age class (34-52 mm), and 52 coho salmon, probably in the 1+ age class (67-108 mm), were captured Feburary 11, 2003. Ten Chinook, probably in the 0+ age class (39-69 mm), and 9 coho salmon, probably in the 1+ age class (104-191 mm), were captured during the April sampling period. No salmon were captured during the June sampling period. Pacific lamprey are another species of interest that were captured in the McCarthy wetland. One pacific lamprey ammocetė (120 mm) was captured during the December sampling period and another ammocete (125 mm) was captured in February.

Table 16. SSWS catch at McCarthy.

MoYr	Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Dec-02	Largescale sucker	Catostomidae	N	1	454	454	990
Dec-02	Prickly sculpin	Cottidae	N	1	178	178	72
Dec-02	Northern pikeminnow	Cyprinidae	N	1	62	62	2
Dec-02	Peamouth	Cyprinidae	N	23	38	270	3355
Dec-02	Threespined stickleback	Gasterosteidae	N	7780	45	57	8330
Dec-02	Pacific lamprey	Petromyzontidae	N	1	120	120	3
Dec-02	Coho salmon	Salmonidae	N	3	93	104	43
Dec-02	**Total Native**		**N**	**7810**			**12795**
Dec-02	Black crappie	Centrarchidae	I	232	64	91	1569
Dec-02	Bluegill	Centrarchidae	I	4	50	125	104
Dec-02	Smallmouth bass	Centrarchidae	I	1	111	111	0
Dec-02	Yellow perch	Percidae	I	2	84	91	17
Dec-02	**Total Introduced**		**I**	**239**			**1690**
	December Total			**8049**			**14485**
Feb-03	Largescale sucker	Catostomidae	N	2	34	48	2
Feb-03	Prickly sculpin	Cottidae	N	5	60	68	15
Feb-03	Northern pikeminnow	Cyprinidae	N	48	30	59	41
Feb-03	Threespined stickleback	Gasterosteidae	N	3177	47	57	3618
Feb-03	Pacific lamprey	Petromyzontidae	N	1	125	125	3
Feb-03	Chinook salmon	Salmonidae	N	1012	34	52	1248
Feb-03	Coho salmon	Salmonidae	N	52	67	108	630
Feb-03	**Total Native**		**N**	**4297**			**5559**
Feb-03	Crappie spp.	Centrarchidae	I	16	62	87	51
Feb-03	Goldfish	Cyprinidae	I	1	53	53	2
Feb-03	Banded killifish	Cyprinodontidae	I	1	40	40	1
Feb-03	**Total Introduced**		**I**	**18**			**53**
	February Total			**4315**			**5612**
Apr-03	Prickly sculpin	Cottidae	N	10	81	154	222
Apr-03	Peamouth	Cyprinidae	N	3	83	249	378
Apr-03	Threespined stickleback	Gasterosteidae	N	1063	49	61	1445
Apr-03	Chinook salmon	Salmonidae	N	10	39	69	25
Apr-03	Coho salmon	Salmonidae	N	9	104	191	317
Apr-03	**Total Native**		**N**	**1095**			**2386**
Apr-03	Black crappie	Centrarchidae	I	1	96	96	14
Apr-03	Bluegill	Centrarchidae	I	1	66	66	6
Apr-03	**Total Introduced**		**I**	**2**			**20**
	April Total			**1097**			**2406**
Jun-03	Prickly sculpin	Cottidae	N	31	87	164	875
Jun-03	Threespined stickleback	Gasterosteidae	N	569	22	66	811
Jun-03	**Total Native**		**N**	**600**			**1686**
Jun-03	Black crappie	Centrarchidae	I	20	74	116	263
Jun-03	Bluegill	Centrarchidae	I	5	45	105	63
Jun-03	Pumpkinseed	Centrarchidae	I	5	91	102	113
Jun-03	White crappie	Centrarchidae	I	1	92	92	8
Jun-03	Common carp	Cyprinidae	I	3	102	131	50
Jun-03	Goldfish	Cyprinidae	I	2	115	118	32
Jun-03	Banded killifish	Cyprinodontidae	I	2	31	32	1
Jun-03	**Total Introduced**		**I**	**38**			**530**
Jun-03	**June Total**		**I**	**638**			**2216**
	Grande Total			**14099**			**24720**

McCarthy Amphibians/Invertebrates

One adult bullfrog and 88 unidentified tadpoles that ranged in size from 45 to 71mm were caught in late-December. The tadpoles were likely bullfrogs. One Asian freshwater shrimp was caught in April.

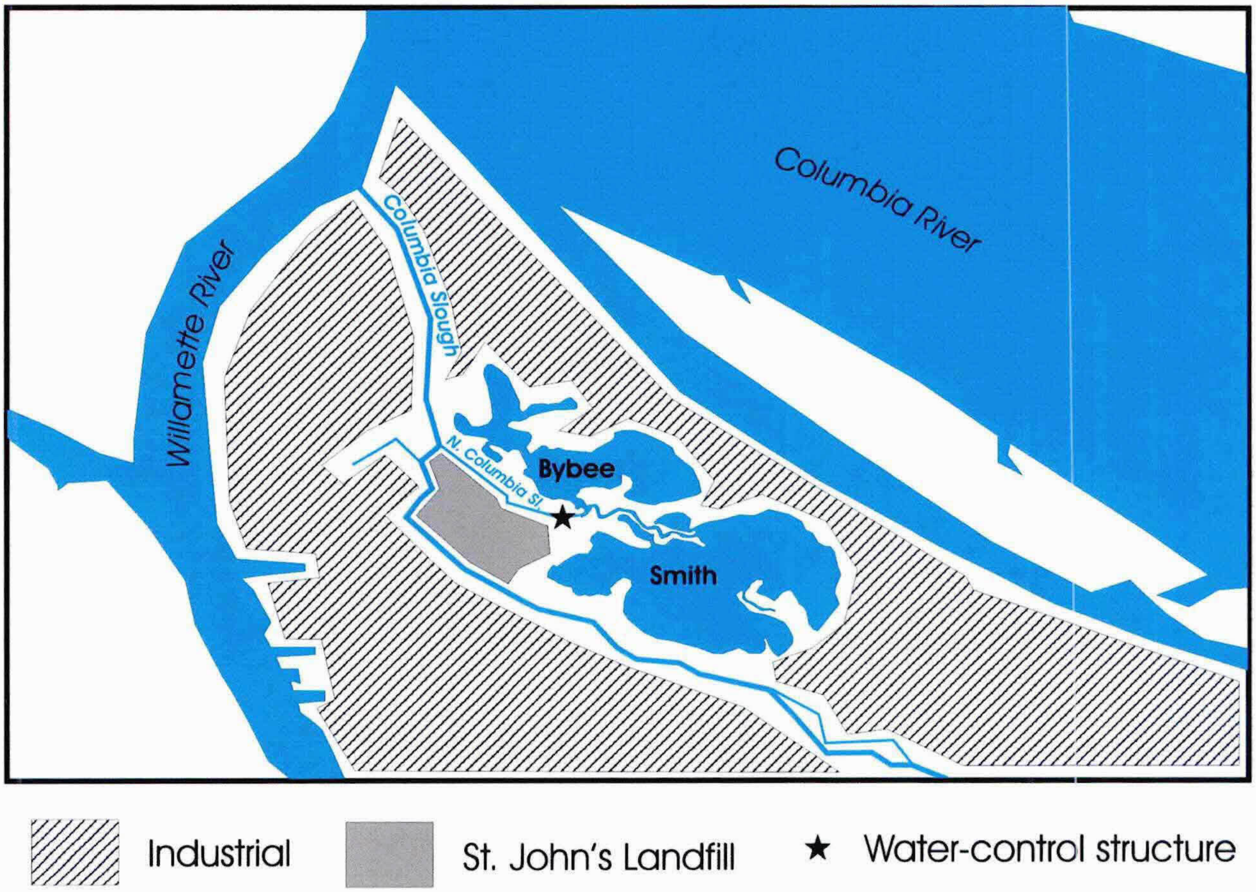
McCarthy data summary

The most notable data at this site was the large catch of YOY Chinook that most likely came into the wetland during the high-flow event February 2, 2003. These fish did not appear to stay in the tidal channel for an extended period, as the SSWS data would suggest from April, when only 10 YOY Chinook were caught.

<u>Columbia Slough, North Columbia Slough and Smith and Bybee Lakes</u>

Smith (800 acres) and Bybee (600 acres) Lakes are seasonal emergent and forested wetland habitats located in North Portland (Figure 20). They are connected to the Willamette River via the Columbia Slough and North Columbia Slough. Pre-project sampling was conducted at this site in anticipation of replacing the current water-control structure with a pool-weir-chute control structure. The project will occur before the next sampling season (in November 2004) and will remove the existing dam and flap gate and install a large, multi-celled water control structure to accommodate fish passage and habitat management. The primary objective of the project is to restore, to the maximum extent possible, the natural hydrology to these large wetlands, with the understanding that during some periods of the year water will need to be physically retained within the wetlands for vegetation management. Currently, water can flow out through the flap gate when the weir is open, but no water can flow into the wetlands from the slough, except when water from the slough rises to above 11 ft. NGVD 1929. The new pool-weir-chute water-control structure will allow fish passage between the Columbia Slough and Smith and Bybee Lakes. For a more complete description of past management and impacts at this site, the reader should refer to the 2002 annual report (Baker and Miranda 2003a,b).

Figure 20. Columbia Slough and Smith and Bybee Lakes.



Columbia Slough temperature and hydrology

The City of Portland operated a Hydrolab® multiprobe in the Columbia Slough at the St. John's Landfill bridge. They recorded water temperature on an hourly basis October 31, 2002 to September 30, 2003. Figure 21 shows the seven-day average maximum for that period. The Oregon state water quality temperature standard is exceeded when that the seven-day average maximum temperature exceeds 20°C (68°F) for waters of the Columbia River or its associated sloughs and channels (OAR 340-041-0006(54)*ii*). This standard was exceeded May 27, 2003 according to data collected in the Columbia Slough.

Figure 22 shows the daily average stage for the Columbia Slough at Lombard Street during WY 2003. When the water surface elevation is above 11 ft. NGVD 1929, water from the Columbia Slough enters Smith/Bybee Lakes in a dike breech on the west side of Bybee Lake. This occurred for three days, February 1-3, 2003.

Figure 21. Seven day maximum average temperature in the Columbia Slough at the St. John's Landfill Bridge, WY 2003

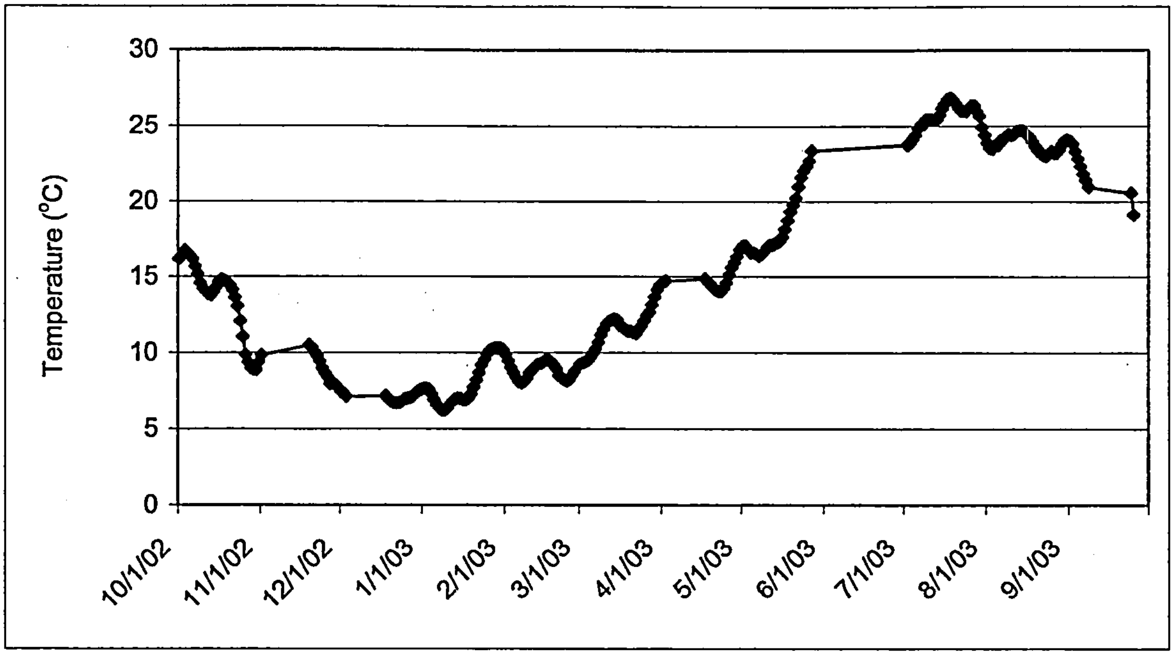
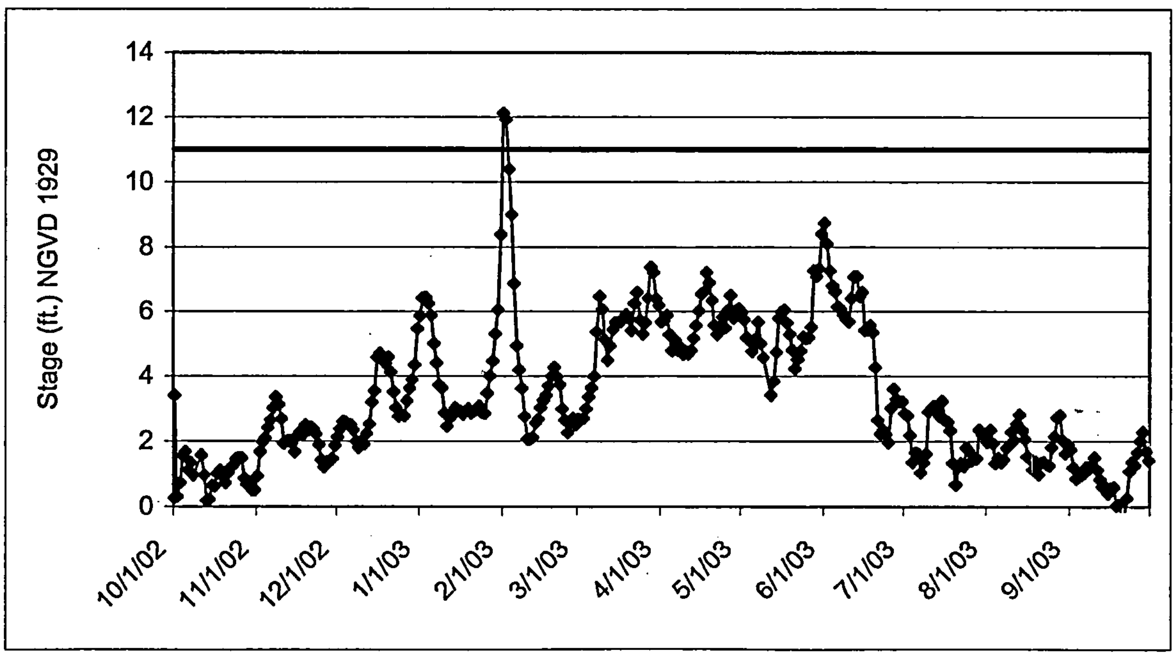


Figure 22. Daily average stage (NGVD 1929) of the Columbia Slough at Lombard St. (USGS 14211820).



Columbia Slough SSWS

Sampling within the Columbia Slough took place near its confluence with the Willamette River near Kelly Point Park. Sampling was done November 19, 2002, January 14, March 18, and May 1, 2003. Fishes were sampled in the Columbia Slough with the Oneida Lake trap. The trap was set for 24 hours during each sampling period.

A total of 193 fish were caught in the Columbia Slough (Table 17). Native species dominated the total catch (78% of catch by number, 74% by weight) throughout the sampling season. Native species caught included threespine stickleback, largescale sucker (*Catostomus macrocheilus*), and prickly sculpin. Threespine stickleback were the most abundant and the one largescale sucker caught had the greatest biomass. Introduced fishes in the catch included black crappie, common carp, yellow perch, pumpkinseed, brown bullhead, and yellow bullhead. No amphibians were captured in the Columbia Slough.

Capture efficiency of the Oneida Lake trap is likely quite low in the Columbia Slough due to strong currents. This made it difficult to effectively set the trap, potentially limiting the number and diversity of fish caught.

Table 17. SSWS catch at Columbia Slough.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Nov-02	Largescale sucker	Catostomidae	N	1	440	440	902
Nov-02	Threespined stickleback	Gasterosteidae	N	3	25	50	2
Nov-02	**Total Native**		N	4			**903**
Nov-02	Black crappie	Centrarchidae	I	6	48	70	19
Nov-02	Common carp	Cyprinidae	I	16	75	130	157
Nov-02	**Total Introduced**		I	22			**177**
	November Total			**26**			**1080**
Jan-03	Prickly sculpin	Cottidae	N	4	118	149	126
Jan-03	Threespined stickleback	Gasterosteidae	N	111	43	58	109
Jan-03	**Total Native**		N	**115**			**235**
Jan-03	**Total Introduced**		I	**0**			**0**
	January Total			**115**			**235**
Mar-03	Prickly sculpin	Cottidae	N	8	101	168	267
Mar-03	Threespined stickleback	Gasterosteidae	N	5	57	60	8
Mar-03	**Total Native**		N	**13**			**275**
Mar-03	Yellow perch	Percidae	I	16	74	106	166
Mar-03	**Total Introduced**		I	**16**			**166**
	March Total			**29**			**441**
May-03	Prickly sculpin	Cottidae	N	14	105	164	418
May-03	Threespined stickleback	Gasterosteidae	N	5	55	59	8
May-03	**Total Native**		N	**19**			**426**
May-03	Pumpkinseed	Centrarchidae	I	1	102	102	26
May-03	Brown bullhead	Ictaluridae	I	1	183	183	83
May-03	Yellow bullhead	Ictaluridae	I	2	184	202	207
May-03	**Total Introduced**		I	4			**316**
	May Total			**23**			**742**
	Grand Total			**193**			**2498**

North Columbia Slough SSWS

Sampling of the North Columbia Slough was done November 19, 2002, January 14, March 18, May 1, and July 2, 2002. Fish were sampled in the North Columbia Slough using the Oneida Lake trap. The trap was set for 24 hours during each sampling period.

A total of 43,796 fish were caught in the North Columbia Slough (Table 18). There were 17 species captured: 6 native and 11 introduced species. Native fishes dominated both in catch by number and catch by weight comprising 97% and 59% respectively of the total catch. Threespine stickleback dominated in both number and biomass during the November and January sampling periods. During the March and May sampling periods threespine stickleback dominated in number, while largescale suckers dominated in biomass. Brown bullhead dominated both in number and biomass during the July sampling. Three bullfrog tadpoles were captured in the North Columbia Slough during the November sampling period. No other amphibians were captured.

Seventy Chinook were caught in the North Columbia Slough. One individual was probably in the 1+ age class (130 mm) and 69 were fry. The 1+ Chinook was caught in November. The 0+ Chinook were caught first in January (27 fry) ranging in size from 39-46mm and then again in March (42 fry) ranging from 44-79mm. No salmonids were captured during the May and July sampling periods.

Table 18. SSWS catch at the North Columbia Slough.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Nov-02	Largescale sucker	Catostomidae	N	10	400	490	9579
Nov-02	Prickly sculpin	Cottidae	N	17	88	152	452
Nov-02	Peamouth	Cyprinidae	N	1	245	245	180
Nov-02	Redside shiner	Cyprinidae	N	2	60	76	8
Nov-02	Threespined stickleback	Gasterosteidae	N	6150	45	60	6589
Nov-02	Chinook salmon	Salmonidae	N	1	130	130	31
Nov-02	**Total Native**		**N**	**6181**			**16838**
Nov-02	Black crappie	Centrarchidae	I	707	44	107	4854
Nov-02	Bluegill	Centrarchidae	I	1	57	57	4
Nov-02	Largemouth bass	Centrarchidae	I	12	114	373	2822
Nov-02	Pumpkinseed	Centrarchidae	I	4	95	119	127
Nov-02	White crappie	Centrarchidae	I	1	61	61	2
Nov-02	Common carp	Cyprinidae	I	122	63	150	1465
Nov-02	Brown bullhead	Ictaluridae	I	2	67	215	139
Nov-02	Yellow perch	Percidae	I	83	82	129	1160
Nov-02	**Total Introduced**		**I**	**932**			**10572**
	November Total			**7113**			**27410**
Jan-03	Largescale sucker	Catostomidae	N	2	450	475	2097
Jan-03	Prickly sculpin	Cottidae	N	8	64	135	115
Jan-03	Northern pikeminnow	Cyprinidae	N	1	58	58	2
Jan-03	Threespined stickleback	Gasterosteidae	N	26695	32	57	17950
Jan-03	Chinook salmon	Salmonidae	N	27	39	46	45
Jan-03	**Total Native**		**N**	**26733**			**20209**
Jan-03	Black crappie	Centrarchidae	I	44	52	92	212
Jan-03	Pumpkinseed	Centrarchidae	I	1	111	111	35
Jan-03	Common carp	Cyprinidae	I	32	64	570	1993
Jan-03	Goldfish	Cyprinidae	I	13	74	138	203

Table 18. Catch from wetland sampling at the North Columbia Slough (Continued).

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Jan-03	Brown bullhead	Ictaluridae	I	1	174	174	71
Jan-03	Yellow perch	Percidae	I	59	80	185	1262
Jan-03	**Total Introduced**		**I**	**150**			**3776**
	January Total			**26883**			**23985**
Mar-03	Largescale sucker	Catostomidae	N	69	309	540	59121
Mar-03	Prickly sculpin	Cottidae	N	4	85	135	86
Mar-03	Peamouth	Cyprinidae	N	6	85	260	743
Mar-03	Threespined stickleback	Gasterosteidae	N	9130	51	62	12401
Mar-03	Chinook salmon	Salmonidae	N	42	44	79	162
Mar-03	**Total Native**		**N**	**9250**			**72513**
Mar-03	Black crappie	Centrarchidae	I	58	166	283	9546
Mar-03	Pumpkinseed	Centrarchidae	I	2	115	135	106
Mar-03	White crappie	Centrarchidae	I	2	250	270	542
Mar-03	Common carp	Cyprinidae	I	5	390	485	4025
Mar-03	Goldfish	Cyprinidae	I	4	127	170	140
Mar-03	Brown bullhead	Ictaluridae	I	30	182	366	6137
Mar-03	Yellow bullhead	Ictaluridae	I	3	216	265	630
Mar-03	Yellow perch	Percidae	I	55	84	218	1474
Mar-03	**Total Introduced**		**I**	**159**			**22600**
Mar-03	**March Total**			**9410**			**95115**
May-03	Largescale sucker	Catostomidae	N	37	54	510	25420
May-03	Prickly sculpin	Cottidae	N	11	68	168	299
May-03	Peamouth	Cyprinidae	N	3	75	233	171
May-03	Threespined stickleback	Gasterosteidae	N	89	49	65	136
May-03	**Total Native**		**N**	**140**			**26026**
May-03	Black crappie	Centrarchidae	I	19	80	258	2206
May-03	Pumpkinseed	Centrarchidae	I	6	112	147	356
May-03	Common carp	Cyprinidae	I	39	143	830	40200
May-03	Goldfish	Cyprinidae	I	10	45	218	232
May-03	Brown bullhead	Ictaluridae	I	7	80	278	976
May-03	Yellow bullhead	Ictaluridae	I	6	236	317	2019
May-03	Yellow perch	Percidae	I	7	54	245	219
May-03	**Total Introduced**		**I**	**94**			**46207**
	May Total			**234**			**72233**
Jul-03	Prickly sculpin	Cottidae	N	3	41	122	42
Jul-03	Threespined stickleback	Gasterosteidae	N	2	67	72	6
Jul-03	**Total Native**		**N**	**5**			**47**
Jul-03	Black crappie	Centrarchidae	I	19	53	220	833
Jul-03	Pumpkinseed	Centrarchidae	I	5	95	137	258
Jul-03	Warmouth	Centrarchidae	I	3	65	137	107
Jul-03	White crappie	Centrarchidae	I	9	45	285	556
Jul-03	Common carp	Cyprinidae	I	5	71	550	4149
Jul-03	Goldfish	Cyprinidae	I	10	53	173	321
Jul-03	Brown bullhead	Ictaluridae	I	85	92	250	4914
Jul-03	Yellow bullhead	Ictaluridae	I	6	210	325	1754
Jul-03	Yellow perch	Percidae	I	9	66	145	187
Jul-03	**Total Introduced**		**I**	**151**			**13078**
	July Total			**156**			**13125**
	Grand Total			**43796**			**231869**

Smith and Bybee Lakes SSWS

Smith and Bybee Lakes were sampled May 6 and 7, and July 2 and 3, 2003. Traps were fished for two 24-hour sets during each sampling period. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap) during the May sampling period. The standard gear was used in the July sampling period with the exception of the Oneida Lake trap due to shallow water.

A total of 5,118 fish were caught in Smith and Bybee Lakes (Table 19). Fifteen different fish species were captured including 4 native species and 11 introduced species. Introduced fish dominated both in numbers and in biomass comprising 84% and 93% respectively of the total fish captured. Black crappie were the most abundant introduced fish species, with 63% of the biomass. Threespine stickleback were the most abundant native fish species (98% of catch by numbers, 75% by weight). Substantially more fish were captured in July as compared to May (94% of total catch by numbers, 85% by weight) even though the Oneida Lake trap was not used in July. Two Chinook salmon, probably in the 1+ age class (147 mm each), were caught in Smith and Bybee Lakes. Both were caught during the May sampling period. Only 1 amphibian was captured during the two sampling periods at Smith and Bybee Lakes. It was a bullfrog tadpole captured during the July sampling period.

Table 19. SSWS catch at Smith and Bybee Lakes.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
May-03	Prickly sculpin	Cottidae	N	9	27	108	86
May-03	Threespined stickleback	Gasterosteidae	N	206	18	69	265
May-03	Chinook salmon	Salmonidae	N	2	147	147	85
May-03	**Total Native**		N	**217**			**436**
May-03	Black crappie	Centrarchidae	I	2	85	95	23
May-03	Bluegill	Centrarchidae	I	15	45	102	101
May-03	Pumpkinseed	Centrarchidae	I	27	63	118	402
May-03	Warmouth	Centrarchidae	I	1	116	116	44
May-03	White crappie	Centrarchidae	I	1	93	93	8
May-03	Common carp	Cyprinidae	I	5	65	180	78
May-03	Brown bullhead	Ictaluridae	I	28	52	285	607
May-03	Yellow perch	Percidae	I	1	102	102	13
May-03	**Total Introduced**		I	**80**			**1277**
	May Total			**297**			**1714**
Jul-03	Prickly sculpin	Cottidae	N	1	114	114	18
Jul-03	Northern pikeminnow	Cyprinidae	N	2	32	92	8
Jul-03	Threespined stickleback	Gasterosteidae	N	523	25	67	315
Jul-03	**Total Native**		N	**526**			**342**
Jul-03	Black crappie	Centrarchidae	I	2474	37	142	6880
Jul-03	Bluegill	Centrarchidae	I	3	49	121	47
Jul-03	Largemouth bass	Centrarchidae	I	1	48	48	1
Jul-03	Pumpkinseed	Centrarchidae	I	18	96	149	654
Jul-03	Common carp	Cyprinidae	I	583	30	94	771
Jul-03	Goldfish	Cyprinidae	I	1	190	190	64
Jul-03	Brown bullhead	Ictaluridae	I	1214	22	195	1177
Jul-03	Mosquitofish	Poeciliidae	I	1	35	35	0
Jul-03	**Total Introduced**		I	**4295**			**9594**
	July Total			**4821**			**9935**
	Grand Total			**5118**			**11649**

Smith/Bybee, North Columbia Slough and Columbia Slough data summary

There was much greater catch in the North Columbia Slough than the Columbia Slough for the same amount of effort. The velocity of the water may be too great in the main slough to fish the Oneida Lake trap, as those sets have not been as good due to the difficulty of setting a large net under conditions of flowing water. Sampling at Smith and Bybee Lakes did not begin until May so salmonid catch may have been greater had sampling occurred earlier in the year. The Chinook likely entered Smith and Bybee Lakes February 1-3 when the water from the Columbia Slough entered Smith/Bybee Lakes through the dike breach. The 27 YOY Chinook that were present in the North Columbia Slough in January and the 42 that were caught in March demonstrate that these fish may enter Smith and Bybee Lakes to rear if given access.

La Center

LaCenter Bottoms is a 184-acre project just south of the town of LaCenter and on the east bank of the East Fork Lewis River (Figure 23). The purpose of this project is to restore floodplain wetlands. Currently, a ditch drains the wetland. A dike, now with a failing slide-gate, has kept the East Fork Lewis River from inundating the floodplain wetland. The old structure will be removed during the summer/fall of 2004 and a set-back levee with a pool-weir-chute water-control structure will be constructed to create about 50 acres of palustrine emergent marsh. Another 30-40 acres will be planted in native trees to restore forested riparian habitat.

Figure 23. Aerial view of LaCenter Bottoms.

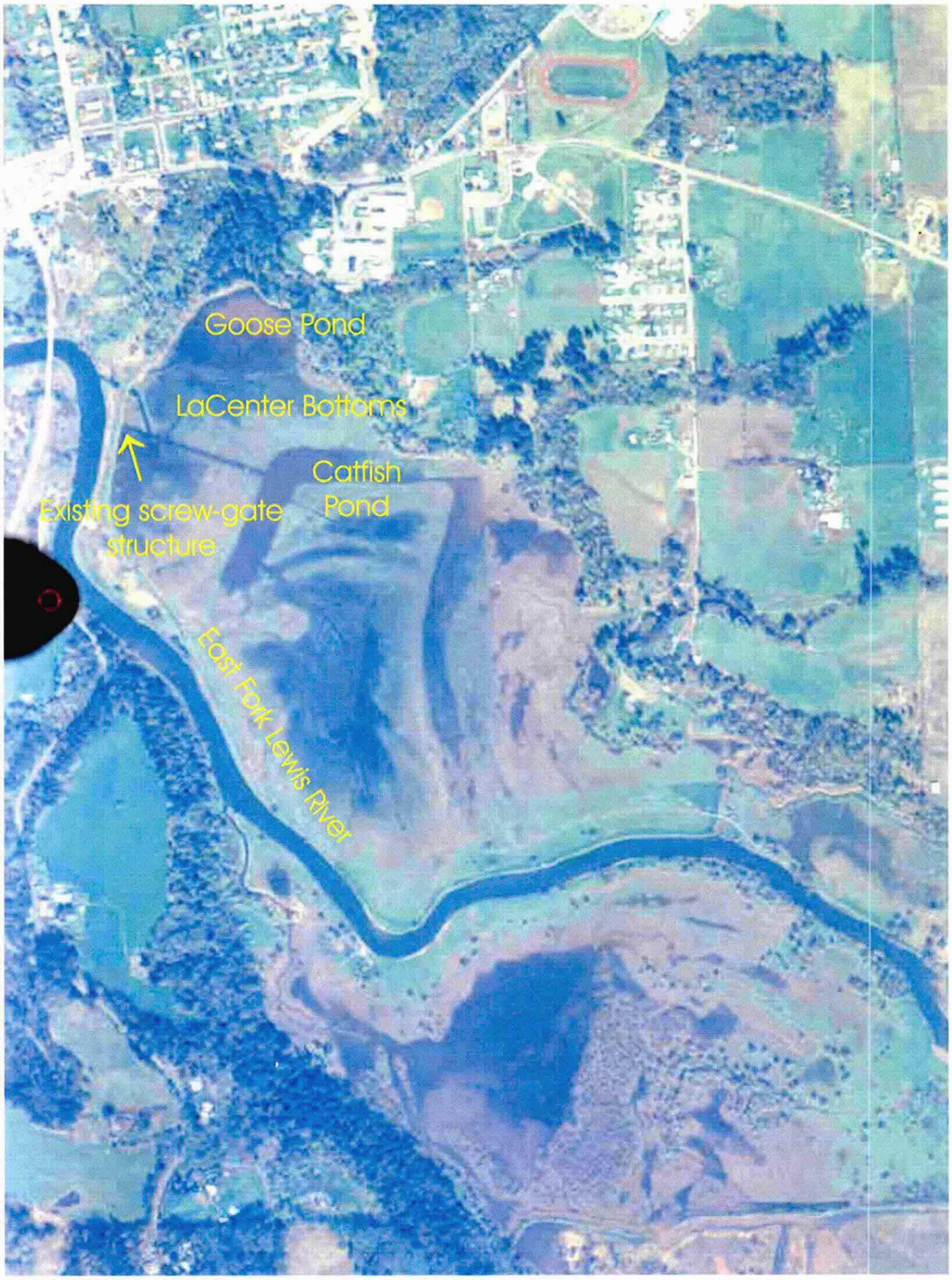
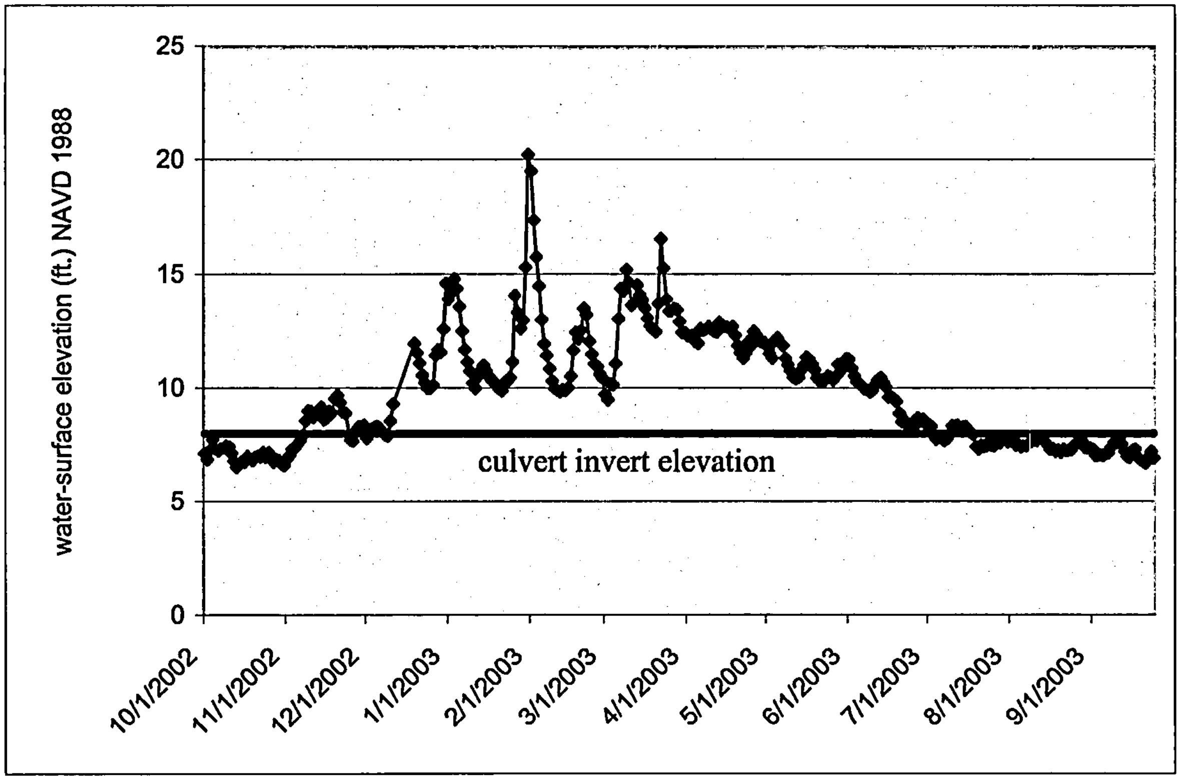


Figure 25. Predicted water-surface elevation for the East Fork Lewis at LaCenter (NAVD 1988) for WY 2003.



La Center SSWS

Sampling of the La Center wetland was done March 15, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap). Nets were set for a 24-hour period.

A total of 221 fish were captured in the La Center wetland (Table 20). Eleven different fish species were caught including 9 native species and 2 introduced species. Native fish dominated the catch (99% catch by number, 96% catch by weight). Threespine stickleback dominated the total catch by number (57%), followed by redside shiners (22%) and northern pikeminnows (10%). Largescale suckers were the most abundant fish species by weight comprising 76% of the total biomass.

Ten salmon were caught in the La Center wetland. Six of the salmon were coho, five of which were probably in the 1+ age class (102 –115 mm) and one in the 0+ age class (54 mm). The remaining four salmon were also in the 0+ age class (37-48 mm) but the species were too small to be identified with certainty.

Ten rough-skinned newts and 2 red-legged frog tadpoles were captured during the La Center sampling period.

LaCenter temperature and hydrology

Water temperature data were recorded on an hourly basis about two feet below the surface in the East Fork Lewis River, on the other side of the dike from the project, and in the two semi-permanent ponds, referred to as Goose and Catfish Ponds (Figure 24).

Part of the dike was breached by high water in the past. The affected portions are now lower than rest, 14 ft. NAVD 1988 and 20 ft. NAVD 1988, respectively. The invert of the culvert, which drains the wetland, is at 8 ft. NAVD 1988. Hydrologic analysis was completed at the site for project design purposes, but also aids in fish data interpretation (Appendix B). On average, the stage of the East Fork Lewis at LaCenter is below 8 ft., thus the culvert is dry, from mid-July until late October based on predicted daily average stage data from the period 10/1/90 to 9/30/01. On average, from November through mid-July water may be high enough to reach the invert elevation of the culvert but may not be deep enough to sample fish with trap nets. The minimum water-surface elevation for the East Fork Lewis at LaCenter to sample fish in LaCenter Bottoms wetland is about 13 ft. NAVD 1988, which occurs periodically (Figure 25). The predicted water-surface elevation for the East Fork Lewis River at LaCenter for WY 2003 is shown in figure 25 (calculated from Appendix B). The river was connected to the wetland via the culvert under the dike from November 8, 2002 to July 18, 2003. The breached part of the dike was overtopped December 31, 2002 to January 4, 2003 and January 26 through February 4, 2003.

Figure 24. Water temperature in E. Fk. Lewis R. and two wetland ponds near LaCenter.

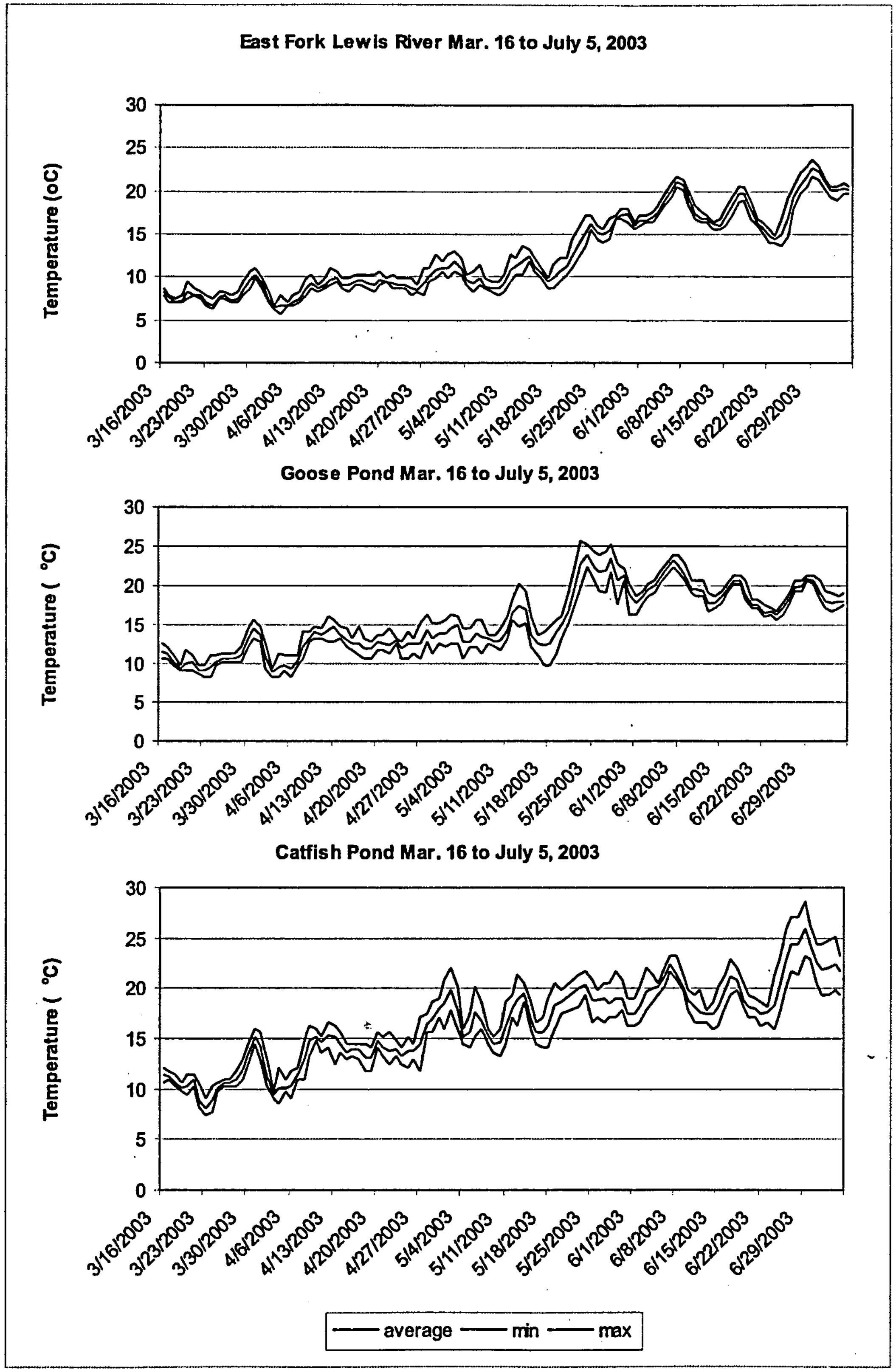
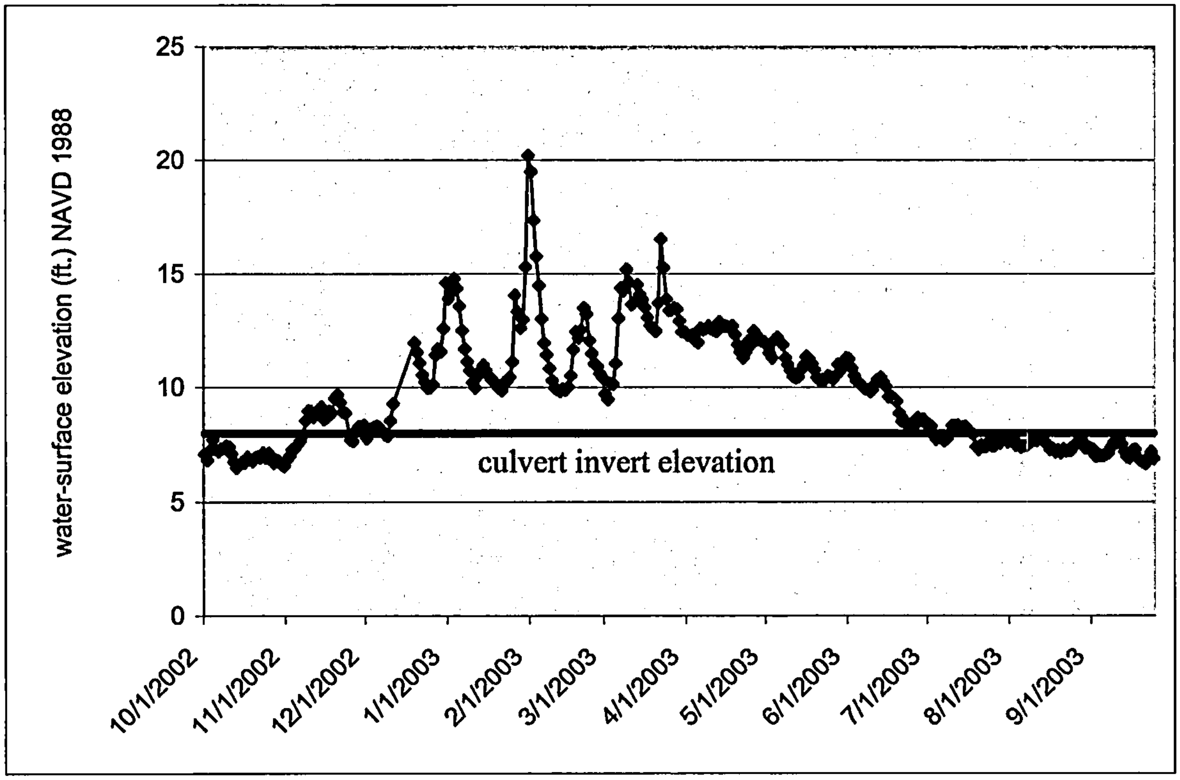


Figure 25. Predicted water-surface elevation for the East Fork Lewis at LaCenter (NAVD 1988) for WY 2003.



La Center SSWS

Sampling of the La Center wetland was done March 15, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap). Nets were set for a 24-hour period.

A total of 221 fish were captured in the La Center wetland (Table 20). Eleven different fish species were caught including 9 native species and 2 introduced species. Native fish dominated the catch (99% catch by number, 96% catch by weight). Threespine stickleback dominated the total catch by number (57%), followed by redside shiners (22%) and northern pikeminnows (10%). Largescale suckers were the most abundant fish species by weight comprising 76% of the total biomass.

Ten salmon were caught in the La Center wetland. Six of the salmon were coho, five of which were probably in the 1+ age class (102 –115 mm) and one in the 0+ age class (54 mm). The remaining four salmon were also in the 0+ age class (37-48 mm) but the species were too small to be identified with certainty.

Ten rough-skinned newts and 2 red-legged frog tadpoles were captured during the La Center sampling period.

Table 20. SSWS catch at La Center.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Mar-03	Largescale sucker	Catostomidae	N	6	57	470	2561
Mar-03	Unidentified sculpin	Cottidae	N	2	72	83	11
Mar-03	Prickly sculpin	Cottidae	N	3	65	150	63
Mar-03	Northern pikeminnow	Cyprinidae	N	21	35	92	84
Mar-03	Peamouth	Cyprinidae	N	1	242	242	173
Mar-03	Redside shiner	Cyprinidae	N	49	34	98	74
Mar-03	Threespined stickleback	Gasterosteidae	N	126	22	59	153
Mar-03	Coho salmon	Salmonidae	N	6	54	115	104
Mar-03	Unidentified salmonid	Salmonidae	N	4	37	48	7
	Total Native		N	**218**			**3230**
Mar-03	Bluegill	Centrarchidae	I	1	129	129	45
Mar-03	Goldfish	Cyprinidae	I	2	152	170	81
	Total Introduced		I	3			126
	Grand Total		I	**221**			**3356**

LaCenter data summary

During the sampling period, which followed a small peak in the hydrograph, mostly native fishes were caught, including ten salmonids. These were mostly coho yearlings and YOY, although some were not positively identified due to their small size. Presently, this wetland does not provide significant rearing habitat because of the existing drainage ditch.

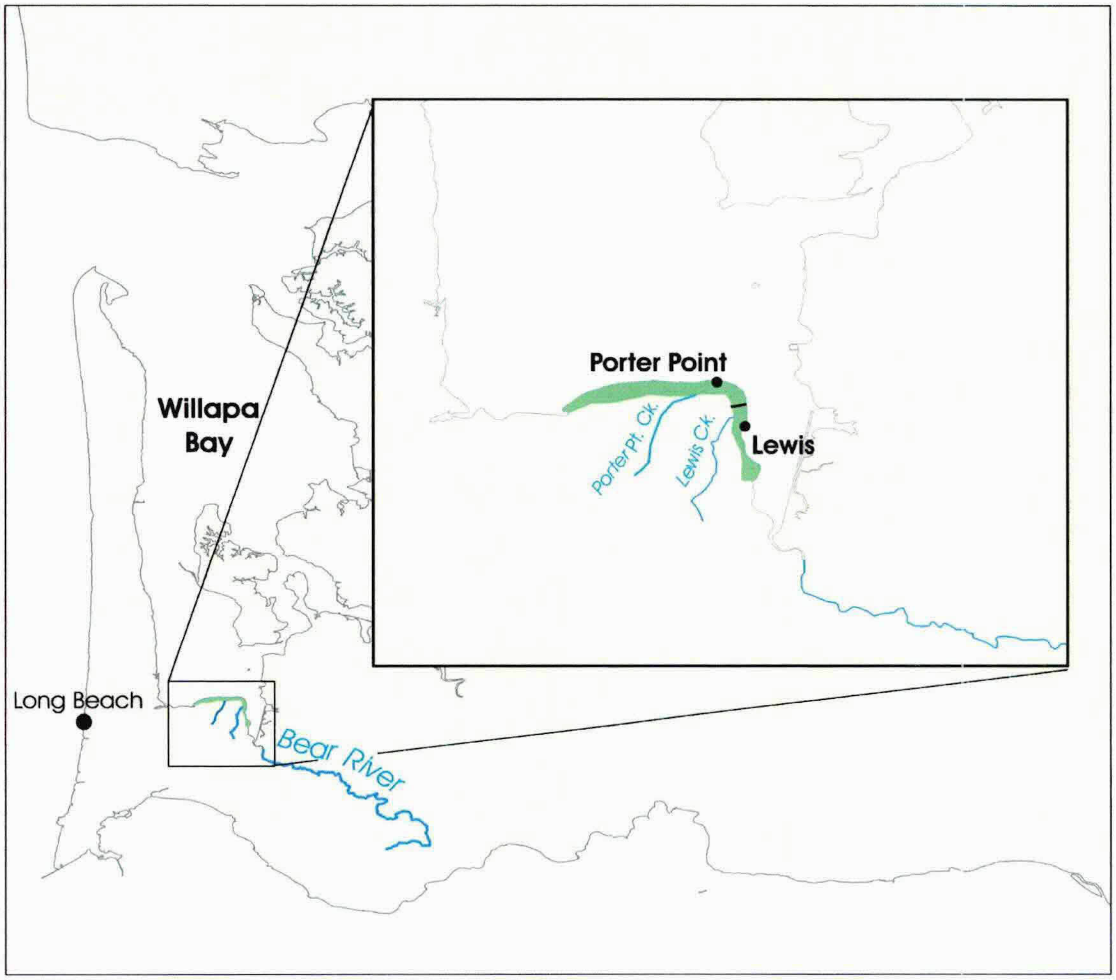
Washington Coast

Two areas of the Washington Coast were sampled in 2003: Willapa Bay National Wildlife Refuge and sites on the lower Chehalis River. The sites on the lower Chehalis River were sampled in partnership with Julie Henning of Washington Department of Fish and Wildlife. Ms. Henning will be reporting on the results from those sites separately.

Lewis and Porter Point Units

Lewis and Porter Point wetlands are located in the Willapa Bay National Wildlife Refuge (Figure 26). The Willapa Bay NWR is on the southern end of Willapa Bay. Unnamed creeks, which will be referred to as Lewis and Porter Creeks, contribute a positive water source to each of the units and pool-weir-chute water-control structures are functioning at both units. For a more complete description of this study site, the reader should refer to the 2002 annual report (Baker and Miranda 2003a,b).

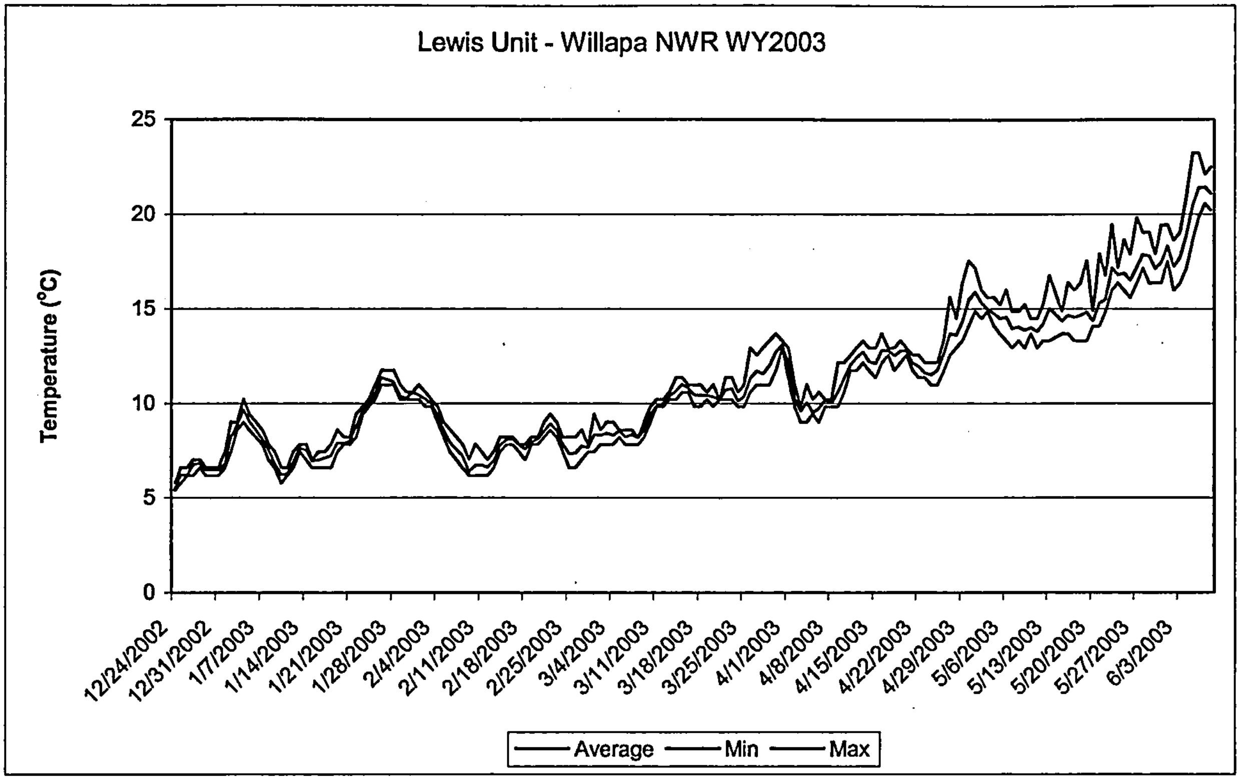
Figure 26. Lewis and Porter Point wetlands, Willapa Bay National Wildlife Refuge.

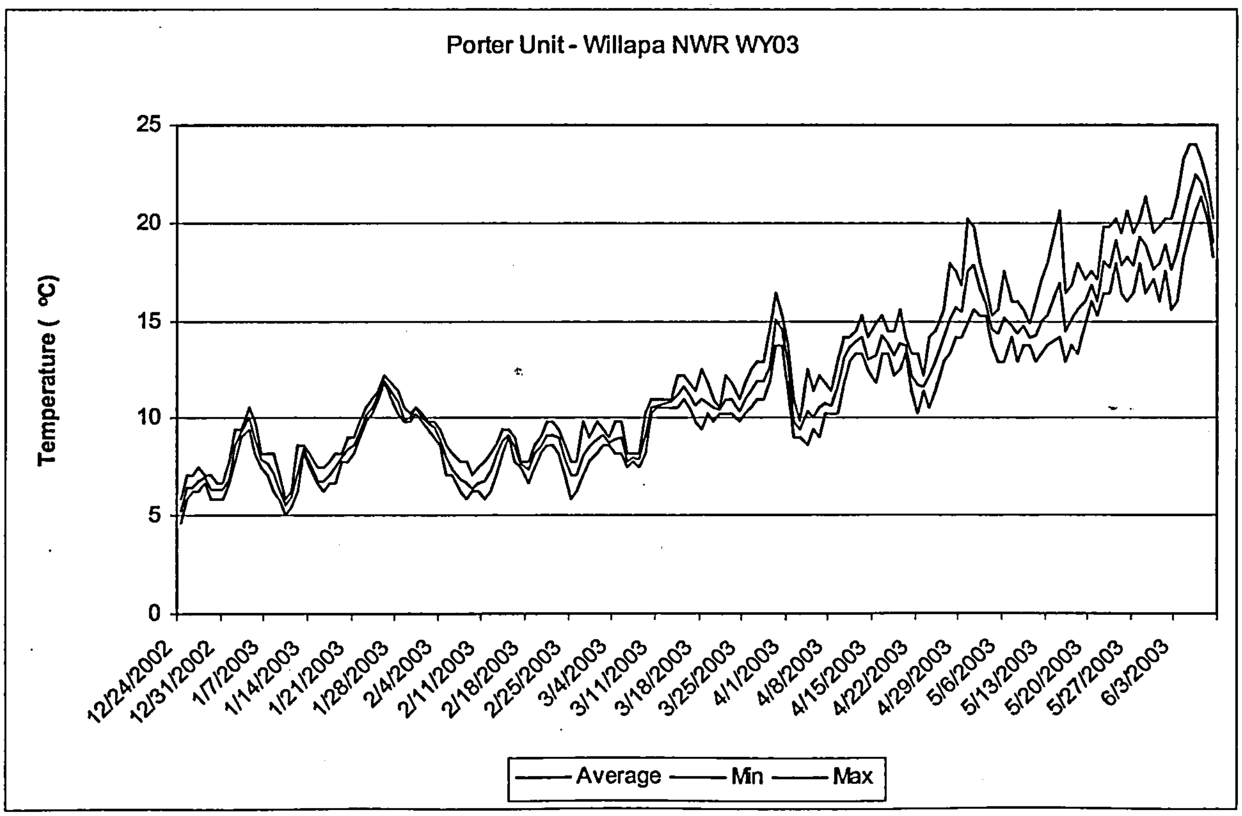


Lewis and Porter Point Temperature data

Water temperature data were recorded on an hourly basis about two feet below the surface on the wetland side of the water-control structure from December 24, 2002 to June 9, 2003. Figure 27 shows the average, minimum and maximum daily temperatures for Lewis and Porter Point units for that period. Water temperatures in both wetlands show similar patterns, staying between 5 and 15°C for most of the winter and early spring then rising rapidly, approaching 20°C toward the end of May.

Figure 27. Average, minimum and maximum daily temperatures for Lewis and Porter Point units.





Lewis Unit SSWS

Sampling of the Lewis Unit wetland was done December 9, 2002, January 28, March 25, May 14, and June 10, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap). Traps were fished for one 24-hour set during each sampling period.

A total of 18,260 fish were captured in the Lewis Unit wetland (Table 21). Six different fish species were captured in all, 5 native species and 1 introduced species. Native species dominated in both catch by number and catch by weight comprising 99% and 84% respectively of the total catch. Threespine stickleback were the most abundant of the native species (99% catch by number, 84% by weight). Brown bullhead were the only introduced fish species captured. Seventy seven percent of the fish were captured during the June sampling period.

A total of 91 coho salmon (52-164mm) were caught during the sampling season in the Lewis unit. Coho were caught during each sampling period, although the majority (76%) were caught during the June sampling. Seventeen of the coho salmon were marked with PIT tags throughout the sampling season. One coho salmon that was marked on May 14, 2003 (96mm, 10.6g) was later recaptured on June 10, 2003 (110mm, 13.0g). This recaptured fish grew 14mm and 2.4g in 27 days (or 0.52mm/d and 0.09g/d).

Three chum salmon (*O. keta*) were caught June 10, 2003 and ranged between 71-76mm fork length. Chum from the Nemah Hatchery (73,100 at 454 fish/lb.) were released in the Lewis unit on April 1, 2003. The fork length of the chum, when released, was estimated to be 46.8mm (Ike at Nemah Hatchery, pers. comm.). The growth rate of the three recaptured fish was approximately 0.38mm/d, which is a 160% increase in length over 71 days.

A total of 504 amphibians were captured in the Lewis unit including northwestern salamanders, red-legged frogs, and rough-skinned newts. Seventy-two percent of the amphibians were captured during the May sampling period. Red-legged frogs were the most abundant of the amphibians comprising 81% of the total caught.

Table 21. SSWS catch at Lewis Unit.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Dec-02	Northern pikeminnow	Cyprinidae	N	1	142	142	30
Dec-02	Threespined stickleback	Gasterosteidae	N	1542	22	67	1114
Dec-02	Coho salmon	Salmonidae	N	3	94	112	47
Dec-02	**Total Native**		N	**1546**			**1191**
Dec-02	Brown bullhead	Ictaluridae	I	9	65	209	403
Dec-02	**Total Introduced**		I	**9**			**403**
	December Total			**1555**			**1594**
Jan-03	Unidentified sculpin	Cottidae	N	7	92	126	138
Jan-03	Threespined stickleback	Gasterosteidae	N	1481	26	51	737
Jan-03	Coho salmon	Salmonidae	N	3	101	114	57
Jan-03	**Total Native**		N	**1491**			**932**
Jan-03	Brown bullhead	Ictaluridae	I	23	55	276	650
Jan-03	**Total Introduced**		I	**23**			**650**
	January Total			**1514**			**1582**
Mar-03	Unidentified sculpin	Cottidae	N	7	53	84	26
Mar-03	Threespined stickleback	Gasterosteidae	N	340	23	52	138
Mar-03	Coho salmon	Salmonidae	N	14	52	164	496
Mar-03	**Total Native**		N	**361**			**661**
Mar-03	Brown bullhead	Ictaluridae	I	9	60	226	190
Mar-03	**Total Introduced**		I	**9**			**190**
	March Total			**370**			**851**
May-03	Threespined stickleback	Gasterosteidae	N	672	15	65	631
May-03	Coho salmon	Salmonidae	N	2	86	96	24
May-03	**Total Native**		N	**674**			**655**
May-03	Brown bullhead	Ictaluridae	I	6	65	74	26
May-03	**Total Introduced**		I	**6**			**26**
	May Total			**680**			**681**
Jun-03	Unidentified sculpin	Cottidae	N	2	97	114	29
Jun-03	Threespined stickleback	Gasterosteidae	N	13940	18	67	8410
Jun-03	Coho salmon	Salmonidae	N	66	65	120	1044
Jun-03	**Total Native**		N	**14008**			**9484**
Jun-03	Brown bullhead	Ictaluridae	I	130	69	226	1271
Jun-03	Pink Salmon	Salmonidae	I	3	71	76	21
Jun-03	**Total Introduced**		I	**133**			**1292**
	June Total			**14141**			**10776**
	Grand Total			**18260**			**15484**

Porter Point SSWS

Fish sampling in Porter Point wetland was done December 10, 2002, January 29, March 26, May 15, and June 11, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap). Traps were fished for one 24-hour set during each sampling period.

A total of 8,158 fish were captured in the Porter Point wetland (Table 22). Four different fish species were captured in all, 3 native species and 1 introduced species. Native fishes dominated the catch in both catch by number and biomass, comprising 99.9% and 83% respectively of the total catch. Threespine stickleback were the most abundant species, comprising 99.6% of the total native fishes captured. Coho salmon followed with 0.3% of the total native fishes caught and sculpins were the least abundant with less than 0.1%. Brown bullhead were the only introduced fish species captured. The majority of the fish were captured during the May (62%) and June (35%) sampling periods.

Twenty-five coho salmon (54-158 mm), were captured in the Porter Point wetland. Coho salmon were captured during each of the sampling periods except for June. The majority of the salmon were caught in March (10 fish) and May (12 fish). Seventy six percent of the salmon were between the sizes of 86mm and 158mm and may be 0+ and or 1+. The other 24% were YOY between 54 and 64mm fork length caught during the March sampling period. Coho fry (50,000) from the Nemah Hatchery were planted in the Porter Point unit on February 10, 2003 (1,000 fish/lb.). It is likely that the captured YOY were hatchery plants as opposed to wild production or from YOY ascending the fish ladder.

A total of 2,665 amphibians were captured in Porter Point. Red-legged frogs were the most abundant amphibian caught comprising 96% of the total. Other amphibians captured include Northwestern salamanders, Pacific tree frogs, and rough-skinned newts. Similarly to the Lewis Unit wetland, the majority of the amphibians were captured during the May sampling period (68% of the total).

Table 22. SSWS catch at Porter Point.

MoYr	Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Dec-02	Threespined stickleback	Gasterosteidae	N	67	29	68	56
Dec-02	Coho salmon	Salmonidae	N	1	93	93	13
Dec-02	**Total Native**		N	**68**			**69**
Dec-02	**Total Introduced**		I	**0**			**0**
	December Total			**68**			**69**
Jan-03	Unidentified sculpin	Cottidae	N	4	86	98	35
Jan-03	Threespined stickleback	Gasterosteidae	N	139	29	71	127
Jan-03	Coho salmon	Salmonidae	N	2	95	111	34
Jan-03	**Total Native**		N	**145**			**196**
Jan-03	**Total Introduced**		I	**0**			**0**
	January Total		N	**145**			**196**
Mar-03	Unidentified sculpin	Cottidae	N	1	92	92	9
Mar-03	Threespined stickleback	Gasterosteidae	N	25	40	75	46
Mar-03	Coho salmon	Salmonidae	N	10	54	158	169
Mar-03	**Total Native**		N	**36**			**224**
Mar-03	Brown bullhead	Ictaluridae	I	1	133	133	32
Mar-03	**Total Introduced**		I	**1**			**32**
	March Total			**37**			**256**
May-03	Unidentified sculpin	Cottidae	N	3	79	100	28
May-03	Threespined stickleback	Gasterosteidae	N	5025	27	75	1106
May-03	Coho salmon	Salmonidae	N	12	86	107	173
May-03	**Total Native**		N	**5040**			**1307**
May-03	Brown bullhead	Ictaluridae	I	1	149	149	45
May-03	**Total Introduced**		I	**1**			**45**
	May Total			**5041**			**1352**
Jun-03	Threespined stickleback	Gasterosteidae	N	2858	25	66	1972
Jun-03	**Total Native**		N	**2858**			**1972**
Jun-03	Brown bullhead	Ictaluridae	I	9	161	189	681
Jun-03	**Total Introduced**		I	**9**			**681**
	June Total			**2867**			**2653**
	Grand Total			**8158**			**4526**

Lewis and Porter Point data summary

There were 55% fewer fishes caught in Porter Point unit than in Lewis unit. This may be due to management activities to control invasive plant species, like reed canarygrass and tussock. Porter Point was drawn down and allowed to dry out during the summer of 2002. The Willapa Bay NWR alternates this management practice with these wetland units so, during summer of 2003, the Lewis unit was drawn down.

Both wetlands have a great abundance of threespine stickleback and red-legged frogs. Species diversity is low. Introduced species are rare and have only included the brown bullhead. Coho were caught in the wetlands from December through June. All coho caught in the wetlands during WY 2003 had intact adipose fins but all of them may not have been wild since hatchery fry, which were not marked, were planted. Three chum planted in the Lewis unit were caught in June and grew at a rate of 0.38mm/d. A recaptured coho in the Lewis unit grew 0.52mm/d and 0.09g/d. Passage of coho into the wetlands via the fish ladders was documented, as well as growth rates of juvenile chum and coho salmon.

Eastern Oregon

Ladd Marsh Wildlife Area

Ladd Marsh was the only site sampled on the east side of the cascades in WY 2003. It is located on Ladd Creek one mile up from the confluence of Catherine Creek (Figure 28). This sampling site is part of Ladd Marsh Wildlife Area, managed by ODFW. During the fall of 2002 about two miles of straightened Ladd Creek was restored as well as a portion of historic Tule Lake (304 acres of wetland and 154 acres of adjacent upland). The original Tule Lake encompassed over 20,000 acres in the Grande Ronde Valley. Extensive drainage and channelization of small streams occurred in the late 1800's and early 1900's to "reclaim" this area for agricultural production. Two pool-weir-chute water-control structures were installed in the reconstructed Ladd Creek, in serial fashion, to recreate some of the historic wetland (Figure 29). A two-way fish trap was installed in the structure furthest downstream on Ladd Creek.

Figure 28. Vicinity map of Ladd Marsh Wildlife Area (see also Figure 1).

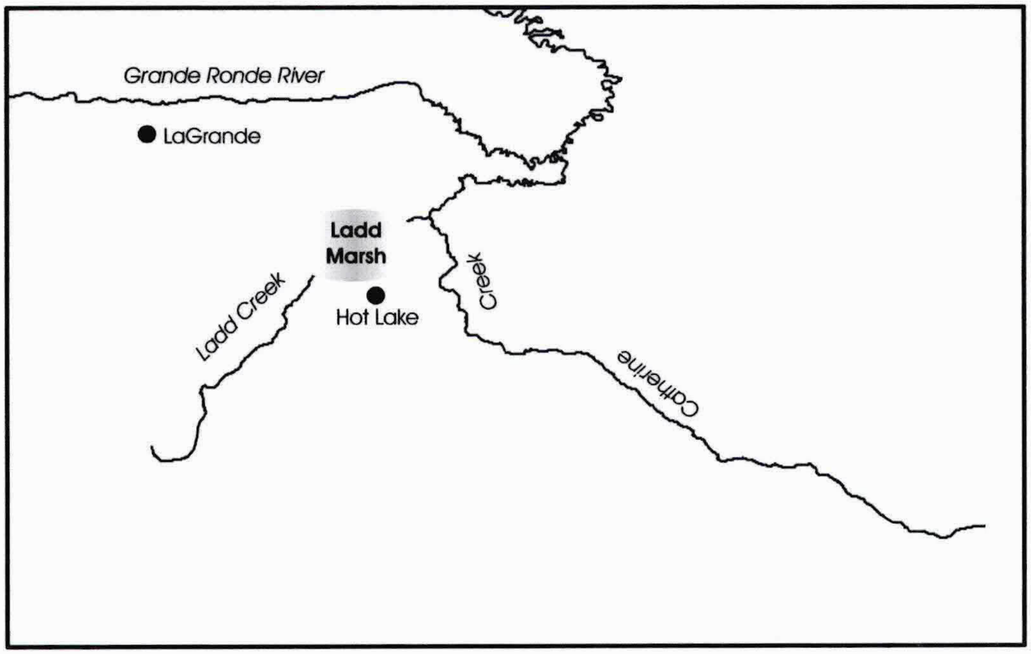


Figure 29. Ladd Marsh Wildlife Area, Tule Lake project.

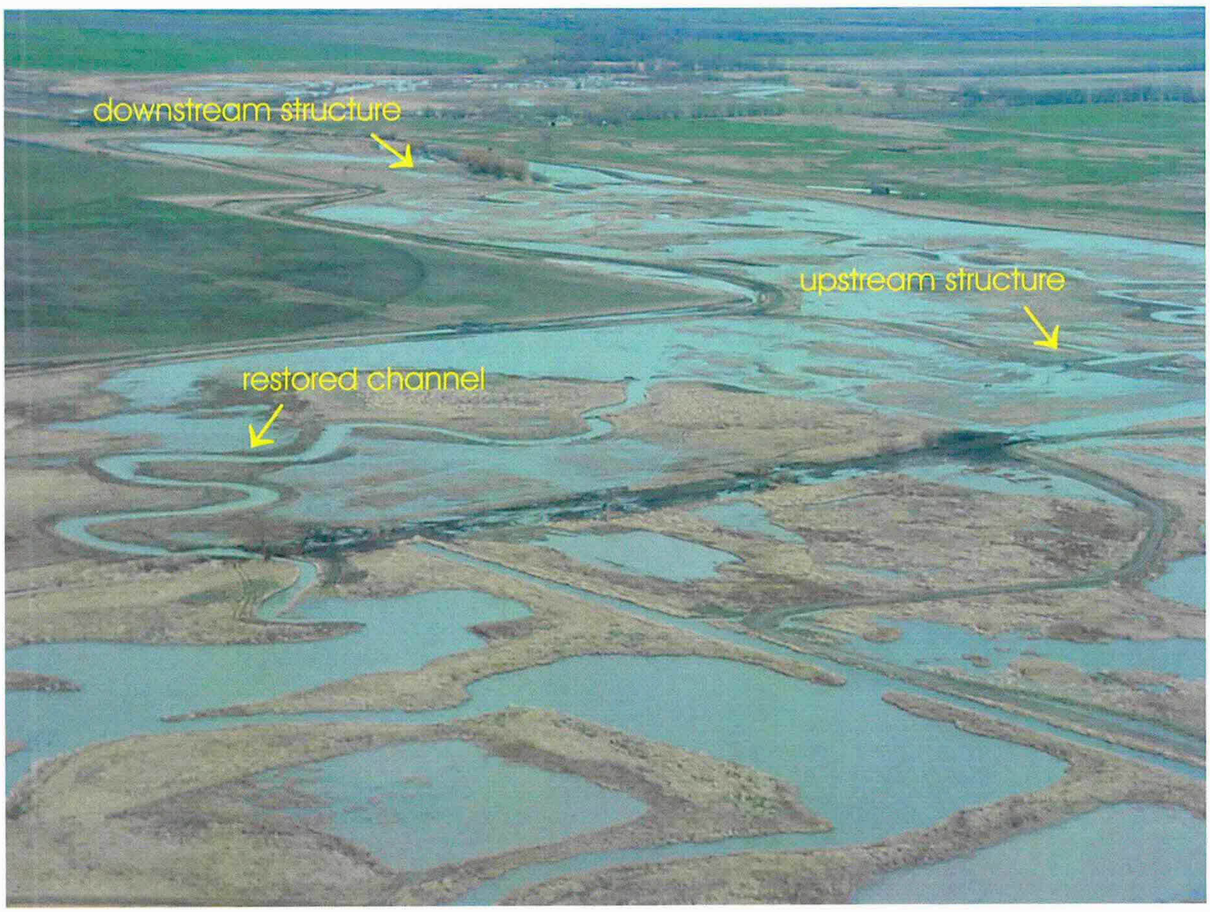
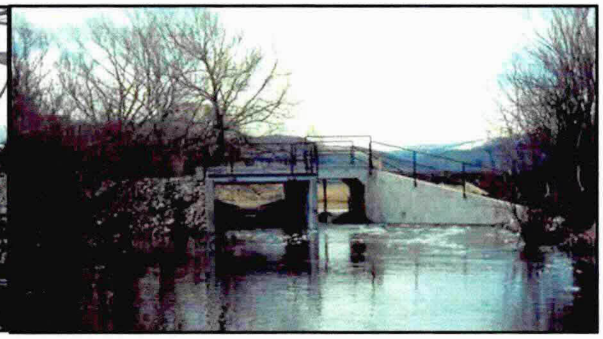


Figure 30. Pool-weir-chute water-control structure on Ladd Creek. Left photo: looking downstream (emergency spillway on left, and fish ladder on right). Right photo: looking upstream.



Ladd Marsh temperature and hydrology

Water temperature data were recorded on an hourly basis at locations above and below Ladd Marsh. Unfortunately, the temperature probe below the marsh was located just downstream of Geckler Slough, which delivers irrigation return water to Ladd Creek. That data does not isolate the effects on water temperature from the marsh. A probe above the marsh recorded data from April 2, 2003 to July 4, 2003. Figure 31 shows the seven-day average maximum temperature and seven-day average daily maximum temperature for that period. The Oregon state water quality temperature standard is exceeded when that the seven-day average maximum temperature exceeds 17.8°C (64°F) in a basin for which salmonid fish rearing is a designated beneficial use (OAR 340-041-0006(54)*i*). This standard was exceeded May 23, 2003 according to data in Ladd Creek, just above Ladd Marsh.

Figure 31. Ladd Creek above Ladd Marsh - Seven day average daily maximum temperature 2003.

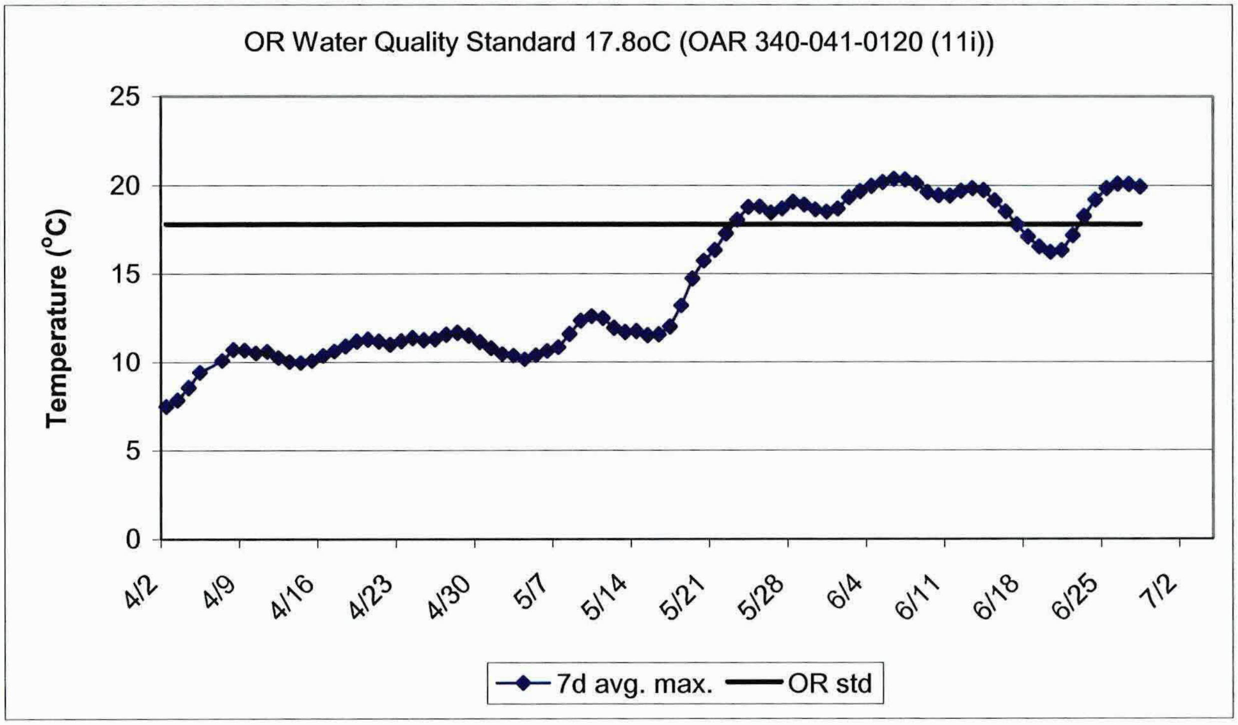
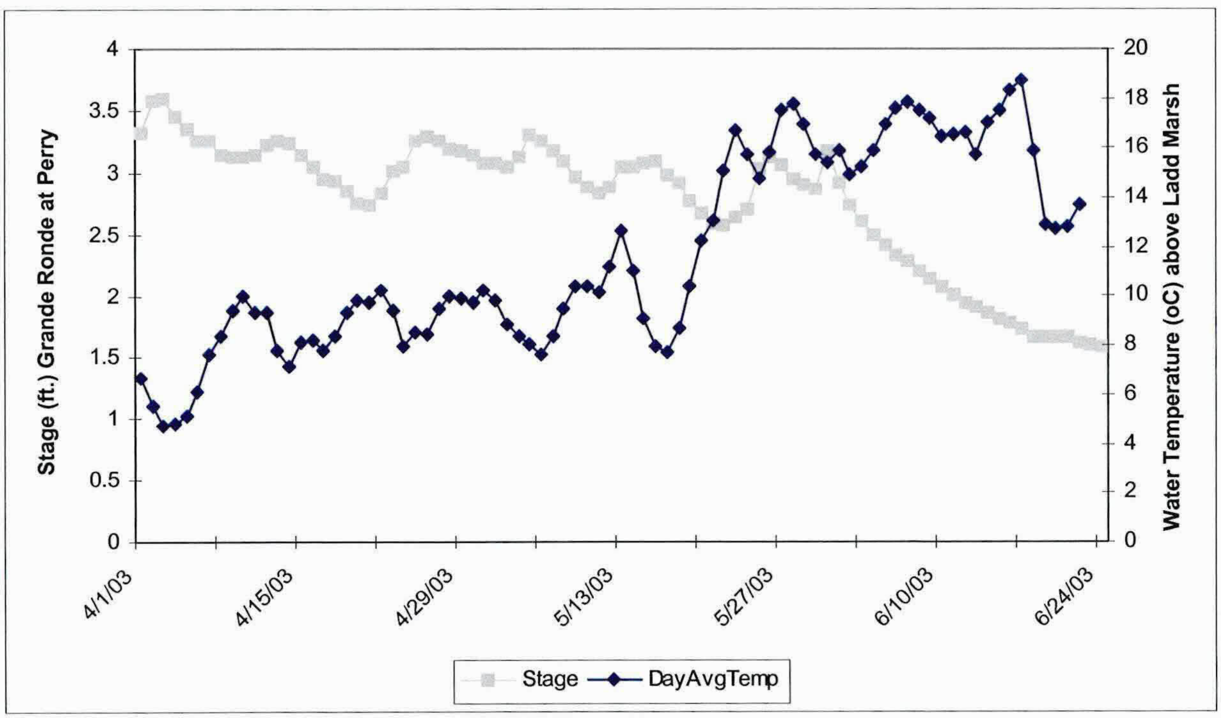


Figure 32. Daily average stage and water temperature near Ladd Marsh, 2003.



Ladd Marsh two-way trap results

A two-way vertical-slot trap was fished in the lowermost fish ladder from April 2 to June 30, 2003 (Figure 33). The inbound trap caught 692 fish and the outbound trap caught 232 fish during that period (Tables 23 and 24). The most abundant native fishes caught inbound were northern pikeminnow (*Ptychocheilus oregonensis*), followed by redside shiner (*Richardsonius balteatus*) (49.1%, 13.6% of the inbound catch, by numbers). Suckers were the most abundant native species, by weight (11% of the inbound catch). There were both largescale and bridgelip (*C. columbianus*) suckers caught in the wetland. The most abundant introduced species, by far, was the carp (24.4% of the inbound catch, by numbers and 83.7% of the catch by weight). Carp was the most abundant species by number and weight in the outbound catch (32.8% by numbers and 53.2% by weight). There were also a number of northern pikeminnow, redside shiner, and introduced white crappie (23.7%, 14.2% and 12.1% of the outbound catch). Suckers also contributed a significant amount of the outbound fish biomass (34.1% of the outbound total weight).

Fish appeared to move through the structure at various times, according to Figure 34. But, fish could also go through the emergency spillway so the two-way trap on the fish ladder was at times only catching a small proportion of the fishes that moved past the structure. A comparison between catch in the outbound two-way trap and fish moving out through the emergency spillway was made by setting an Oneida Lake trap immediately below the spillway overnight on May 19, 2003. Ninety-five percent of the fish caught in both traps were in the Oneida Lake trap below the spillway (Table 25). When water is going through the emergency spillway, which was most of the time from April through June in 2003, the outbound two-way trap may be catching only 5% of the fish moving past the structure.

Figure 33. Two-way fish trap in fish ladder at Ladd Marsh. Cathy Nowak is checking the trap.

Figure 34. Two-way trap catch in the Ladd Marsh fish ladder.

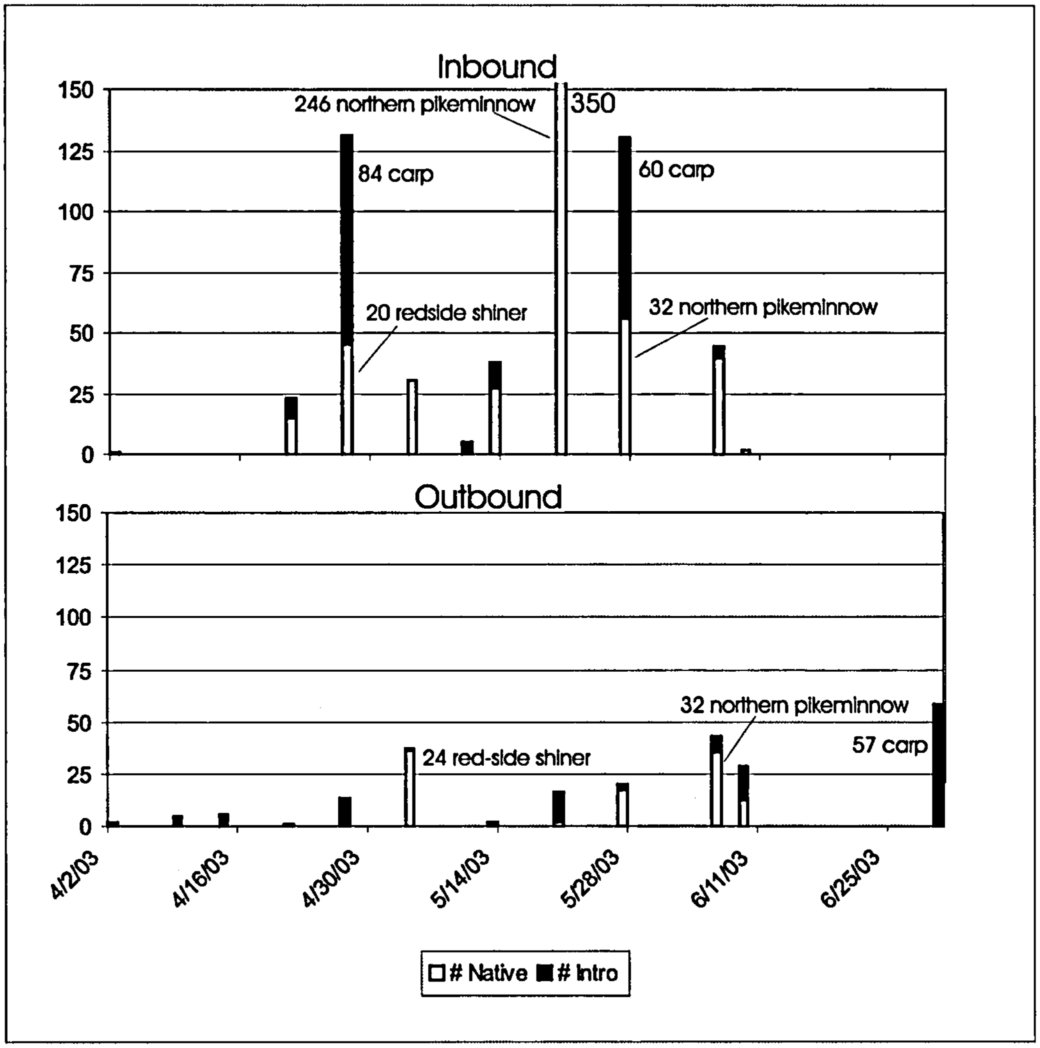


Table 23. All fishes caught in INBOUND 2-way trap at Ladd Marsh.

Family	Common Name	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Catostomidae	Bridgelip sucker	1	415	415	757
Catostomidae	Largescale sucker	33	337	460	22973
Cyprinidae	Northern pikeminnow	340	33	180	7651
Cyprinidae	Redside shiner	94	70	111	758
Salmonidae	Chinook salmon	7	61	80	43
Salmonidae	Rainbow trout	27	86	177	681
Total Native		**502**			**32863**
Centrarchidae	Black crappie	1	190	190	111
Centrarchidae	Largemouth bass	2	182	196	192
Centrarchidae	Warmouth	3	52	85	28
Cyprinidae	Common carp	169	340	575	175066
Ictaluridae	Brown bullhead	13	90	252	869
Percidae	Yellow perch	1	97	97	12
Total Introduced		**189**			**176277**
Grand Total		**691**			**209141**

Table 24. All fishes caught in OUTBOUND 2-way trap at Ladd Marsh from April 2, 2003 to June 30, 2003.

Family	Common Name	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Catostomidae	Bridgelip sucker	2	80	395	659
Catostomidae	Largescale sucker	10	75	465	5372
Cyprinidae	Northern pikeminnow	55	32	155	235
Cyprinidae	Redside shiner	33	68	104	245
Salmonidae	Chinook salmon	1	71	71	6
Salmonidae	Rainbow trout	1	90	90	12
Total Native		**102**			**6530**
Centrarchidae	Bluegill	6	44	117	88
Centrarchidae	Warmouth	4	86	124	130
Centrarchidae	White crappie	28	52	166	517
Cyprinidae	Common carp	76	42	540	8378
Ictaluridae	Brown bullhead	1	120	120	23
Percidae	Yellow perch	15	64	96	89
Total Introduced		**130**			**9226**
Grand Total		**232**			**15755**

Table 25. Comparison of catch between the outbound two-way trap and an Oneida Lake trap set below the emergency spillway May 19, 2003.

Species	outbound two-way trap		Oneida Lake trap	
	number	fk. length (mm)	number	fk. length (mm)
sucker	1	80	2	76-342
chinook salmon	1	71	1	63
common carp	1	75		
northern pikeminnow			4	97-138
rainbow trout			2	111, 193
redside shiner			119	65-92
warmouth	2	86, 95		
yellow perch	2	71, 81		

Ladd Marsh SSWS results

Fish sampling in Ladd Marsh wetland occurred on April 3 and 4, May 20 and 21, June 27 and 28, 2003. Fishes were sampled with the standard gear (2 box traps, 2 fyke nets, and 1 Oneida Lake trap) during the April and May sampling periods. The standard gear was used in the June sampling period with exception of the Oneida Lake trap due to shallow water and an abundance of aquatic plants. Traps were fished for two 24-hour sets during each sampling period.

A total of 1,661 fish were captured in the Ladd Marsh wetland (Table 26). Thirteen different fish species were captured in all, 7 native species and 6 introduced. Native species dominated the total catch in biomass (79% of total weight) while introduced species dominated the catch in total number of fish (79%). Common carp were the most abundant of the introduced species (97% catch by number, 79% by weight). Of the native fish, suckers were the most abundant species by weight (68%) and redside shiners were the most abundant by number (67%).

Seven rainbow trout (*O. mykiss*) and three Chinook salmon were captured in the Ladd Marsh wetland. Two rainbow trout (179-267mm) were captured during the April sampling period. Five rainbow trout (111-300mm) and 3 Chinook salmon (61-71mm) were captured during the May sampling period. No salmonids were captured during the June sampling period.

Great Basin spadefoot tadpoles (*Spea intermontana*) were the only amphibians captured in Ladd Marsh. None were caught during the April sampling, 1 was caught in May, and 3 were caught in June.

Table 26. SSWS catch at Ladd Marsh.

MoYr	Common Name	Family	NatInt	Number	Min_FL (mm)	Max_FL (mm)	WT (g)
Apr-03	sucker	Catostomidae	N	1	58	58	2
Apr-03	Northern pikeminnow	Cyprinidae	N	11	109	190	429
Apr-03	Redside shiner	Cyprinidae	N	2	83	99	18
Apr-03	Speckled dace	Cyprinidae	N	4	55	68	10
Apr-03	Rainbow trout	Salmonidae	N	2	179	267	0
Apr-03	**Total Native**		N	**20**			**459**
Apr-03	Bluegill	Centrarchidae	I	1	33	33	1
Apr-03	White crappie	Centrarchidae	I	4	62	66	10
Apr-03	Common carp	Cyprinidae	I	3	58	74	9
Apr-03	Yellow perch	Percidae	I	1	71	71	5
Apr-03	**Total Introduced**		**I**	**9**			**24**
	April Total			**29**			**483**
May-03	Bridgelip sucker	Catostomidae	N	12	45	416	6132
May-03	Largescale sucker	Catostomidae	N	1	400	400	679
May-03	Northern pikeminnow	Cyprinidae	N	11	33	180	217
May-03	Redside shiner	Cyprinidae	N	227	65	92	1328
May-03	Chinook salmon	Salmonidae	N	3	61	71	15
May-03	Rainbow trout	Salmonidae	N	5	111	300	0
May-03	**Total Native**		N	**259**			**8372**
May-03	Warmouth	Centrarchidae	I	1	110	110	37
May-03	White crappie	Centrarchidae	I	10	56	77	30
May-03	Common carp	Cyprinidae	I	6	73	95	43
May-03	**Total Introduced**		**I**	**17**			**110**
	May Total			**276**			**8481**
Jun-03	Bridgelip sucker	Catostomidae	N	4	69	429	1658
Jun-03	Northern pikeminnow	Cyprinidae	N	4	49	187	123
Jun-03	Redside shiner	Cyprinidae	N	1	38	38	1
Jun-03	Speckled dace	Cyprinidae	N	53	28	40	26
Jun-03	**Total Native**		**N**	**62**			**1808**
Jun-03	White crappie	Centrarchidae	I	17	32	193	394
Jun-03	Common carp	Cyprinidae	I	1272	25	166	2286
Jun-03	Brown bullhead	Ictaluridae	I	5	120	130	139
Jun-03	**Total Introduced**		**I**	**1294**			**2819**
	June Total			**1356**			**4627**
	Grand Total			**1661**			**13591**

Ladd Marsh data summary

The most abundant fishes in Ladd Marsh were carp, northern pikeminnow, redside shiner and bridgelip and largescale sucker. Ladd Marsh was the only site sampled in WY 2003 where threespine stickeback were not present and were not the most abundant fish in the catch. Threespine stickleback are endemic to the west side of the Cascade Range and do not occur, except though introduction, on the east side.

Eleven juvenile Chinook were present in the wetland or caught in the two-way trap for a very limited period, May 15-23, 2003. These Chinook were probably from Catherine Creek and came up Ladd Creek into the wetland during spring run-off when water backed up into the wetland. It is not clear whether the 7 caught in the inbound trap swam up the ladder or were transported in from Ladd Creek flowing "backwards" into the wetland.

Water temperature above Ladd Marsh rose abruptly in late May and water level in the wetland decreased rapidly after spring run-off in late June, as did catch in the two-way trap. Catch in the two-way trap only reflects a portion of the fishes moving out (and probably in) through the structure. Adult carp were observed congregated below the emergency spillway in May, during their spawning season, and some likely entered the wetland when Ladd Creek backed up into the marsh.

Discussion

Monitoring fishes in seasonal floodplain wetlands across Oregon and Washington in WY 2003 have resulted in greater understanding of fish use of floodplain wetland habitat and have further confirmed passage capability through water-control structures. Additionally, a few examples of apparent growth rates of salmonids in wetlands were obtained. There were 13 species of native fishes and 15 species of introduced fishes caught in WY 2003 (Table 27). The greatest species richness is in the Lower Willamette and Columbia River sites.

Table 27. Species list of catch by sub-region.

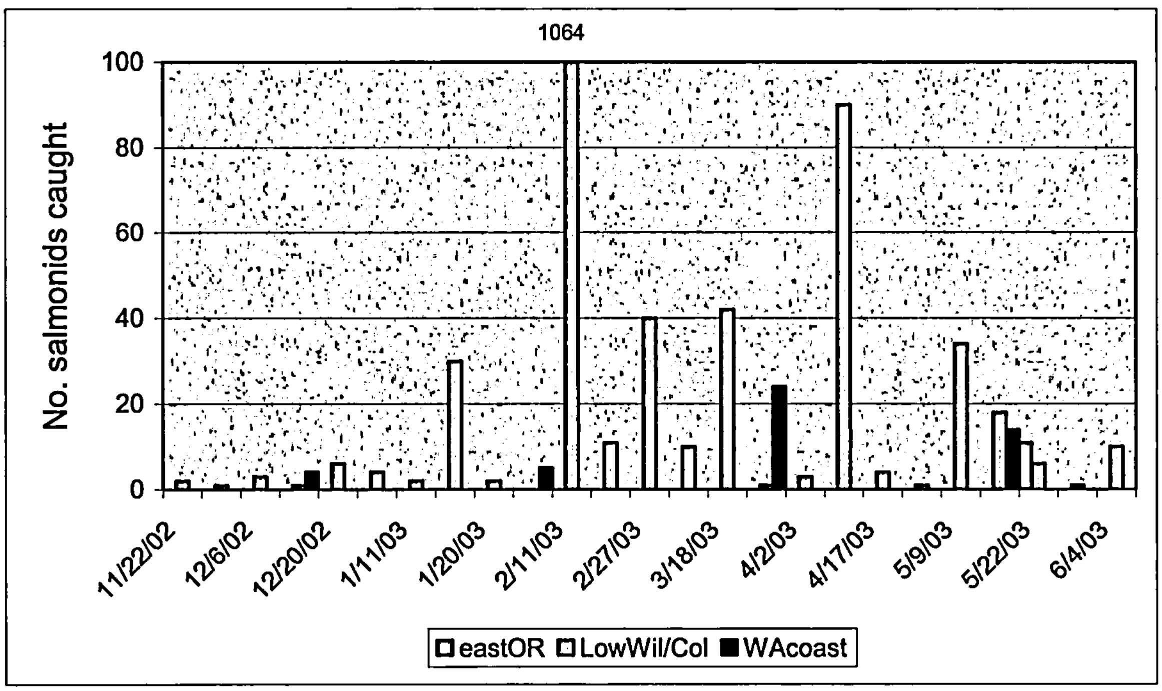
Nat/Int	Family	Species	WA coast	LowWil/Col	east OR
N	Catostomidae	Bridgelip sucker			X
N	Salmonidae	Chinook salmon	X	X	X
N	Salmonidae	Chum salmon	X		
N	Salmonidae	Coho salmon	X	X	
N	Catostomidae	Largescale sucker		X	X
N	Cyprinidae	Northern pikeminnow		X	X
N	Petromyzontidae	Pacific lamprey		X	
N	Cyprinidae	Peamouth		X	
N	Cottidae	Prickly sculpin		X	
N	Salmonidae	Rainbow trout			X
N	Cyprinidae	Redside shiner		X	X
N	Cyprinidae	Speckled dace			X
N	Gasterosteidae	Threespined stickleback		X	
		TOTAL NATIVE	**3**	**9**	**7**
I	Cyprinodontidae	Banded killifish		X	
I	Centrarchidae	Black crappie		X	X
I	Centrarchidae	Bluegill		X	X
I	Ictaluridae	Brown bullhead	X	X	X
I	Cyprinidae	Common carp		X	X
I	Cyprinidae	Golden shiner		X	
I	Cyprinidae	Goldfish		X	
I	Centrarchidae	Largemouth bass		X	X
I	Poeciliidae	Mosquitofish		X	
I	Cobitidae	Oriental weatherfish		X	
I	Centrarchidae	Pumpkinseed		X	
I	Centrarchidae	Smallmouth bass		X	
I	Centrarchidae	Warmouth		X	X
I	Centrarchidae	White crappie		X	X
I	Percidae	Yellow perch		X	X
		TOTAL INTRODUCED	**1**	**15**	**8**
		GRAND TOTAL	**4**	**24**	**15**

Juvenile salmon use of floodplain wetlands

Juvenile salmonids were caught at every site sampled in WY 2003. There were 1,515 salmon (coho, Chinook or chum) and 35 rainbow trout caught during WY 2003. The trout were all caught at Ladd Marsh Wildlife Area. Of the salmon caught, only two were adipose-clipped hatchery fish that were caught in the outbound trap at Multnomah North. Coho and chum planted in Lewis and Porter Point units at Willapa Bay National Wildlife Refuge were not marked. All chum and coho below 65mm were assumed to be hatchery released fish since there is no known natural production in streams feeding these wetlands.

Salmon catch is summarized by sub-region over the water-year (Figure 35). There was more fishing effort in the Lower Willamette River with the two-way traps, but most of the salmon catch was from SSWS, especially after high-water events. For example, at McCarthy, 1,012 recently emerged Chinook were caught February 11, right after a high-water event February 2, 2003. The week of April 10, 90 Chinook and coho were caught at McCarthy and Multnomah North. The salmon in the Multnomah North wetland (71) had been in there since the early February high water brought them. Those at McCarthy (19) had free access into and out of the wetland but may have over-wintered since entering the wetland in February.

Figure 35. All salmon caught at all sites, all gear, by week, in WY 2003.



A high proportion of the salmon catch in the Lower Willamette/Columbia Rivers were YOY Chinook. Chinook begin to emerge late December, come downriver during high flows and enter floodplain wetlands. Tributaries known as spawning areas for Chinook upstream from the Lower Willamette River sites are the Clackamas and McKenzie Rivers. Figure 36 shows the pattern of salmon use of floodplain wetlands by estimated age class (based on size). Coho were not easily broken into age classes, based on size, so were combined. Size at age analysis from scales collected from coho will sort this out. After the YOY Chinook enter the wetlands during winter high flows, they may stay for many months. This was the case with 0+ Chinook in Multnomah North, which entered February 2 and stayed until spring run-off in May. Although, 0+ Chinook caught at McCarthy after this same high water event (1,064 salmon) did not seem to be around in great numbers during the subsequent sampling period April 10 (19 salmon).

Seventy-three percent of the salmon caught in the inbound two-way traps in the Lower Willamette River in 2002 and 2003 entered November through March and 83% of the outbound salmon were caught in April and May. Figure 37 shows salmon movement out of Multnomah North in 2002 and 2003. Though the traps were overtopped during high flows in the spring, a pulse of salmon leaving the wetland can be seen in response to fluctuating water levels and rising water temperatures in the spring. Yearling Chinook seem to be rare (Figure 36). They may over-winter in different habitat than the YOY. Yearlings may over-winter or use habitat more transiently. Recaptured fish leaving the wetlands through the outbound traps is rare. One example is a 139mm hatchery-clipped coho, likely a yearling, which was released into Multnomah North March 31, 2003 and left April 2, 2003.

Figure 36. Lower Willamette sites, SSWS 2002 and 2003, salmon by estimated age class.

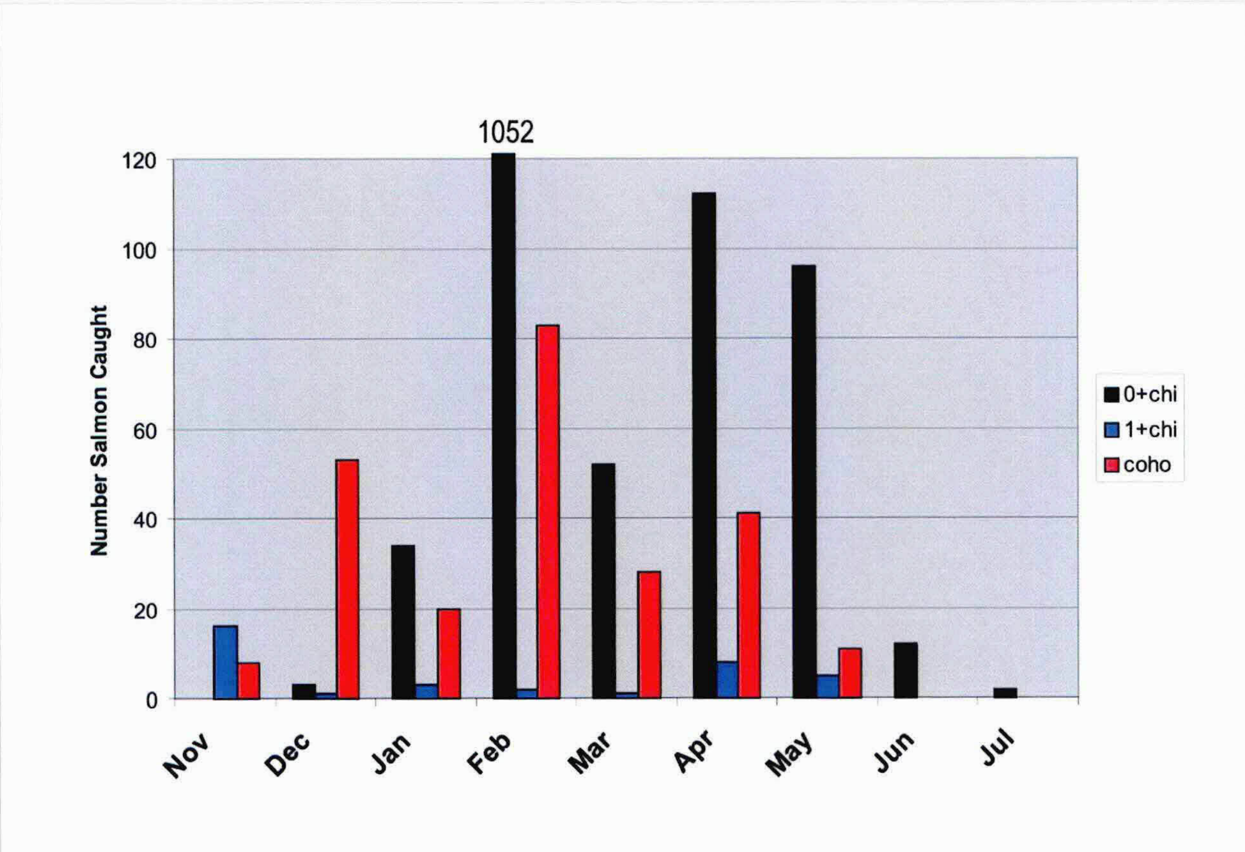
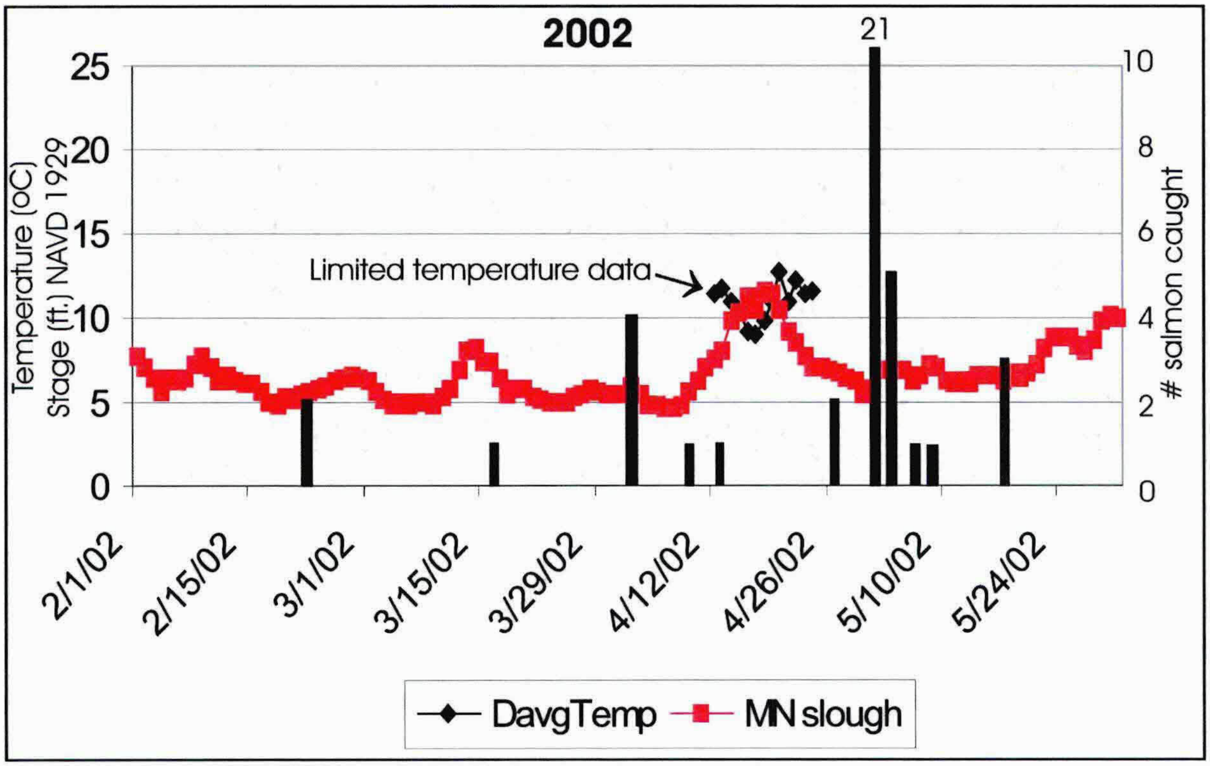
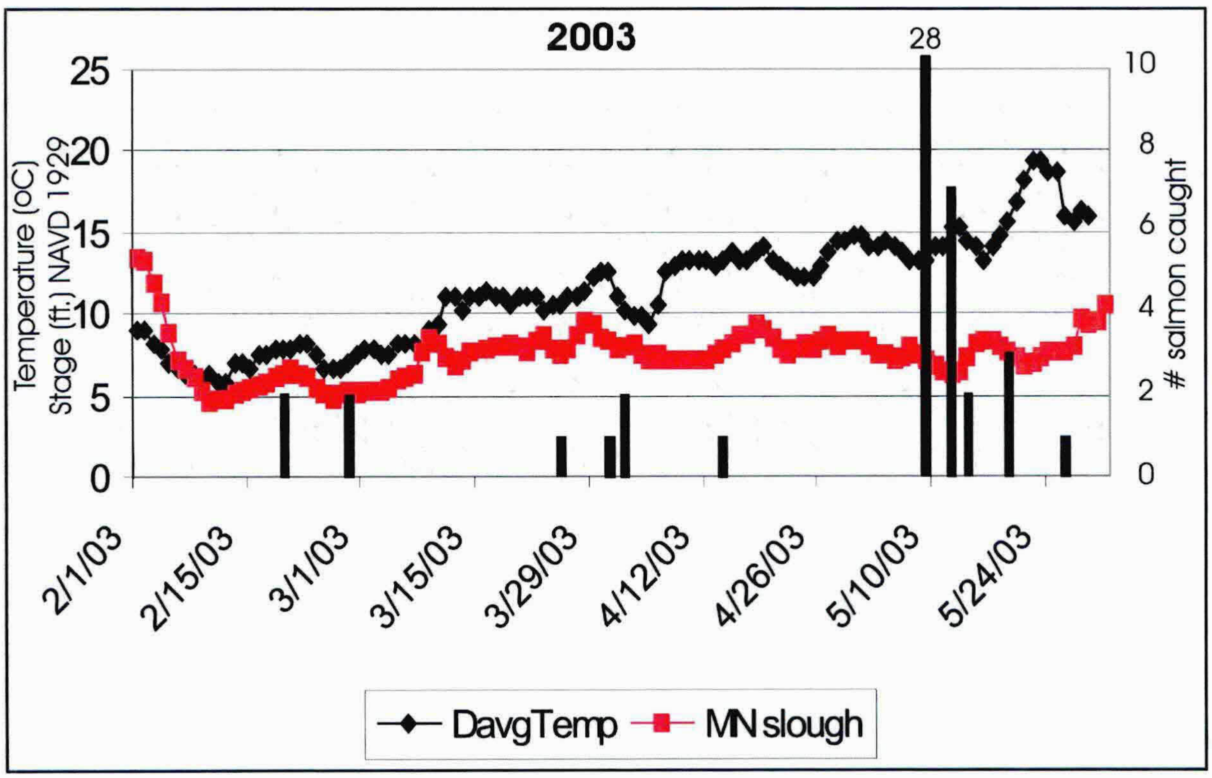


Figure 37. Salmon catch in the OUTBOUND trap at Multnomah North 2002 and 2003.

Daily average water temperature, stage of slough at Multnomah North, and salmon catch





Growth rates of juvenile salmon in floodplain wetlands

Examples of apparent growth rates of juvenile salmon in wetlands have been few and serendipitous. In Mulnomah North, 71 YOY Chinook were captured during the April SSWS and 10 were captured during the June SSWS. These Chinook had come in during a high-water event February 2, 2003. The same cohort had been sampled at McCarthy February 11 and an average fork length obtained from measuring 104 Chinook at McCarthy (39mm) was used to compare Chinook at Multnomah North in April and June. The average fork length of YOY Chinook caught at Multnomah North during the April SSWS was 71mm (range 53-89, n=71) and 88mm for the June SSWS (range 79-102, n=10). This gives an average growth rate of 0.59mm/d for the group caught in April and 0.44mm/d for the group caught in June.

In the Lewis unit at Willapa Bay National Wildlife Refuge there are two examples of growth rates, one from chum and one from coho salmon. Three chum salmon were caught June 10, 2003 and ranged between 71-76mm fork length. Chum from the Nemah Hatchery were released in the Lewis unit on April 1, 2003. The fork length of the chum, when released, was estimated to be 46.8mm. The growth rate of these fish then was 0.38mm/d, which is a 160% increase in length over 71 days. One coho salmon that was marked on May 14, 2003 (96mm, 10.6g) was later recaptured on June 10, 2003 (110mm, 13.0g). This recaptured fish grew 14mm and 2.4g in 27 days (or 0.52mm/d and 0.09g/d).

In 2002, one coho was recaptured at Hoxit Farms by a one-way trap attached to the water-control structure (see the 2002 annual report Baker and Miranda 2003a for more information). One coho, batch marked January 8, 2002 (n=8, 93-118mm, av. 104mm) in the wetland, was recaptured 3/26/02 at a length of 152mm in the one-way trap. In 77 days that coho grew 48mm (0.62mm/d) (calculated from the average length of 104mm in January), which was a 32% increase in fork length. During this period, minimum temperature was 2.9°C (1/29/02), maximum temperature was 12.2 °C (3/25/02), and average daily average water temperature was 6.6°C.

Apparent growth rates of juvenile Chinook in the Yolo Bypass, an engineered wetland in the Sacramento Valley in California, and Chinook in the Sacramento River were compared to assess the quality of wetland habitat to Chinook (Sommer et al.2001). In 1998 and 1999, coded-wire tagged Chinook were released and recaptured. They were released March 2, 1998 at an average fork length of 57.5mm and February 11, 1999 at 56.8mm fork length. In the Yolo Bypass, these Chinook grew 0.80mm/d and 0.55mm/d, in 1998 and 1999, respectively. During the same time, Chinook in the Sacramento River grew 0.52mm/d and 0.43mm/d.

Over-winter growth rates of juvenile coho were estimated in a paper comparing coded-wire tags and passive integrative transponder tags (Petersen 1994) but the rates were not given in the same units (mm/d) used here for comparison. Nevertheless, over 600 coho were tagged in 1990 and 1991 between October 1-5 and recaptured the following spring, between April 15 and June 15, in which initial lengths were 64.1mm and 67.8mm, respectively. The authors report an average increase in fork length between 21.8mm and 28.8mm over winter.

Published literature that report over-winter apparent growth rates of salmon is sparse. Growth rates of Chinook caught in the Multnomah North wetland were similar to those reported in the Sacramento River and Yolo Bypass (Table 28). Apparent growth rates of chum and coho caught at other DU sampling locations bound those reported for juvenile Chinook. Published values for growth rates of chum and coho for comparison have not been found.

Table 28. Comparison of growth rates of salmonids in wetlands

site	n	species	average initial fork length (mm)/date	# days	growth rate (mm/d)
Multnomah N.	81	Chinook	39 (2/11/03)	54	0.59
Multnomah N.	10	Chinook	39 (2/11/03)	111	0.44
Lewis	3	chum	46.8 (4/1/03)	71	0.38
Lewis	1	coho	96 (5/14/03)	27	0.52
Hoxit	1	coho	104 (1/8/02)	77	0.62
Sacramento R.*	10	Chinook	57.5 (3/2/98)	55.4	0.52
Sacramento R.*	8	Chinook	56.8 (2/11/99)	58.6	0.43
Yolo Bypass*	9	Chinook	57.5 (3/2/98)	46.2	0.80
Yolo Bypass*	9	Chinook	56.8 (2/11/99)	58.2	0.55

*data from Sommer et al. 2001

Native vs. introduced fishes in floodplain wetlands

There are some general patterns of presence of native and introduced fish in wetlands by season and by sub-region emerging. Catch by all gear in 2002 and 2003 indicate decreasing proportion of native to introduced fishes from west to east (Figure 38). Catch in wetlands along the Washington coast, on the lower Chehalis River and Willapa Bay, are mostly native species in both the winter and spring, whether expressed as abundance (numbers of individuals) or biomass.

In the lower Willamette and Columbia Rivers, there are more native fishes in the winter and spring than introduced fishes but a smaller proportion than on the coast. The introduced fish biomass in the Lower Willamette and Columbia River sites are about equal in the winter and the introduced fish biomass is greater in the spring, mostly from carp (40% of spring introduced fish biomass). Even though two-way trap data showed the opposite pattern of more introduced fish in the catch than native fishes in WY 2003, even with less effort of the SSWS, all gear combined, there were more native fishes overall. This pattern is due to the threespine stickleback dominating the catch in the SSWS and the black crappie dominating the catch in the two-way traps (Figure 39).

In eastern Oregon (Ladd Marsh Wildlife Area in 2003) and Washington (Satus Wildlife Area in 2002), introduced fishes represented most of the catch, though the spring biomass is about equal. In the absence of threespine stickleback on the east side of the Cascade Range, introduced fishes such as juvenile brown bullhead, carp, black crappie, and yellow perch are abundant at Satus Wildlife Area. Ladd Marsh Wildlife Area may show a different pattern than Satus Wildlife Area. Ladd Marsh was only sampled in the spring of 2003 and it appeared that introduced fish abundance earlier in the spring (April and May) were not as dominant as the catch at Satus Wildlife Area (Figure 40). Native northern pikeminnow and redside shiner were the most abundant fish in Ladd Marsh in May, 45% and 44% of the total abundance in May, respectively. In June, carp were 96% of the catch at Ladd Marsh. In Satus Wildlife Area, catch decreases from winter to spring. This may be due to declining water-quality (i.e. higher temperature and less dissolved oxygen) through the seasons but generalization of this data over time (year-to-year) should not be made since data was collected over a limited period.

Figure 38. Native and introduced fish catch (% abundance and % biomass) by sub-region, seasonally in 2002 and 2003.

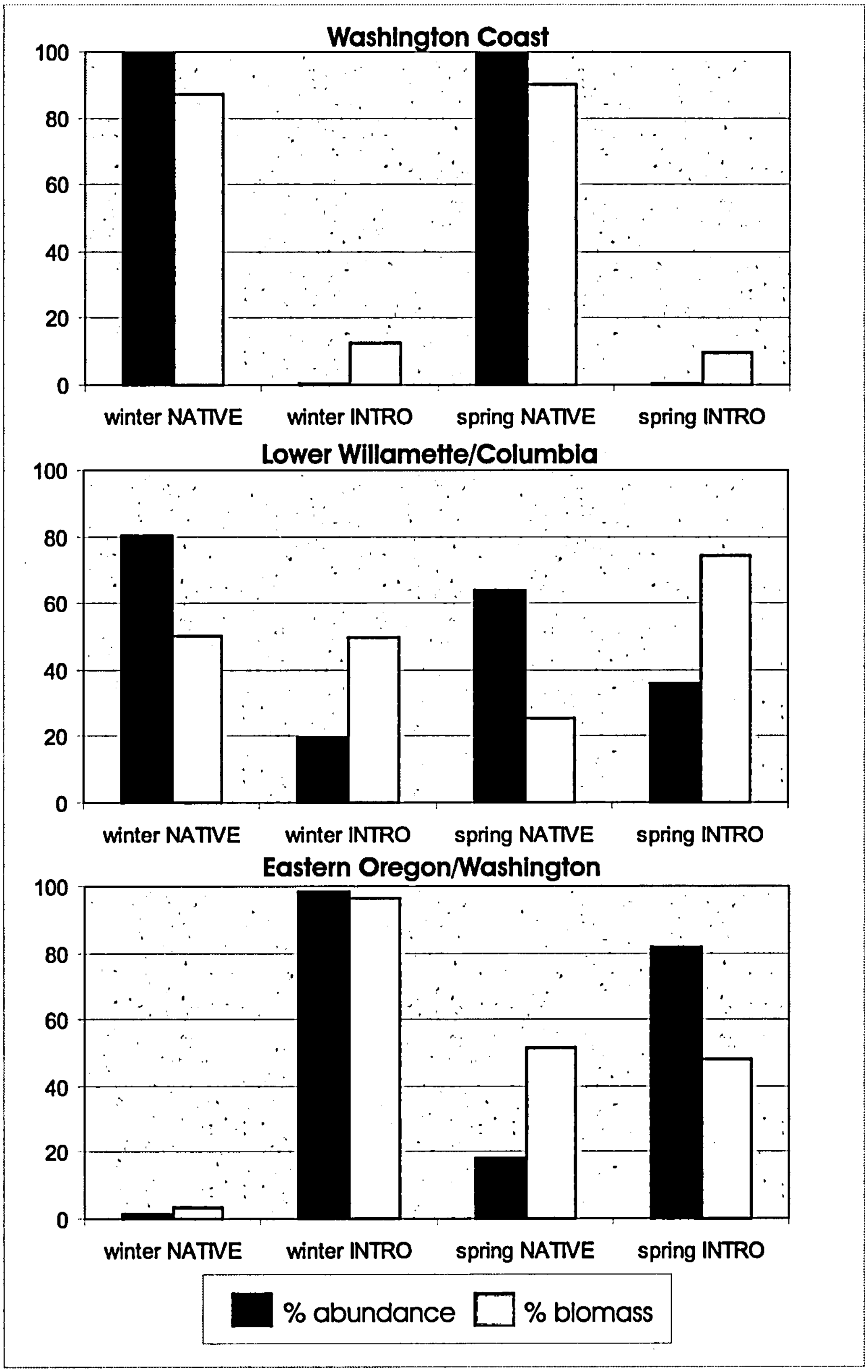
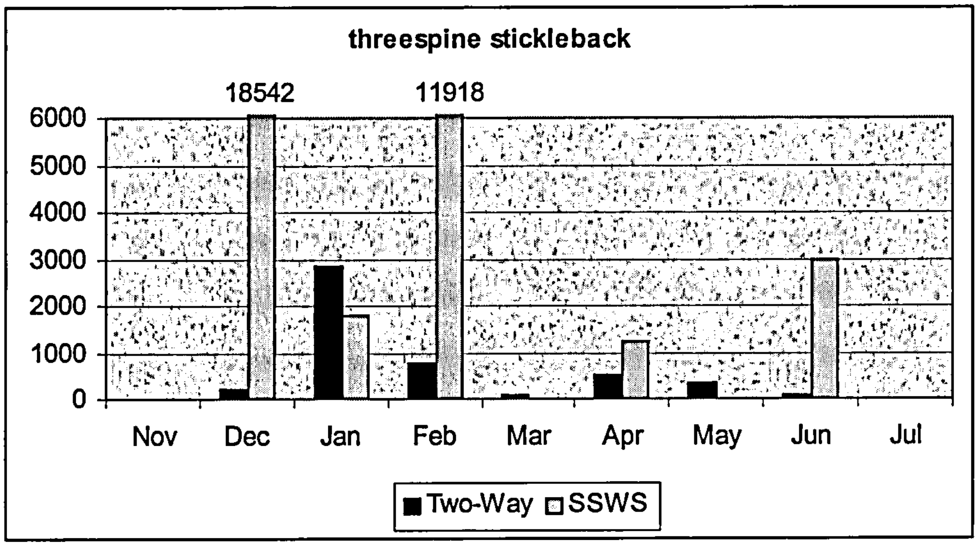


Figure 39. Dominant native and introduced species in the two-way trap and SSWS catch at Multnomah North, Ruby and Wigeon Lakes, WY 2003.



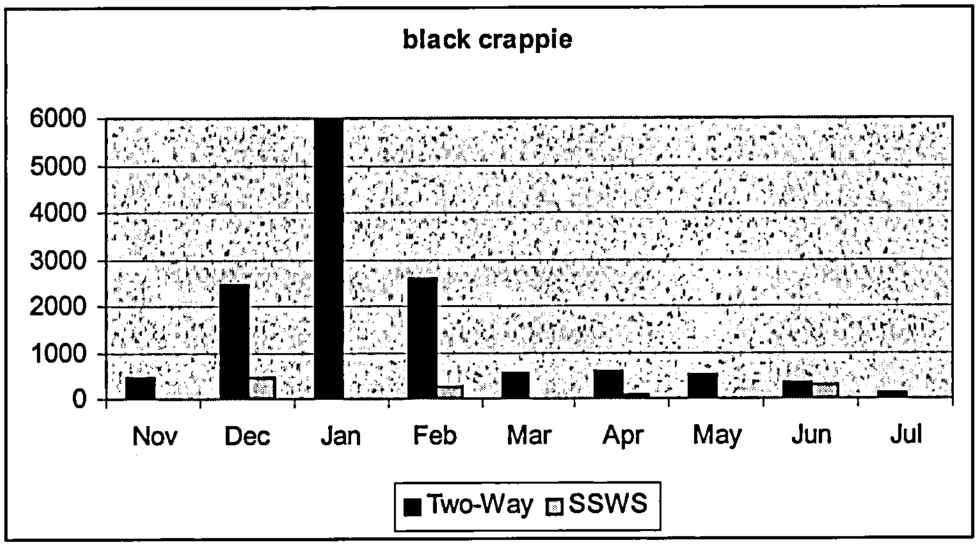
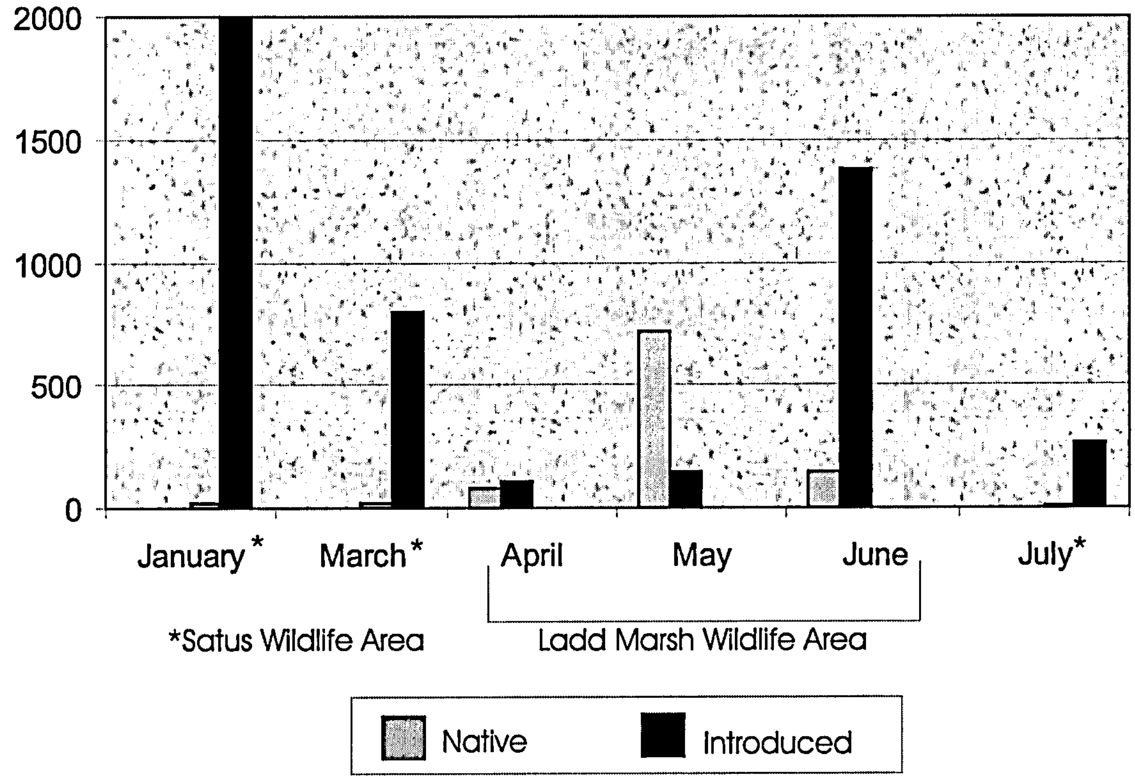


Figure 40. Native and introduced fish catch by all gear, spring 2003 at Ladd Marsh Wildlife Area and winter and spring 2002 at Satus Wildlife Area.



Consistent with the WY 2002 catch (Baker and Miranda 2003b), 99.5% of fish catch in all wetlands and two-way traps in WY 2003 were less than 200mm fork length. Of the catch greater than 200mm, 35% were carp, 27% largescale sucker, and 16% brown bullhead. There were only 12 largemouth bass (*Micropterus salmoides*) larger than 200mm, 2 smallmouth bass (*M. dolomieu*) and 6 yellow perch in that size class. Small-bodied fishes are favored in seaaonal floodplain wetlands where high growth rates and production occur (Bayley 1992). The size class was chosen arbitrarily to describe that few large fishes were caught and of those larger fishes, most are not piscivorous (*i.e.* carp, largescale sucker). Smaller predatory fishes also have a small gape, which limits the size of prey they can handle.

Characteristics of floodplain wetlands that may explain fish use patterns

The major environmental variables that explain fish presence in floodplain wetlands are likely water temperature and hydrology. Dissolved oxygen may become important in the spring when water temperature cannot hold as much oxygen and organic material begins to decompose creating a biological oxygen demand. Life history stage of fishes with respect to time of year also determines presence of fishes in wetlands.

A recurring pattern at all sites where water temperature data were collected was the sharp increase in temperature in the spring. This sharp increase in water temperature may act as a cue for juvenile salmon to leave floodplain wetlands and seek either summer habitat or continue downstream to the ocean. The recommended water temperature for juvenile rearing salmon is between 7.9°C and 13.8°C and the tolerance range is 2°C to 16°C (Armour 1991). During the winter, wetland water temperature fall within the recommended range, which may help explain positive growth rates in addition to high invertebrate productivity of wetlands (Gladden and Smock 1990). As the sharp rise in temperature in the spring begins to exceed the tolerance, water levels fluctuate with spring run-off, which may encourage salmon to leave for cooler habitat.

As mentioned, juvenile salmon move downstream with high-water events and move out of wetlands when water levels fluctuate with spring runoff and with increasing water temperatures. Countless salmon came into the wetland when traps were overtopped, indicating that they move at higher flows than what the traps are able to fish. Generally, catch in the two-way traps were low when water levels were stable and catch increased when water levels were either rising or falling.

Salmon move into the wetlands as juveniles to over-winter or rest and feed on their way downstream. Other species, such as carp, enter wetlands to spawn. The trapper observed a spawning migration of carp into the Ladd Marsh wetland in May and early June (Cathy Nowak, pers. comm.). They were congregated below the emergency spillway and a large pulse came through the inbound two-way trap during that period. Carp are not a desirable species to have in a wetland because they destroy submerged vegetation to the detriment of native fishes and waterfowl (Crivelli 1983, Ivey 1998). Water-control structures provide a constriction and create an opportunity to remove some of these exotic fishes, which may help limit their destruction.

Fish-passage capability through water-control structures

Fish passage was documented by capturing fishes within the water-control structure, at Ladd Marsh, or immediately below the structure in the outbound traps at Mulnomah North and Ruby and Wigeon Lakes. Fish passage was documented at the Lower Willamette sites at these half- and full-round riser water-control structures in WY 2002, as well (Baker and Miranda 2003a). Confirmation of fish passage at the pool-weir-chute water-control structure at Ladd Marsh is new but not unexpected since fish ladders have been used for years. Fishes from 33mm to 575mm ascended the ladder and were caught in the inbound two-way trap at Ladd Marsh. Water may have backed up into the wetland during part of the spring, allowing fish an easier entry over the fish ladder. Even so, during times of lower water levels, small fishes were able to enter the wetland via the fish ladder. Structures are designed to overtop during high flows.

Water-stage data were used to describe fish-passage opportunity through water-control structures at Mulnomah North and South, and Ruby and Wigeon Lakes (Table 29, Figures 6, 11, 15, and 19). This table does not reflect, however, the frequency that the reverse tide-gates are open so should be considered an underestimate. Nevertheless, it shows that water from Multnomah Channel rarely rose to overtop the dikes and the two-way traps were frequently overtopped, which limited fish data collection at high flows. It shows that the wetlands that had no positive water source, Multnomah North and Ruby and Wigeon Lakes had limited time for exchange of fish and aquatic organisms. Even so, a large number of YOY Chinook apparently entered Multnomah North despite the limited access because they were moving with the high water on February 2, 2003. Salmon either entered the wetland during the high-water event or through the inbound two-way traps. Once fish from the inbound two-way traps are identified and measured they are released into the wetlands. There were only 29 salmonids that entered the two-way traps in WY 2003 at the three Lower Willamette sites. These salmon entered the traps from mid-January to late-February, except for three that entered in mid-May during spring run-off. This indicates that the traps either deter juvenile salmon or that they typically move into the wetlands at high water levels. Fishes had 100% chance to leave the Multnomah South unit because Crabtree Creek provided ample water to this wetland and water flowed over the riser and through the sloping-weir fishway the entire season.

Table 29. Percent frequency that water overtops features at Lower Willamette River sites.

Site	dike	riser	trap	egress channel
Mulnomah N.	1.0	1.9*	16.4	NA
Multnomah S.	0	1.3	NA	NA
Ruby Lake	1.0	3.4*	14.4	54.3
Wigeon Lake	3.0	7.7*	21.2	NA

*limited water moving through these wetlands because there are no streams feeding them

Even though stage data were not recorded, fishes had access to move into or out of the wetlands at Ladd Marsh Wildlife Area and the Lewis and Porter Point units at Willapa Bay National Wildlife Refuge. Personnel at these refuges monitor these structures closely, assuring that water is flowing through the pool-weir-chute water control structures. These three wetlands also have creeks entering them with plenty of flow to run the fish ladders.

Conclusion

Salmonids used floodplain wetlands November through June at study sites in WY 2003. Salmon movement was documented by catch in two-way traps; 73% of the salmon caught moving into wetlands in the Lower Willamette River entered November through March and 83% of the salmon in the outbound traps were caught in April and May with spring run-off. There were examples of YOY Chinook using wetlands throughout the winter, at Multnomah North and McCarthy. Yearling coho and Chinook were caught throughout the sampling season but were not recaptured. A few examples of growth rates of salmon in wetlands emerged from the data, which demonstrated positive growth rates of salmon in wetland habitat during the winter. Only two hatchery-clipped coho were caught in the wetlands.

A pattern of decreasing proportion of native to introduced fishes from west to east was distinguished. Most of the fish caught in the wetlands were small-bodied ($\leq$200mm fork length) and most (62%) of the larger fishes were non-piscivorous carp or largescale sucker. Very few piscivorous fishes with a gape large enough to ingest salmon were caught in the wetlands. Piscivorous fishes are, of course, a natural part of the wetland ecosystem and fishes adapted to life in this environment are likely to have the ability to avoid predation to some degree.

All wetlands with water temperature data showed a sharp increase in the spring. Fish movement appeared to be associated with fluctuating water levels and increasing water temperatures. During the winter, wetland water temperatures fall within the recommended range, which may help explain positive growth rates in addition to high invertebrate productivity of wetlands.

Absolute fish-passage capability has been demonstrated through three types of water-control structures under study. Passage at some wetlands that do not have a positive source of water is restricted during parts of the winter and spring. Wetlands with a flowing creek that continuously runs over the riser boards have continuous passage out of the wetlands. Exchange into these wetlands may be restricted for aquatic organisms that cannot ascend a fish ladder with a six-inch step. These water-control structures are designed to overtop by high-water events and exchange of aquatic organisms can occur freely during these periods. Water-control structures are meant to manage relatively low and normal water levels only.

Water-control structures were shown to increase water-surface elevation and surface area. Floodplain wetlands provide productive over-winter habitat for juvenile salmon as well as many other native fishes and animals. Water-control structures provide a means for wetland managers to increase wetland size and duration of flooding. Water-control structures also provide a means for managers to control invasive plants like reed canarygrass and encourage a greater diversity of native plant species in the wetlands.

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Appendix A

Sloping-weir fishway fish-passage evaluation
Rose Miranda
Upstream Fish Passage

A fish trap was set at the wetland side of the water control structure in order to catch fish that move from the riverside of the water control structure through the sloping-weir fishway into the wetland. The trap was set in such a way that one hundred percent of the fish that moved upstream through the sloping weir fishway and into the wetland would be caught in the trap. The trap was first put in on April 28 but was not fishing properly. With three consecutive days of adjustments the trap was operating properly on May 1. The trap was running continuously through May 7. No fish were trapped during this period. A velocity of approximately 4.5 feet per second was measured at the opening of the bypass on the wetland side on May 1 using a Marsh-McBirney flow meter. The opening was approximately eight inches in diameter. The flow was measured in the center of the opening.

In a continued attempt to catch fish moving into the wetland a block net was placed on the riverside of the sloping weir fish way and fish were placed in the lower end of the fish way. The fish were able to either remain at the bottom of the fish way or swim up the fish way into our trap. On May 8, nine Chinook, four black crappies, and one yellow perch were placed at the lower end of the bypass. The trap on the wetland side of the fish bypass was checked on May 9 and again on May 12. No fish were in the trap on either of these days.

Fishes placed in lower end of sloping weir fish way

Species	Fork Length (mm)	Weight (g)
Chinook	85	6.5
Chinook	89	8.5
Chinook	92	7.3
Chinook	94	8.6
Chinook	92	8.5
Chinook	92	7.6
Chinook	85	6.5
Chinook	93	8.3
Chinook	86	6.5
Black crappie	95	12.2
Black crappie	83	8.2
Black crappie	88	9.9
Black crappie	80	7.1
Yellow perch	102	13.5

We were not able to determine if upstream fish passage was possible from these tests.

Downstream Fish Passage

In order to monitor downstream fish passage capabilities of the sloping weir fish way, fish were placed in the upper end of the bypass structure and trapped at the downstream end. The trap was placed in such a way that only fish coming from the bypass structure would be caught in the trap. Two coho, three Chinook, thirteen crappie, and two largemouth bass were marked either by fin clips or PIT tags and placed in the upper end of the sloping weir fish way on May 12. The trap was checked May 13. One Chinook, one largemouth bass, and one black crappie that were placed in the upper end of the bypass structure the previous day were recaptured in the trap. None showed signs of de-scaling. In addition to those fish placed in the fish way, a variety of other fish came through the fish way. None of these fish showed signs of de-scaling. Following is a summary of the catch.

Fishes caught in the downstream trap at the sloping weir fish way.

Species	Number of Individuals
Chinook	3
Threespine stickleback	9200 (estimate)
Banded killifish	3
Bluegill	2
Largemouth bass	1
Yellow perch	1
Asian freshwater shrimp	1
Oriental weatherfish	11
Pumpkinseed	1
Prickly sculpin	1
Salmonid	2 (mortalities, decomposed)

Not all of the fish placed in the upper end of the sloping weir fishway were caught in the trap below. It is possible that either they were holding in the fishway or found a way to escape under the trap.

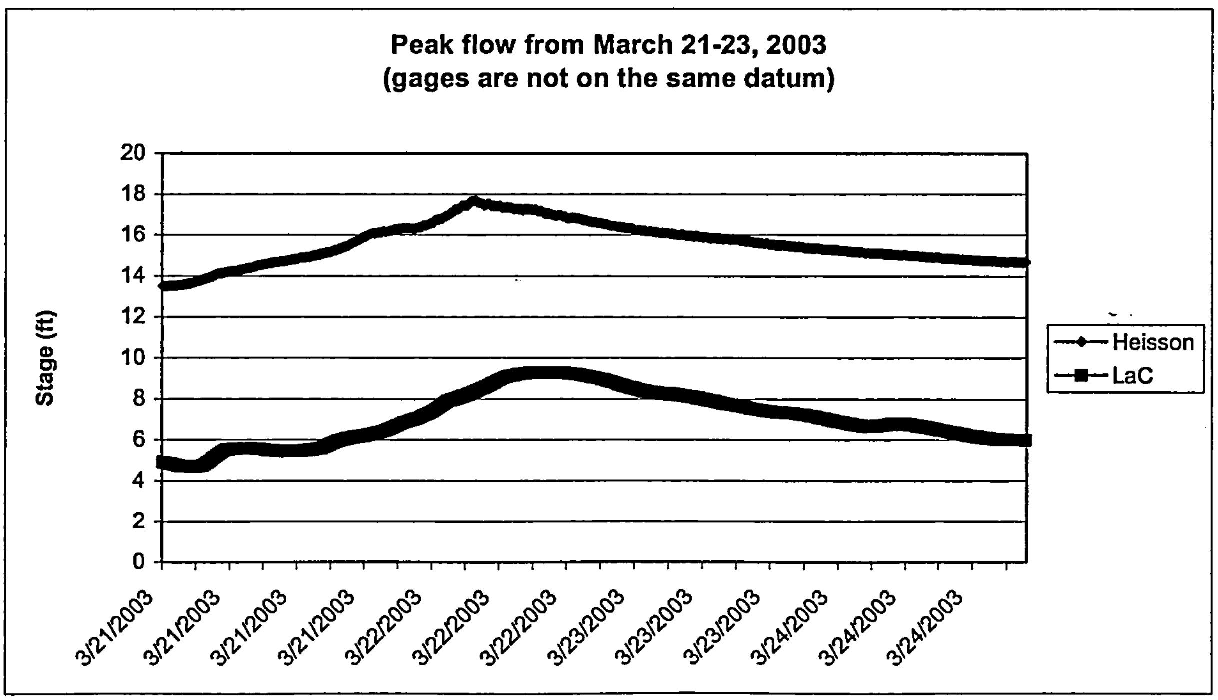
The two salmonid mortalities appeared to have been dead for quite some time. They may have been from the group of fish that were placed in the downstream side on May 8. No PIT tags were found in the fish, although it would be a possibility that the tags fell out of the fish due to their decomposition.

Appendix B
LaCenter Hydrology Calculations
Cyndi Baker

The objective of this hydrologic exercise was to correlate stage data from the Columbia River at St. Helens and the East Fork Lewis near Heisson to the water-level logger (Global Water Instrumentation, Inc.) at LaCenter, which is in between the two gages. Neither gage fit the LaCenter water depth data because the St. Helens gage heights reflect the tides and flow characteristics present in the upper Columbia River Estuary and the Heisson gage heights reflect the flashiness of the upper East Fork Lewis watershed.

My approach was to adjust the Heisson stage for time of travel to LaCenter and correlate Heisson and St. Helens to LaCenter using a multiple linear regression. Raw data (15 min. intervals from 11/12/02 to 4/1/03) from the Heisson gage was used "as is" since this gage site is not referenced to a datum. The St. Helens data (1 hr. intervals plus a few irregular times, same period) was adjusted to NGVD 1929 by adding 0.89 ft. to the raw data. The LaCenter data (15 min. intervals, same period) are depth of the water over the sensor. Raw data from the probe on the river-side of the wetland was used at LaCenter. In order to adjust this to NAVD88, I added 7.91 (LaC + 7.91 = NAVD 88 [ft.]).

First, I adjusted the travel time of the Heisson data to match LaCenter. I looked for a large peak flow during the period of record. The largest was between January 30 and February 2, 2003 but the water-level logger at LaCenter did not capture the peak; I got the 0 to 15 ft. logger. It would have been better to order the 0 to 30 ft logger then I wouldn't have missed the peak. The logger read fine to 16.13 feet then failed at 16.21 feet, which was not the real maximum. I had to find the next best peak, which was March 21-23. This went to 9.28 feet. I matched the date and times of Heisson and LaCenter and found that there was an 8 hour and 15 minute travel time between peaks at Heisson and LaCenter (determined from database, not chart below).



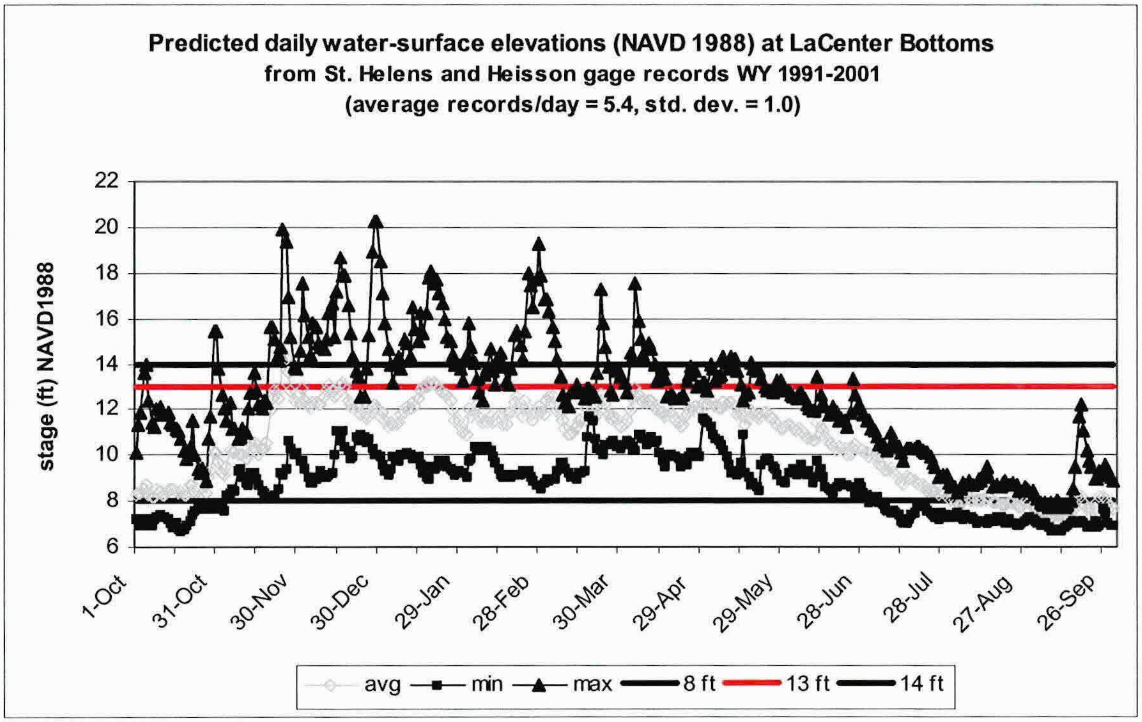
After advancing the Heisson data by 8 hours and 15 minutes, my next step was to match up the date and times at all three sites and run the multiple linear regression. I matched these up and ran the regression with the program NCSS2000 in which LaCenter was the response variable and Heisson and St. Helens were the explanatory variables. I got a 94.2% correlation (see attached).

{μ: LaCenter | Heisson, St. Helens} = -13.11 + 1.06 Heisson + 0.456 St. Helens

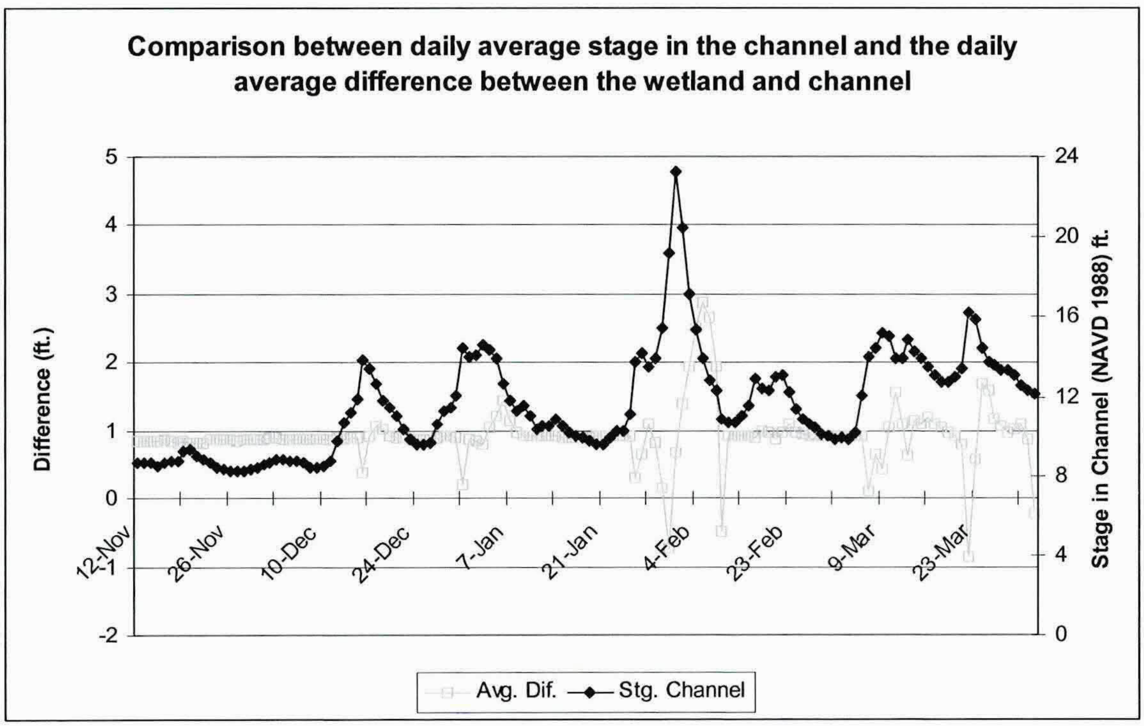
The invert elevation of the culvert (existing slide-gate) under the dike is 8 ft. NAVD 88 and the elevation of the breech in the dike is 14 ft. NAVD 88. The project engineer wanted to know the frequency that the LaCenter stage is between 8 and 14 feet NAVD 88 so, I needed a long record of recent gage-height data (post-dam). I downloaded St. Helens data from 10/0/90 to 9/30/01 and combined those instantaneous gage-height values into daily average gage heights. I requested daily average gage heights for the same period for the USGS gage at Heisson. I then matched up dates for these sites and plugged them into the equation (above) to calculate the predicted depth of water at LaCenter. I added 7.91 feet to the LaCenter predicted values to get a predicted stage in NAVD 88.

I graphed daily average, maximum and minimum stage at LaCenter from the predicted values for the period 10/1/1990 to 9/30/2001 (see below). There were gaps in the data, for example, the Heisson gage was not able to record the peak of the 1996 flood. Predicted daily average stage at LaCenter was based on an average of 5.4 values/day from the period 10/1/90 to 9/30/01, with a standard deviation of 1.0. Most average daily values fall between the 8 and 14 ft range. The invert elevation of the culvert is at 8ft; the elevation of full pool is estimated to be 13 ft; and the elevation of the lowest point at the top of the dike is 14 ft. I queried the database for values greater or equal to 14 ft. and found that 153 out of 1990 records (7.7%) fit these criteria. The earliest date (in the water year) that water met or exceeded 14 ft. was 10/3/97 and the latest date in the spring was 5/12/00. On average, the water exceeds 14 ft. for only a couple days in late November but there is considerable variation with the high flows. Water elevation exceeded 13 ft. an average of 12 days out of the year for the period, between the dates Nov. 25 and January 21. There were 296 records out of 1990 (14.9%) that met or exceeded 13 ft. I did the same for values less than or equal to 8 ft. and found 340 records out of 1990 (17.1%). The earliest date that water fell below 8 ft. was 7/23/00 and the latest date water remained below 8 ft was in the fall on 11/03/91, but on average, the stage is below 8 ft from mid-July until late October.

From daily average differences between the stage in the channel outside the wetland and the stage inside the dike (11/12/02 to 4/1/03), I calculated that the stage in the wetland was 0.93 ft. greater than the stage in the channel, on average, with a range of –0.86 to 2.88 ft. The difference remained steady until a peak in the hydrograph caused the difference to fluctuate (see graph below).



Predicted daily water-surface elevations (NAVD 1988) at LaCenter Bottoms
from St. Helens and Heisson gage records WY 1991-2001
(average records/day = 5.4, std. dev. = 1.0)
stage (ft) NAVD1988
22
20
18
16
14
12
10
8
6
1-Oct
31-Oct
30-Nov
30-Dec
29-Jan
28-Feb
30-Mar
29-Apr
29-May
28-Jun
28-Jul
27-Aug
26-Sep
avg
min
max
8 ft
13 ft
14 ft



Comparison between daily average stage in the channel and the daily average difference between the wetland and channel
Difference (ft.)
5
4
3
2
1
0
-1
-2
Stage in Channel (NAVD 1988) ft.
24
20
16
12
8
4
0
12-Nov
26-Nov
10-Dec
24-Dec
7-Jan
21-Jan
4-Feb
23-Feb
9-Mar
23-Mar
Avg. Dif.
Stg. Channel

Multiple Regression Report

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Database	C:\BAKER\HYDRO\LACENTER\LACORR.S0
Dependent	LaC_stg

Regression Equation Section

Independent Variable	Regression Coefficient	Standard Error	T-Value (Ho: B=0)	Prob Level	Decision (5%)	Power (5%)
Intercept	-13.10526	7.149827E-02	-183.2947	0.000000	Reject Ho	1.000000
Heisson	1.063029	6.911661E-03	153.8023	0.000000	Reject Ho	1.000000
StH_29	0.4562964	5.891085E-03	77.4554	0.000000	Reject Ho	1.000000
R-Squared	0.941788					

Regression Coefficient Section

Independent Variable	Regression Standardized Coefficient Coefficient	Standard Error	Lower 95% C.L.	Upper 95% C.L.	
Intercept	-13.10526	7.149827E-02	-13.24539	-12.96512	0.0000
Heisson	1.063029	6.911661E-03	1.049483	1.076576	0.6937
StH_29	0.4562964	5.891085E-03	0.4447501	0.4678427	0.3494
T-Critical	1.959964				

Analysis of Variance Section

Source	Power DF (5%)	Sum of Squares	Mean Square	F-Ratio	Prob Level
Intercept	1	67921.15	67921.15		
Model	2 1.000000	31689.52	15844.76	45170.9622	0.000000
Error	5584	1958.717	0.3507731		
Total(Adjusted)	5586	33648.23	6.023673		

Root Mean Square Error	0.592261	R-Squared	0.9418
Mean of Dependent	3.486689	Adj R-Squared	0.9418
Coefficient of Variation	0.1698635	Press Value	1963.737
Sum |Press Residuals|	2317.26	Press R-Squared	0.9416

Normality Tests Section

Assumption	Value	Probability	Decision(5%)
Skewness	31.1580	0.000000	Rejected
Kurtosis	30.1310	0.000000	Rejected
Omnibus	1878.7022	0.000000	Rejected

Serial-Correlation Section

Lag	Correlation	Lag	Correlation	Lag	Correlation
1	0.291350	9	0.238246	17	0.181903
2	0.296475	10	0.234326	18	0.156014
3	0.282306	11	0.228384	19	0.191980
4	0.227034	12	0.214355	20	0.150822
5	0.252294	13	0.226539	21	0.145145
6	0.245968	14	0.193237	22	0.152629
7	0.226066	15	0.194822	23	0.131497
8	0.254408	16	0.175353	24	0.150523

Above serial correlations significant if their absolute values are greater than 0.026757

Durbin-Watson Value 1.4127

Multiple Regression Report

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Database	C:\BAKER\HYDRO\LACENTER\LACORR.S0
Dependent	LaC_stg

Multicollinearity Section

Independent Variable	Variance Inflation	R-Squared Vs Other X's	Tolerance	Diagonal of X'X Inverse
Heisson	1.951588	0.487597	0.512403	1.361879E-04
StH_29	1.951588	0.487597	0.512403	9.893825E-05

Eigenvalues of Centered Correlations

No.	Eigenvalue	Incremental Percent	Cumulative Percent	Condition Number
1	1.698281	84.91	84.91	1.00
2	0.301719	15.09	100.00	5.63

All Condition Numbers less than 100. Multicollinearity is NOT a problem.