Multnomah Channel Wetland Restoration Monitoring Project
2014 Annual Report

Prepared for

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EXECUTIVE SUMMARY

In 2014 we initiated surveys to determine the temporal composition and abundance of fish assemblages and habitat use and residency by juvenile salmonids at the Multnomah Channel Marsh Natural Area, a ~120 ha floodplain wetland acquired and managed by Metro near Portland, Oregon. The research has been supported by the Metro Natural Areas Program with support from the Oregon Watershed Enhancement Board (OWEB) and Ducks Unlimited (DU). The project was designed to evaluate the effectiveness of a 2014 restoration project directed by Metro and partners at the Multnomah Channel Marsh. The work was implemented through a collaborative process engaging key conservation groups in the region associated with salmon recovery, including NOAA, ODFW, the West Multnomah Soil and Water Conservation District, DU, OWEB, and the Lower Columbia Estuary Program. The research employed a variety of methods to sample the freshwater tributaries entering the wetland, the north and south wetland ponds, and nearby shoreline habitats along Multnomah Channel and the mainstem Columbia River. The survey was intended to document fish use of the wetland during the spring and early summer immediately preceding a planned restoration project to lower portions of the natural riparian berm separating the wetland from Multnomah Channel.

Some of the highest-value aquatic habitat was observed in the wetland tributaries, Patterson and Crabapple creeks, which were inhabited primarily by native fish and amphibians, including consistent numbers of reticulate sculpin (*Cottus perplexus*) and coastal cutthroat trout (*Oncorhynchus clarki clarki*). In contrast, >50% of species sampled in the wetland ponds in March, April, and June consisted of introduced taxa, including a high proportion of pollution-tolerant species. A total of 27 species of fish and crustaceans—12 native and 15 non-native—were collected in the ponds. Three species of salmonids were present in small numbers: Chinook salmon *(Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), and coastal cutthroat trout. A variety of potential salmonid predators also occupy the ponds, including an apparent resident spawning population of largemouth bass (*Micropterus salmoides*). For most of the sampling periods, native and non-native fish communities in the wetland ponds were more diverse than those in Multnomah Channel or in the main stem Columbia River.

Between March and July we captured four salmonid species, seven other native species, and 14 non-native species at Multnomah Channel locations in the vicinity of the Multnomah wetland and Columbia River main stem locations. Chinook salmon was the most common salmonid species. Catches of juvenile Chinook salmon peaked in April and May and were consistently higher in the main stem than in Multnomah Channel. Non-native species dominated most main stem (9 species) and Multnomah Channel (14 species) collections, and yellow perch (*Perca flavescens*) and banded killifish (*Fundulus diaphanous*) occurred throughout the sampling period. A higher proportion of native species was observed at main stem locations, but the proportion of non-native taxa steadily increased and by July dominated at main stem as well as

Multnomah Channel sites. By July salmon had nearly disappeared from the main stem, and none were captured at survey sites in Multnomah Channel.

We detected 15 individual fish (tagged and released from various upriver locations) entering the Multnomah Channel Marsh's south outlet channel past a PIT antenna array installed near the channel mouth, indicating volitional movement of fish from Multnomah Channel toward the flooded wetland. Among these were eight hatchery spring Chinook salmon that had been released into the North Santiam River by ODFW. We found no evidence that any tagged fish migrated into the south pond through the south water control structure that regulates pond elevation. However, most of the tagged fish were detected at the south outlet channel array before additional PIT arrays had been installed at the water control structure.

We conducted a series of experimental releases of tagged salmon into the south pond to evaluate salmon residence times and egress from the ponds. We documented periods of passage and no passage of experimental groups at the south water control structure, coinciding with times when water did or did not allow adequate spill for fish to exit the ponds over the flash boards. Approximately 25% of salmon released into the south pond were able to locate and pass the south water control structure and enter Multnomah Channel via the south outlet channel. Another 25% made it to the water control structure but were unable to pass. The tagging studies indicate that juvenile salmon in Multnomah Channel would benefit from improved access to the wetland provided barriers do not obstruct their ability to exit. During floodplain residency by salmon, water levels may recede below dike elevation. Careful management of outflow from the ponds is crucial to ensure individuals can exit the wetland at all times, especially as water temperatures rise, dissolved oxygen levels decline, and smoltification progresses.

INTRODUCTION

The loss of approximately 70% of historical tidal wetlands (Marcoe and Pilson 2013) and the listing of 13 stocks of salmonids under the Endangered Species Act has led to an extensive estuarine wetland restoration program to aid recovery of Columbia River salmon (Thom et al. 2013). Restoration projects in recent years have expanded to include floodplain wetlands and other off-channel habitats in the tidal fresh reaches of the upper Columbia River estuary. Genetic studies have documented a high diversity of juvenile Chinook salmon stocks in the vicinity of the Willamette River confluence, where a mixture of upper Columbia River, lower Columbia River, and Willamette River stocks consistently congregate (Teel et al. 2009; 2014). As the first large off-channel area below Bonneville Dam, the Willamette River confluence may provide an important transitional habitat for upriver stocks adjusting to a tidal environment (Teel et al. 2014). This report summarizes results of surveys designed to evaluate the response by juvenile salmon to a wetland restoration project at the Multnomah Channel Marsh, a floodplain wetland managed by Metro in the upper Columbia River estuary near the confluence of the Willamette and Columbia rivers.

Habitat restoration efforts face difficult challenges in the tidal-fresh reaches of the Columbia River estuary, where fluvial processes shape physical habitat and fish rearing opportunities. The Federal Columbia River Power System, which now controls annual average flow and seasonal timing, magnitude, and duration of the spring freshet, has reduced the historical frequency and duration of floodplain inundation, the total area of wetted land, and salmon access to off-channel rearing habitats (Kukulka and Jay 2003; Bottom et al. 2005). Changes in hydrological patterns, nutrient availability, or other disturbances also may have contributed to the spread of non-native reed canarygrass (*Phalaris aundinacea L.*) (Kercher and Jedler 2004a, 2004b; Jenkins et al. 2008), which has replaced native floodplain vegetation across much of the tidal-fluvial estuary (Diefenderfer et al. 2013). Historical changes to the Columbia River hydrograph and the ecological responses to these changes now may limit the opportunities and effectiveness of floodplain restoration for salmon.

An objective of many salmon restoration projects in the tidal-fluvial estuary is to control or eliminate invasive reed canarygrass, although the effects on floodplain-habitat quality and capacity for juvenile salmon are poorly understood. Control measures generally involve physical manipulations, for example, "scraping down" a site to remove reed canarygrass, lowering site elevations to increase flooding frequency, or installing water control structures to artificially retain water on the floodplain. The effectiveness of various measures to control reed canarygrass is often speculative, and in some cases, may be counter-productive for salmon recovery. For example, water control structures can impede the ability of migrating juveniles to freely access or exit floodplain habitats. Uncertainties about the risks and benefits of floodplain restoration to juvenile salmon are reflected in seemingly contradictory management actions in the tidal-fluvial estuary, where some water control structures are used to control reed canarygrass (Lavergne and Molofsky 2006) while others have been removed to improve salmon access (P.C. Trask and Associates et al. 2013). The research described here evaluates the response of salmon to a series of floodplain restoration actions implemented at the Multnomah Channel Marsh over the past 15 years, intended to restore a more natural seasonal flood regime to the wetlands. Goals for the restoration include suppression of pasture weeds (such as reed canarygrass, meadow foxtail, thistles and blackberry), expansions of native emergent and shrub wetland vegetation, and habitat uplift for native wetland species including salmon, pond-breeding amphibians, birds and mammals.

The Multnomah Channel Marsh Natural Area (hereafter, the "Multnomah Channel Marsh") is a ~120 ha floodplain wetland located approximately 24 km northwest of Portland and owned by Metro, an Oregon regional government serving nearly 1.5 million people in Clackamas, Multnomah, and Washington counties. The wetland stretches 2.9 km along the west bank of Multnomah Channel, a large secondary channel connecting the lower Willamette River to the main stem Columbia River on the west side of Sauvie Island (Figure 1). Two tidal creeks at either end of the property drain each of two hydrologically-connected wetland basins where water is stored annually from January to July by managing water control structures located in each creek. An extensive monitoring program from 2001 to 2006 evaluated the potential risks and benefits of floodplain use by fish and the capacity of salmon and other species to enter and leave the marsh through the water control structures (Baker 2008). Survey results at the north wetland pond depicted three general patterns: (1) relative abundance of native fish spp. decreased from winter to spring; (2) most salmon entered the wetland before April, and outmigrants were caught primarily in April and May; and (3) fish catches were generally greater compared to catches at similar wetlands nearby, where the distance to and from Multnomah Channel was greater (Baker and Miranda 2003).

In 2009, the perennial stream (Crabapple Creek) feeding Multnomah wetland was realigned to maintain positive flows from the two outlet creeks and to benefit salmon egress from the site. Additional restoration actions are planned in the Fall 2014, including (1) partial removal of a barrier berm at two locations to improve direct fish access from Multnomah Channel during high-flow events, and (2) removal of passage barriers within the wetland that limit connectivity between the north and south wetland ponds. We initiated surveys in 2014 to re-examine fish use of the Multnomah wetland since the 2009 Crabapple Creek realignment but before the planned breaching of the barrier berm. Fish abundance, species composition, and salmon residency data were collected to provide baseline data for evaluating effects of the berm breaches on floodplain connectivity and fish access from Multnomah Channel. Our sampling was designed to meet the following objectives with the goal of quantifying the effects of the planned habitat improvements being undertaken by Metro. In addition, our goal is to provide data that may help with conservation and habitat improvements elsewhere in the region.

OBJECTIVES:

1. **Characterize wetland use by fish populations at Multnomah Channel Marsh**
   Characterize the current, pre-project wetland use by fish populations, focusing on salmonids but including other fish species in the two large wetland basins at the Multnomah Channel Marsh.

2. **Characterize movements of stream-dwelling salmon**
   Characterize stream movements of juvenile salmon, specifically focusing on the ability of these fish to pass through culverts under Highway 30.

3. **Characterize salmon movement to and from the Multnomah Channel and the Multnomah Channel Marsh wetlands**
   Characterize movements of juvenile salmon, specifically focusing on the ability of these fish to pass through possible barriers presented by the two large water control structures present near the outlets of the two large wetland basins.

4. **Compare relative habitat capacities and juvenile salmon performance in reed canary grass and natural emergent marsh vegetation.**
   Test experimentally the relative growth potential of juvenile Chinook salmon in areas of the Multnomah Channel Marsh that are dominated by natural emergent vegetation vs. reed canarygrass, and monitor the residency and distributions of tagged individuals within each vegetation type.

5. **Characterize effects of river flow and water elevation on salmon dispersal and access to floodplain habitats in the upper estuary.**
   Monitor temporal variations in fish abundance, species composition, and river flow and water elevation in the main stem Columbia River and Multnomah Channel to assess remote influences on fish use of the Multnomah Channel floodplain.

METHODS

Fish sampling

Wetland ponds

We sampled the two largest ponds within the Multnomah Channel Marsh Natural Area for fish in 2014. Large crustaceans and amphibians were incidentally captured during these surveys and were recorded, but were not the focus of the study. The North Pond was 17 ha and the South Pond was 26 ha in size when fully inundated (Figure 1). Fish sampling occurred four days per week in each pond from January 8 to June 5, 2014. Fish were captured using mini Oneida Lake traps (1.2 m^3 box, 2.1m x 1.8m wings, and 1.2 m x 22.9 m lead; 3.1mm mesh). Two traps were deployed in each pond (Figure 2). Traps were set in various locations within the ponds, including channels, open areas and shallow areas with emergent vegetation (Figure 3, 4).

Trap locations were distributed in a variety of habitat types and water depths. Sites were chosen to represent the available habitat or to target juvenile salmonids entering and leaving the wetland. Traps were set mid-morning and checked approximately 24 hours later. Traps were set for two weeks in each location. Traps were then cleaned and moved to a new location.

The north pond was sampled on one occasion using a 5.5-m aluminum electroshocking boat, equipped with a Smith-Root GPP 2.5 generator powered pulsator, set on DC current (400 V, 60-70 hz, 6.0 ms). Sampling consisted of one person operating the boat and two controlling the shocker and netting disabled fish. The boat was operated along shorelines and throughout the main pond at <3 mph. Continuous electrofishing time was recorded. Fish processing followed the same protocol as those for Oneida Lake traps.

Trap location (UTM coordinates) within ponds, water depth (m) and species captured were recorded each time the traps were checked. Amphibians and fish were identified to species. During processing, fork length (FL; mm) and wet weights (g) (salmonids only) of fish were recorded. Amphibians were measured by snout-vent length. Captured fish were transported to shore in buckets and separated into 5-gallon buckets with aerators. Fish were anesthetized with tricaine methanesulfonate (50mg/L). Sodium bicarbonate solution and VIDALIFE® water conditioner were added to the sampling water to reduce gill injury, stress and abrasion during handling. Salmonids were scanned for previously inserted passive integrated transponder (PIT) tags. During a sample week, the first 30 fish of the same species were measured and subsequent fish tallied. Untagged Chinook or coho salmon were measured, PIT-tagged (12-mm tag), and a genetic sample was taken from the caudal fin. Fish were released in the general area of the pond where captured.

Wetland tributaries

Fish were sampled by electrofishing in one 100-m reach of Crabapple Creek, a tributary entering the South pond, and two 100-m reaches in Patterson Creek, a tributary of Crabapple Cr. (Figure 5). Reaches were sampled bimonthly, as conditions allowed, using a Smith-Root LR24 backpack electroshocker. Shocker settings were determined by using the quick set up feature of the electrofishing unit (typically between 150 – 300 volts, 30 hz, and 12% pulse rate). Block nets were placed across the stream at the upper and lower ends of the reach during sampling. The three-pass removal method was used to sample each reach, with operator and assistant capturing stunned fish. After each pass, the elapsed continuous sampling time was recorded and reset to determine catch per effort. Shocker settings (voltage, hz, pulse rate) remained unchanged during each pass. Fish processing followed the same protocol as the Oneida Lake traps. In addition, crayfish caught in the streams were identified to species and counted.

Multnomah Channel and Columbia River main stem

In 2014, we collected fish along the margins of Multnomah Channel at four sites associated with the Metro property study area (Figure 1) and three sites on main stem channels of the Columbia and Willamette rivers (Figure 6). In Multnomah Channel, two sites were located on the Metro property and two adjacent sites along Sauvie Island. Main stem sites were located on Kelly Point Park near the mouth of the Willamette River and two sites in the Columbia River (OR and WA shorelines) 2.8 km downstream from the Willamette River mouth. Sampling was conducted monthly from March to July using a 38 x 2.7-m bag seine (variable knotless mesh panels 1.9 and 1.3 cm with 0.32-cm center bag). Standard net deployment consisted of towing the seine from shore with a boat, sweeping the water column in a half-circle then retrieving the seine sides equally to guide the fish into the center bag. The fish were then transferred to buckets or held in the net until processed. Every effort was made to sample each site consistently; however, seasonal variations in water levels altered the area swept and effectiveness of the seine therefore hampering the ability to make quantitative comparisons of fish abundances among sites.

Fish were identified to the lowest practical taxonomic level, most often genus/species. Introduced larval or post–larval fish were grouped by family and enumerated. In Multnomah Channel all non-salmonids were individually counted at each sample location, and the first 30 of each species (all the locations combined) were measured. In the Columbia River main stem the first 30 at each sample location were measured and the remaining individuals counted. For salmonid species regardless of location, the first 100 randomly selected fish were processed as follows: 0-30 were measured (FL, mm) and weighed (nearest 0.1 g), checked for tags (CWT, PIT) and external markings or anomalies (latex tags, adipose fin clip, parasites); 31-100 were measured and checked for tags/marks. Any individuals remaining after processing the first 100 were counted only. A small tissue sample from the caudal fin was removed from each of the first 30 Chinook salmon and any salmon with CWT or PIT tag. Tissues were archived in ethanol for future genetic analysis. Salmon with coded wire tags (CWT) were retained to retrieve the codes.

Fish data analysis

Communities with high biotic integrity are generally dominated by native, pollution-intolerant species, which infers that habitat and other environmental conditions are of high quality. To provide an initial broad-scale assessment of biotic integrity across sampling sites, we summarized the fish community structure by tolerance to environmental disturbance and adult freshwater feeding guild in the north and south ponds, Multnomah Channel, and main stem Columbia River using classifications established by Zaroban et al. (1999). In addition, community structure indices provide insight to observed changes within communities of particular habitats or study areas. We calculated three community structure indices for fishes for each sampling area: species richness (number of species per sample site), the Shannon-Weiner diversity index, and species evenness. The Shannon-Weiner diversity index includes two components of diversity; 1) number of species and 2) the evenness of those individuals among those species (Krebs 1978). Species evenness measures the proportional abundances among the species in a sample (Pielou 1966) and has a possible range of 0.00-1.00, where 1.00 indicates all species in the sample are numerically equal.

PIT detection

Sites and infrastructure

We installed two PIT detection arrays on the outlet channel to the south pond (Figure 1). The first array was located near the confluence of the south outlet channel (SOC) and Multnomah Channel, and hereafter is referred to as SOC array. The second array was located at the water control structure on the south outlet channel (SWCS), and hereafter is referred to as SWCS array. The SOC array was operational from February 13 – July 17, and SWCS array was operational from February 26 – July 17. Each array consisted of six antennas connected to a multiplexing transceiver (Destron Fearing® FS1001M). Twenty-four volt DC power was provided by a bank of four 12-V batteries supplemented by photovoltaic panels. Data were stored locally on transceivers and transmitted daily via cellular modems.

The SOC array consisted of two parallel sets of three antennas that transected the thalweg of the channel (Figure 7). The two sets created downstream and upstream detection lines approximately 2 m apart, by which directional movement of tagged fish could be ascertained. Each antenna was 1.2 m wide and 3.1 m in height. Fish were guided through the array with block nets that spanned from the outermost antenna to shore.

PIT antennas were installed on both the upstream and downstream side of the SWCS (Figure 8). On the upstream side, three 1.2 x 3.1-m antennas were installed close to the east bank and a block net extended from the westernmost antenna to the west bank. On the downstream side the antennas were aligned with the downstream ends of the two culverts and one fishway. Two 1.2 x 3.1-m antennas were installed approximately 0.3 m downstream from each culvert's trash rack. A 1.2 x 1.8-m PIT antenna was installed approximately 0.3 m from the downstream opening of the fishway. Block nets were not used on the downstream side of SWCS array.

Water temperature and depth data loggers were deployed at SOC array and on both the upstream and downstream sides of the SWCS.

Group releases

We captured, PIT-tagged, and released groups of juvenile salmon on four occasions. On March 26, April 17, and April 28 ODFW used an electrofishing boat (Methods section: *Wetland Ponds*) to collect juvenile salmon in areas of Multnomah Channel near its confluence with the SOC. On May 7 NOAA Fisheries used a bag seine (Methods section: *Multnomah Channel and Columbia River main stem*) to collect juvenile salmon from the Columbia River main stem sampling site on the Washington shore (Figure 6). All juvenile salmon were anesthetized using tricaine methanesulfonate (50mg/L), identified to species, and checked for external marks such as an adipose fin clip and previously inserted PIT or CWT tags. If a fish already had a PIT tag, the code was recorded and the fish was identified as a "recapture". Fork length (nearest mm), and weight (nearest 0.1 g) were recorded for all individuals and a 12-mm PIT tag was inserted into the body cavity of individuals that were not previously PIT-tagged, following regional guidelines for PIT marking (PTSC 2014). Genetic samples were collected from fish with an intact adipose fin and archived. Salmon collected from the Columbia River main stem were transported via boat and truck to the Multnomah wetlands property after processing.

Tagged fish were allowed to recover for 1-2 hr before release into the wetlands (Figure 1). Fish tagged on March 26 were released the same day in the SOC downstream of the SWCS. Fish tagged and released on April 17 and 28 were divided into two groups and released into two separate locations within the south pond. Fish tagged and released on May 7 were divided into five groups and released at three locations in the south pond and two locations in the north pond. NOAA monitored SOC and SWCS arrays for detection data from PIT-tagged fish, and ODFW monitored the north and south ponds for PIT-tagged fish (Methods section: *Wetland Ponds*).

From the detection data we determined whether fish from upriver sources entered the SOC from Multnomah Channel and how long they stayed. For the release groups we measured four metrics: 1) time-to-first detection, which for most groups is a measure of how long it took fish to maneuver through the wetland to the SWCS; 2) meso-scale residence time (R_{MESO}), which is the time from release to time-of-last detection on either array; 3) SOC residence time (R_{SOC}), which is the time spent in the SOC downstream of the SWCS (post SWCS passage for south pond release groups); and 4) inter-array transit time, which is the elapsed time between the last detection at SWCS and the first detection at SOC array. Inter-array transit time is a positive value for fish that only moved in a downstream direction past both SWCS and SOC arrays. However, fish that moved back-and-forth between the SWCS and SOC arrays have a negative value because the last detection at SWCS array occurred after the first detection at SOC array. We also monitored upstream vs downstream passage at the SWCS.

For tag-recovery analyses we assumed that: 1) tagging mortality did not affect detection probability; 2) survival in the wetlands was equal among all fish released; and 3) detections depicted the behavior of tagged salmon rather than the movement of salmon predators through the electromagnetic field of the antennas.

Growth Experiments

In the South pond, temporary holding pens were used to compare juvenile salmon growth rates in two areas (Figure 1) comprised of vegetation dominated by either native emergent plants or reed canary grass. Three replicate pens were placed in each area. The nets were 1.2-m high and constructed of 0.64-cm Ace knotless netting. Each 1.2 x 3.7-m pen was attached to a rectangular "frame" of metal posts. Lead weights held the sides of each net to the substrate surface. On 29 May, we distributed 10 hatchery-reared juvenile Chinook salmon in each of the six net pens. The fish used in the experiment ranged from 92 to 99 mm FL, however the size range of individuals placed in each pen varied no more than 2 mm FL. The three reed canarygrass pens included one group of fish 92-92 mm FL and two groups 94-95 mm FL. The native vegetation included two groups, 96-97 mm FL, and one group, 98-99 mm FL. The growth experiment continued for 13 days. We deployed a scoop net, constructed of 0.64-cm mesh stretched over a 1.2 x 1.5-m rigid frame, to recover fish from each pen.

RESULTS

Fish sampling

Wetland ponds

We caught a total of 27 species of fishes and crustaceans in the ponds; 12 native and 15 exotic (Table 2). The two species of crustaceans were native signal crayfish (*Pacifastacus leniusculus*) and invasive Siberian shrimp (*Exopalaemon modestus*). The fish species represented 12 families, with the largest percentages from the families Cyprinidae and Centrarchidae (Figure 9). Most species in the ponds were tolerant of pollution (Figure 10). Invertivores were the most common adult feeding guild, either as obligate invertivores or combined with piscivory (Figure 11). Native threespine stickleback (*Gasterosteus aculeatus*) were by far the most abundant fish in our catch, followed by non-native brown bullhead (*Ameiurus nebulosus*). Threespine stickleback had a fairly narrow range of lengths, with a mean of 52.7 mm FL. Brown bullhead were caught in a wide range of sizes, including some large adults (Table 3.) Community structure indices were higher for the non-native species most months. Diversity and evenness of non-native species in the ponds increased over the sampling period while representatives of the native fish community declined (Figure 12), most likely in response to higher temperatures and lower dissolved oxygen concentrations during summer months. Population structure indices showed that both diversity and evenness of native species in the north and south ponds was greatest in March, while the diversity and evenness of non-native species peaked in May (Figure 12). The percentage of native species in our catch varied by month, averaging 62% for the entire sampling period (range 33-93%; Table 4).

Three species of salmonids were caught in the ponds; juvenile Chinook salmon, coho salmon and coastal cutthroat trout. Abundance in the ponds was low relative to most other species. Juvenile coho salmon were the most abundant, with a total of 17 caught from February – mid April. We caught two juvenile Chinook salmon in April and three in May. Fish likely entered the ponds during a high water event on March 10-11; we caught juvenile salmon intermittently from March 18 until early May. Chinook salmon had a mean length of 101.6 mm FL. One was an age-0 juvenile, while the others were age-1 juveniles. Juvenile coho salmon had a mean length of 124.2 mm FL as most of them were age-1 (Table 3). We caught four cutthroat trout in February, when Crabapple Creek was high, and one in March, May and June.

Amphibians were frequently caught incidentally in the Oneida traps; tadpoles of American bullfrogs (*Lithobates catesbeianus*) were the most common catch (Table 5). Bullfrogs were caught all six months, with the most caught in March. Northwestern salamanders (*Ambystoma gracile*) were the most common native species of amphibian caught in the ponds. Native amphibians were caught primarily January through March, during the breeding season.

A single boat electrofishing survey of the north pond in March captured many of the same species as the Oneida traps and some individuals were much larger than those caught in the trap nets (Table 6). For example, we caught largemouth bass and largescale sucker that were too big to fit into the Oneida trap nets. The most common fish caught by boat electrofishing were peamouth (*Mylocheilus caurinus*). We also collected additional juvenile Chinook and coho salmon (one each) via boat electrofishing that we PIT tagged and released back into the pond. These fish were not detected by the PIT antenna arrays at the SWCS or SOC arrays but may have left the Multnomah Channel Marsh via the north outlet channel.

Wetland tributaries

Native species dominated the backpack electrofishing catch from Patterson and Crabapple creeks (Table 7). Reticulate sculpin and coastal cutthroat trout were the most common fish species caught upstream of Highway 30, and only native species were caught in the two sampling reaches upstream of the highway. Native and non-native fish species were caught in the one reach downstream of Highway 30; reticulate sculpin and western brook lamprey (*Lampetra richardsoni*) were the most abundant. We caught cutthroat trout of a wide range of sizes, suggesting a number of different year classes (Table 8). Native signal crayfish were the only crustacean caught in the streams. Three species of amphibians were caught in the streams; invasive American bullfrogs and native Pacific giant salamanders (*Dicamptodon tenebrosus*) and red-legged frogs (*Rana aurora*).

Multnomah Channel and Columbia River main stem

The number of river sites sampled via bag seining at each location remained consistent throughout the season (Table 9). However, effort at each site was influenced by river flow, which affected the ability to sample and collect up to 30 salmon at each location. Between March and July, four salmonid, seven native (non-salmonid) and 14 non-native species were captured in the Columbia River main stem and Multnomah Channel locations (Table 10).

Chinook salmon was the most common salmonid species in each location; however, catch rates were consistently higher in the main stem. The peak abundances in April and May are consistent with spring migration and hatchery releases in the region. Thirteen families were represented in Multnomah Channel and ten families in the main stem. There were fewer pollutant tolerant species in the main stem versus Multnomah Channel; likewise, the greatest percentage of invertivore/piscivore and obligate invertivores were found in the main stem Columbia River.

Catch rates per effort in both locations for native species were consistently low throughout the sampling period, with the exception of threespine stickleback, typically >10/effort. Juvenile starry flounder (*Platichthys stellatus*) and peamouth were also common in both locations in much lower numbers, <3/effort. Non-native species were dominant in most samples in both the main stem (9 species) and Multnomah Channel (14 species) locations. Yellow perch and banded killifish were commonly found during the entire sampling period. Several taxa did not appear until later in the summer such as juvenile centrarchids, brown bullheads, juvenile cyprinids, golden shiner (*Notemigonus crysoleucas*), and common carp (*Cyprinus carpio*). Seasonal changes in proportional abundance generally coincided with increasing water temperature and decreasing dissolved oxygen levels in the main stem and Multnomah Channel, March – July (Figure 13, 14). The main stem had a higher proportion of native species than Multnomah Channel from March through May. Both locations transitioned between May and June, with nearly equal proportions. By July non-native species were dominant everywhere.

More salmon were captured in the Columbia River main-stem locations than in Multnomah Channel, with Chinook salmon the predominant species in both locations. Length frequencies depict fry (<60 mm) and yearling (>100 mm) size classes in March, hatchery-reared (marked) fingerlings (60-89 mm) in April, and peak numbers of unmarked fry in May (Figure 15). By July salmon had nearly disappeared from the main stem, and none were found in Multnomah Channel.

For most of the sampling periods native and non-native fish communities in the wetland ponds were more diverse than those in Multnomah Channel and the main stem Columbia River (Figure 12). The main stem had a relatively low number and an equal number of species until later in the sampling period, when river temperatures warmed. By June the non-native species component increased and was dominated by a single species (yellow perch). Community structure indices generally were higher for non-native than for native fish species at the Multnomah Channel survey sites (Figure 12). Non-native fish values increased during the sampling period; however, the evenness values were mid-range, indicating that several species were well represented.

Fifteen coded-wire tags (CWT) were recovered from Chinook salmon captured in both locations, representing nine different codes (Table 11). The majority of the tags were from spring Chinook salmon from the Willamette River basin, with one from the Sandy River. Fall-run type Chinook salmon were primarily from Spring Creek Hatchery on the main stem of the Columbia River. Days-at-large after hatchery release varied from 12-140 days with most between 14 and 34. It was not possible to estimate growth between release and capture because lengths at the time of hatchery release were not recorded. Mean weights also are difficult to compare because release sizes can vary significantly with duration of hatchery rearing and degree of feeding competition among hatchery fish.

PIT detection of salmonids

Run-of-river fish

Fifteen fish from upriver sources (i.e., tagged by other entities) were detected on SOC array (Table 12), and none of these fish were detected on SWCS array, with one exception noted below. However, eleven of the fish were detected at SOC before the SWCS array was installed. Detection dates ranged from February 14 – May 9. Eight individuals were spring hatchery Chinook salmon from a single release on the North Santiam River (Willamette River Basin). Seven of these fish were detected between February 14 and February 17, 2014, during the run-up to a high water event. An additional three wild spring Chinook salmon that were tagged at Leaburg Dam on the McKenzie River (Willamette River Basin) were also detected during this timeframe. One hatchery summer steelhead (*Oncorhynchus mykiss*) released on April 29, 2014 on the lower Salmon River, ID (Snake River Basin) was detected on May 9. Two fish were detected for which no species or location information is available. On March 26, 2014 one of these "orphans" –a wild juvenile Chinook salmon– was recaptured by ODFW; it was released near and detected at the downstream SWCS array. The remaining tagged fish that entered the site from an outside source was a northern pikeminnow (*Ptychocheilus oregonensis*) that was tagged in 2012.

Meso-scale residence time (R_{MESO} – time between first detection and last detection, regardless of array) of juvenile salmonids ranged from 2 sec to 8 days with a median of 6.9 hr. Members of the large group of fish that were detected during the high water event had a median R_{MESO} time of 6.8 hr and a maximum of 2 days. The orphan wild Chinook salmon resided for 8.1 days, the longest R_{MESO} for a salmonid. The summer steelhead R_{MESO} was 31 min. The longest R_{MESO} was expressed by the northern pikeminnow, which was detected intermittently (almost daily) for 42 days from February 21 to April 5.

Individual releases in ponds

None of the fish that were collected, PIT-tagged, and released by ODFW within either the north or south ponds were later detected on either SWCS or SOC arrays.

Group releases in ponds

Numbers of salmon tagged, dates and locations of release, and numbers detected on each array or recaptured in traps are listed in (Table 13). None of the fish released into the north pond (areas D and E) or near the culverts connecting the north and south ponds (area C) were detected on either PIT array or recaptured in Oneida traps. Fish released in the south pond or directly into the south outlet channel were detected on both SWCS and SOC arrays.

Time-to-first detection data indicate that fish typically spent at least 2 weeks in the south wetland before navigating to SWCS and SOC (Figure 16-A). The median time-to-first detection was 24, 19, and 16 days for groups released on April17, April 28, and May 7, respectively. The group released just downstream of the SWCS on March 26 had a much lower median time-to-first detection of one day.

R_{MESO} was slightly greater than time-to-first detection (Figure 16-B). The median R_{MESO} for groups released in the south pond on April 17, April 28, and May 7 were 30, 21, and 22 days, respectively. R_{MESO} for fish released downstream of SWCS was 6 days.

The March 26 release group had the greatest SOC residence time (R_{SOC}) with a median of 7.2 d. Each subsequent release group had successively lower R_{SOC} median values of 7.6 hr, 47.5 min, and 40.3 min for groups released April 17, April 28, and May 7, respectively.

Inter-array transit time (elapsed time between the last detection at SWCS array and first detection at SOC array) was measured for 32 fish that were released in the south pond and were detected on both SWCS and SOC. Transit time ranged from -2.3 to 12.6 days. Negative transit times are a result of fish moving upstream to SWCS array after having been detected at SOC array. The median transit time for groups released on April 17, April 28, and May 7 were 3.6 hr, 1.8 hr, and 34.7 min. Fish released in the south outlet channel on March 26th had a wider range of inter-array transit times: -6.8 to 17.0 days. The median transit time for this group was 1.3 days.

Thirty-three Chinook salmon and five coho salmon that were released in the south pond successfully passed the SWCS. However, 28 Chinook salmon and 5 coho salmon were detected upstream of the SWCS but were not detected downstream or at the SOC array (Figure 17). These fish are presumed to have not passed. No single release group was more or less likely to pass the SWCS as the proportions of fish from each release group that passed and did not pass were similar. There was no evidence of fish moving from the downstream side of the SWCS to the upstream side.

Salmon passage and non-passage typically occurred during distinct time periods (Figure 18). Passage initially occurred between April 19 and May 11. During this time the water level upstream of the SWCS fluctuated between 1.9 and 2.3 m, and all passage detections occurred at water depth of 2.0 m or greater. During this time water was spilling over the flash boards of the SWCS. A period of non-passage occurred from May 11 to May 28. During this timeframe water had ceased spilling from the upstream side of the SWCS. This no-passage scenario was interrupted on May 28 by the water level on the downstream side rising due to increased outflow from Bonneville Dam and coincidental spring tides. The downstream water depth increased enough to overtop the flash boards. At this point salmon were again able to pass. However, passage continued even as the water level upstream of the SWCS decreased to depths below the flash boards. During the high water event some boards on the fishway became dislodged and as the water receded, debris was trapped between the boards, allowing water and salmon to pass. The debris was removed and the boards were reseated on June 3 which coincided with the last salmon that successfully passed the SWCS.

Growth experiment

Due to a delay in holding pen construction and delivery, the growth experiment was conducted later in the year than anticipated. Concerns regarding rising temperatures and lowering oxygen levels in the south pond proved valid when no live hatchery salmon were recovered at the end of the 13-day experiment.

DISCUSSION

The Columbia and Willamette river basins have a long history of exotic fish introductions, both intentional and accidental, and the fish communities of the north and south Metro ponds contain many of those non-endemic species. Bullhead catfish, the most common non-native fish we captured, were intentionally released and established in Oregon by about 1890, and for a time supported a small fishing industry at Sauvie Island and surrounding waters (Lampman 1946). Also present in our surveys were a number of exotic species documented in the region within the last few decades, including Siberian shrimp (Emmett et al. 2002), Amur goby (*Rhinogobius similis*), Oriental weatherfish (*Misgurnus anguillicaudatus*) (Strecker et al. 2011), and banded killifish (LaVigne et al. 2008). Three of the species we collected (American bullfrog, largemouth bass, common carp) are among the “100 of the world’s worst invasive alien species” (Lowe et al. 2004). We also note that the Oregon Invasive Species Council (2014) lists golden shiners among the “100 worst” potential invasive species but states they are currently not present; we captured >500 in the ponds in 2014.

Though the ponds were numerically (72% of catch) dominated by native fish species for all months combined, a single species (threespine stickleback) comprised 94% of the native individuals, and non-native species composed >50% of the catch in March, April, and June. We did not sample in summer and fall, when conditions in the ponds would presumably favor non-native species, especially centrarchids and American bullfrogs. The preponderance of exotic species and high proportion of individuals tolerant to pollution suggests the biotic integrity (see Karr 1981) of the native pond community is substantially compromised. However, the presence of three salmonid species, two lamprey species, and a number of other endemic fishes and amphibians is encouraging. In addition to providing greater access to off-channel areas for juvenile anadromous salmonids, the planned restoration to improve connectivity of the wetland to Multnomah Channel could help to moderate high temperatures that favor exotic species, allow larval fish to escape to the river, and improve access to Crabapple and Patterson creeks for lamprey and salmonids.

Fish and amphibians known to be major predators of salmonids were common throughout the north and south ponds, but the actual risk of predation appeared to be minimal based on their apparent low densities and small sizes. For example, juvenile salmonids are the primary diet item of northern pikeminnow >250 mm FL in the lower Columbia River (Vigg et al. 1991), but we captured only 67 northern pikeminnow (<0.2% of the total catch) and none exceeded 136 mm FL. Other important predators of salmonids in the Pacific Northwest, such as smallmouth bass (*Micropterus dolomieu*) (Carey et al. 2011) and walleye (*Sander vitreus*) (Rieman et al. 1991) are known to be established in the Willamette River (LaVigne et al. 2008) but were completely absent from the Oneida trap and boat electrofishing catches. We intend to conduct additional boat electrofishing in 2015 pending sampling conditions and availability of the equipment.

Sampling bias undoubtedly affected our catch, as the Oneida traps were designed to capture juvenile salmonids, not large predators. We collected 1,772 largemouth bass, another potential predator, in the Oneida traps; these had a mean FL of 36 mm and only three were large enough to consume a juvenile salmonid. However, boat electrofishing during a single day produced three largemouth bass with a mean FL of 379 mm. The capture of the large individuals in late winter followed by many small (young-of-year) bass in the spring suggests a resident spawning population is present. The risk of predation to salmonids is likely greatest in the spring and summer when any salmonids entrapped in the site would be exposed to adult largemouth bass (and other warmwater fish) that have finished spawning, and to American bullfrogs that have transformed into adults.

In contrast to the ponds, Patterson and Crabapple creeks were nearly devoid of introduced fish, amphibians, or crustaceans, with only a single American bullfrog and two oriental weatherfish captured, all below the highway crossing and near the ponds. The cutthroat trout population appears to be small but is likely self-sustaining as evidenced by the range of sizes observed. Given adequate access through the ponds and culverts, limited spawning by coho salmon may be possible in these creeks. In any case the streams constitute some of the highest-value habitat in the study area based on the high-quality composition of the aquatic community. Habitat preferences likely drive the exclusion of exotic species in the streams, so the habitat restoration is not likely to compromise the stream community by encouraging the establishment of additional exotic species. To the contrary, greater access will likely be provided for native anadromous species.

Despite differences in sampling efficiency that preclude quantitative comparisons between the beach seine and Oneida trap, our results reveal an apparent gradient in fish species composition and feeding guilds from estuary main stem to Multnomah Channel to wetland ponds. Generally we documented increasing proportions of pollution tolerant species, omnivorous taxa, and non-native fishes along the lateral gradient from the outer main stem river to the interior wetland ponds. A wider range of sizes and age classes were represented among many of the non-native species collected in the ponds (e.g., black crappie, brown bullhead, common carp, goldfish, largemouth bass, pumpkinseed, brown bullhead) compared with the same species sampled in Multnomah Channel. While apparent differences in size distributions could be an artifact of the different sampling methods for the two areas, the results indicate that larger non-native species of reproductive size do occupy the wetland.

Surveys in Multnomah Channel found juvenile salmon in the vicinity of the Multnomah Channel Marsh that could potentially enter during periods when the ponds are accessible. This was demonstrated when juvenile Chinook salmon and coho salmon were captured in the Oneida traps after natural breaching of Multnomah Channel into the north pond. Teel et al. (2014) reported a strong seasonality in the life histories and stock composition of Chinook salmon in the vicinity of Sauvie Island and the Willamette River confluence (i.e., estuary reaches E/F) that will determine the sources and abundance of salmon available to enter the Multnomah Channel Marsh at any particular time. Monthly salmon surveys conducted at wetland and main stem habitats in 2012 reported temporal abundances as follows:

- Willamette River Spring stock, January – March (yearling and fry migrants);
- Spring Creek Group fall stock, April – May (fry and fingerlings); and
- Upper Columbia River Summer/Fall stocks, June – July.

Total Chinook salmon abundance in the area declined rapidly across all sites after July but increased again in November and December with the appearance of Willamette River Spring, West Cascade Fall, and Upper Columbia River Summer/Fall stocks (Roegner et al. 2014).

Very few Chinook salmon accessed the wetland ponds, and beach seine catches of salmon in the Columbia River main stem were consistently higher than those in Multnomah Channel (Table 10). These results suggest a lateral decrease in salmon abundance with distance from the main-stem river to the off-channel areas behind Sauvie Island. The proportion of large, hatchery-marked salmon was also relatively higher at main-stem sites than in Multnomah Channel collections except during the May survey, when a larger number of Chinook fry occurred in the main-stem samples (Figure 15).

The temporal abundance and life histories of salmon in Multnomah Channel may depend on a complex relationship between the seasonality of stock migrations among various genetic stock groups (i.e., Willamette River, interior basins, and lower Columbia tributaries) and the timing of river-flow conditions that affect fish dispersal from the main stem Columbia and Willamette rivers to the back side of Sauvie Island. A 2011 sample collection in Multnomah Channel and Cunningham Slough (lower Sauvie Island) documented a substantial number of upper Columbia River summer/fall stocks on the lower Sauvie Island floodplain (Cunningham Slough) during an extreme flow event that coincided with the migration period for this stock (Roegner et al. 2011). However, Chinook salmon abundance in Multnomah Channel during more moderate flow conditions in 2012 was much lower than that of nearby survey sites on the main stem Columbia River (Roegner et al. 2014). As noted above, a similar spatial pattern was evident during 2014 beach seine collections for the present study (Table 10).

Salmon use of the Multnomah wetland thus likely depends on a combination of local and regional factors influencing juvenile salmon migrations, dispersal, and habitat opportunities. Understanding interactions between river flow, salmon distribution, and stock composition in the vicinity of the Metro site will require sampling over a wider range of Columbia and Willamette River flow conditions throughout the seasonal migrations of different genetic stocks.

Once in the wetlands salmon movement throughout the habitat may be limited. None of the PIT-tagged fish that were released in the north pond (individual and group releases) or near the culvert dividing the north and south ponds were seen in the south pond Oneida traps or detected on SWCS or SOC arrays. This limit in movement could result from lack of connectivity between the north and south ponds, physical restriction from the abundance of reed canarygrass, or the natural behavior of the salmon. We also do not know if these tagged fish left the north pond during a high water event or after water levels had receded below dike elevation. There is a small fish passage structure at the NWCS whereby fish could exit once water levels recede, but we do not know how effectively it passes juvenile salmon. We recommend that a PIT detection array be installed at the north water control structure to monitor potential ingress and egress of PIT-tagged salmon through the NWCS.

Access to the south pond from Multnomah Channel will be enhanced during elevated flow regimes when the post-restoration dike breach is overtopped. However, during average flow conditions access to the south pond is blocked by the SWCS when the tide gates are closed (typically January – June). None of the PIT-tagged fish that were released downstream of the SWCS were detected on the upstream SWCS array or in the south pond Oneida traps. Whether salmon that enter the SOC from Multnomah Channel swim far enough upstream to reach the SWCS is uncertain. Of the 13 salmon known to have entered SOC from Multnomah Channel, none were detected on SWCS array. However, 11 of these fish were in SOC prior to SWCS array being operational, whereas, eight of the PIT-tagged salmon released in SOC on March 26, frequently moved back-and-forth between SOC and downstream SWCS arrays.

Juvenile salmon in the March 26 release group differ from the groups released in the south pond. Because the release location was located near the downstream SWCS array, their time-to-first detection was much less than the south pond release groups. Likewise their R_{MESO} was less because they did not have to navigate through the wetland to reach either SWCS or SOC arrays. However, the amount of time spent in SOC downstream of the SWCS (R_{SOC}) was greatest for this group and was successively lower for each subsequent release group. Likewise the inter-array transit time was slowest for the March 26 release group and successively faster for each subsequent release group. Individuals in the March 26 group appeared to be milling around the area for a period of time before moving into Multnomah Channel, but the south pond release groups quickly moved into Multnomah Channel after passing the SWCS. A likely explanation for this behavior is that increased water temperatures and declining dissolved oxygen levels in the pond prompted salmon to exit quickly. Stage of smoltification may also be a factor as each group was released successively later in the season.

Approximately 25% of salmon released into the south pond were able to locate and pass the SWCS and enter Multnomah Channel via the SOC. Yet, another 25% made it to the SWCS but were unable to pass it. Consequently, we saw a reduction in the numbers of PIT-tagged salmon detected at SWCS array versus SOC array. We could not account for the remaining 50% of salmon that were released in the south pond. Had the fishway at the SWCS not been closed we likely would have seen more salmon pass and exit to Multnomah Channel. The debris jam in the fishway after the high water event on May 28 gave us a glimpse of how an operational fishway would allow otherwise trapped salmon to exit to Multnomah Channel. Additionally, the small amount of flow generated from an operational fishway *may* create enough of an attraction current to guide fish in the south pond to the outlet channel (Coutant 2001). We recommend that the SWCS fishway be better managed to allow fish passage especially as floodplain water temperatures rise and diel dissolved oxygen levels decline.

In conclusion, recent survey results indicate that salmonids from wetland tributaries and from Multnomah Channel may benefit from rearing habitat in the Multnomah Channel Marsh from winter through spring, when water temperatures and dissolved oxygen conditions are suitable. However, it appears these benefits are not fully realized because barriers impede fish migrations to and from Multnomah Channel and between the north and south ponds. Tagging experiments and PIT tag detections confirm that juvenile salmon do not pass the SWCS after the pond fills; fish movements from north to the south wetland ponds are likely impeded by the narrow culverts connecting the ponds; and fish egress from the south pond is restricted when water levels drop below dike elevation, and spill over the SWCS flash boards is limited. A restoration project undertaken in fall 2014 was designed to remove migration barriers within the wetland and increase fish access from Multnomah Channel while continuing to impound water for reed canarygrass control. At the time of this report, the restoration project has been successfully completed. The survey results reported here establish a useful baseline for evaluating the response of juvenile salmon and other native fish to this restoration project. These results should apply broadly to other floodplain restoration projects in the tidal-fluvial reaches of the Columbia River estuary.

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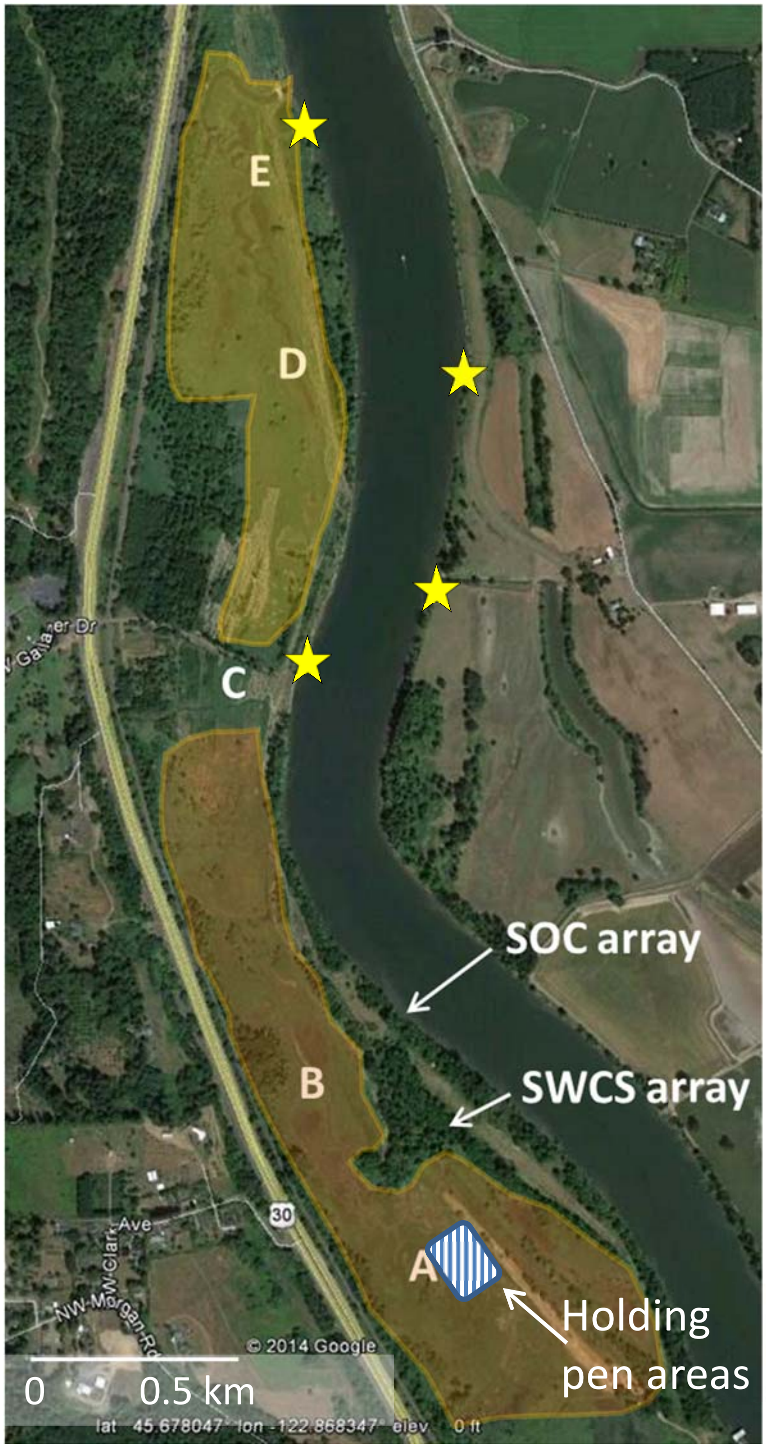

Figure 1. Map of Multnomah Channel Marsh. Yellow shaded area is the north wetland pond; orange shaded area is the south wetland pond. Stars indicate locations of Multnomah Channel bag seine sampling. Letters indicate 2014 PIT tag group release locations. Locations of PIT detection arrays (SOC & SWCS) and net pen area are labeled.

Figure 2. Oneida trap deployed in the south Metro pond, winter 2014.

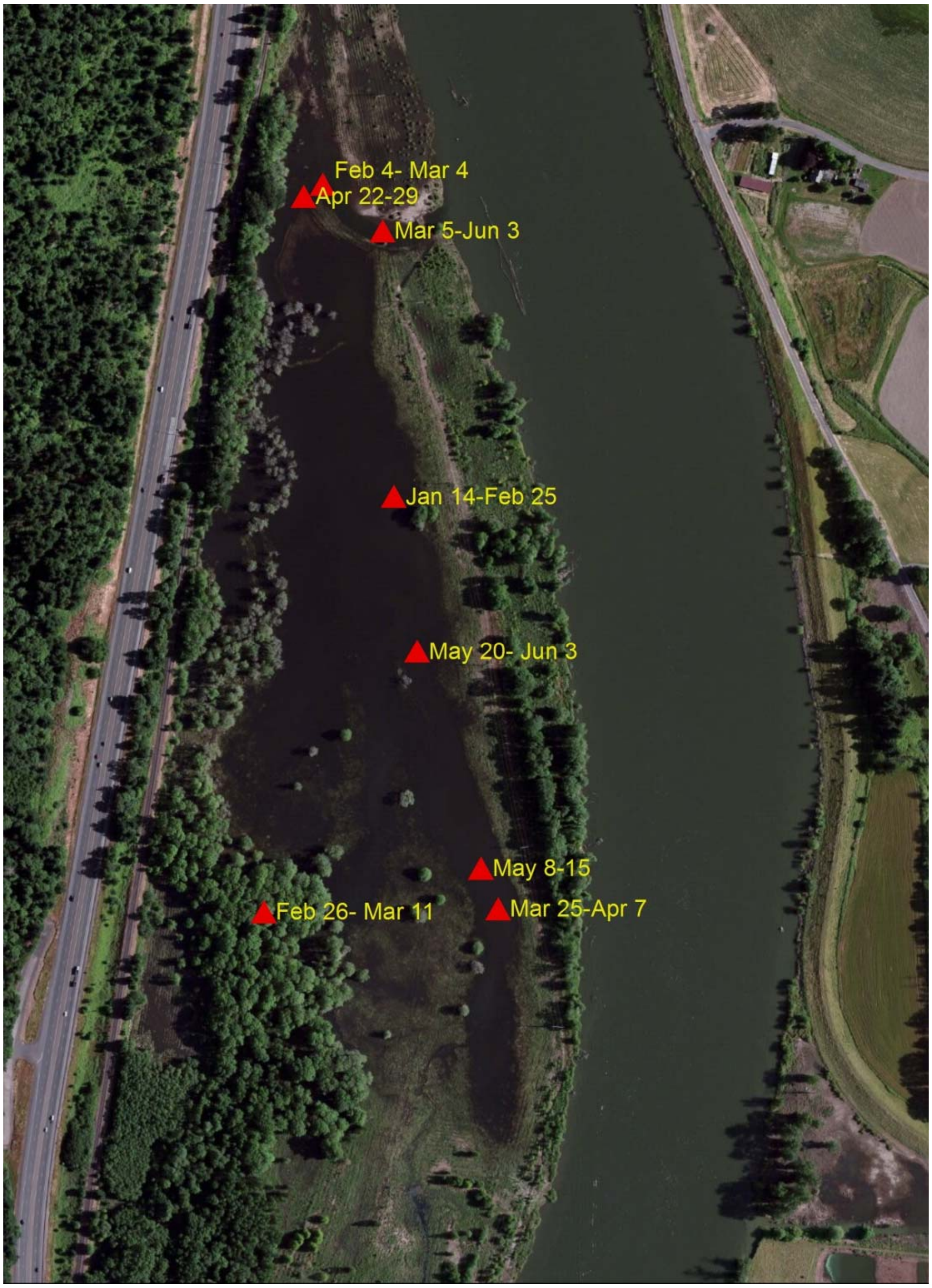

Figure 3. Locations of Oneida traps in the north pond with dates sampled in 2014.

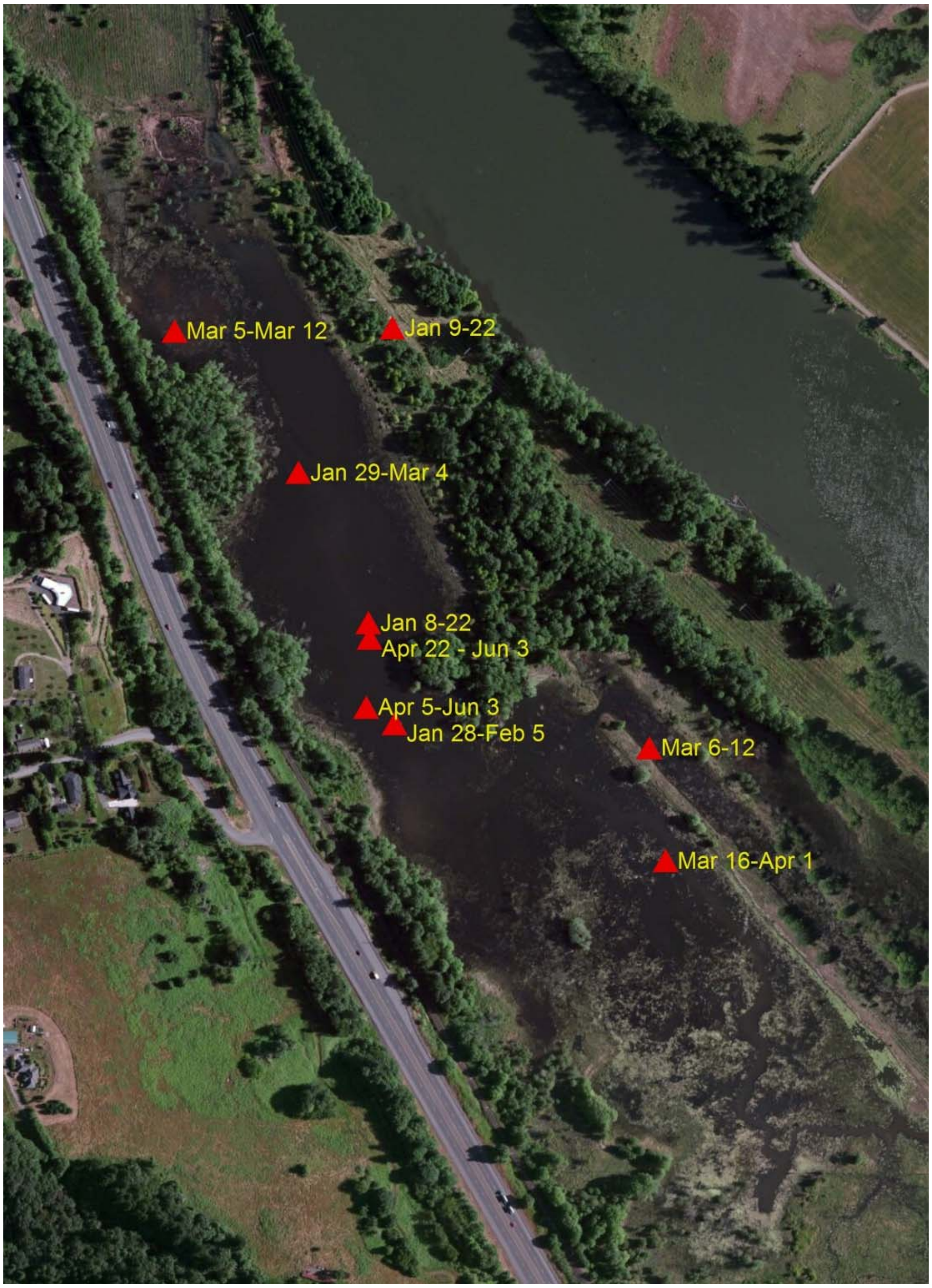

Figure 4. Locations of Oneida traps in the south pond with dates sampled in 2014.

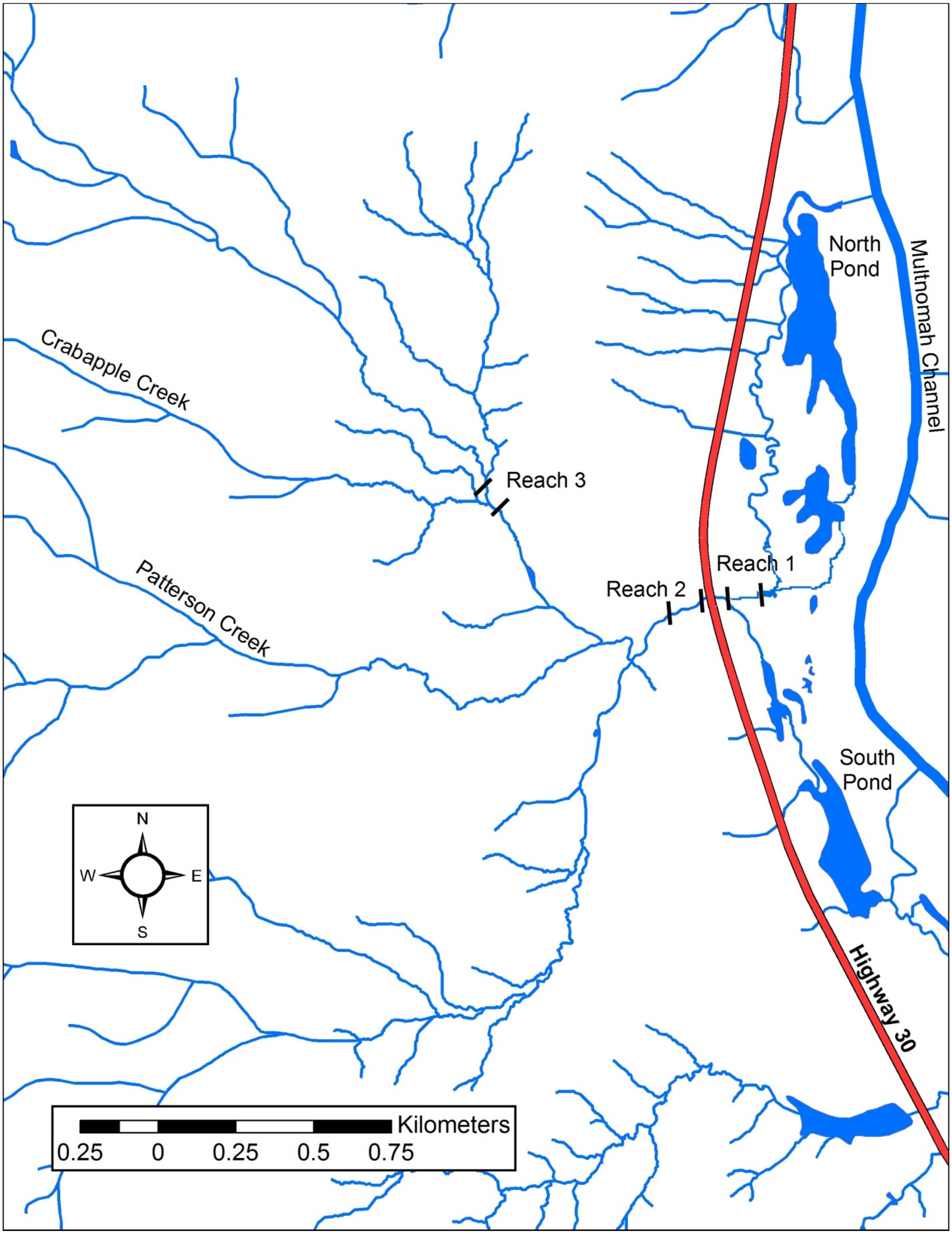

Figure 5. Crabapple and Patterson creeks with reaches sampled by backpack electrofishing in 2014.

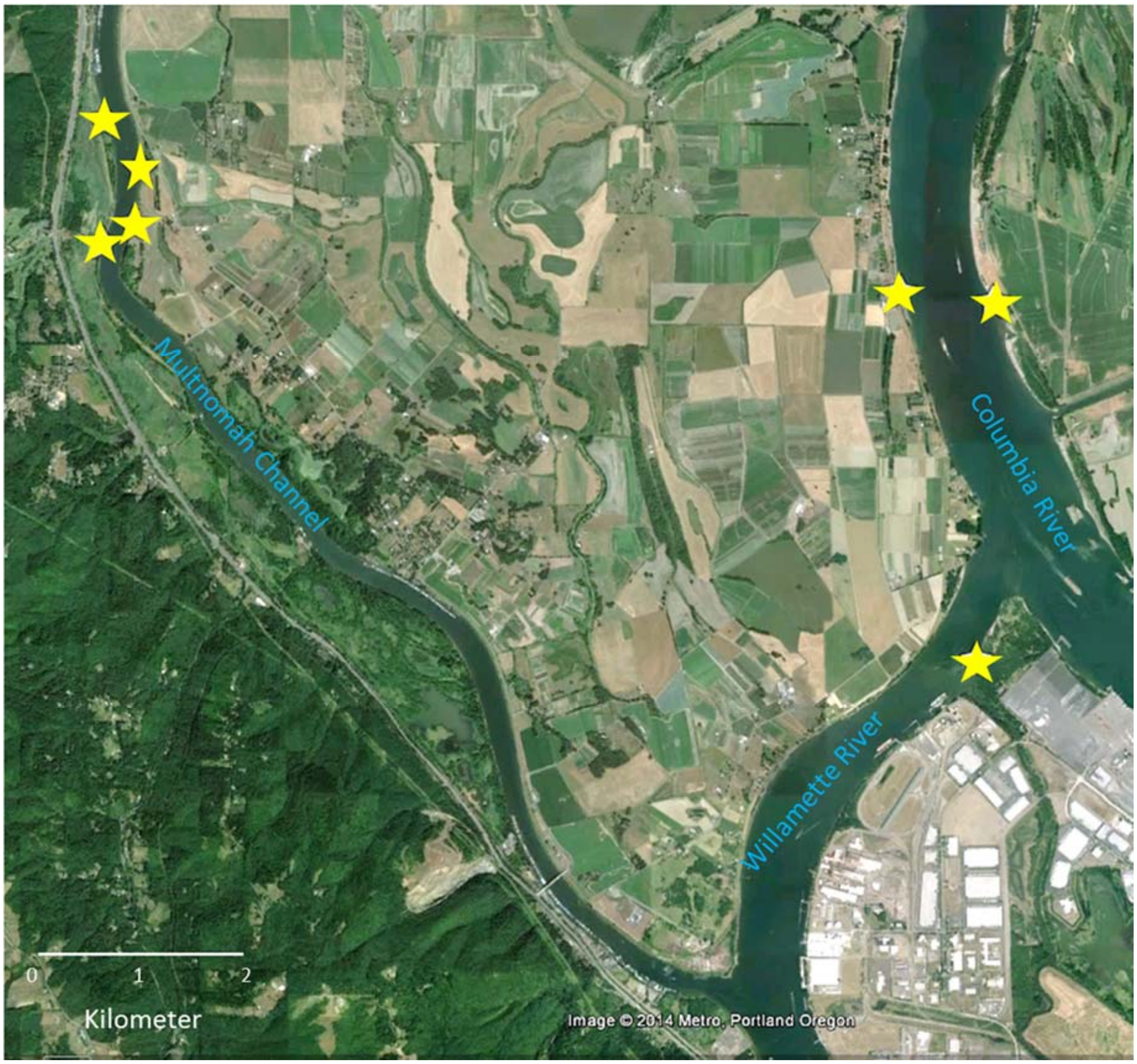

Figure 6. Confluence of the Willamette River with the Columbia River, and upstream end of Multnomah Channel. Stars indicate 2014 bag seine sampling sites.

Figure 7. Antenna configuration at the SOC array.

A

B

Figure 8. Antenna configuration at the upstream (A) and downstream (B) sides of the SWCS array.

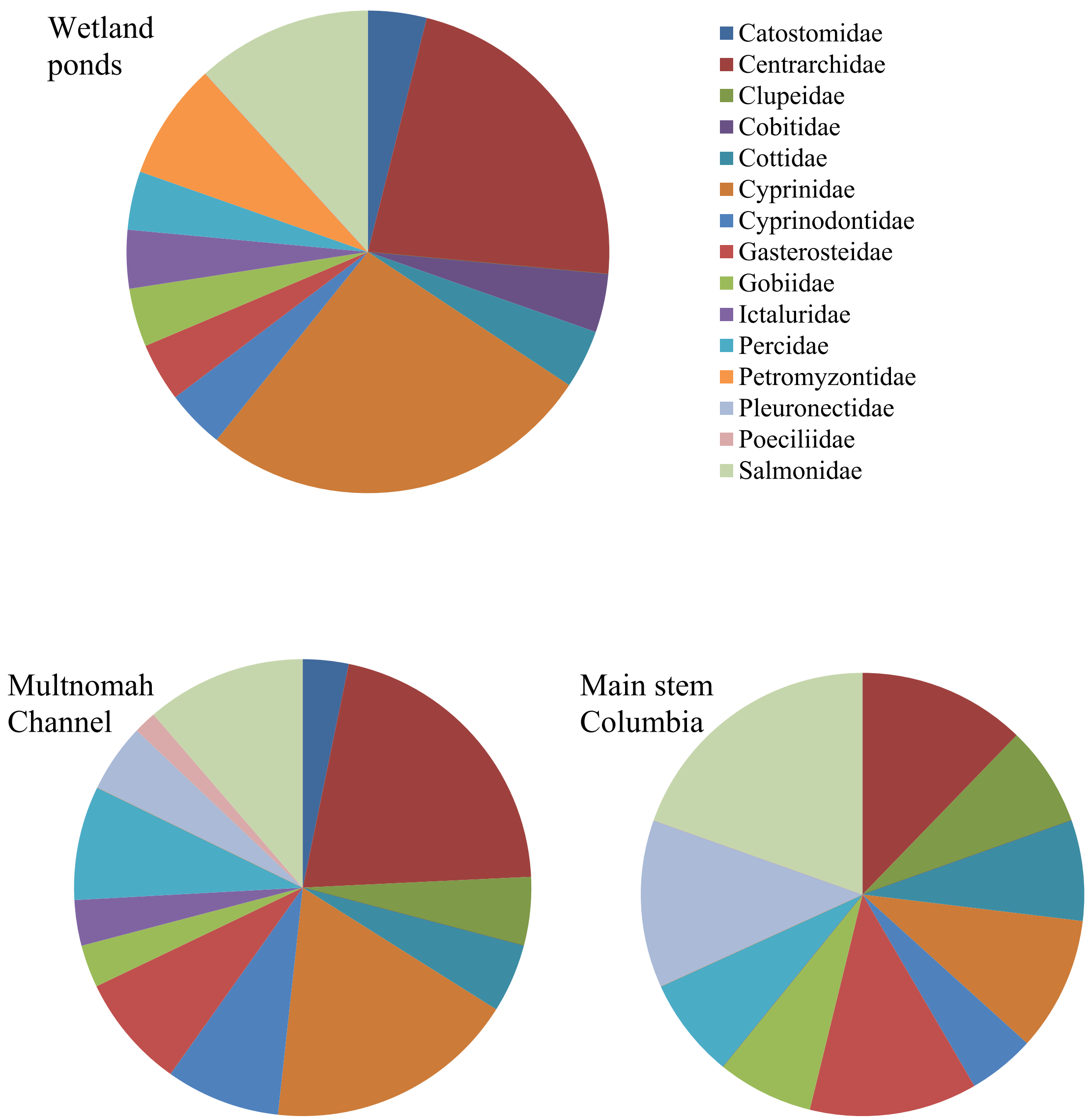

Figure 9. Composition of fish species by family in (A) the north and south Metro ponds, January – June 2014 (Oneida trap catch only); (B) Multnomah Channel, March – July 2014; and (C) main stem Columbia River, March – July 2014.

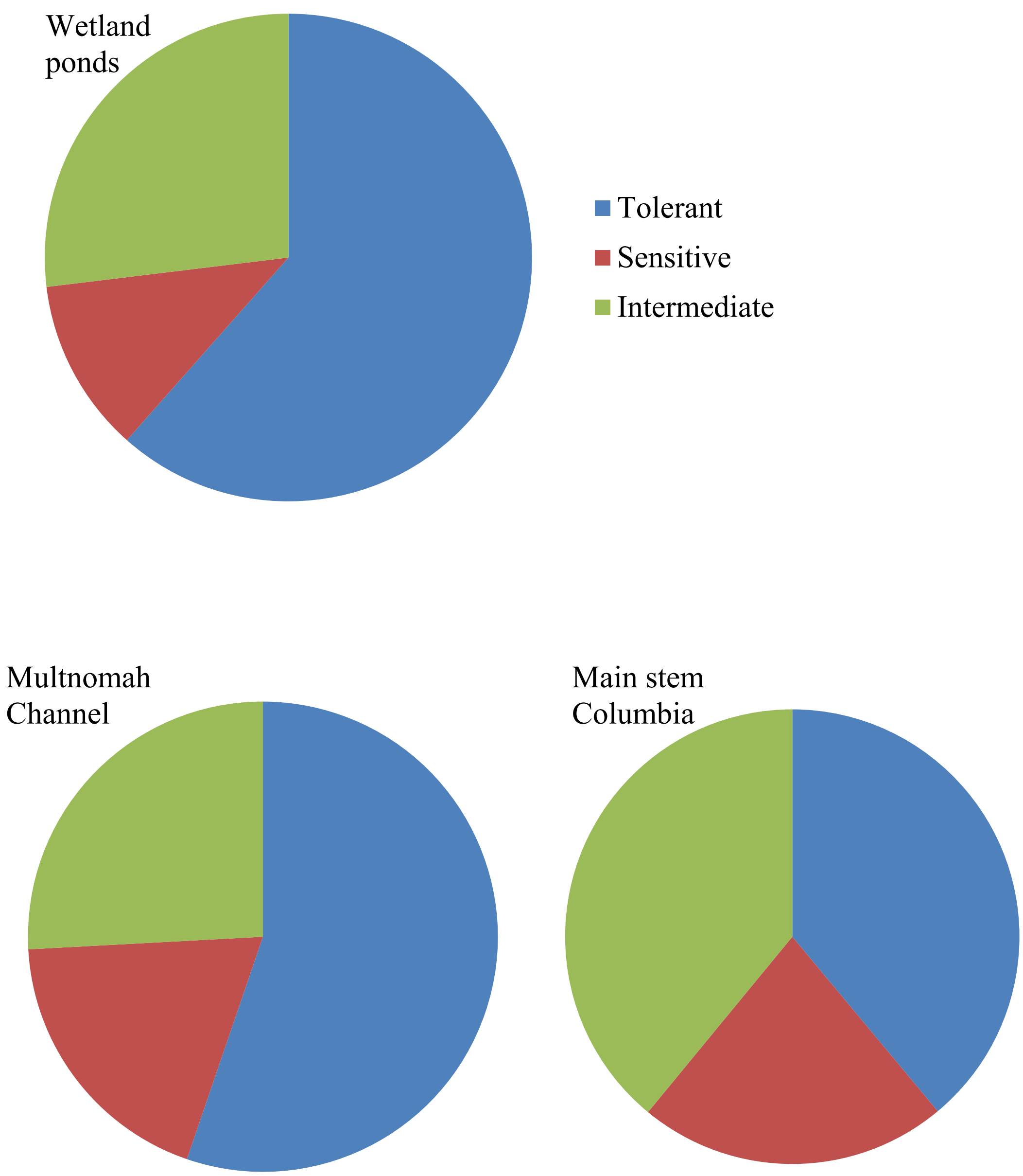

Figure 10. Composition of fish species by pollution tolerance in (A) the north and south Metro ponds, January – June 2014 (Oneida trap catch only); (B) Multnomah Channel, March – July 2014; and (C) main stem Columbia River, March – July 2014. Tolerance classifications follow those of Zaroban et al. (1999).

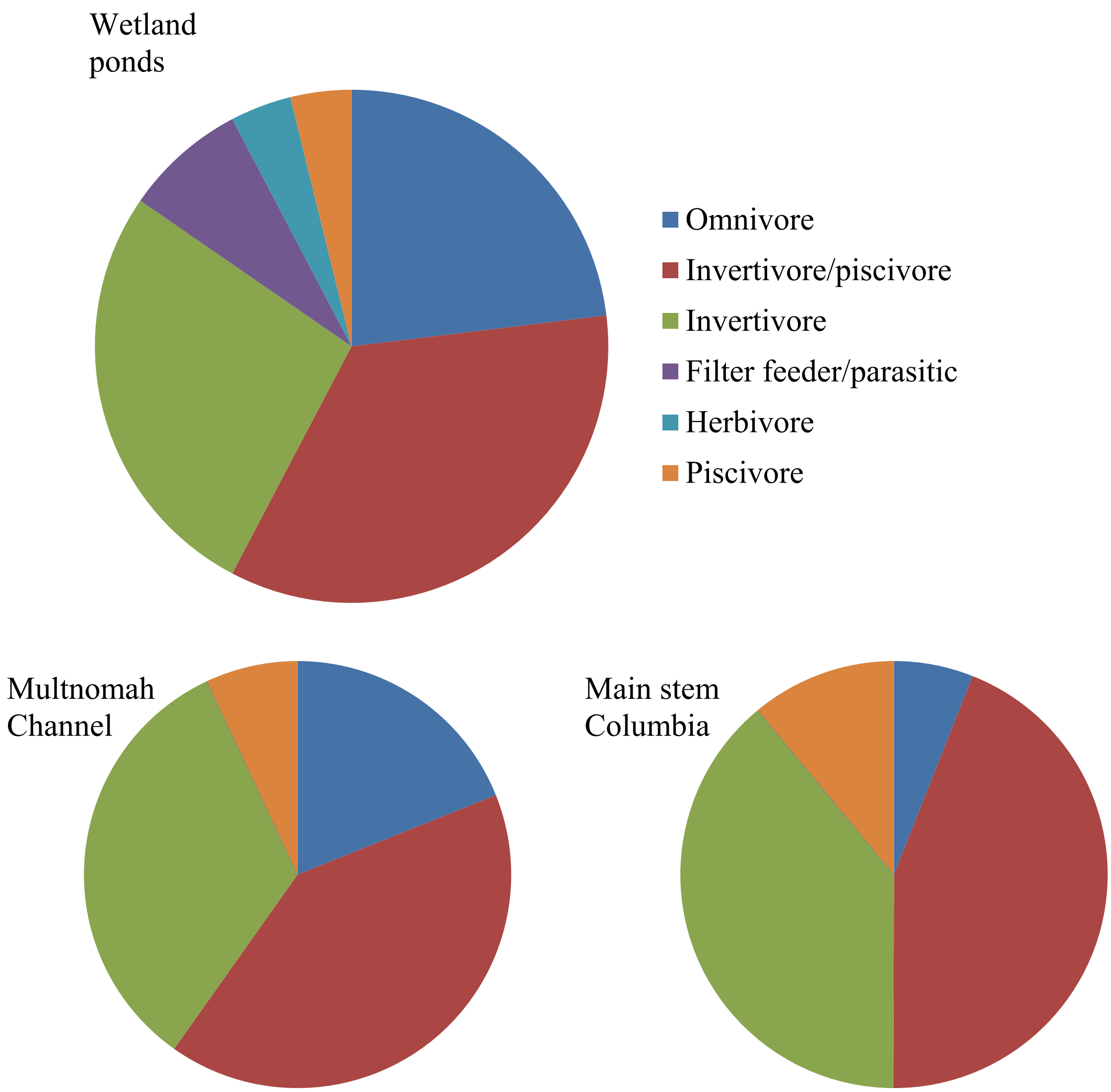

Figure 11. Composition of fish species by adult feeding guild in (A) the north and south Metro ponds, January – June 2014 (Oneida trap catch only); (B) Multnomah Channel, March – July 2014; and (C) main stem Columbia River, March – July 2014. Feeding guilds follow those of Zaroban et al. (1999).

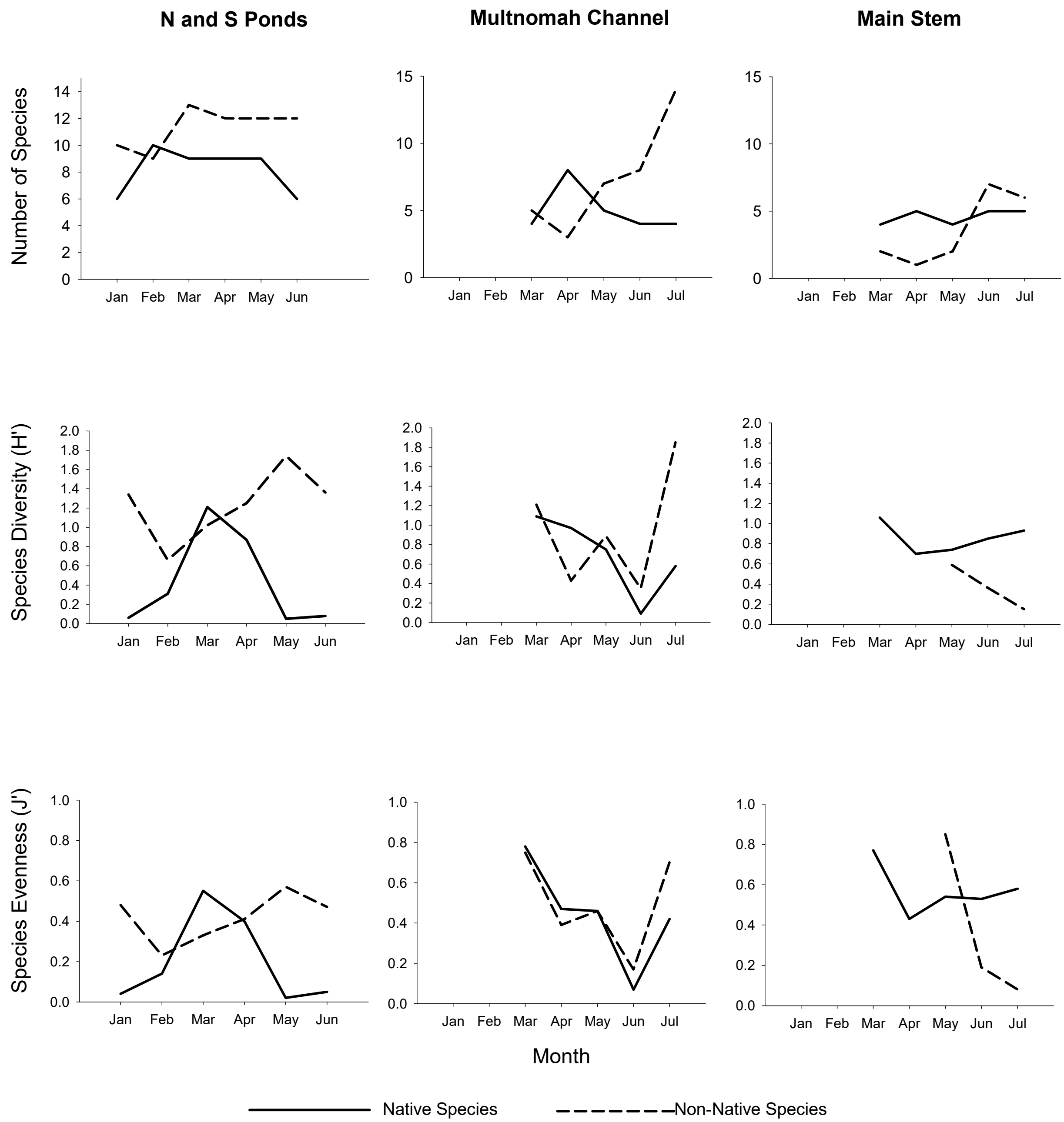

Figure 12. Community structure indices for all fishes captured in 2014 at sampling sites in the main stem Columbia River, Multnomah Channel, and north (N) and south (S) wetland ponds.

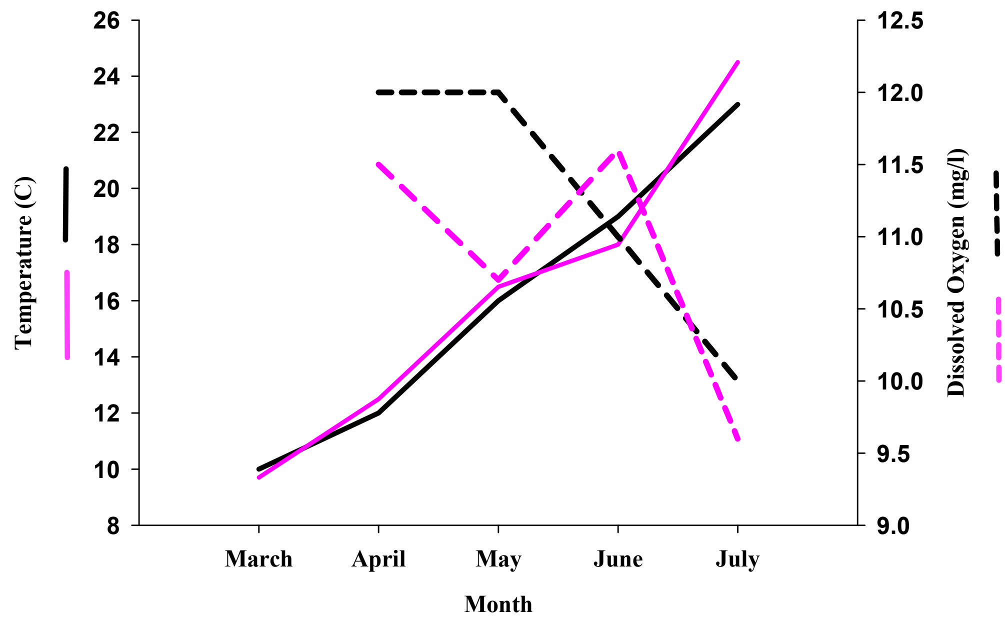

Figure 13. Average temperature (solid line) and dissolved oxygen (dashed line) levels in main stem Columbia River (black) and Multnomah Channel (pink) bag seining locations, March-July 2014.

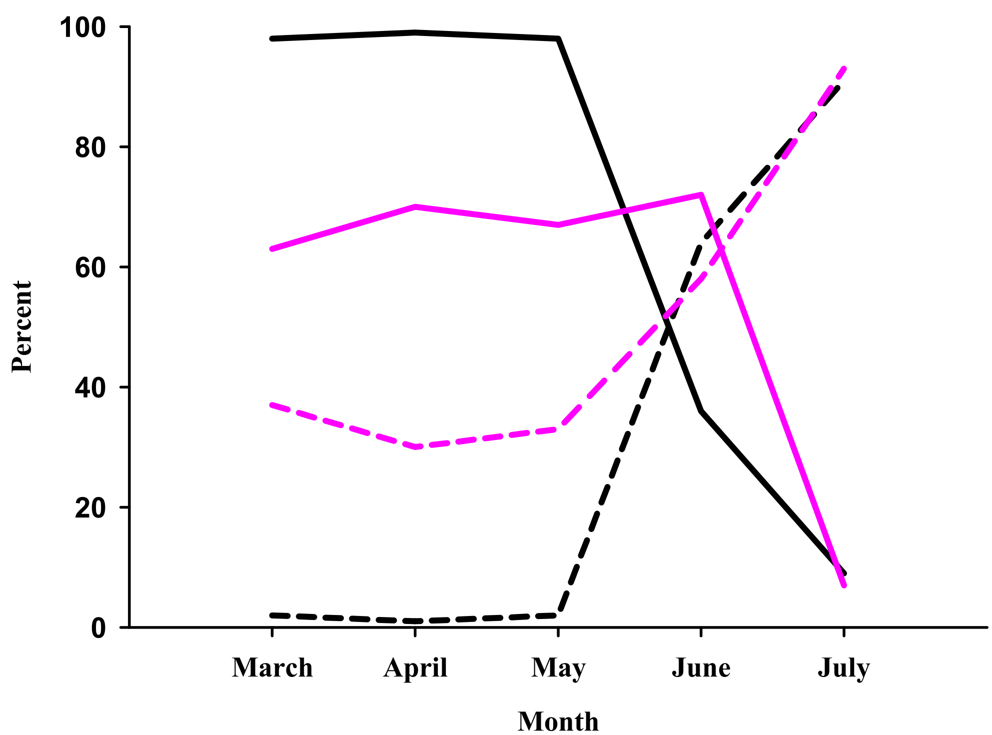

Figure 14. Relative percent of native (solid line) and non-native (dashed line) fish species sampled in the main stem Columbia River (black) and Multnomah Channel (pink), March-July 2014.

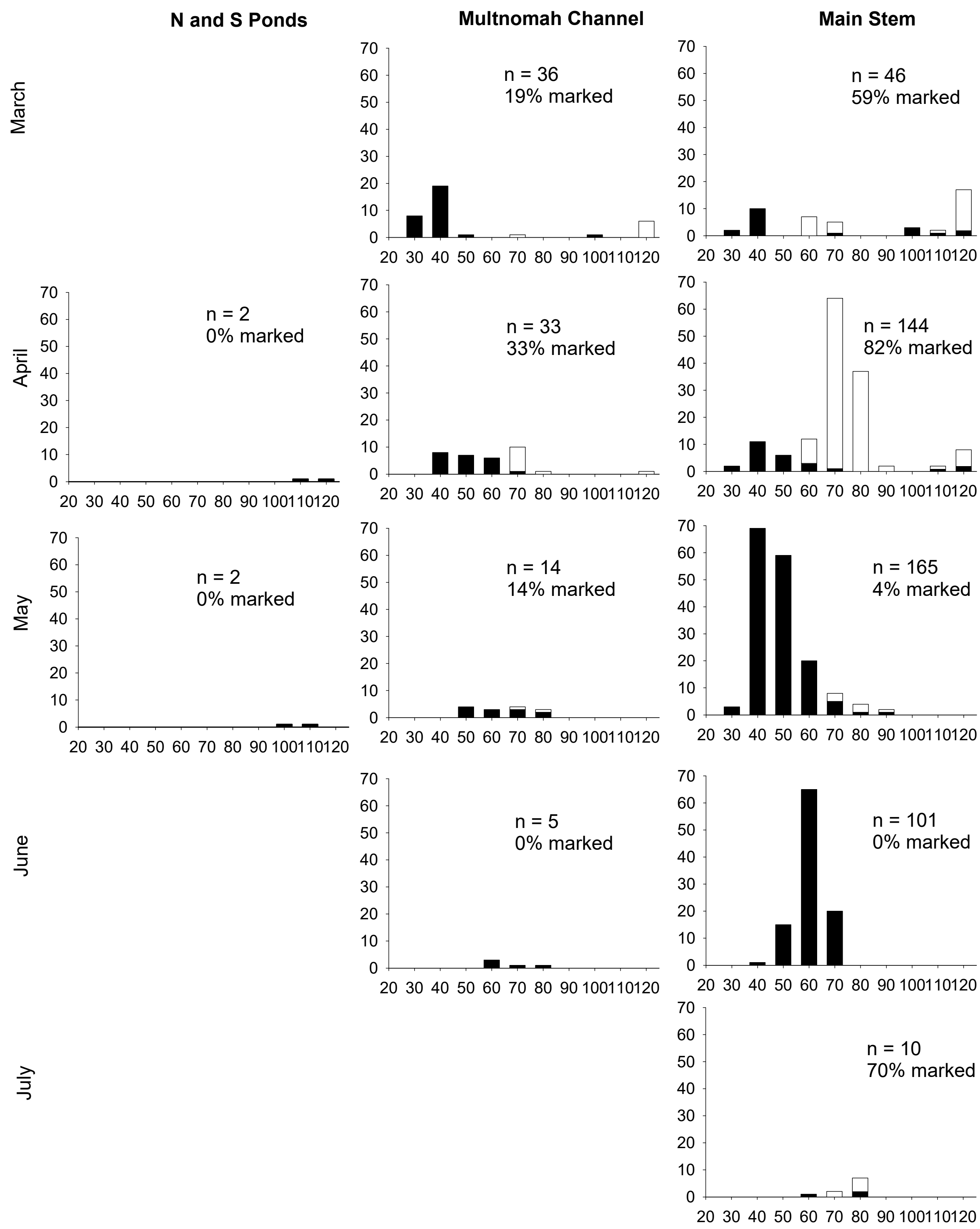

Figure 15. Chinook salmon length frequency (fork length, mm) and percent marked (adipose fin clipped or not clipped) by location and month, March-July 2014. Black bars indicated fish that were not marked; open bars represent fish with an adipose fin clip.

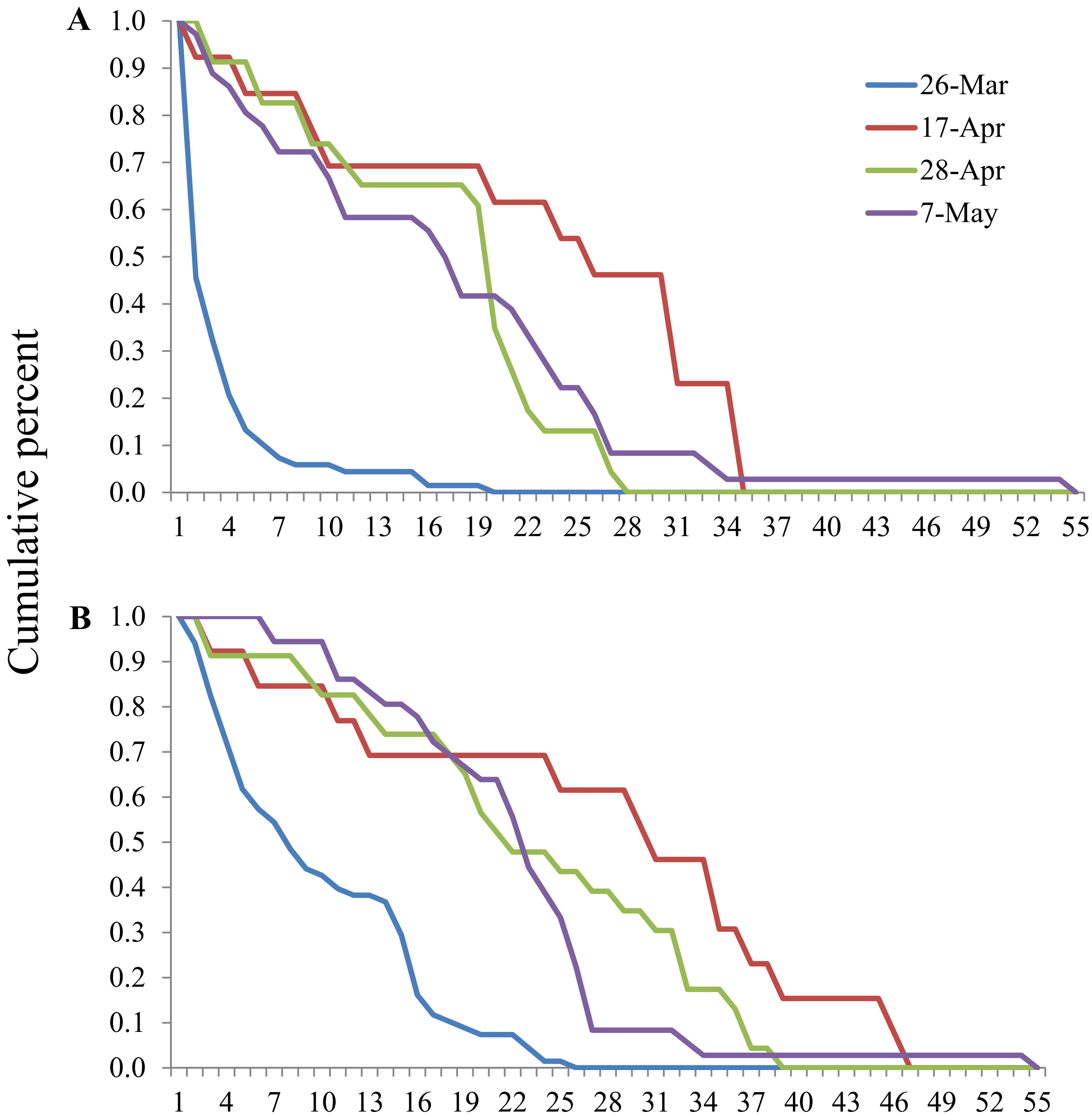

Figure 16. Time-to-first detection (A) and R_{MESO} (B) of juvenile salmon from group releases in the south outlet channel (March 26, 2014) and the south pond.

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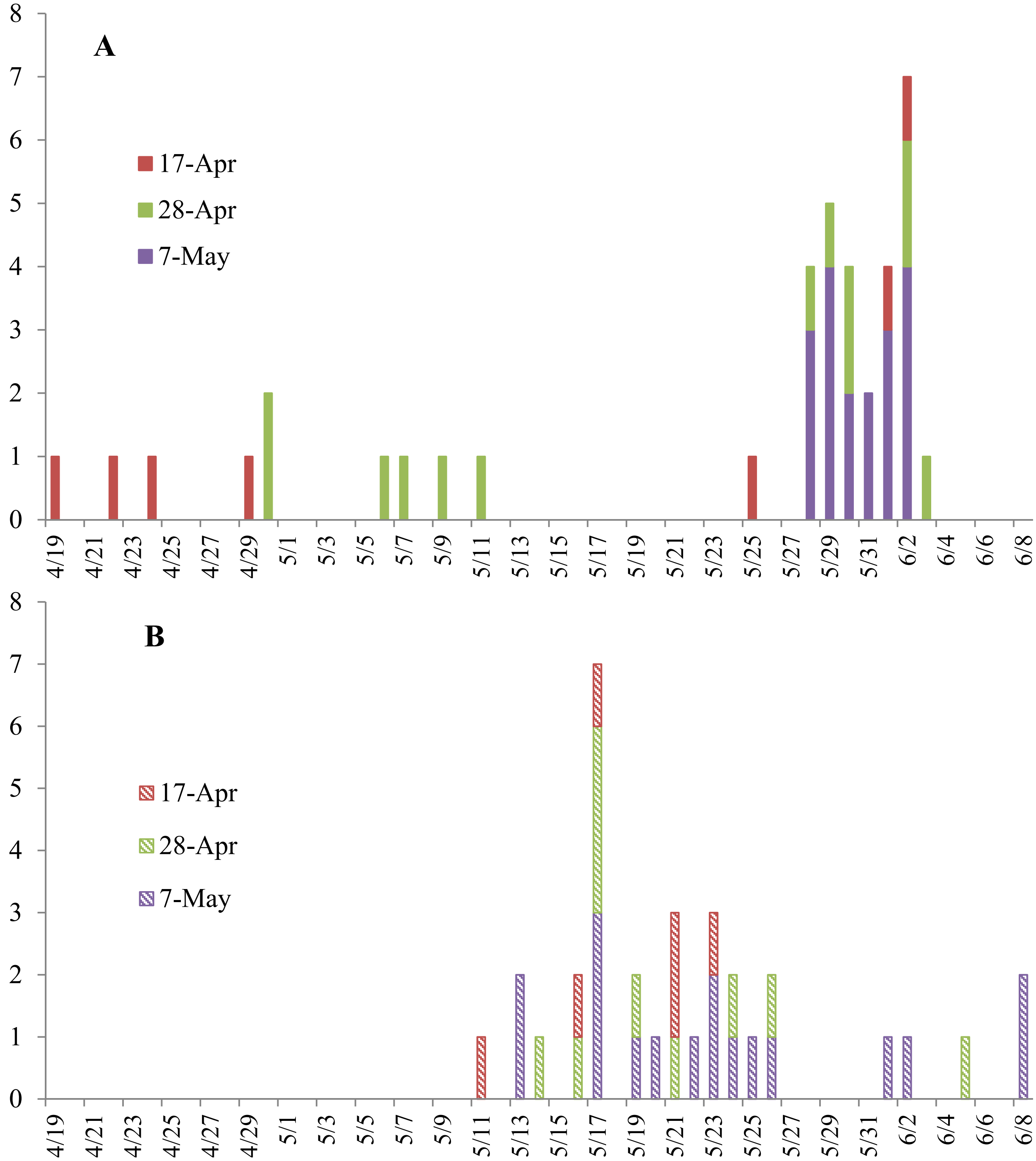

Figure 17. Passage and non-passage of juvenile salmon at the SWCS array, 2014. Panel A shows the date of passage for 38 salmon. Panel B shows the last date of detection for 33 salmon that did not pass the SWCS.

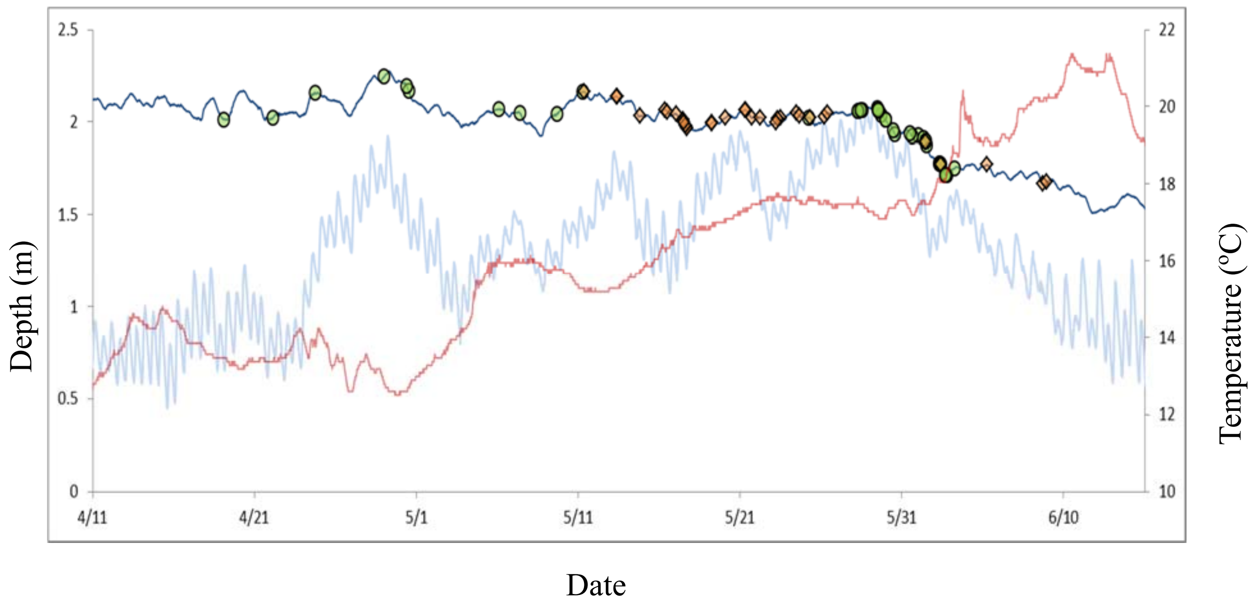

Figure 18. Passage detections and last detection without passage data overlaid on water level and temperature, 2014. Successful passage for an individual is indicated by a green circle. Unsuccessful individual passage attempts are indicated by an orange diamond. Water levels upstream of the SWCS are shown by the dark blue line. Water levels immediately downstream of the SWCS are in light blue. Temperature is the red line.

Table 1. Common and scientific names of fishes, crustaceans, and amphibians sampled by location, January – July, 2014.

		Location			
Common Name	Scientific Name	Streams	Ponds	Multnomah Channel	Main stem
Fishes					
American shad	*Alosa sapidissima*			x	x
Amur goby	*Rhinogobius similis*		x	x	x
Banded killifish	*Fundulus diaphanus*		x	x	x
Black crappie	*Pomoxis nigromaculatus*		x	x	x
Bluegill	*Lepomis macrochirus*		x	x	
Brown bullhead	*Ameiurus nebulosus*		x	x	
Chinook salmon	*Oncorhynchus tshawytscha*		x	x	x
Chiselmouth	*Acrocheilus alutaceus*		x		
Coho salmon	*Oncorhynchus kisutch*		x	x	
Common carp	*Cyprinus carpio*		x	x	
Cutthroat trout	*Oncorhynchus clarki clarki*	x	x	x	x
Golden Shiner	*Notemigonus crysoleucas*			x	
Goldfish	*Carassius auratus*		x	x	
Largemouth bass	*Micropterus salmoides*		x	x	x
Largescale sucker	*Catostomus macrocheilus*		x	x	
Mosquitofish	*Gambusia affinis*			x	
Mountain whitefish	*Prosopium williamsoni*				x
Northern pikeminnow	*Ptychocheilus oregonensis*		x	x	x
Oriental Weatherfish	*Misgurnus anguillicaudatus*	x	x		
Pacific Lamprey	*Entosphenus tridentatus*	x			
Peamouth	*Mylocheilus caurinus*		x	x	x
Prickly sculpin	*Cottus asper*			x	x
Pumpkinseed	*Lepomis gibbosus*		x	x	
Rainbow trout (steelhead)	*Oncorhynchus mykiss*			x	x
Redside Shiner	*Richardsonius balteatus*		x		
Reticulate sculpin	*Cottus perplexus*	x			
Smallmouth bass	*Micropterus dolomieu*			x	x
Starry flounder	*Platichthys stellatus*			x	x
Threespine stickleback	*Gasterosteus aculeatus*	x	x	x	x
Unidentified centrarchid	*Centrarchidae*		x	x	x
Unidentified cyprinid	*Cyprinidae*		x	x	
Unidentified fish				x	
Unidentified sculpin	*Cottidae*			x	x
Warmouth	*Lepomis gulosus*		x		

Table 1 (continued).

Western brook lamprey	*Lampetra richardsoni*	x			
White Crappie	*Pomoxis annularis*		x		
Yellow perch	*Perca flavescens*		x	x	x
Crustaceans					
Signal crayfish	*Pacifastacus leniusculus*	x	x		
Amphibians					
American bullfrog	*Lithobates catesbeianus*	x	x		
Long-toed salamander	*Ambystoma macrodactulum*		x		
Northwestern salamander	*Ambystoma gracile*		x		
Pacific giant salamander	*Dicamptodon tenebrosus*	x			
Red-legged frog	*Rana aurora*	x	x		
Rough skinned newt	*Taricha granulosa*		x		

Table 2. Monthly Oneida net catch of fish and crustacean species in the north and south Metro wetland ponds, January – June 2014 (data combined for both ponds). Parentheses indicate sampling effort in trap-days.

Species	January (26)	February (60)	March (58)	April (34)	May (42)	June (11)	Total
Salmonids							
Chinook (juvenile)				2	3		5
Coho (juvenile)		1	2	14			17
Coastal cutthroat trout		4	1		1	1	7
Native Species							
Chiselmouth		1					1
Largescale sucker		3	7	4	5	6	25
Northern pikeminnow	31	22	6	1	1	6	67
Pacific lamprey					1	2	3
Peamouth	2	10	664	180	6		862
Redside shiner	17	206	116	5	20		364
Reticulate sculpin	5	23	212	85	80	15	420
Threespine stickleback	5,966	3,847	868	766	16,044	2,340	29,831
Western brook lamprey	1	7	4	2			14
Signal crayfish			1				1
Non-Native Species							
Amur goby			1	3	2		6
Banded killifish	1		3	1	10	4	19
Bluegill	6	3	17	50	67	13	156
Black crappie				7	4	115	126
Brown bullhead	470	1,547	2,438	713	309	456	5,933
Common carp		1	5			1,475	1,481
Golden shiner	467	9	7	13	26	4	526

Table 2 (continued).

Goldfish	82	92	712	20	138	8	1,052
Largemouth bass			1	1	3	881	886
Oriental weatherfish	106	196	497	408	310	40	1,557
Pumpkinseed	43	18	59	109	242	66	537
Siberian shrimp				2	5		7
Warmouth	5	9	5	4	25	3	51
White crappie	5		4				9
Yellow perch	2	3	11	13	4	27	60
Total Catch	7,209	6,004	5,640	2,401	17,301	5,477	44,023

Table 3. Fork length (FL) data for fish species caught in the ponds with Oneida trap nets and boat electrofishing, January – June 2014; in Multnomah Channel, March – July 2014; and main-stem Columbia River, March – July 2014. SD = standard deviation.

	Metro Ponds				Multnomah Channel				Main-stem Columbia River			
Species	Mean FL	Min FL	Max FL	SD	Mean FL	Min FL	Max FL	SD	Mean FL	Min FL	Max FL	SD
American Shad					46	24	96	28	97	85	127	13
Amur Goby	54	46	63	9	39	26	57	9	33	28	37	3
Banded Killifish	66	36	82	12	63	24	91	17	75	58	89	11
Black Crappie	58	29	223	52	83	83	83	----	62	54	68	7
Bluegill	107	33	180	28	105	80	130	35				
Brown Bullhead	124	34	367	69	51	43	87	8				
Chinook Salmon	102	45	135	34	64	36	158	28	69	34	218	25
Chiselmouth	64	64	64	----								
Coho Salmon	124	74	149	21	138	138	138	----				
Common Carp	89	28	485	111	68	52	104	12				
Cutthroat Trout	160	71	264	89	162	162	162	----	210	210	210	----
Golden Shiner	71	34	165	29	70	49	122	22				
Goldfish	151	29	582	72	62	54	69	8				
Largemouth Bass	48	20	423	79	73	42	114	22	42	40	45	3
Largescale Sucker	151	57	438	68	131	67	152	32				
Mosquitofish					35	29	39	4				
Mountain Whitefish									67	67	67	
Northern Pikeminnow	68	39	136	20	74	74	74	----	93	89	97	4
Oriental Weatherfish	130	21	220	23								
Peamouth	151	32	267	60	83	28	126	31	55	25	124	35
Prickly Sculpin					116	99	133	24	65	65	65	----
Pumpkinseed	97	30	171	29	96	68	135	16				

Table 3 (continued).

Rainbow Trout (steelhead)					230	230	230	----	213	195	226	13
Redside Shiner	68	32	148	22								
Smallmouth Bass					79	40	140	54	152	152	152	----
Starry Flounder					93	76	129	13	97	70	157	18
Threespine Stickleback	53	21	72	10	38	20	65	12	48	24	72	12
Unidentified centrarchid	38	26	89	12	47	23	87	11	41	32	48	4
Unidentified cyprinid	42	34	48	7	44	34	58	6				
Unidentified fish					31	27	35	4				
Unidentified Sculpin					25	20	31	4	46	38	60	12
Warmouth	104	49	166	38								
White Crappie	97	55	160	44								
Yellow Perch	99	28	183	42	78	35	182	35	62	35	150	15

Table 4. Monthly percentages of native and non-native fishes and amphibians from Oneida nets in the north and south Metro ponds, January – June 2014 (ponds combined; total catch in parentheses).

Species type	January	February	March	April	May	June
Native fishes	84 (6,022)	69 (4,124)	33 (1,880)	44 (1,059)	93 (16,161)	43 (2,370)
Non-native fishes	16 (1,187)	31 (1,878)	67 (3,760)	56 (1,342)	7 (1,140)	57 (3,092)
Native amphibians	42 (93)	17 (155)	6 (85)	11 (5)	19 (3)	67 (2)
Non-native amphibians	58 (130)	83 (742)	94 (1,250)	89 (40)	81 (13)	33 (1)

Table 5. Monthly catch of amphibian species from Oneida nets in the north and south Metro ponds, January – June 2014.

Species	January	February	March	April	May	June
American bullfrog	130	742	1,250	40	13	1
Long-toed salamander	6	29	7			
Northwestern salamander	54	69	16			
Red-legged frog	10	16	5			1
Rough skinned newt	23	41	57	5	3	1

Table 6. Species and number of fish captured by boat electroshocking in the north Metro pond, March 18, 2014 and associated mean fork length (FL), minimum, maximum and standard deviation.

Species	Number	Mean FL	Min FL	Max FL	Standard Deviation
Brown Bullhead	1	236.0	236.0	236.0	----
Chinook Salmon (juvenile)	1	45.0	45.0	45.0	----
Coho Salmon (juvenile)	2	95.5	89.0	102.0	9.2
Common Carp	2	457.5	430.0	485.0	38.9
Goldfish	6	239.0	218.0	288.0	27.9
Largemouth Bass	3	378.7	338.0	423.0	42.6
Largescale Sucker	1	438.0	438.0	438.0	----
Peamouth	19	112.8	79.0	185.0	35.5
Pumpkinseed	2	87.5	77.0	98.0	14.8

Table 7. Total number of fish, amphibians, and crayfish captured in Patterson and Crabapple creeks by electrofishing, January – June 2014. Parentheses indicate the number of days sampled.

Species	January (3)	February (4)	March (3)	April (7)	May (3)	June (2)
Coastal Cutthroat Trout	24	44	24	54	25	13
Pacific Lamprey						2
Reticulate Sculpin	123	161	118	324	190	98
Threespine Stickleback	2	2	1	6	1	4
Western Brook Lamprey	4	2	11	35	5	2
Oriental Weatherfish			1	1		
American bullfrog		1				
Pacific giant salamander		1		2	1	
Red-legged frog					1	
Signal crayfish				1		1

Table 8. Mean, minimum, and maximum fork length (FL) and standard deviation of fish species caught in the streams with backpack electrofishing.

Species	Mean FL	Min FL	Max FL	Standard Deviation
Coastal Cutthroat Trout	117.7	41	243	47.3
Oriental Weatherfish	137.0	131	145	5.8
Pacific Lamprey	152.5	145	160	10.6
Reticulate Sculpin	60.4	24	142	17.9
Threespine Stickleback	39.5	26	52	7.5
Western Brook Lamprey	116.2	47	158	24.8

Table 9. Number of sites sampled and total bag-seining effort (in parentheses) by month and sampling area, March-July 2014.

	March	April	May	June	July
Multnomah Channel	5 (6)	4 (8)	4 (7)	4 (7)	4 (5)
Main-stem Columbia River	3 (5)	3 (5)	3 (4)	3 (7)	3 (6)

Table 10. Average abundance of each species captured with a bag seine by location and month, March-July 2014.

	Main-stem Columbia River					Multnomah Channel				
Species	March	April	May	June	July	March	April	May	June	July
Salmon										
Chinook salmon	9	36	41	14	2	6	4	2	1	
Coho salmon							<1			
Cutthroat trout		<1							<1	
Rainbow trout (steelhead)		1					<1			
Native Species (7)										
Threespine stickleback	5	12	69	30	9	2	<1	24	81	10
Starry flounder	3	<1	1	1	<1	4	<1	1		
Peamouth			1	2	1	<1	<1	3	<1	2
Largescale sucker								1		<1
Prickly sculpin	<1						<1			<1
Mountain whitefish				<1						
Northern pikeminnow					1		<1			
Non-Native Species (14)										
Yellow perch			2	79	120	2	2	11	106	135
Banded killifish				1	1	2	<1	<1	6	4
American shad			1	3	1			1	<1	46
Amur goby	<1	1		<1		3			1	
Unidentified centrarchid				2	<1			<1	<1	107
Unidentified sculpin	<1			<1					1	
Pumpkinseed						<1		1		1
Largemouth bass				<1				<1		3
Bluegill							<1	<1		
Brown bullhead						<1				197
Smallmouth bass					<1				<1	<1
Black crappie					1					<1
Unidentified cyprinid									<1	35
Unidentified fish							<1			<1
Golden shiner										37
Common carp										91
Mosquitofish										1
Goldfish										1

Table 11. Coded-wire tag recoveries for Chinook salmon captured in the main stem of the Columbia River and in Multnomah Channel, March-July 2014.

Release Information				Recapture information				
							# of tags recovered	
Run (Brood year)	Location	Last date	Ave. Weight (g)	Length Range (mm)	Weight Range (g)	Days at large	Main stem	Mult. channel
Fall (2013)	Little White Salmon River	2-Jul-14		83	6.4	30	1	
Fall (2013)	Spring Creek, Col River	11-Apr-14		74-84	4.0 - 7.3	14	3	2
Fall (2013)	Spring Creek, Col River	11-Apr-14		81	5.2	14		1
Spring (2012)	Bull Run River/Sandy	4-Apr-14	44.50	132-183	20.5 - 59.1	~14*	3	
Spring (2012)	Clackamas River	14-Apr-14	45.36	140-169	28.1 - 47.9		2	
Spring (2012)	McKenzie River	4-Nov-13	39.44	165	40.2	140	1	
Spring (2012)	McKenzie River	1-Mar-14	44.25	151	35.3	24	1	
Spring (2012)	Willamette River	18-Feb-14	45.82	155	35.8	34		1
Spring (2012)	Clackamas River	11-Mar-14	39.44	161-168	45.1 - 47	12	2	

*One Chinook salmon was captured prior to the last release date.

Table 12. Tagging information and detection timing for fish from upriver sources that were detected on SOC array, 2014. Start date is the date of first detection and End date is the date of last detection.

Tag id	Release date	Release site	Migration year	Rear type/run/species	Fork length (mm)	Start date	RKm	End date
3DD.003BC534A6	1/29/2014	Leaburg Dam, OR	2014	wild spring Chinook Salmon	114	2/14/2014	501	2/14/2014
3DD.003BC57C23	10/17/2013	Leaburg Dam, OR	2013	wild spring Chinook Salmon	108	2/14/2014	501	2/16/2014
3D9.1C2E082345	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	69	2/14/2014	356	2/15/2014
384.3B239EE0CD	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	71	2/14/2014	356	2/15/2014
384.3B23A1DC05	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	67	2/15/2014	356	2/16/2014
3D9.1C2E02D58C	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	61	2/15/2014	356	2/16/2014
3D9.1C2E07B945	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	70	2/16/2014	356	2/16/2014
384.3B239D81A5	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	81	2/16/2014	356	2/16/2014
3DD.003BC57E08	10/28/2013	Leaburg Dam, OR	2013	wild spring Chinook Salmon	93	2/17/2014	501	2/19/2014
3D9.1C2E07EB46	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	73	2/17/2014	356	2/17/2014
3D9.1C2D934496	4/18/2012	Columbia River, OR/WA	2012	Northern Pikeminnow	400	2/21/2014	0	4/5/2014
3D9.1C2D6D1491		Orphan	2014	orphan (unknown)		3/7/2014		3/7/2014
3D9.1C2D6BBEDE		Orphan	2014	wild Chinook Salmon	101	3/23/2014		3/31/2014
3D9.1C2E07C1D4	6/27/2013	North Santiam River, OR	2013	hatchery spring Chinook Salmon	69	4/19/2014	356	4/22/2014
3DD.00774DBB8A	4/29/2014	Lower Salmon River, ID	2014	hatchery summer Steelhead		5/9/2014	965	5/9/2014

Table 13. Date of release, number, and species of juvenile salmon PIT-tagged and recaptured in 2014. See Figure 1 for location of release sites.

Date	Release Site	Species	Number Tagged	Number Detected SWCS array	Number Detected SOC array	Number Recaptured by Oneida Traps
26 March	SWCS (downstream)	Chinook Salmon	72	46	62	
		Coho Salmon	1	1	1	
17 April	A	Chinook Salmon	13	7	4	
	B	Chinook Salmon	12	6	2	
28 April	A	Chinook Salmon	14	9	3	1
		Coho Salmon	3	3	1	
	B	Chinook Salmon	14	9	7	1
		Coho Salmon	2	2	1	
7 May	A	Chinook Salmon	40	15	8	
		Coho Salmon	5	2	1	
	B	Chinook Salmon	38	13	8	
		Coho Salmon	7	2	1	
	C	Chinook Salmon	9	0	0	
		Coho Salmon	3			
	D	Chinook Salmon	42	0	0	
		Coho Salmon	4			
	E	Chinook Salmon	39	0	0	
		Coho Salmon	6			