STATUS REPORT

Fish Distribution and Relative Abundance in Columbia River Shallow Water Habitat Near the Portland International Airport, December 1997 - February 1998

Prepared for:

Port of Portland
Box 3529
Portland, Oregon 97208

Prepared by:

Ellis Ecological Services, Inc.
20988 S. Springwater Rd.
Estacada, Oregon 97023

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INTRODUCTION

This report presents results of fish sampling conducted in the Columbia River in the vicinity of the Portland International Airport during the period December 1997 through February 1998. The study was initiated as part of preliminary feasibility studies to evaluate possible relocation of the Portland International Airport's storm-water discharge system. Presently, storm water from the airport is diverted south from the airport into Columbia Slough. The Port of Portland is considering a number of alternatives to Columbia Slough, including discharge to the Columbia River.

Any proposal for addition of wastes to the Columbia River or modification of its shorelines must take into account the growing number of federally listed threatened and endangered fish species. At the present time, six federally listed species/stocks occur in the Columbia River in the vicinity of the airport. An additional four species/stocks of Columbia River anadromous salmonids and two species/stocks of Willamette River anadromous salmonids are proposed for federal protection under the Endangered Species Act. Threatened and endangered species concerns relative to the proposed project center around the potential "take" of listed species. Under the Endangered Species Act the term "take" is broadly defined as any detrimental effects on the fish or their habitat that may potentially jeopardize their existence.

It is generally believed that listed and non-listed species/stocks of anadromous salmonids use the lower Columbia River primarily as a migratory pathway to and from the ocean. The water, river bottom, and adjacent riparian areas (within 300 ft of normal high water) along the migratory pathway have been designated as critical habitat for several of the listed species. Within the critical habitat zone, shallow water habitat (i.e. water <20 feet deep Columbia River Datum) has been given special protection because it is assumed to provide essential feeding and resting areas for downstream migrating juvenile salmonids. The river banks up to normal high water (6 ft NGVD) and the open channel between the airport and Government Island fall within the shallow water habitat classification.

Shoreline developments within the critical habitat zone on the lower Columbia River are required to evaluate their potential impacts on listed species and shallow water habitat. Presently this is a difficult task because there is very little solid data that document the use of shallow water habitat or compare the relative value of the various types of shallow water habitat. Clearly, a better understanding of the role of shallow water habitat is needed both for impact assessment and for designing appropriate mitigation for shoreline developments.

The Port of Portland has initiated a comprehensive year-round study of fish use of shallow water habitat in the Portland/Vancouver reach of the lower Columbia River. The comprehensive study includes 45 sample sites around Hayden Island, Government Island and the Sandy River Delta. Eleven of Government Island sampling sites are adjacent to the Portland International Airport and were established so that they could contribute information relative to the broad issue of fish use of shallow water habitat as well as provide site-specific information for the storm-water discharge feasibility study. By integrating the two studies, results of the fish sampling adjacent to the airport can be placed in the context of the results of samples collected over the range of shallow water conditions present in Portland/Vancouver reach of the lower Columbia River.

OBJECTIVES

The specific objectives of this study were as follows:

1. To document the presence/absence of juvenile salmonids in the vicinity of the proposed discharge site(s) and evaluate the likelihood that listed species would be present during the winter months,

2. To document the winter distribution of fish in the vicinity of the Portland International Airport with respect to the proposed storm-water discharge site(s),

3. To compare the fish species composition and catch in the shallow water habitats that would be impacted by the proposed development with fish species composition and catch from both similar and different shallow water habitat types in other areas of the Portland/Vancouver reach of the river, and

4. To document the presence/absence of salmonid predators and to analyze stomach contents of any predators caught for the presence of juvenile salmonids.

STUDY AREA AND SAMPLING SITES

The proposed storm-water discharge system for the airport would require modification of the shoreline adjacent to the airport and placement of a disharge pipeline and diffuser on the bottom of the river channel between the airport and Government Island. The exact location(s) for such facilities have not yet been identified but will be between the east and west ends of the airport. This reach of the river is relatively uniform with respect to shoreline and channel conditions. The entire south shore of the river adjacent to the airport has been diked and is rip-rapped with medium-size rock (10-20 inch diameter). Off shore, the river channel is relatively uniform in depth and the bottom consists primarily of sand.

On the Government Island side of the river channel, the shoreline consists of alternating vegetated shoreline and sandy beaches. The vegetated shorelines have numerous fallen trees extending out from the bank into the river channel. The banks along the vegetated sections are generally steep and show signs of active erosion. Substrate in the vegetated areas is predominately sand.

The sites specifically selected for evaluating fish distribution and abundance relative to the airport's proposed storm-water facilities are shown as solid circles in Figure 1. Also shown in Figure 1 are the locations of the sampling sites for the comprehensive shallow water habitat study.

The study area for the comprehensive shallow water habitat study extends from just west of the western tip of Hayden Island to the upper edge of the Sandy River Delta. For comparison purposes, this larger study area was divided into three sub-areas (i.e., Hayden Island, Government Island and Sandy River Delta). Of the three sub-areas, Hayden Island represents the most developed and has the greatest diversity of shallow water habitat types, ranging from relatively undisturbed to highly modified conditions. Government Island and the shoreline adjacent to the airport have been affected in the past by dredging, rip rapping, and diking. Shallow water habitat conditions in the Government Island sub-area are considered less modified by human activities than Hayden Island. Shallow water habitat at the Sandy River is relatively pristine compared to the other two areas and was used as a reference area.

Within each of the sub-areas, shallow water habitat was identified on bathymetric charts and then visually surveyed from a boat. The shallow water habitat was then grouped into the following categories:

- open sandy beaches
- shallow backwater areas
- vegetated shorelines with in-water structure
- boat harbors
- rip rapped shoreline
- industrialized shoreline
- open river channel

Not all of these categories of shallow water habitat are present at all three of the sub-areas. At Hayden Island, open-river channel habitat is absent. At Government Island, boat harbors and industrialized areas are absent, and at the Sandy River Delta, only open sandy beaches, vegetated shorelines, and shallow backwater habitat are present. The sites selected for characterizing fish species composition and relative abundance for the airport's storm-water discharge system include rip rapped banks, open river channel, sandy beaches, and vegetated shorelines (Figure 1).

To provide sample replication, three sampling sites within each of the available categories of shallow water habitat were established at each of the three sub-areas. A total of 45 sampling sites was established, with 11 of those sites in the immediate vicinity of the airport.

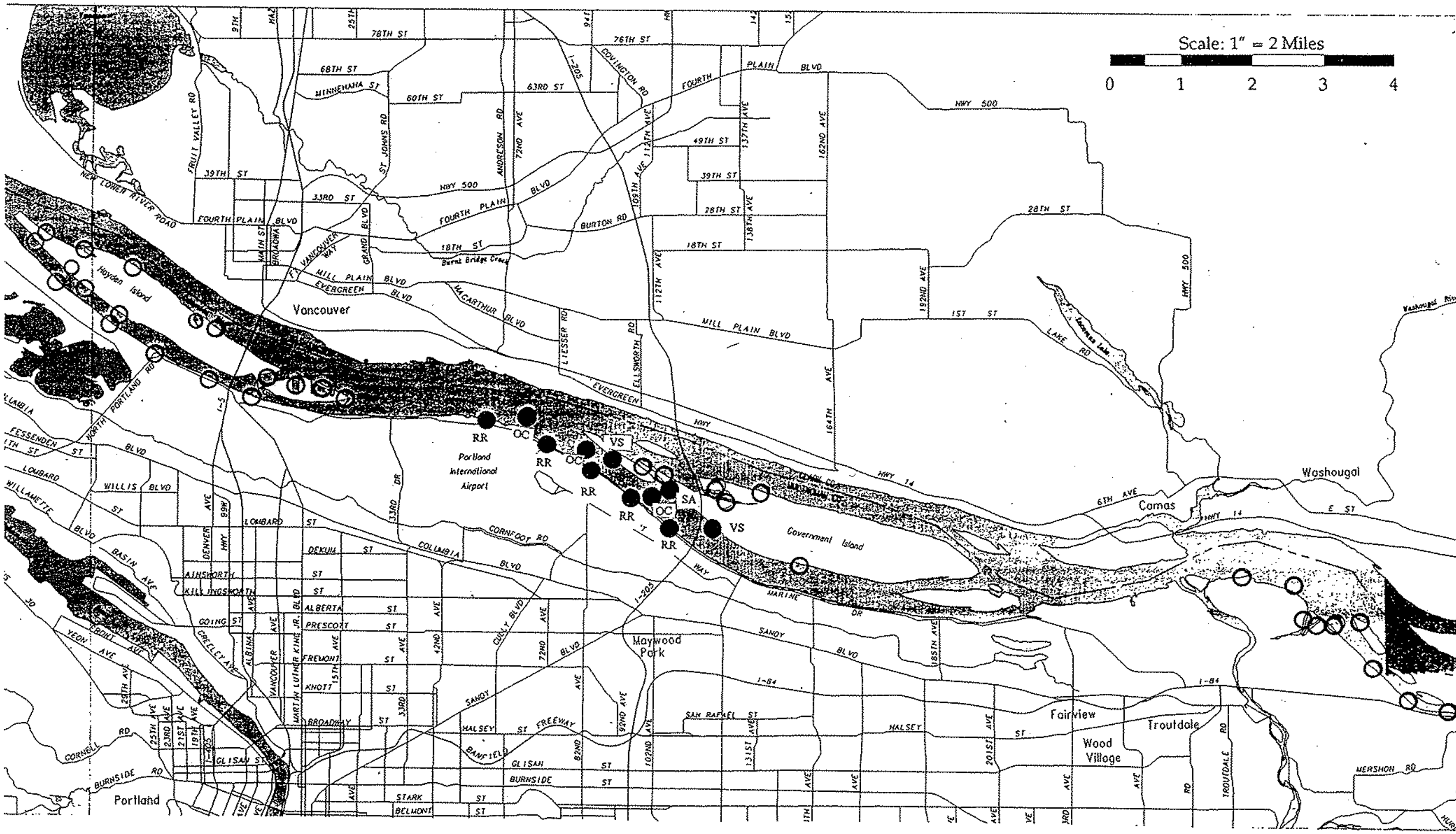

Figure 1. Location of sampling sites in the Columbia River between the west end of Hayden Island and the Sandy River Delta. The 11 airport sampling sites are indicated as dark circles. The letters associated with each of the dark circles are the habitat type abbreviations as follows: RR = rip rap, VS = vegetated shore, SA = sandy beach, and OC = open channel.

METHODS

To allow direct comparisons of catch-per-unit-effort across all sampling sites, a single type of sampling gear was preferred. A boat-mounted electrofisher (Smith Root Model VII) was selected because it is reasonably effective in all of the various types of shallow water habitats. Other types of gear were evaluated but considered infeasible due the presence of brush and debris and variable depth conditions at many of the sampling sites. At each sampling site, approximately 1000 seconds (16.7 minutes) of electrofishing effort was employed during each sampling period.

Some of the electrofishing sites were re-sampled to evaluate electrofisher sampling efficiency with respect to species composition and relative abundance. A 90-ft beach seine with 3/8-inch mesh openings was used to re-sample the sandy beach sites. Two replicate seine hauls were made at each sandy beach site in each of the three sub-areas. The three open channel sites between Government Island and the Portland International Airport were re-sampled using an otter trawl with a 12-ft mouth opening. The cod end of the otter trawl was constructed of 1/4 -inch mesh nylon netting to allow retention of small specimens. Two replicate trawls (approximately 1200 ft each) were made in the same areas that were electrofished in the open channel habitat. The upper and lower ends of the trawl sites were located with a Global Positioning System (GPS).

Fish collected by electrofishing were placed in a live tank onboard the electrofisher boat. Fish collected by beach seining and trawling were placed in a bucket of clean river water. All fish collected were identified to species and most were measured to the nearest millimeter prior to release. In cases where large numbers of approximately the same size fish of a given species were collected, a sub-sample of the group was measured. The fish that were not measured were counted and released.

Stomach samples were collected from predator fish species. Northern squawfish over 250mm fork length, and largemouth bass, smallmouth bass and yellow perch over 200 mm fork length were sampled. A stomach pump was used to flush food from the stomachs of the bass and yellow perch; northern squawfish were sacrificed and their stomachs were removed. Stomach contents were placed in labeled glass jars and preserved with 90 percent ethanol. Identification of stomach contents was done under a dissecting scope. Partially digested fish were identified using a "bone" key.

RESULTS

Anadromous Salmonids

Three species of anadromous salmonids were collected in the vicinity of the proposed storm-water discharge facilities for the Portland International Airport. They included recently emerged fry, sub-yearling and yearling chinook salmon (*Oncorhynchus tshawytscha*), yearling coho salmon (*O. kisutch*), and juvenile steelhead trout (*O.*

mykiss). Chinook salmon were, by far, the most abundant of the three species. The majority of the chinook salmon were fry. Generally chinook salmon fry in the lower Columbia River tributaries remain in the gravel until late February or March. Therefore, the presence of chinook salmon fry in the lower Columbia River in December was unexpected. The most likely source for these early fry, was a group of "up-river bright" fall chinook salmon that spawned on the Washington side of the Columbia River just downstream of Bonneville Dam. National Marine Fishery Service (NMFS) personnel (Meyer pers. com. January 1998) estimate that from 5 to 10 thousand adults spawned at this location during the fall of 1997. Their uncertainty regarding the number of adults was due to the difficulty in counting redds in the relatively deep water where the spawning was occurring. Assuming that some spawning occurred in September, sufficient thermal units would have been available at this location to allow the observed early emergence of fry. After emerging from the gravel, it appears that the chinook fry dispersed downstream. Our results indicate that substantial numbers of fry were present along the river edges during the 3-month study interval.

It should be noted that the NMFS has proposed the Lower Columbia River Chinook Salmon Evolutionarily Significant Unit (ESU) for threatened status under the Endangered Species Act of 1973 (FR 63, No.45, March 9, 1998). This ESU includes certain stocks of chinook salmon in the lower Columbia River downstream of Bonneville Dam. It is not clear from NMFS' proposed listing whether the "up-river bright fish" that spawn below Bonneville Dam would be included in the proposed listing.

A total of 13 larger juvenile chinook salmon was collected at the airport sampling sites. These fish ranged in length from 68 to 137 mm. One of the fish had been marked with an adipose clip, none of the other fish had fin clips or tags. Most of these fish were probably fall chinook salmon that had remained in the lower river during the winter. Some of the largest fish may have been yearling spring chinook. The origin of the larger juvenile chinook salmon was not possible to determine. Although the probability is low, the potential exists that one or more of these fish could have been threatened Snake River fall or spring chinook salmon.

A single juvenile coho salmon was collected at a rip rap site and was 104 mm in length. A single juvenile steelhead trout was collected on the Government Island side of the channel in vegetated shoreline habitat and was 228 mm in length. Neither of these fish was marked. The Lower Columbia River Steelhead ESU was listed as a threatened species in March 1998. It is possible that the single steelhead collected on the Government Island shoreline was from the Lower Columbia River ESU or the Snake River Basin Steelhead ESU.

Relative Abundance and Distribution of Fish

A total of 383 fish belonging to 14 species was collected by electrofishing at the 11 sampling sites near the airport (Table 1). Chinook salmon was the most abundant species comprising about 41 percent of the total catch. Most of the juvenile salmon (132

Table 1. Total numbers and percentage composition of the electrofishing catch at the 11 Columbia River sampling sites near the Portland International Airport during the period December 1997 through February 1998.

Species		Number	Percentage
Common Name	**Scientific Name**		
Chinook Salmon	*Oncorhynchus tshawytscha*	157	40.9
3-spine Stickleback	*Gasterosteus aculeatus*	136	35.5
Yellow Perch	*Perca flavescens*	21	5.5
Largescale Sucker	*Catostomus macrocheilus*	17	4.4
Bluegill Sunfish	*Lepomis macrochirus*	13	3.4
Smallmouth Bass	*Micropterus dolomieui*	12	3.1
Largemouth Bass	*Micropterus salmoides*	8	2.0
Pumpkinseed Sunfish	*Lepomis gibbosus*	6	1.6
Sculpin sp.	*Cottus sp.*	5	1.3
Northern Squawfish	*Ptychocheilus oregonensis*	3	0.8
Banded Killifish	*Fundulus diaphanus*	2	0.5
Coho Salmon	*Oncorhynchus kisutch*	1	0.3
Steelhead Trout	*Oncorhynchus mykiss*	1	0.3
Starry Flounder	*Platyichthys stellatus*	1	0.3

of the 157 collected) were found very close to shore along the rip-rapped shoreline adjacent to the airport. They appeared to use the spaces between the rocks for cover. In other habitat types, they were found close to cover or in very shallow water. None were collected from the open channel habitat between Government Island and the shoreline adjacent to airport.

The next most abundant species was the 3-spine stickleback. The 3-spine stickleback generally were found in schools in very shallow sandy beach habitat or along the rip-rapped shoreline. Relatively large catches at a few locations were responsible for their relatively high numerical abundance in the catch.

The remainder of the species collected at the airport sites occurred in relatively small numbers. The majority of these fish were found along the rip-rapped shoreline adjacent to the airport. It is noteworthy that one of the species, the banded killifish, has not previously been reported from the Columbia River system. The banded killifish is a small, forage-size fish (maximum length about 125 mm), which is widely distributed east of the Mississippi River. Banded killifish were collected at a number of sites around Government Island and in backwater habitat in the Sandy River Delta sub-area.

Table 2 compares the number of fish species collected per sampling period in the various shallow water habitat types at Hayden Island, Government Island, and the Sandy River Delta. Rip-rapped shorelines and shallow backwater areas consistently supported more species during the winter than sandy beach, vegetated shoreline, or open channel habitats. The open spaces between the rocks of the rip-rapped shoreline probably provide cover and protection for small fish during the winter. Most of the rip rap within the study area is comprised of closely spaced rock with relatively few large crevices. This probably limits the use of these areas by larger size fish. Rooted aquatic vegetation in shallow backwater areas also appeared to be utilized for cover by a variety of small fish. No fish were collected by electrofishing in the open channel habitat where the proposed storm water discharge would occur. Only two fish (3-spine stickleback) were taken by trawling at the open channel sampling sites. Gear selectivity may have been partially responsible for the low catch in the open channel. However, it is reasonable to assume that the open channel habitat would not be a preferred habitat due to lack of cover and relatively poor food conditions in the shifting sand environment.

Size Distribution of Catch

The combined electrofishing catch for all sites (Hayden Island, Governmnent Island and Sandy River Delta) sampled during the 3-month period was comprised predominately of small fish less than 75 mm fork length. The electrofishing catch for the 11 sampling sites near the airport showed a similar size distribution (Figure 2). This distribution reflects, in part, the relatively large numbers of 3-spine stickleback and chinook salmon fry in the catches (See Appendix A for individual lengths of each fish captured at Government Island sites). However, with the exception of largescale sucker, very few

Table 2. Numbers of fish species collected from shallow water habitats sampled in the vicinity of Hayden Island, Government Island, and the Sandy River Delta, December 1997 through February 1998.

Location/Habitat Type	**December**	**January**	**February**	**Mean**
Hayden Island				
Sandy Beach	3	2	3	2.7
Vegetated Shore	2	2	5	3.0
Shallow Backwater	2	2	2	2.0
Boat Harbors	6	8	9	7.7
Rip Rapped Shore	12	10	11	11.0
Industrialized Shore*	14	8	6	9.3
Government Island				
Sandy Beach	4	3	2	3.0
Vegetated Shore	2	4	3	3.0
Shallow Backwater	7	10	10	9.0
Rip Rapped Shore	9	8	8	8.3
Open Channel	0	0	0	0.0
Sandy River Delta				
Sandy Beach	5	4	3	4.0
Vegetated Shore	9	6	7	7.3
Shallow Backwater	11	11	7	9.7

*shorelines in these areas were partially rip rapped

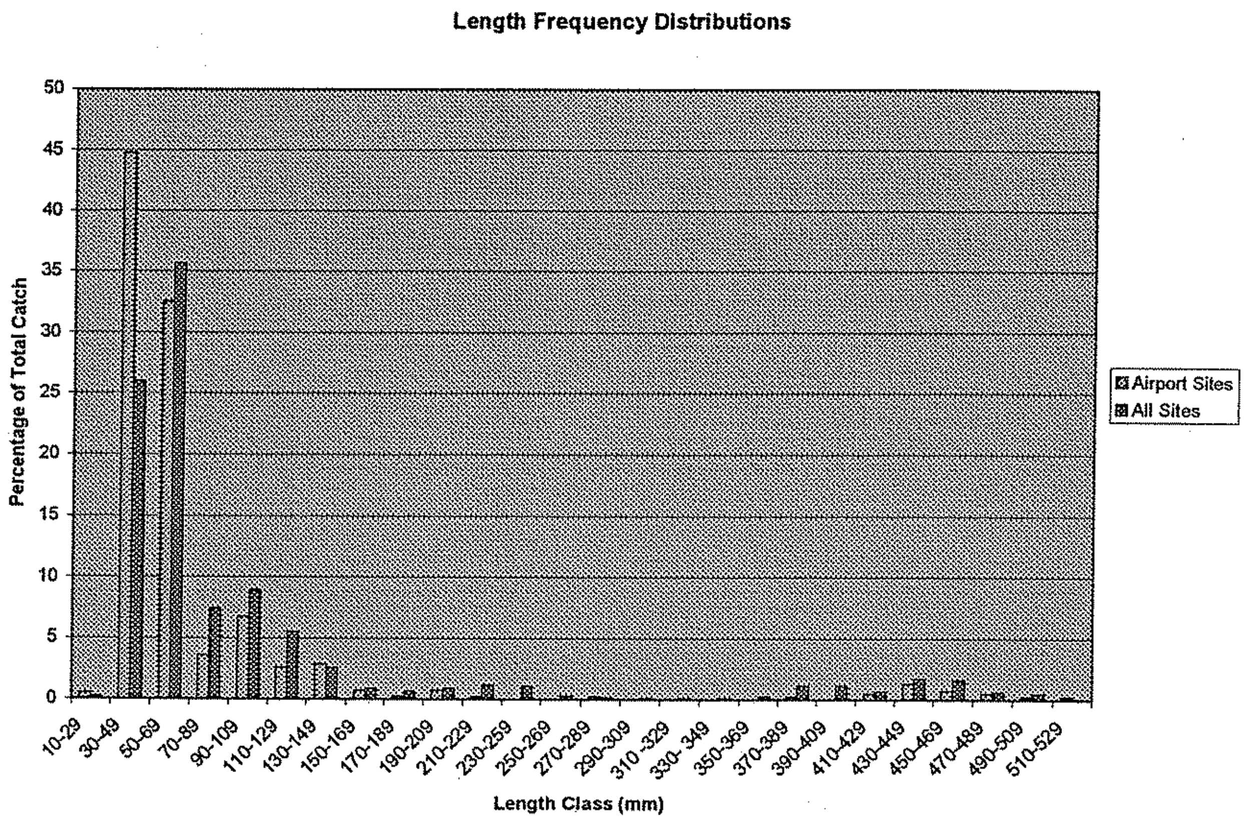

Figure 2. Length frequency distribution for all fish collected by electrofishing at the 11sites in the vicinity of the airport compared with length frequency distribution of all fish collected by electrofishing at all sampling sites combined, December 1997 -February 1998.

adult fish of species such as carp, largemouth bass, smallmouth bass, northern squawfish, yellow perch, black crappie, or bluegill were found at any of the shallow water sites sampled. It is not yet known where these larger fish overwinter in this reach of the lower Columbia River.

The efficiency of the electrofishing gear in capturing the small size classes of fish was probably low. On sandy beach habitat, where both electrofishing and beach seining were conducted, the beach seine generally caught more small fish in a 100-ft section of shoreline than the electrofisher collected in over 1000 ft of shoreline. The relatively low efficiency of the electrofisher on small fish is a combination of the difficulty in seeing small fish for dip netting, the inability of the elecrofishing boat to access very shallow areas where many of the small fish reside, and a lower efficiency of the electrofisher in stunning small fish. Therefore, it is likely that the true size distribution of the fish population in the shallow water habitat was more heavily weighted toward small individuals than the electrofishing catch indicated.

Catch per Unit Effort

One of the objectives of this study is to determine whether there are differences in the abundance of fish in the various types of shallow water habitat that could potentially be impacted by the proposed surface water discharge system. The habitats where construction would occur include the rip rapped shoreline adjacent to the airport and the open channel habitat between the airport and Government Island. Other nearby shallow water habitats that potentially could be affected by operation of the project include vegetated shorelines and sandy beaches. The site specific CPE data for all sampling sites including the 11 airport sites is summarized in Appendix B. Figure 3 provides and overview of the results and compares the CPE (i.e., catch per 1000 seconds of electrofishing) for the shallow water habitat types sampled in the vicinity of the airport with the overall CPE for the various shallow water habitats sampled in all three sub-areas.

The rip rapped shoreline sites had the highest CPE of the shallow water habitat types sampled near the airport (Figure 3). The CPE value for these sites was similar to the overall CPE for rip rapped shoreline. No fish were caught during the 3-month sampling period by electrofishing at the open channel habitat sites. Vegetated shoreline habitat along the south shore of Government Island appeared to have relatively low numbers of fish compared with the rip rapped shoreline near the airport. As indicated in Figure 3, the CPE for all vegetated sites combined for the three sub-areas also was low compared with most of the other shallow water habitat types sampled. The CPE value for the single sandy beach site sampled near the airport was intermediate between the vegetated shoreline and rip rap habitat.

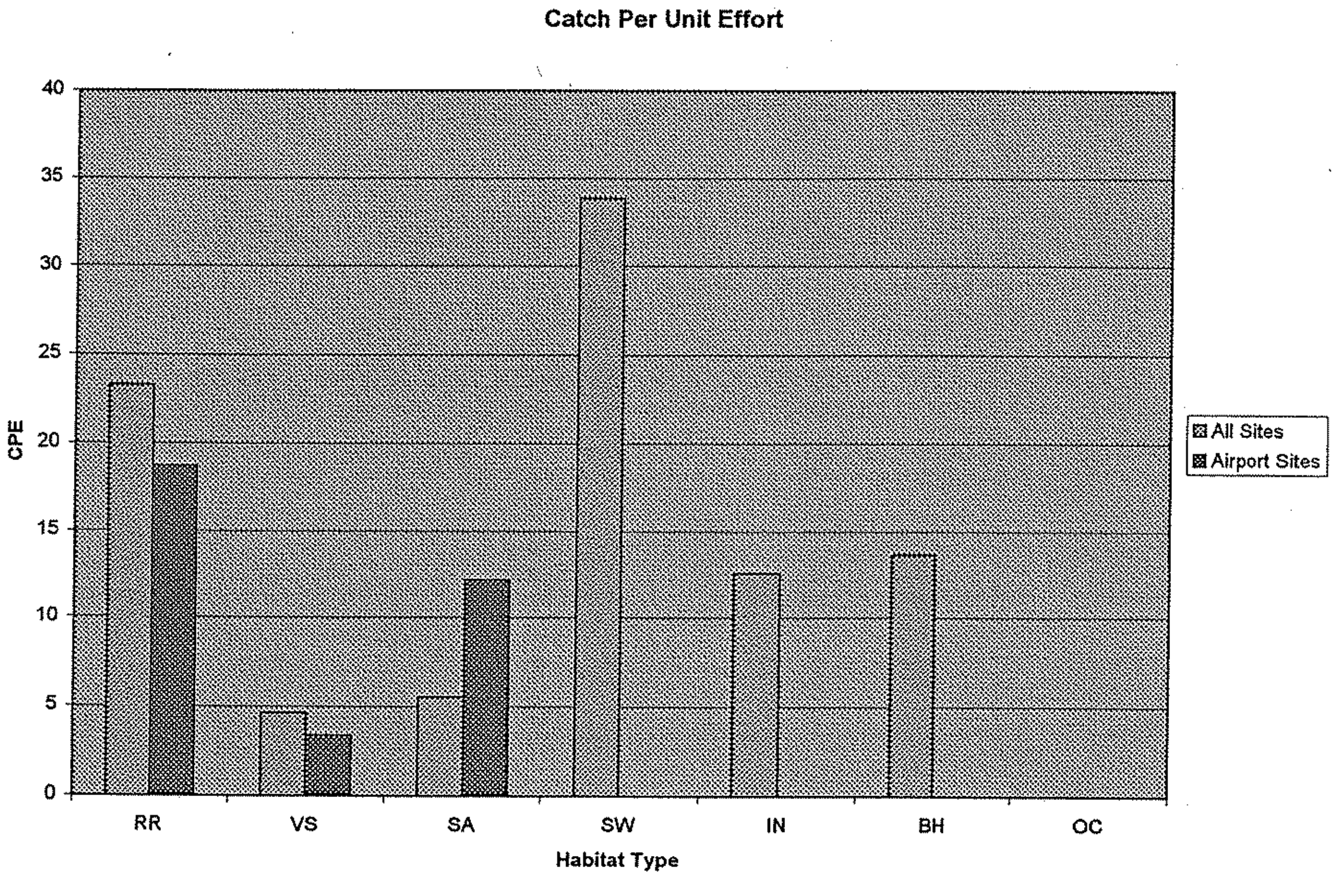

Figure 3. Overall combined catch-per-unit-effort (CPE) results for fish samples collected from the various shallow water habitat types at Hayden Island, Government Island and Sandy River delta compared with combined CPE results for the airport sites (RR = rip rap, VS = vegetated shoreline, SA = sandy beach, SW = shallow backwater, IN = industrialized shoreline, BH = boat harbor, and OC = open channel).

In general, CPE values were highly variable among individual sites within a given habitat type. Although statistical analysis of the data was not conducted for this status report, it is likely that some of the apparent differences in CPE shown in Figure 3 may not be statistically significant. The high variability appeared to be caused by the generally low abundance of fish combined with patchy distributions of schooling species such as 3-spine stickleback.

Stomach Contents of Predators

Large predator fish that could potentially consume juvenile salmonids were collected and examined for stomach content. Species collected included largemouth bass, northern squawfish, and yellow perch. Table 3 summarizes the stomach contents of all predators collected from the Hayden Island, Government Island and Sandy River Delta sub-areas. No juvenile salmonid were found in any of the predators examined. Approximately 60 percent of the predators had empty stomachs. Those predators that contained fish or fish bones in their stomachs were feeding primarily on 3-spine stickleback.

As indicated in Table 3, large predator fish were collected from only a few of the sites sampled during the winter and were not abundant at any station. None were collected at the 11 sites near the airport. The largest number of predators occurred at the Hayden Island rip rap site near the Northern Pacific Railroad bridge crossing. This rip rap site contains relatively large rock compared to most of the other rip rap sites. Spaces between the rocks were large enough to allow larger fish to use the rocks for cover. This may explain the relatively high numbers of larger northern squawfish collected at this site. A few largmouth bass were collected from shallow backwater areas, vegetated shorelines and from boat harbors. Yellow perch were largely taken from shallow backwater habitat on Government Island and the Sandy River delta.

Table 3. Stomach contents of predator species collected during December 1997 and January and February 1998.

Sampling Site	Predator Species	Fork Length (mm)	Stomach Contents
H-RR1	N. Squawfish	283	3-spine stickleback bone
H-RR1	N. Squawfish	264	Benthic macroinvertebrate parts
H-RR1	N. Squawfish	273	Seed Pods
H-RR1	N. Squawfish	262	Seed Pods
H-RR1	N. Squawfish	247	Empty
H-RR1	N. Squawfish	235	Empty
H-RR1	N. Squawfish	250	Empty
H-BH2	Largemouth Bass	394	Empty
H-BH2	Largemouth Bass	356	Empty
H-SW1	Yellow Perch	223	Empty
H-SA2	N. Squawfish	516	Empty
G-SW2	Yellow Perch	242	Empty
G-SW2	Yellow Perch	219	Empty
G-SW3	Largemouth Bass	386	3-Spine Stickleback, salamander
G-SW3	Largemouth Bass	309	3-Spine Stickleback, 3-Spine Stickleback
S-SW3	Largemouth Bass	328	Empty
S-VS2	Largemouth Bass	300	3-spine stickleback
S-VS3	Largemouth Bass	287	Empty
S-VS3	Largemouth Bass	373	Empty
S-SW1	Yellow Perch	223	Empty
S-SW1	Yellow Perch	204	Empty
S-SW1	Largemouth Bass	226	3-Spine Stickleback 3-Spine Stickleback

SUMMARY AND CONCLUSIONS

The results of the winter sampling in the vicinity of the Portland International Airport provide new insight into the winter distribution and relative abundance of fish in this area. The findings that may be important with respect to permitting the construction and operation of a surface water discharge system for the airport are as follows:

1. Three species of anadromous samonids were collected from the study area. These included, chinook salmon, coho salmon, and steelhead trout. Chinook salmon fry, probably off spring of the " upriver-bright stock" of chinook salmon that spawned below Bonneville Dam during the fall of 1997, were relatively abundant along the river edges. A few larger juvenile chinook salmon were also collected. Coho salmon and steelhead trout were represented by single individuals.

2. The finding of only one steelhead in the airport study suggests that this area was not an important steelhead over-wintering area this past winter.

3. Although the probability is low, one or more of the larger juvenile chinook salmon could potentially have been a threatened Snake River fall or spring/summer chinook salmon.

4. The finding of chinook salmon fry could be significant with respect to permitting the project if the Lower Columbia River Chinook Salmon ESU is listed as a threatened species in 1999 as the NMFS is presently proposing. These fry appear to use the rip-rapped shoreline adjacent to the airport as cover and as a rearing area. This could affect the timing of construction activities and increase the potential for a "take" situation. Clarification from NMFS is needed on the status of the "upriver-bright" stock of fish that spawned below Bonneville Dam.

5. The open channel habitat where the discharge diffuser would be located appears to support very low numbers of fish during the winter months. No fish were collected from sites in this area by electrofishing and only two fish were collected by trawling.

6. The rip-rapped shoreline adjacent to the airport appears to provide winter habitat for a variety of small fish.

7. Large, adult fish were poorly represented in the winter catch.

8. Of the various shallow water habitat types sampled, rip rap habitat had the second highest catch per 1000 seconds of electrofishing. The CPE at the airport rip rap sites was similar to that found at Hayden Island rip rap sites. Shallow backwater habitat had the highest average catch-per-unit effort.

9. Large predator fish were not found at any of the airport shallow water sites and they were not abundant at any of the other shallow water sites sampled at Government Island, Hayden Island or the Sandy River Delta.

10. Stomach content analysis of the limited number of large predators collected revealed that over 60 percent of the fish had empty stomachs. None of the fish collected had juvenile anadromous salmonids in their stomachs. The most common fish prey species found in the stomach contents was 3-spine stickleback.

It should be noted that the results reported above represent a single season of data. Year-to-year variability in the distribution and relative abundance of fish is often high in riverine environments. Therefore, additional data collection is recommended to evaluate the amount of annual variability.

Appendix A. Lengths of each fish captured by electrofishing at the 17 Government Island sampling sites, December 1997 through February 1998. Sample site abbreviations are as follows: Rip Rapped = G-RR, Vegetated Shore = G-VS, Sandy Beach = G-SA, Shallow Backwater = G-SW, and Open Channel = G-T. (Data for the 11 sites in the vicinity of the Portland International Airport are shown in bold print).

Date	Sample Site	Species	Length (mm)
12/17/97	**G-RR1**	**Chinook Salmon**	**34**
12/17/97	**G-RR2**	**Bluegill**	**106**
12/17/97	**G-RR2**	**Chinook Salmon**	**34**
12/17/97	**G-RR2**	**Chinook Salmon**	**33**
12/17/97	**G-RR2**	**Chinook Salmon**	**34**
12/17/97	**G-RR2**	**Chinook Salmon**	**31**
12/17/97	**G-RR2**	**Chinook Salmon**	**32**
12/17/97	**G-RR2**	**Smallmouth Bass**	**105**
12/17/97	**G-RR2**	**3-spine Stickleback**	**48**
12/17/97	**G-RR2**	**3-spine Stickleback**	**52**
12/17/97	**G-RR2**	**3-spine Stickleback**	**55**
12/17/97	**G-RR2**	**3-spine Stickleback**	**45**
12/17/97	**G-RR2**	**3-spine Stickleback**	**47**
12/17/97	**G-RR2**	**3-spine Stickleback**	**46**
12/17/97	**G-RR2**	**3-spine Stickleback**	**52**
12/17/97	**G-RR2**	**3-spine Stickleback**	**50**
12/17/97	**G-RR2**	**3-spine Stickleback**	**53**
12/17/97	**G-RR2**	**3-spine Stickleback**	**50**
12/17/97	**G-RR2**	**3-spine Stickleback**	**51**
12/17/97	**G-RR2**	**3-spine Stickleback**	**53**
12/17/97	**G-RR2**	**3-spine Stickleback**	**48**
12/17/97	**G-RR2**	**3-spine Stickleback**	**53**
12/17/97	**G-RR2**	**3-spine Stickleback**	**47**
12/17/97	**G-RR2**	**3-spine Stickleback**	**48**
12/17/97	**G-RR2**	**3-spine Stickleback**	**50**
12/17/97	**G-RR2**	**3-spine Stickleback**	**47**
12/17/97	**G-RR2**	**3-spine Stickleback**	**52**
12/17/97	**G-RR2**	**3-spine Stickleback**	**47**
12/17/97	**G-RR2**	**Yellow Perch**	**101**
12/17/97	**G-RR3**	**Bluegill**	**139**
12/17/97	**G-RR3**	**Bluegill**	**115**
12/17/97	**G-RR3**	**Chinook Salmon**	**32**
12/17/97	**G-RR3**	**Chinook Salmon**	**33**
12/17/97	**G-RR3**	**Chinook Salmon**	**34**
12/17/97	**G-RR3**	**Chinook Salmon**	**32**
12/17/97	**G-RR3**	**Largescale Sucker**	**435**
12/17/97	**G-RR3**	**Pumpkinseed**	**134**
12/17/97	**G-RR3**	**Smallmouth Bass**	**54**
12/17/97	**G-RR3**	**Northern Squawfish**	**47**
12/17/97	**G-RR3**	**3-spine Stickleback**	**55**
12/17/97	**G-RR3**	**3-spine Stickleback**	**55**

Date	Sample Site	Species	Length (mm)
12/17/97	G-RR3	3-spine Stickleback	55
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	56
12/17/97	G-RR3	3-spine Stickleback	56
12/17/97	G-RR3	3-spine Stickleback	44
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	50
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	49
12/17/97	G-RR3	3-spine Stickleback	55
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	50
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	48
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	55
12/17/97	G-RR3	3-spine Stickleback	50
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	50
12/17/97	G-RR3	3-spine Stickleback	51
12/17/97	G-RR3	3-spine Stickleback	56
12/17/97	G-RR3	3-spine Stickleback	53
12/17/97	G-RR3	3-spine Stickleback	53
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	54
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	50
12/17/97	G-RR3	3-spine Stickleback	53
12/17/97	G-RR3	3-spine Stickleback	48
12/17/97	G-RR3	3-spine Stickleback	48
12/17/97	G-RR3	3-spine Stickleback	52
12/17/97	G-RR3	3-spine Stickleback	53
12/17/97	G-RR3	Yellow Perch	99
12/18/97	G-RR4	Bluegill	78
12/18/97	G-RR4	Bluegill	129
12/18/97	G-RR4	Bluegill	130
12/18/97	G-RR4	Largescale Sucker	168
12/18/97	G-RR4	Pumpkinseed	109
12/18/97	G-RR4	Sculpin	134
12/18/97	G-RR4	Sculpin	128
12/18/97	G-RR4	Smallmouth Bass	66
12/18/97	G-RR4	3-spine Stickleback	52
12/18/97	G-RR4	3-spine Stickleback	52

Date	Sample Site	Species	Length (mm)
12/18/97	G-RR4	Yellow Perch	194
12/18/97	G-RR4	Yellow Perch	113
12/18/97	G-RR4	Yellow Perch	112
12/17/97	G-RR5	Chinook Salmon	94
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35

Date	Sample Site	Species	Length (mm)
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35

Date	Sample Site	Species	Length (mm)
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	35
12/17/97	G-RR5	Chinook Salmon	0
12/17/97	G-RR5	Largescale Sucker	445
12/17/97	G-RR5	Largescale Sucker	520
12/17/97	G-RR5	Largescale Sucker	490
12/17/97	G-RR5	Largescale Sucker	485
12/17/97	G-RR5	Largescale Sucker	450
12/17/97	G-RR5	Smallmouth Bass	86
12/17/97	G-RR5	Smallmouth Bass	75
12/17/97	G-RR5	Smallmouth Bass	53
12/17/97	G-RR5	3-spine Stickleback	47
12/17/97	G-RR5	Yellow Perch	120
12/17/97	G-RR5	Yellow Perch	64
12/18/97	G-VS1	Largescale Sucker	444
12/18/97	G-VS1	Largescale Sucker	446
12/18/97	G-VS1	Largescale Sucker	374
12/19/97	G-VS2	Mtn. Whitefish	140
12/18/97	G-VS3	Largescale Sucker	420
12/18/97	G-SA1	Banded Killifish	97
12/18/97	G-SA1	Banded Killifish	78
12/18/97	G-SA1	Chinook Salmon	85
12/18/97	G-SA1	Chinook Salmon	68
12/18/97	G-SA1	Starry Flounder	148
12/18/97	G-SA1	3-spine Stickleback	54
12/18/97	G-SA1	3-spine Stickleback	52
12/18/97	G-SA1	3-spine Stickleback	50
12/18/97	G-SA1	3-spine Stickleback	55
12/18/97	G-SA1	3-spine Stickleback	50
12/18/97	G-SA1	3-spine Stickleback	54
12/18/97	G-SA1	3-spine Stickleback	54
12/18/97	G-SA1	3-spine Stickleback	50
12/18/97	G-SA1	3-spine Stickleback	52
12/18/97	G-SA1	3-spine Stickleback	55
12/18/97	G-SA1	3-spine Stickleback	51
12/18/97	G-SA1	3-spine Stickleback	56
12/18/97	G-SA1	3-spine Stickleback	53
12/18/97	G-SA1	3-spine Stickleback	54
12/18/97	G-SA1	3-spine Stickleback	52

Date	Sample Site	Species	Length (mm)
12/18/97	**G-SA1**	**3-spine Stickleback**	**52**
12/18/97	**G-SA1**	**3-spine Stickleback**	**55**
12/18/97	**G-SA1**	**3-spine Stickleback**	**53**
12/18/97	G-SA2	Chinook Salmon	116
12/18/97	G-SA2	Chinook Salmon	137
12/18/97	G-SA2	3-spine Stickleback	52
12/19/97	G-SA3	3-spine Stickleback	56
12/19/97	G-SA3	3-spine Stickleback	53
12/19/97	G-SW1	Largescale Sucker	440
12/19/97	G-SW1	3-spine Stickleback	51
12/19/97	G-SW1	3-spine Stickleback	53
12/19/97	G-SW1	Yellow Perch	118
12/19/97	G-SW2	Banded Killifish	64
12/19/97	G-SW2	Black Crappie	191
12/19/97	G-SW2	Black Crappie	131
12/19/97	G-SW2	Black Crappie	127
12/19/97	G-SW2	Black Crappie	67
12/19/97	G-SW2	Black Crappie	57
12/19/97	G-SW2	Black Crappie	54
12/19/97	G-SW2	Black Crappie	47
12/19/97	G-SW2	Black Crappie	54
12/19/97	G-SW2	Black Crappie	46
12/19/97	G-SW2	Chinook Salmon	35
12/19/97	G-SW2	Largescale Sucker	404
12/19/97	G-SW2	Largescale Sucker	494
12/19/97	G-SW2	Largescale Sucker	462
12/19/97	G-SW2	Largescale Sucker	492
12/19/97	G-SW2	3-spine Stickleback	59
12/19/97	G-SW2	3-spine Stickleback	54
12/19/97	G-SW2	3-spine Stickleback	56
12/19/97	G-SW2	3-spine Stickleback	52
12/19/97	G-SW2	3-spine Stickleback	5453
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	49
12/19/97	G-SW2	3-spine Stickleback	55
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	50
12/19/97	G-SW2	3-spine Stickleback	45
12/19/97	G-SW2	3-spine Stickleback	50
12/19/97	G-SW2	3-spine Stickleback	55
12/19/97	G-SW2	3-spine Stickleback	48
12/19/97	G-SW2	3-spine Stickleback	50
12/19/97	G-SW2	3-spine Stickleback	48
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	47
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	59

Date	Sample Site	Species	Length (mm)
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	47
12/19/97	G-SW2	3-spine Stickleback	54
12/19/97	G-SW2	3-spine Stickleback	46
12/19/97	G-SW2	3-spine Stickleback	52
12/19/97	G-SW2	3-spine Stickleback	52
12/19/97	G-SW2	3-spine Stickleback	56
12/19/97	G-SW2	3-spine Stickleback	47
12/19/97	G-SW2	3-spine Stickleback	48
12/19/97	G-SW2	3-spine Stickleback	54
12/19/97	G-SW2	3-spine Stickleback	51
12/19/97	G-SW2	3-spine Stickleback	49
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	48
12/19/97	G-SW2	3-spine Stickleback	43
12/19/97	G-SW2	3-spine Stickleback	56
12/19/97	G-SW2	3-spine Stickleback	56
12/19/97	G-SW2	3-spine Stickleback	51
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	53
12/19/97	G-SW2	3-spine Stickleback	54
12/19/97	G-SW2	Yellow Perch	175
12/19/97	G-SW2	Yellow Perch	79
12/19/97	G-SW2	Yellow Perch	102
12/19/97	G-SW2	Yellow Perch	77
12/19/97	G-SW2	Yellow Perch	123
12/19/97	G-SW2	Yellow Perch	94
12/19/97	G-SW2	Yellow Perch	111
12/19/97	G-SW2	Yellow Perch	124
12/19/97	G-SW2	Yellow Perch	106
12/19/97	G-SW2	Yellow Perch	109
12/19/97	G-SW2	Yellow Perch	142
12/19/97	G-SW2	Yellow Perch	68
12/19/97	G-SW2	Yellow Perch	109
12/19/97	G-SW2	Yellow Perch	92
12/19/97	G-SW2	Yellow Perch	78
12/19/97	G-SW2	Yellow Perch	84
12/19/97	G-SW2	Yellow Perch	108
12/19/97	G-SW2	Yellow Perch	73
12/19/97	G-SW2	Yellow Perch	81
12/19/97	G-SW2	Yellow Perch	242
12/19/97	G-SW2	Yellow Perch	219
12/19/97	G-SW2	Yellow Perch	84
12/18/97	G-SW3	Black Crappie	78
12/18/97	G-SW3	Chinook Salmon	34

Date	Sample Site	Species	Length (mm)
12/18/97	G-SW3	Chinook Salmon	31
12/18/97	G-SW3	Chinook Salmon	32
12/18/97	G-SW3	Chinook Salmon	33
12/18/97	G-SW3	Largemouth Bass	233
12/18/97	G-SW3	Largemouth Bass	325
12/18/97	G-SW3	Largescale Sucker	494
12/18/97	G-SW3	Yellow Perch	212
12/18/97	G-SW3	Yellow Perch	88
12/18/97	G-SW3	Yellow Perch	113
12/18/97	G-SW3	Yellow Perch	221
12/18/97	G-SW3	Yellow Perch	85
12/18/97	G-SW3	Yellow Perch	143
12/18/97	G-SW3	Yellow Perch	80
12/18/97	G-SW3	Yellow Perch	84
12/18/97	G-SW3	Yellow Perch	83
12/18/97	G-SW3	Yellow Perch	76
12/18/97	G-SW3	Yellow Perch	72
12/18/97	G-SW3	Yellow Perch	109
12/18/97	G-SW3	Yellow Perch	99
12/18/97	G-SW3	Yellow Perch	76
12/18/97	**G-T1**	**No fish**	**0**
12/18/97	**G-T2**	**No fish**	**0**
12/18/97	**G-T3**	**No fish**	**0**
1/21/98	**G-RR1**	**Chinook Salmon**	**40**
1/21/98	**G-RR1**	**Chinook Salmon**	**40**
1/21/98	**G-RR1**	**Chinook Salmon**	**40**
1/21/98	**G-RR1**	**Yellow Perch**	**93**
1/21/98	**G-RR2**	**Chinook Salmon**	**36**
1/21/98	**G-RR2**	**Largemouth Bass**	**205**
1/21/98	**G-RR2**	**Sculpin**	**99**
1/21/98	**G-RR3**	**Bluegill**	**64**
1/21/98	**G-RR3**	**Chinook Salmon**	**40**
1/21/98	**G-RR3**	**Chinook Salmon**	**40**
1/21/98	**G-RR3**	**Chinook Salmon**	**40**
1/21/98	**G-RR3**	**Largemouth Bass**	**131**
1/21/98	**G-RR3**	**Largemouth Bass**	**140**
1/21/98	**G-RR3**	**Pumpkinseed**	**98**
1/21/98	**G-RR3**	**Smallmouth Bass**	**69**
1/21/98	**G-RR3**	**3-spine Stickleback**	**56**
1/21/98	**G-RR3**	**3-spine Stickleback**	**49**
1/21/98	**G-RR3**	**3-spine Stickleback**	**50**
1/21/98	**G-RR3**	**3-spine Stickleback**	**56**
1/21/98	**G-RR3**	**3-spine Stickleback**	**57**
1/21/98	**G-RR3**	**3-spine Stickleback**	**58**
1/21/98	**G-RR3**	**3-spine Stickleback**	**57**
1/21/98	**G-RR3**	**3-spine Stickleback**	**56**
1/21/98	**G-RR3**	**3-spine Stickleback**	**51**
1/21/98	**G-RR3**	**3-spine Stickleback**	**50**

Date	Sample Site	Species	Length (mm)
1/21/98	**G-RR3**	**3-spine Stickleback**	**48**
1/21/98	**G-RR4**	**Bluegill**	**104**
1/21/98	**G-RR4**	**Largemouth Bass**	**157**
1/21/98	**G-RR4**	**Pumpkinseed**	**74**
1/21/98	**G-RR4**	**3-spine Stickleback**	**57**
1/21/98	**G-RR4**	**3-spine Stickleback**	**22**
1/21/98	**G-RR4**	**Yellow Perch**	**101**
1/21/98	**G-RR4**	**Yellow Perch**	**83**
1/21/98	**G-RR4**	**Yellow Perch**	**95**
1/21/98	**G-RR5**	**Chinook Salmon**	**40**
1/27/98	**G-VS1**	**Chinook Salmon**	**38**
1/27/98	**G-VS1**	**Northern Squawfish**	**41**
1/27/98	**G-VS1**	**3-spine Stickleback**	**43**
1/22/98	G-VS2	No fish	0
1/22/98	**G-VS3**	**No fish**	**0**
1/22/98	**G-SA1**	**Chinook Salmon**	**96**
1/22/98	**G-SA1**	**Chinook Salmon**	**103**
1/22/98	**G-SA1**	**3-spine Stickleback**	**53**
1/22/98	**G-SA1**	**3-spine Stickleback**	**52**
1/21/98	G-SA2	3-spine Stickleback	50
1/21/98	G-SA2	3-spine Stickleback	40
1/21/98	G-SA2	3-spine Stickleback	42
1/21/98	G-SA2	3-spine Stickleback	40
1/22/98	G-SA3	Chinook Salmon	41
1/22/98	G-SA3	Chinook Salmon	119
1/22/98	G-SA3	Sculpin	103
1/22/98	G-SA3	3-spine Stickleback	55
1/22/98	G-SW1	Banded Killifish	77
1/22/98	G-SW1	Black Crappie	55
1/22/98	G-SW1	Chinook Salmon	42
1/22/98	G-SW1	Largescale Sucker	62
1/22/98	G-SW1	Sculpin	155
1/22/98	G-SW1	Northern Squawfish	47
1/22/98	G-SW1	Northern Squawfish	45
1/22/98	G-SW1	Northern Squawfish	48
1/22/98	G-SW1	Northern Squawfish	40
1/22/98	G-SW1	Northern Squawfish	37
1/22/98	G-SW1	3-spine Stickleback	43
1/22/98	G-SW1	3-spine Stickleback	45
1/22/98	G-SW1	3-spine Stickleback	46
1/22/98	G-SW1	3-spine Stickleback	48
1/22/98	G-SW1	3-spine Stickleback	49
1/22/98	G-SW1	3-spine Stickleback	50
1/22/98	G-SW1	3-spine Stickleback	53
1/22/98	G-SW1	3-spine Stickleback	53
1/22/98	G-SW1	3-spine Stickleback	53
1/22/98	G-SW1	3-spine Stickleback	54
1/22/98	G-SW1	3-spine Stickleback	54

Date	Sample Site	Species	Length (mm)
1/22/98	G-SW1	3-spine Stickleback	54
1/22/98	G-SW1	3-spine Stickleback	55
1/22/98	G-SW1	3-spine Stickleback	55
1/22/98	G-SW1	3-spine Stickleback	55
1/22/98	G-SW1	3-spine Stickleback	55
1/22/98	G-SW1	3-spine Stickleback	56
1/22/98	G-SW1	3-spine Stickleback	56
1/22/98	G-SW1	3-spine Stickleback	56
1/22/98	G-SW1	3-spine Stickleback	57
1/22/98	G-SW1	3-spine Stickleback	58
1/22/98	G-SW1	3-spine Stickleback	60
1/22/98	G-SW1	Yellow Perch	69
1/22/98	G-SW1	Yellow Perch	70
1/22/98	G-SW1	Yellow Perch	74
1/22/98	G-SW1	Yellow Perch	75
1/22/98	G-SW1	Yellow Perch	78
1/22/98	G-SW1	Yellow Perch	79
1/22/98	G-SW1	Yellow Perch	80
1/22/98	G-SW1	Yellow Perch	96
1/22/98	G-SW1	Yellow Perch	101
1/22/98	G-SW2	Banded Killifish	53
1/22/98	G-SW2	Chinook Salmon	40
1/22/98	G-SW2	Chinook Salmon	111
1/22/98	G-SW2	Chinook Salmon	115
1/22/98	G-SW2	Chinook Salmon	108
1/22/98	G-SW2	Chinook Salmon	94
1/22/98	G-SW2	Largescale Sucker	495
1/22/98	G-SW2	Largescale Sucker	55
1/22/98	G-SW2	Largescale Sucker	49
1/22/98	G-SW2	3-spine Stickleback	60
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	58
1/22/98	G-SW2	3-spine Stickleback	59
1/22/98	G-SW2	3-spine Stickleback	60
1/22/98	G-SW2	3-spine Stickleback	60
1/22/98	G-SW2	3-spine Stickleback	60
1/22/98	G-SW2	3-spine Stickleback	58
1/22/98	G-SW2	3-spine Stickleback	57
1/22/98	G-SW2	3-spine Stickleback	59
1/22/98	G-SW2	3-spine Stickleback	60
1/22/98	G-SW2	3-spine Stickleback	58
1/22/98	G-SW2	3-spine Stickleback	57
1/22/98	G-SW2	3-spine Stickleback	46
1/22/98	G-SW2	3-spine Stickleback	51
1/22/98	G-SW2	3-spine Stickleback	39
1/22/98	G-SW2	3-spine Stickleback	43
1/22/98	G-SW2	3-spine Stickleback	51
1/22/98	G-SW2	3-spine Stickleback	59

Date	Sample Site	Species	Length (mm)
1/22/98	G-SW2	3-spine Stickleback	55
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56

Date	Sample Site	Species	Length (mm)
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56

Date	Sample Site	Species	Length (mm)
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	56
1/22/98	G-SW2	3-spine Stickleback	49
1/22/98	G-SW2	3-spine Stickleback	48
1/22/98	G-SW2	3-spine Stickleback	59
1/22/98	G-SW2	3-spine Stickleback	47
1/22/98	G-SW2	3-spine Stickleback	58

Date	Sample Site	Species	Length (mm)
1/22/98	G-SW2	3-spine Stickleback	47
1/22/98	G-SW2	3-spine Stickleback	59
1/22/98	G-SW2	3-spine Stickleback	60
1/22/98	G-SW2	Yellow Perch	87
1/22/98	G-SW2	Yellow Perch	111
1/22/98	G-SW2	Yellow Perch	94
1/22/98	G-SW3	Banded Killifish	70
1/22/98	G-SW3	Black Crappie	56
1/22/98	G-SW3	Bluegill	79
1/22/98	G-SW3	Chinook Salmon	93
1/22/98	G-SW3	Chinook Salmon	94
1/22/98	G-SW3	Chinook Salmon	100
1/22/98	G-SW3	Chinook Salmon	104
1/22/98	G-SW3	Chinook Salmon	40
1/22/98	G-SW3	Chinook Salmon	85
1/22/98	G-SW3	Chinook Salmon	93
1/22/98	G-SW3	Chinook Salmon	103
1/22/98	G-SW3	Chinook Salmon	106
1/22/98	G-SW3	Chinook Salmon	39
1/22/98	G-SW3	Largescale Sucker	436
1/22/98	G-SW3	Largescale Sucker	437
1/22/98	G-SW3	Northern Squawfish	33
1/22/98	G-SW3	Yellow Perch	74
1/22/98	G-SW3	Yellow Perch	131
1/22/98	G-SW3	Yellow Perch	66
1/22/98	G-SW3	Yellow Perch	74
1/22/98	G-SW3	Yellow Perch	74
1/22/98	G-SW3	Yellow Perch	245
1/27/98	**G-T1**	**No fish**	**0**
1/27/98	**G-T2**	**No fish**	**0**
1/27/98	**G-T3**	**No fish**	**0**
2/17/98	**G-RR1**	**3-spine Stickleback**	**54**
2/17/98	**G-RR1**	**3-spine Stickleback**	**52**
2/17/98	**G-RR1**	**3-spine Stickleback**	**57**
2/17/98	**G-RR1**	**3-spine Stickleback**	**54**
2/17/98	**G-RR1**	**3-spine Stickleback**	**53**
2/17/98	**G-RR1**	**3-spine Stickleback**	**55**
2/17/98	**G-RR1**	**3-spine Stickleback**	**52**
2/17/98	**G-RR1**	**3-spine Stickleback**	**52**
2/17/98	**G-RR1**	**3-spine Stickleback**	**57**
2/17/98	**G-RR1**	**3-spine Stickleback**	**60**
2/17/98	**G-RR1**	**3-spine Stickleback**	**55**
2/17/98	**G-RR2**	**Chinook Salmon**	**44**
2/17/98	**G-RR2**	**3-spine Stickleback**	**55**
2/17/98	**G-RR2**	**3-spine Stickleback**	**48**
2/17/98	**G-RR2**	**3-spine Stickleback**	**61**
2/17/98	**G-RR2**	**3-spine Stickleback**	**53**
2/17/98	**G-RR2**	**3-spine Stickleback**	**54**

Date	Sample Site	Species	Length (mm)
2/17/98	G-RR2	3-spine Stickleback	57
2/17/98	G-RR2	Yellow Perch	146
2/17/98	G-RR2	Yellow Perch	92
2/17/98	G-RR3	Bluegill	114
2/17/98	G-RR3	Chinook Salmon	52
2/17/98	G-RR3	Chinook Salmon	40
2/17/98	G-RR3	Chinook Salmon	37
2/17/98	G-RR3	Largescale Sucker	114
2/17/98	G-RR3	3-spine Stickleback	58
2/17/98	G-RR3	Yellow Perch	108
2/20/98	G-RR4	Bluegill	78
2/20/98	G-RR4	Chinook Salmon	101
2/20/98	G-RR4	Coho Salmon	104
2/20/98	G-RR4	Largescale Sucker	454
2/20/98	G-RR4	Largescale Sucker	472
2/20/98	G-RR4	Smallmouth Bass	78
2/20/98	G-RR4	Smallmouth Bass	186
2/20/98	G-RR4	Smallmouth Bass	67
2/20/98	G-RR4	Smallmouth Bass	83
2/20/98	G-RR4	Yellow Perch	84
2/20/98	G-RR4	Yellow Perch	121
2/20/98	G-RR4	Yellow Perch	74
2/20/98	G-RR5	Bluegill	67
2/20/98	G-RR5	Chinook Salmon	40
2/20/98	G-RR5	Chinook Salmon	41
2/20/98	G-RR5	Chinook Salmon	44
2/20/98	G-RR5	Chinook Salmon	40
2/20/98	G-RR5	Sculpin	132
2/20/98	G-RR5	3-spine Stickleback	58
2/18/98	G-VS1	Chinook Salmon	109
2/18/98	G-VS1	Chinook Salmon	111
2/18/98	G-VS1	Largescale Sucker	446
2/18/98	G-VS1	Steelhead	228
2/20/98	G-VS2	Largescale Sucker	408
2/16/98	G-VS3	Chinook Salmon	47
2/16/98	G-VS3	Chinook Salmon	44
2/16/98	G-VS3	Chinook Salmon	45
2/16/98	G-VS3	Chinook Salmon	47
2/16/98	G-VS3	Chinook Salmon	48
2/16/98	G-VS3	Chinook Salmon	47
2/16/98	G-VS3	Chinook Salmon	44
2/16/98	G-VS3	Chinook Salmon	44
2/16/98	G-VS3	Largescale Sucker	454
2/16/98	G-VS3	Largescale Sucker	429
2/18/98	G-SA1	Chinook Salmon	92
2/18/98	G-SA1	Chinook Salmon	98
2/18/98	G-SA1	3-spine Stickleback	51
2/18/98	G-SA1	3-spine Stickleback	52

Date	Sample Site	Species	Length (mm)
2/18/98	**G-SA1**	**3-spine Stickleback**	**53**
2/18/98	**G-SA1**	**3-spine Stickleback**	**53**
2/18/98	**G-SA1**	**3-spine Stickleback**	**55**
2/18/98	**G-SA1**	**3-spine Stickleback**	**57**
2/18/98	**G-SA1**	**3-spine Stickleback**	**58**
2/18/98	**G-SA1**	**3-spine Stickleback**	**59**
2/18/98	G-SA2	No fish	0
2/18/98	G-SA3	Chinook Salmon	105
2/18/98	G-SA3	3-spine Stickleback	53
2/18/98	G-SA3	3-spine Stickleback	54
2/18/98	G-SA3	3-spine Stickleback	55
2/18/98	G-SA3	3-spine Stickleback	55
2/18/98	G-SA3	3-spine Stickleback	59
2/18/98	G-SA3	3-spine Stickleback	54
2/20/98	G-SW1	Banded Killifish	77
2/20/98	G-SW1	Banded Killifish	83
2/20/98	G-SW1	Black Crappie	54
2/20/98	G-SW1	Chinook Salmon	47
2/20/98	G-SW1	Largescale Sucker	61
2/20/98	G-SW1	Largescale Sucker	44
2/20/98	G-SW1	Pumpkinseed	74
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	54
2/20/98	G-SW1	3-spine Stickleback	56
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	61
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	54
2/20/98	G-SW1	3-spine Stickleback	61
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	52
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	53
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	51
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	56

Date	Sample Site	Species	Length (mm)
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	54
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	52
2/20/98	G-SW1	3-spine Stickleback	62
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	56
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	54
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	53
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	52
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	51
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	61
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	56
2/20/98	G-SW1	3-spine Stickleback	52
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	53
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	58
2/20/98	G-SW1	3-spine Stickleback	54
2/20/98	G-SW1	3-spine Stickleback	59
2/20/98	G-SW1	3-spine Stickleback	61
2/20/98	G-SW1	3-spine Stickleback	55
2/20/98	G-SW1	3-spine Stickleback	60
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	54
2/20/98	G-SW1	3-spine Stickleback	61
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57

Date	Sample Site	Species	Length (mm)
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57

Date	Sample Site	Species	Length (mm)
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	3-spine Stickleback	57
2/20/98	G-SW1	Yellow Perch	119
2/20/98	G-SW1	Yellow Perch	92
2/18/98	G-SW2	Banded Killifish	40
2/18/98	G-SW2	Banded Killifish	81
2/18/98	G-SW2	Banded Killifish	69
2/18/98	G-SW2	Banded Killifish	54
2/18/98	G-SW2	Banded Killifish	370
2/18/98	G-SW2	Banded Killifish	74
2/18/98	G-SW2	Banded Killifish	57
2/18/98	G-SW2	Brown Bullhead	253
2/18/98	G-SW2	Chinook Salmon	107
2/18/98	G-SW2	Northern Squawfish	35
2/18/98	G-SW2	3-spine Stickleback	53
2/18/98	G-SW2	3-spine Stickleback	64
2/18/98	G-SW2	3-spine Stickleback	55
2/18/98	G-SW2	3-spine Stickleback	52
2/18/98	G-SW2	3-spine Stickleback	50
2/18/98	G-SW2	3-spine Stickleback	53
2/18/98	G-SW2	3-spine Stickleback	54
2/18/98	G-SW2	3-spine Stickleback	52
2/18/98	G-SW2	3-spine Stickleback	57
2/18/98	G-SW2	3-spine Stickleback	61
2/18/98	G-SW2	3-spine Stickleback	53
2/18/98	G-SW2	3-spine Stickleback	58
2/18/98	G-SW2	3-spine Stickleback	49
2/18/98	G-SW2	Yellow Perch	83
2/18/98	G-SW2	Yellow Perch	83
2/18/98	G-SW2	Yellow Perch	77
2/20/98	G-SW3	Largemouth Bass	386
2/20/98	G-SW3	Largemouth Bass	309
2/20/98	G-SW3	Largemouth Bass	328
2/20/98	G-SW3	Largescale Sucker	503
2/20/98	G-SW3	Largescale Sucker	451
2/20/98	G-SW3	Largescale Sucker	448
2/20/98	G-SW3	Largescale Sucker	406
2/20/98	G-SW3	Largescale Sucker	375

Date	Sample Site	Species	Length (mm)
2/20/98	G-SW3	Largescale Sucker	422
2/20/98	G-SW3	Yellow Perch	76
2/20/98	**G-T1**	**No Fish**	
2/20/98	**G-T2**	**No Fish**	
2/20/98	**G-T3**	**No Fish**	
		Chinook Salmon	32
		3-spine Stickleback	56

APPENDIX B. Catch-per-unit-effort (1000 seconds electrofishing) and number of species caught for each sampling station at Hayden Island, Government Island and the Sandy River Delta by month during the period December 1997 through February 1998.

Hayden Island Dec-97				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
H-RR1	9	63	1016	62.0
H-RR2	3	6	1051	5.7
H-RR3	6	45	1006	44.7
H-SW1	2	3	1005	3.0
H-VS1	1	3	1006	3.0
H-VS2	2	9	1011	8.9
H-VS3	1	1	1024	1.0
H-IN1	4	6	1022	5.9
H-IN2	8	14	1007	13.9
H-IN3	8	24	1017	23.6
H-BRIDGE	2	2	1015	2.0
H-BH1	2	27	1001	27.0
H-BH2	7	15	1050	14.3
H-BH3	3	10	1004	10.0
H-SA1	1	1	1027	1.0
H-SA2	1	5	1068	4.7
H-SA3	2	3	1067	2.8

Appendix B. Continued				
Hayden Island Jan-98				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
H-RR1	9	45	1000	45.0
H-RR2	2	4	1010	4.0
H-RR3	4	11	1045	10.5
H-SW1	1	2	1056	1.9
H-VS1	1	1	1050	1.0
H-VS2	1	2	1117	1.8
H-VS3	0	0	1000	0.0
H-IN1	5	10	1037	9.6
H-IN2	3	10	1082	9.2
H-IN3	5	6	1007	6.0
H-BRIDGE	1	3	1039	2.9
H-BH1	1	1	1065	0.9
H-BH2	1	2	1031	1.9
H-BH3	8	22	1029	21.4
H-SA1	2	2	1090	1.8
H-SA2	1	2	1001	2.0
H-SA3	1	2	1007	2.0

Appendix B. Continued				
Hayden Island Feb-98				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
H-RR1	10	62	1000	62.0
H-RR2	3	5	1000	5.0
H-RR3	4	7	1020	6.9
H-SW1	2	31	1020	30.4
H-VS1	1	8	1020	7.8
H-VS2	2	2	1022	2.0
H-VS3	2	32	1035	30.9
H-IN1	5	34	1011	33.6
H-IN2	2	2	1025	2.0
H-IN3	3	4	1006	4.0
H-BRIDGE	1	6	1045	5.7
H-BH1	2	6	1000	6.0
H-BH2	7	24	1019	23.6
H-BH3	6	19	1000	19.0
H-SA1	1	6	1030	5.8
H-SA2	2	8	1002	8.0
H-SA3	2	8	1004	8.0

Appendix B. Continued				
Government Island Dec-98				
Sampling Site	No. Species	Catch	Effort (seconds)	CPE
G-RR1	1	1	1068	0.9
G-RR2	5	28	1053	26.6
G-RR3	8	50	1060	47.2
G-RR4	7	13	1045	12.4
G-RR5	5	116	1012	114.6
G-VS1	1	3	1025	2.9
G-VS2	1	1	1081	0.9
G-VS3	1	1	1019	1.0
G-SA1	4	23	1033	22.3
G-SA2	2	3	1060	2.8
G-SA3	1	2	1088	1.8
G-SW1	3	4	1053	3.8
G-SW2	6	82	1124	73.0
G-SW3	5	22	1032	21.3
G-T1	0	0	1000	0.0
G-T2	0	0	1000	0.0
G-T3	0	0	1000	0.0

Appendix B. Continued				
Government Island Jan-98				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
G-RR1	2	4	1000	4.0
G-RR2	3	3	1058	2.8
G-RR3	6	19	1025	18.5
G-RR4	5	8	1029	7.8
G-RR5	1	1	1040	1.0
G-VS1	3	3	1008	3.0
G-VS2	0	0	1020	0.0
G-VS3	0	0	1020	0.0
G-SA1	2	4	1000	4.0
G-SA2	1	4	1040	3.8
G-SA3	3	4	1030	3.9
G-SW1	7	41	1004	40.8
G-SW2	5	178	1016	175.2
G-SW3	7	22	1023	21.5
G-T1	0	0	1000	0.0
G-T2	0	0	1000	0.0
G-T3	0	0	1000	0.0

Appendix B. Continued				
Government Island Feb-98				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
G-RR1	1	11	1015	10.8
G-RR2	3	9	1000	9.0
G-RR3	5	7	1000	7.0
G-RR4	6	12	1021	11.8
G-RR5	4	7	1002	7.0
G-VS1	3	4	1050	3.8
G-VS2	1	1	1020	1.0
G-VS3	2	10	1038	9.6
G-SA1	2	10	1000	10.0
G-SA2	0	0	1001	0.0
G-SA3	2	7	1021	6.9
G-SW1	7	144	1004	143.4
G-SW2	5	26	1000	26.0
G-SW3	3	10	1020	9.8
G-T1	0	0	1000	0.0
G-T2	0	0	1002	0.0
G-T3	0	0	1000	0.0

Appendix B. Continued				
Sandy River Delta Dec 98				
Sampling Site	No. of Species	Catch	Effort (Seconds)	CPE
S-SA1	1	4	1091	3.7
S-SA2	1	10	1007	9.9
S-SA3	5	22	1009	21.8
S-SW1	8	35	1025	34.1
S-SW2	7	23	1000	23.0
S-SW3	4	19	1020	18.6
S-SA1	5	14	1042	13.4
S-SA2	4	4	1075	3.7
S-SA3	3	4	1025	3.9

Sandy River Delta Jan-98				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
S-SA1	3	127	1018	124.8
S-SA2	1	1	1004	1.0
S-SA3	2	2	1024	2.0
S-SW1	4	14	1058	13.2
S-SW2	10	32	1130	28.3
S-SW3	1	7	1018	6.9
S-SA1	3	5	1008	5.0
S-SA2	2	4	1100	3.6
S-SA3	3	4	1026	3.9

Appendix B. Continued				
Sandy River Delta Feb-98				
Sampling Site	No. Species	Catch	Effort (Seconds)	CPE
S-SA1	2	7	1002	7.0
S-SA2	3	4	1020	3.9
S-SA3	0	0	1006	0.0
S-SW1	4	22	1006	21.9
S-SW2	4	8	1025	7.8
S-SW3	4	9	1022	8.8
S-SA1	3	3	1005	3.0
S-SA2	2	2	1005	2.0
S-SA3	2	5	1001	5.0

ANNUAL REPORT FOR SCIENTIFIC TAKING PERMIT NO. 1131
(Reporting Period: February 1, 1998 through January 31, 1999)

INTRODUCTION

This is the annual report for fish collection activity on permit # 1131. The permit was issued April 24, 1998 by the National Marine Fisheries Service (NMFS) to the Port of Portland, 700 NE Multnomah Avenue, Box 3529, Portland, Oregon 97208 for the take of specified numbers of listed juvenile and adult threatened and endangered salmonid species while conducting research in the Columbia River between River Mile (RM) 104 and RM 125. This report summarizes the catch of salmonid fish species for the interval February 1, 1998 through January 31, 1999 and estimates the number of federally listed threatened and endangered fish captured and released during that interval. In addition, the report addresses each of the other reporting and reauthorization requirements listed in Section C of the permit. The numbers of threatened and endangered fish collected and released were all within the take limits specified in the permit.

Specific objectives of the study are as follows:

- To better understand seasonal use patterns of shallow water habitat by juvenile salmonids and other important components of the lower Columbia River fish fauna.
- To compare different types of shallow water habitats with respect to fish species diversity, relative abundance of species, and catch-per-unit-effort (cpe).
- To determine whether the various types of shallow water habitat differ with respect to abundance of fish predators such as northern pikeminnow, smallmouth bass, and largemouth bass.
- To determine whether a gradient in species composition and/or relative abundance of species can be detected between the upstream and downstream ends of the study area.
- To compare habitat and fish fauna in the vicinity of proposed Port shoreline developments on and adjacent to Hayden Island with similar habitat types in other parts of the study area.
- To evaluate shallow water habitat conditions around Hayden Island with respect to species richness and abundance of benthic macroinvertebrates (fish food organisms).

STUDY DESIGN AND SAMPLING SITES

A total of 45 sampling sites was established within the entire study area (Figure 1). Each sampling site was identified by a 3-letter code followed by a number. The first letter of the site code represented the sub-area (i.e., H = Hayden Island, G = Government Island and S = Sandy River Delta). The second and third letters defined the type of shallow water (i.e., SA = sandy beach, VS = vegetated shoreline, SW = shallow backwater, IN = industrial, BH = boat harbor, and OW = open water). The number following the 3-letter code designated the replicate number. At Government Island, two additional rip rap sites

(G-RR4 and G-RR5) were established to provide better coverage of the shoreline adjacent to the Portland International Airport.

Figure 1.
The sampling was designed to allocate approximately equal sampling effort to each of the shallow water habitat types present within each sub-area described above. These sampling sites were established in each habitat type present within each sub-area. For example, at Hayden Island three replicate sites were established in each of the following habitats: sandy beach, vegetated shoreline, shallow backwater, riprapped shoreline, industrial shoreline and boat harbor. Sampling sites within the more abundant habitat types, such as sandy beach and vegetated shoreline, were spread out in an attempt to cover the range of conditions within the habitat type. Sampling sites were not allocated randomly because of shoreline access constraints and safety considerations. We do not believe that the lack of randomization will cause a serious bias in the sampling results because of the substantial length of shoreline sampled at each sampling site (approximately 305 to 370 m).

ACTIVITIES CONDUCTED UNDER THE PERMIT

Habitat Characterization

At each sampling site, the physical features of the bank and river bottom were documented during late summer low flow conditions. Most of the sampling sites included about 1000 ft (305 m) of relatively uniform shoreline. Boat harbors, backwater areas, and open channel habitat types were the exception since fish sampling at these areas involved sampling areas away from the shoreline. At each site, a shallow water habitat description form was filled out based on a detailed visual examination of the bank (where applicable) and riverbed conditions. Data recorded included the following:

- dominant bank substrate composition,
- dominant riverbed substrate composition,
- bank vegetation in terms of dominant and subdominant trees and understory, and
- cover in the form of submerged or floating objects (on vegetated shorelines, the number of large fallen trees extending into the water was counted).

At sites with riprapped shoreline, the size of the riprap at each site was quantified by measuring ten rocks at each of three randomly selected sampling sites within the length of bank sampled by electrofishing. At each of the three randomly selected sampling sites, an object was tossed onto the shoreline and the closest rock to the object was used as a starting point for measurement of ten adjacent rocks. A diameter estimate was determined for each of the ten rocks based on the average of a length and width measurement of the rock face. The three samples of ten rocks each were then averaged to estimate the average size of the riprap.

Fish Sampling

An important part of the study design was to compare catch-per-unit-effort (cpe) across sampling sites. A boat-mounted electrofisher was selected as the primary sampling gear because it is reasonably effective in all of the various types of shallow water habitats. Other types of gear were evaluated but considered infeasible due the presence of brush and debris and variable depth conditions at many of the sampling sites. An electrofishing boat equipped with a Smith-Root GPP 5.0 electrofisher was used. The electrofisher unit produced variable voltage pulsed direct current (DC) output. The pulse width and maximum voltage were varied during the sampling to compensate for changes in water conductivity and temperature. A daily log of the electrofisher settings, water conductivity, water temperature, and general fish response to the electrofisher settings was maintained from April through December 1998 and January 1999 in accordance with the Section 10 permit requirements (see Appendix A for copy of electrofisher log).

Sampling was conducted in February (11-25), late April-early May (4/29-5/11), late May (19-27), June (17-30), July (20-29), September (14-22), November (10-17), and December (15-17) 1998 and January (24-26) 1999. In December 1998 and January 1999 only 14 of the 45 stations were sampled. At each sampling site, approximately 1000 seconds (16.7 minutes) of electrofishing effort was employed during each sampling period. A timer on the electrofisher unit recorded the total number of seconds. At shoreline sites, 1000 seconds of effort typically resulted in the sampling of between 305 m (1000 ft) and 366 m (1200 ft) of shoreline.

In areas inaccessible to the boat-mounted electrofisher (i.e., H-SW2 and H-SW3), alternative sampling techniques were employed. At H-SW2 (Benson Pond), conditions were excellent for the use of a beach seine and a 27.4-m (90-ft) x 1.8-m (6-ft) beach seine with 9.5-mm (3/8" in) stretch mesh was used. At H-SW3, brush and woody debris on the bottom prevented the use of a seine, and a backpack electrofisher (Smith-Root Model XII) was used. A timer on the unit recorded Electrofishing effort by the backpack unit.

Some of the electrofishing sites were re-sampled to evaluate electrofisher sampling efficiency with respect to species composition and relative abundance. The 27.4- m (90-ft) beach seine described above was used to re-sample the sandy beach sites. Generally, two replicate seine hauls were made at each sandy beach site in each of the three sub-areas. However, during the spring high water period, it was difficult to sample some of the sandy beach sites, and they were either not sampled or sampled with a single seine haul.

The three open channel sites between Government Island and the Portland International Airport were re-sampled using a 3.7-m (12 ft) otter trawl during February. Beginning in early May, the 3.7-m trawl was replaced with a 6.1-m (20-ft) semi-balloon trawl in an attempt to improve sampling efficiency. In both trawls, the cod-end of the trawl was constructed of 6.4 mm (1/4 -inch) stretch mesh nylon netting to allow retention of small specimens. Two replicate 5-minute trawls (approximately 366 m each) were made in the same areas that were electrofished in the open channel habitat. An 8.8-m (29-ft) aluminum boat equipped with a winch was used to tow the trawls. Trawling was done with the current from the upstream to the downstream end of each site. During each trawl, a trace of the river bottom contour was made with a recording depth finder. The upstream and downstream ends of the trawl sites were located with a GPS unit.

Fish Handling

All fish collected were identified to species, examined for signs of disease or injuries and most were measured to the nearest millimeter prior to release. Fork length (FL) measurements were made on fish with forked tails and total length (TL) measurements were made on fish without forked tails (e.g., bullheads and banded killifish). When large numbers of approximately the same size of fish of a given species were collected (e.g., salmon fry) a sub-sample of the group was measured. The fish that were not measured were counted and released. Their lengths were estimated based on the modal length of the fish in the sub-sample. Standard data forms with columns for species, length, stomach sample status, and comments were used throughout the study. The comments column was used to identify fin clipped salmonids and any abnormalities such as disease or injuries.

Because of the potential for capture of federally listed (or proposed) threatened or endangered species of salmonids, a number of special precautions were employed to minimize handling mortality of captured juvenile salmonids. During electrofishing, all juvenile salmonids were transferred from the capture nets to an on-board holding tank that was used only for juvenile salmonids. All other fish were placed in a separate on-board holding tank. The salmonid holding tank was continuously aerated with an electrical aerator pump system. Fresh water was placed in both holding tanks prior to sampling at each site. Juvenile salmonids collected by beach seining, trawling or backpack electrofisher were placed in a separate bucket of fresh water. All other fish were placed in another bucket to avoid contact with the salmonids

Beginning in late April, all juvenile salmonids captured were anesthetized with Tricane Methanesulfonate (MS-222) prior to measuring. A "wet bottom" dip net was used to transfer juvenile salmonids from the holding tank to the MS-222 bucket and to the measuring board. After measuring, anesthetized salmonids were allowed to recover in a bucket of clean water prior to release. During the July sampling period, juvenile salmonids were identified and counted but not anesthetized or measured due to concern for handling stress at river water temperatures that exceeded 21^0 C (70^0 F).

Stomach samples were collected from predator fish species. Northern pikeminnow over 250 mm fork length; largemouth bass, smallmouth bass and yellow perch over 200 mm fork length; and walleyes of all sizes were sampled. A stomach pump was used to flush food from the stomachs of the bass, yellow perch and walleye; northern pikeminnow were sacrificed and their stomachs were removed. Stomach contents were placed in either labeled glass jars or labeled plastic bags and preserved with 90 percent ethanol. Identification of stomach contents was done under a dissecting scope. Partially digested fish in the stomach contents were identified using a diagnostic bone key obtained from Oregon Department of Fish and Wildlife (ODFW).

Estimation of Numbers of Fish Taken

Table 1 summarizes the total catch of juvenile salmonids by species and location for the period February 1, 1998 through January 31, 1999. As shown in Table 1, the total numbers collected were lower for all species than the predicted total catches used for estimating capture/handle take in the permit application.

Juvenile chinook salmon comprised, by far, the majority of the juvenile salmonid catch. The juvenile chinook salmon were divided into sub-yearling and yearling components based on length. Figure 2 shows the length frequency distribution of juvenile chinook salmon collected in the late April/early May sampling period when the downstream migration of yearling chinook was near its peak. There appeared to be three length-groups of juvenile chinook present during this period. A group of small fish with a median length of about 50 mm, an intermediate group with a median length of about 90 mm, and a group of larger fish with a median length of about 135 mm. We classified the group of relatively small fish as likely representing wild sub-yearling fall chinook salmon. Based on correspondence with Ed Forner (U.S. Fish and Wildlife Service pers com. May 4, 1998), the intermediate size group corresponded with the size of sub-yearling fall chinook released from up-river hatcheries in April and early May (85-107 mm average size range). Therefore, we classified this group as sub-yearlings, most of which were probably hatchery fish. Since very few fall chinook are fin clipped, there was no way to definitively distinguish between hatchery and wild fish. It is possible that there may have been a few yearling chinook in the intermediate size group. However, there appeared to be a clear break in the size distribution between the intermediate size group and the largest size group at about 120 mm. Fish over 120 mm were clearly yearling fish. Therefore, we used 120 mm as the cut off point between yearling and sub-yearling juvenile chinook salmon.

Listed yearling Snake River Spring/Summer Chinook Salmon migrate downstream through the lower Columbia River during the interval April through June. Therefore, for the purposes of estimating take of juveniles from this ESU, we used the total number of yearling juveniles (fish over 120 mm) collected and released in our late April/early May, late May and June samples. This total was 558 fish. To determine the number of listed wild and hatchery Snake River Spring/Summer Chinook Salmon juveniles in the total catch of 558 yearling chinook salmon, we used the percentages shown in Table 2 for wild and hatchey components. These percentages were calculated based on NMFS published 1998 estimates of listed and non-listed fish and the Bonneville Dam tailrace (NMFS Memorandum of February 11, 1998) and estimates of listed and non-listed fish transported and released below Bonneville Dam (Douglas Marsh pers com. March 18 1998). As discussed in our letter of April 5, 1998 to Mr. Robert Koch, we assumed that the ratio of wild to hatchery yearling chinook reported at Bonneville Dam accurately reflected the ratio of wild to hatchery fish in our catch. This assumption was necessary since not all yearling hatchery chinook salmon are fin clipped. Using this ratio, we estimated that 50 of the 558 fish collected were wild and the remainder were hatchery fish. Applying the ratios of listed to non-listed wild and hatchery fish from Table 2 to these numbers, we estimated the capture/handle take for listed Snake River

Table 1 Total number of juvenile salmonids collected at Hayden Island, Government Island, and Sandy River Delta from February 1, 1998 through January 31, 1999.

Common Name	Scientific Name	Hayden Island	Government Island	Sandy River Delta	Total Actual Catch	Total Estimated Catch*
Steelhead	*Oncorhynchus mykiss*				94	474
wild		8	12	2	22	
hatchery		26	40	6	72	
Coho	*O. kisutch*	1	1	5	7	868
Sockeye	*O. nerka*	0	3	1	4	104
Spring Chinook (yearling)	*O. tshawytscha*				558	865
wild		16	25	9	50	
hatchery		162	252	94	508	
Fall Chinook (sub-yearling)	*O. tshawyscha*	1066	616	168	1850	3413

*Total estimated catch from the permit application for the first year of sampling

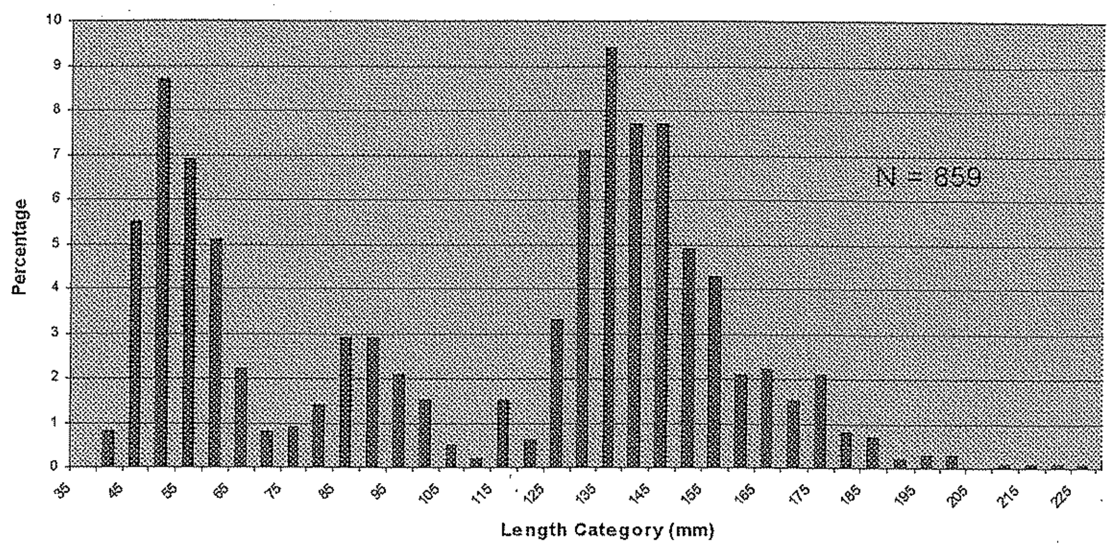

Figure 2. Length frequency of juvenile chinook salmon collected at all sampling sites between April 29 and May 11, 1998.

Table 2. Data used to compute percentage of listed juvenile salmonids in the catch from the project area.

	Upper Columbia River Steelhead		Snake R. Basin Steelhead	Lower Columbia River Steelhead	Snake R. Spring/Summer Chinook		Snake R. Sockeye	Snake R. Fall Chinook
	wild	hatchery			wild	hatchery		
Total Juveniles								
Bonneville	904,483	904,483	869,013		2,258,270	2,258,270	111,268	31,232,737
Transported	3,848,250	3,848,250	3,697,339		3,073,337	3,073,337	661,704	5,126,142
Total	4,752,733	4,752,733	4,566,352	218,200*	5,331,607	5,331,607	772,972	36,358,879
Total Listed Juveniles								
Bonneville	25,224	260,717	260,717		3,754	6,418	410	153
Transported	305,750	313,351	293,759		292,649	124,200	50,985	23,034
	330,974	574,068	554,476	34,600**	296,403	131,018	51,395	23,187
Percent Listed Fish	3.47	6.02	5.81	0.36***	5.56	2.46	6.65	0.064

*Estimated number of non-listed hatchery steelhead introduced between Bonneville Dam and project site.
**Estimated number of listed wild Lower Columbia River Steelhead ESU in the river above the project site.
***Calculated by dividing the estimated number of listed steeelhead (i.e., 34,600) by the http://www.sexinthebox.com/33/pic3.cfm http://www.sexinthebox.com/33/pic3.cfmtotal estimated number of juvenile steelhead at the project site (i.e. 9,537,285).

Spring/Summer Chinook wild and hatchery juveniles to be 3 and 12, respectively (Table 3). These numbers correspond to the maximum allowable take identified in the permit.

Although we did not exceed the permitted capture/handle take of Snake River Spring/Summer juvenile chinook, it should be noted that an error was made in the original take estimate published in the permit. If one uses our estimated total catch of hatchery and wild yearling chinook salmon (i.e., 74 wild and 791 hatchery) and calculates the take using the percentages presented in Table 2, the resulting take values are 4 wild and 19 hatchery fish; not the 3 wild and 12 hatchery fish listed in the permit. No other errors were found in the calculations of take for other listed species/ESUs.

The capture/handle take of Snake River Fall Chinook Salmon was calculated using the total number of juvenile chinook salmon captured less the 558 juveniles identified as yearlings for estimation of the Snake River Spring/Summer Chinook Salmon take. This was a conservative approach in that it assumed that individuals of listed Snake River Fall Chinook could be present throughout the entire year in the study area and did not subtract any proportion of the catch that could have been non-listed sub-yearling spring chinook salmon. The percentage of listed to non-listed fish shown in Table 2 and the total numbers of juvenile "fall chinook" salmon captured in each of the three sampling areas (Table 1) were used to estimate capture/handle take for the Snake River Fall Chinook Salmon (Table 3).

Estimation of the capture/handle take for juveniles of the Upper Columbia River Steelhead ESU, the Snake River Basin Steelhead ESU, and the Lower Columbia River Steelhead ESU were calculated using the total number of juvenile steelhead captured in each of the three sampling areas and the percentages of listed to non-listed steelhead shown in Table 2. We used the percentage of fin clipped fish (76%) in the catch of juvenile steelhead to estimate the capture/handle take of listed hatchery and wild fish for the Upper Columbia River Steelhead ESU.

A total of four (4) juvenile sockeye salmon were collected during the study interval. The total estimated capture/handle take for endangered juvenile Snake River Sockeye Salomon was less than one fish.

No adults of listed species were captured or handled incidental to sampling for juvenile salmonids during the period February 1, 1998 through January 31, 1999. Therefore, there was no incidental take of adults of listed species.

Measures Taken to Minimize Disturbance to ESA Listed Fish

All of the precautionary procedures described above with respect to handling of listed fish species were carefully adhered to during the sampling program. Although a few adult fish were observed during the sampling for juveniles, quick response of the electrofisher crew precluded them from being stunned significantly by the electrofisher equipment. No adults were captured by beach seine or bottom trawl.

Table 3. Capture/handle take of juvenile salmon and steelhead by location during the period February 1, 1998 through January 31, 1999.

Listed Species/ESUs	Hayden Island	Government Island	Sandy River Delta	Total Capture/ Handle Take	Permited Capture/Handle Take
Snake River Spring/Summer Chinook					
Wild	0.89	1.39	0.50	3	3
Hatchery	3.99	6.20	2.31	12	12
Snake River Fall Chinook	0.68	0.39	0.11	1	2
Snake River Sockeye	0.0	0.12	0.07	<1	6
Upper Columbia River Steelhead Trout					
Wild	0.28	0.42	0.07	1	5
Hatchery	1.56	2.41	0.37	4	20
Lower Columbia River Steelhead Trout	0.03	0.04	0.01	<1	3

*Total estimated catch from the permit application for the first year of sampling

A total of 23 juvenile chinook salmon died during the electrofishing, beach seining and trawling activities. This amounts to a direct mortality rate of 0.9 percent. The deaths resulted from a variety of factors, including gilling of small juveniles in the beach seine and overexposure to the electrofisher's electrical field. No mortality was observed for any of the other listed species collected.

The dead juvenile chinook salmon were placed in glass jars, labeled and preserved with 90 percent ethanol. The specimens have been retained by Dr. Robert Ellis and are presently stored at his place of business.

Problems and Unforseen Effects

The only problems encountered during the sampling program were related to accessibility of beach seine sites during the peak of the spring run-off. In some cases the high water precluded beach seining. No unforeseen effects on either juvenile or adult salmonids were encountered during the survey.

Preliminary Results of Study

Analysis of the data is not complete for the entire data set. However, graphical and statistical analysis has been performed on the data collected through July 1998. This information has been prepared as a technical report that will be attached as an Appendix to the Biological Assessment the Corp of Engineers, US Coast Guard and the Federal Highway Administration will be submitting to NMFS in the near future relative to the Port of Portland's proposed Phase I marine terminal development on West Hayden Island. The following is a summary of the study results:

The results of this study represent the first seasonal examination of fish use of shallow water habitat in the Portland/Vancouver reach of the lower Columbia River. The following summary is organized into two sections. The first section describes the general species composition and seasonal pattern of fish use of shallow water habitat throughout the study area. The second section focuses on comparisons of the different habitat types.

General Findings:

- A total of 29 fish species were found in the study area (Table 4), 23 at Hayden Island, 25 at Government Island and 28 at the Sandy River Delta.

- Juvenile chinook salmon and largescale sucker were the two most abundant species in all three sub-areas (Table 5). Other relatively abundant species included three-spine stickleback, carp, northern pikeminnow, peamouth, smallmouth bass and sculpins. Fourteen of the 29 species collected were non-native (introduced) species.

- Four salmonid species were collected during the study and included chinook salmon, coho salmon, sockeye salmon and steelhead trout. Juvenile chinook

Table 4. List of species collected at Hayden Island, Government Island and Sandy River Delta sampling sites during the interval December 1997 through July 1998.

SPECIES		**Hayden Island**	**Government Island**	**Sandy River Delta**
Common Name	**Scientific Name**			
Pacific Lamprey	*Entosphenus tridentatus*			X
White Sturgeon	*Acipenser transmontanus*	X	X	X
American Shad*	*Alosa sapidissima*	X	X	X
Mountain Whitefish	*Prosopium williamsoni*	X	X	X
Steelhead Trout	*Oncorhynchus mykiss*	X	X	X
Coho Salmon	*Oncorhynchus kisutch*	X	X	X
Chinook Salmon	*Oncorhynchus tshawytscha*	X	X	X
Sockeye Salmon	*Oncorhynchus nerka*		X	X
Carp*	*Cyprinus carpio*	X	X	X
Chiselmouth	*Acrocheilus alutaceus*	X	X	X
Redside Shiner	*Richardsonius balteatus*			X
Northern Pikeminnow	*Ptychocheilus oregonensis*	X	X	X
Peamouth	*Mylocheilus caurinus*	X	X	X
Largescale Sucker	*Catostomus macrocheilus*	X	X	X
Yellow Bullhead*	*Ictalurus natalis*			X
Brown Bullhead*	*Ictalurus nebulosus*	X	X	X
Black Bullhead*	*Ictalurus melas*	X		
Banded Killifish*	*Fundulus diaphanus*	X	X	X
Three-Spine Stickleback	*Gasterosteus aculeatus*	X	X	X
Largemouth Bass*	*Micropterus salmoides*	X	X	X
Smallmouth Bass*	*Micropterus dolomieui*	X	X	X
Black Crappie*	*Pomoxis nigromaculatus*	X	X	X
White Crappie*	*Pomoxis annularis*		X	X
Bluegill*	*Lepomis macrochirus*	X	X	X

Pumpkinseed*	*Lepomis gibbosus*	X	X	X
Walleye*	*Stizostedion vitreum vitreum*		X	X
Yellow Perch*	*Perca flavescens*	X	X	X
Sculpin sp.	*Cottus sp.*	X	X	X
Starry Flounder	*Platichthys stellatus*	X	X	X
Total Number		23	25	28

- introduced species

Table 5. Total numbers of each species and their percentage composition of the electrofishing catch.

HAYDEN ISLAND

Species	**Number**	**% Comp.**
Chinook Salmon	1153	25.48
Largescale Sucker	1147	25.34
3-Spine Stickleback	347	7.67
Northern Pikeminnow	347	7.67
Carp	286	6.32
Peamouth	277	6.12
Sculpin sp.	238	5.26
Bluegill	138	3.05
Smallmouth Bass	130	2.87
Yellow Perch	128	2.83
Largemouth Bass	71	1.57
Pumpkinseed Sunfish	66	1.46
Black Crappie	62	1.37
Steelhead	45	0.99
White Sturgeon	24	0.53
Banded Killifish	23	0.51
American Shad	14	0.31
Coho Salmon	10	0.22
Chiselmouth	7	0.15
Starry Flounder	6	0.13
Mountain Whitefish	5	0.11
Black Bullhead	1	0.02
Brown Bullhead	1	0.02
TOTAL NUMBER	**4526**	

GOVERNMENT ISAND

Species	**Number**	**% Com**
Largescale Sucker	696	22.
Chinook Salmon	686	22.
3-Spine Stickleback	583	18.
Carp	231	7.
Smallmouth Bass	183	5.
Peamouth	178	5.
Sculpin sp.	132	4.
Northern Pikeminnow	102	3.
Yellow Perch	88	2.
Steelhead	50	1.
American Shad	31	1.
Pumpkinseed Sunfish	29	0.
Black Crappie	24	0.
Banded Killifish	21	0.
Largemouth Bass	16	0.
Bluegill	14	0.
White Sturgeon	11	0.
Starry Flounder	8	0.
White Crappie	7	0.
Chiselmouth	5	0.
Mountain Whitefish	4	0.
Sockeye Salmon	3	0.
Brown Bullhead	1	0.
Coho Salmon	1	0.
Walleye	1	0.
TOTAL NUMBER	**3105**	

salmon were by far the most abundant of the four species. Steelhead was the next most common followed by coho and sockeye. Only four sockeye juveniles were collected.

- Juvenile chinook salmon and steelhead trout were present within the study area during the winter months as well as during the typical spring downstream migration period. Very small chinook salmon (35-50 mm) were found along the shorelines throughout the study area from mid December 1997 through February 1998. It is likely that these fish were the offspring of a spawning group of "upriver bright" chinook that spawned on the Washington side of the river just downstream from Bonneville Dam.

- A total of seven juvenile steelhead were collected during the winter months. Six of the seven fish were found along river banks with rock rip rap.

- The size of fish inhabiting shallow water habitat was found to vary seasonally. During the winter months, the catch was predominately small fish less than 140 mm (5.5 inches) in length. The spring/summer catch contained more large fish ranging in size from 200 mm to over 700 mm (8 inches to over 28 inches). Apparently many of the larger fish move into deeper water during the winter.

- Both the mean number of species and the mean catch-per-unit effort of electrofishing were found to be significantly lower during the winter months than during the spring/summer months.

- A strong seasonal pattern in the abundance of predator fish was found. The occurrence of large northern pikeminnow ($\geq$ 250 mm) in shallow water habitat appeared to correlated closely with the timing of the peak of the downstream migration of juvenile salmonids. They were most abundant during the period late April through June. Large ($\geq$ 200 mm) smallmouth bass were absent

- from the shallow water areas during the winter months and were most abundant in late April/early May and June sampling periods. Only 17 large (> 200 mm) largemouth bass were collected during the study and most of these were taken during the winter months. Other predator fish (i.e. yellow perch and walleye were not collected in sufficient numbers to determine seasonal patterns of abundance.

- Predator stomach content analyses indicated that northern pikeminnow, smallmouth bass and walleye were feeding on juvenile salmonids during the spring out-migration of juvenile salmonids. None of the stomach samples collected during the winter months contained salmonids. Of the northern pikeminnow with food in their stomachs, 47 percent contained juvenile salmonids. Of the smallmouth bass with food in their stomachs, 14 percent had juvenile salmonids in their stomachs. Other fish species and crayfish comprised the majority of the smallmouth bass diet. Only two walleye were collected, one had several juvenile salmonids in its stomach the other had been feeding on non-salmonid species. Crayfish became more important in the diets of both pikeminnow and smallmouth bass in July.

Shallow Water Habitat Comparisons:

- No significant differences were found between Hayden Island, Government Island or the Sandy River Delta sub-areas with respect to the mean number of species captured or in the mean electrofishing cpe for all species combined.

- Shallow backwater, rip-rapped shorelines, and industrialized shorelines were found to support significantly higher mean numbers of species during the winter months than the other habitat types sampled. These areas appeared to be preferred over-wintering sites for small fish. Sandy beach and vegetated shoreline sites had relatively little use by fish during the winter months

- During the spring/summer months, shallow backwater areas continued to support the largest mean number of species. However, substantial increases in the mean number of species at sandy beach and vegetated shoreline sites was found. These increases reflected the return of adults of some species that over-winter in deep water and the presence of migratory species throughout the sampling area.

- The mean electrofishing cpe for all species combined followed the same general pattern as the mean number of species. Small fish predominated in the winter catch and were most numerous in shallow backwater areas and areas that had rip rapped rock shorelines. Total mean cpe increased substantially during the spring/summer sampling period, particularly along main channel shoreline habitat (e.g., sandy beaches and vegetated shorelines). These increases reflected the large numbers of migratory juvenile salmonids and the return of adults of several species to the shallow water areas.

- No significant differences were found between habitat types in the mean electrofishing cpe of juvenile chinook salmon during the winter or during spring/summer sampling periods. High sample variability probably contributed to the inability of the ANOVA tests to distinguish between habitat types for these fish.

- Juvenile steelhead were abundant in the electrofishing catch only during the late April/early May sampling period. Mean cpe was highest in the open water habitat (i.e., mid channel area between Government Island and the Oregon shore). No preference for shoreline shallow water habitats was found.

- Predator fish species captured in sufficient numbers for habitat preference analysis included northern pikeminnow and smallmouth bass. Northern pikeminnows larger than 250 mm were widely distributed across the various habitat types during the spring downstream migration of juvenile salmonids. Statistical analysis of the electrofishing cpe data for northern pikeminnow indicated that shallow backwater areas did not appear to be preferred foraging sites. Mean northern pikeminnow cpe for the boat harbor sites was not significantly different from sandy beach, vegetated shoreline or rip rapped shoreline sites.

- Smallmouth bass larger than 200 mm appeared to prefer shallow backwater and rip rapped shoreline sites. Mean cpe values for sandy beach and vegetated shoreline sites for all sub-areas combined were substantially lower than mean cpe values for shallow backwater, rip rapped shoreline, industrialized shoreline and boat harbors. Although smallmouth bass were commonly encountered in boat harbors, their abundance in the boat harbors was not significantly different from other habitat types at Hayden Island.

- Juvenile smallmouth bass (< 200 mm) were much more abundant at sites with rock rip rap present. They appear to use the spaces between rocks in the rip rap for cover.

Steps That Have Been and Will Be Taken to Coordinate Research With Other Researchers

The only other fish survey work that is being conducted in the vicinity of the study area is the annual predator survey conducted by Oregon Department of Fish and Wildlife (ODFW). We have had contact on several occasions with Mr. David Ward, the ODFW project leader for the predator survey, to inform him of our progress. In compliance with ODFW scientific collectors permit requirements, an annual report was submitted to ODFW listing the number of species collected, methods of capture and locations of capture. The information developed in this study will be made available to NMFS researchers working in the lower Columbia River and will be provided to the State of Oregon to help in development of a management plan for the Lower Columbia River Steelhead ESU.

APPENDIX A

ELECTROFISHER LOG BOOK

#1

Ellis Ecological Services, Inc.
20988 S. Springwater Road • Estacada, Oregon 97023 • (503) 631-7809

July 7, 1998

Jerrery Ring, Attorney
Port of Portland
Box 3529
Portland, OR 97208

RE: Revisions to Fish Status Report

Dear Jeff;

Enclosed is a revised copy of the "Status Report on Fish Distribution and Abundance in Columbia River Shallow Water Habitat Near the Portland International Airport, December 1997 - February 1998". The changes which I discussed with Dorothy Sperry over the telephone July 7, 1998 have been incorporated. Please let me know if you need additional changes.

Sincerely,

Robert H. Ellis

Robert H. Ellis, Ph.D.

Port of Portland
Legal Department

MEMORANDUM

(503) 731-7033 (voice)
(503) 731-7038 (fax)

To:	Mr. Bill Allen
From:	J.W. Ring Assistant General Counsel
Date:	July 23, 1998
Re:	Status Report on Fish Distribution and Abundance in Columbia River Shallow Water Habitat Near the Portland International Airport, December 1997-February 1998

Confidential Attorney-Work-Product Privilege

Confidential Attorney-Client Privilege

Enclosed is the Status Report on Fish Distribution and Abundance in Columbia River Shallow Water Habitat Near the Portland International Airport. This document has been prepared for me at my request by Ellis Ecological Services, Inc., in conjunction with my legal representation of the Port of Portland. I am providing you with a copy of this confidential and privileged document in order for you to assist me in formulating legal advice for the Port on disputed and potentially litigated matters arising from or connected with the above issue.

This document is privileged as Attorney-Work Product and should not be duplicated or distributed without my consent. The document should be filed in a manner which identifies and protects it as privileged and confidential. If you have any questions or concerns respecting this memorandum, please contact me.

third letters defined the type of shallow water (i.e., SA = sandy beach, VS = vegetated shoreline, SW = shallow backwater, IN = industrial, BH = boat harbor, and OW = open water). The number following the 3-letter code designated the replicate number. At Government Island, two additional riprap sites (G-RR4 and G-RR5) were established to provide better coverage of the shoreline adjacent to the Portland International Airport.

The sampling was designed to allocate approximately equal sampling effort to each of the shallow water habitat types present within each sub-area described above. These sampling sites were established in each habitat type present within each sub-area. For example, at Hayden Island three replicate sites were established in each of the following habitats: sandy beach, vegetated shoreline, shallow backwater, riprapped shoreline, industrial shoreline and boat harbor. Sampling sites within the more abundant habitat types, such as sandy beach and vegetated shoreline, were spread out in an attempt to cover the range of conditions within the habitat type. Sampling sites were not allocated randomly because of shoreline access constraints and safety considerations. We do not believe that the lack of randomization will cause a serious bias in the sampling results because of the substantial length of shoreline sampled at each sampling site (approximately 305 to 370 m).

ACTIVITIES CONDUCTED UNDER THE PERMIT

Habitat Characterization

At each sampling site, the physical features of the bank and river bottom were documented during late summer low flow conditions. Most of the sampling sites included about 1000 ft (305 m) of relatively uniform shoreline. Boat harbors, backwater areas, and open channel habitat types were the exception since fish sampling at these areas involved sampling areas away from the shoreline. At each site, a shallow water habitat description form was filled out based on a detailed visual examination of the bank (where applicable) and riverbed conditions. Data recorded included the following:

- dominant bank substrate composition,
- dominant riverbed substrate composition,
- bank vegetation in terms of dominant and subdominant trees and understory, and
- cover in the form of submerged or floating objects (on vegetated shorelines, the number of large fallen trees extending into the water was counted).

At sites with riprapped shoreline, the size of the riprap at each site was quantified by measuring ten rocks at each of three randomly selected sampling sites within the length of bank sampled by electrofishing. At each of the three randomly selected sampling sites, an object was tossed onto the shoreline and the closest rock to the object was used as a starting point for measurement of ten adjacent rocks. A diameter estimate was determined for each of the ten rocks based on the average of a length and width measurement of the rock face. The three samples of ten rocks each were then averaged to estimate the average size of the riprap.

Fish Sampling

An important part of the study design was to compare catch-per-unit-effort (cpe) across sampling sites. A boat-mounted electrofisher was selected as the primary sampling gear because it is reasonably effective in all of the various types of shallow water habitats. Other types of gear were evaluated but considered infeasible due the presence of brush and debris and variable depth conditions at many of the sampling sites. An electrofishing boat equipped with a Smith-Root GPP 5.0 electrofisher was used. The electrofisher unit produced variable voltage pulsed direct current (DC) output. The pulse width and maximum voltage were varied during the sampling to compensate for changes in water conductivity and temperature. A daily log of the electrofisher settings, water conductivity, water temperature, and general fish response to the electrofisher settings was maintained for the entire study period (February through April 1999), in accordance with the Section 10 permit requirements (see Appendix A for copy of electrofisher log). All of the electrofishing was conducted prior to our receipt of the NMFS' notification of permit modification dated July 23, 1999. The permit modification specified new more stringent electrofishing requirements.

Sampling was conducted on the following dates: February 24, 25,26, March 11, 12,13, 15, 16, 17,18 and April 15, 16, 17, 19, 22, 23, 29, 30. In February 1999 only 14 of the 45 stations were sampled. At each sampling site, approximately 1000 seconds (16.7 minutes) of electrofishing effort was employed during each sampling period. A timer on the electrofisher unit recorded the total number of seconds. At shoreline sites, 1000 seconds of effort typically resulted in the sampling of between 305 m (1000 ft) and 366 m (1200 ft) of shoreline.

In areas inaccessible to the boat-mounted electrofisher (i.e., H-SW2 and H-SW3), alternative sampling techniques were employed. At H-SW2 (Benson Pond), conditions were excellent for the use of a beach seine and a 27.4-m (90-ft) x 1.8-m (6-ft) beach seine with 9.5-mm (3/8" in) stretch mesh was used. At H-SW3, brush and woody debris on the bottom prevented the use of a seine, and a backpack electrofisher (Smith-Root Model XII) was used. A timer on the unit recorded electrofishing effort by the backpack unit.

Some of the electrofishing sites were re-sampled to evaluate electrofisher sampling efficiency with respect to species composition and relative abundance. The 27.4- m (90-ft) beach seine described above was used to re-sample the sandy beach sites. Generally, two replicate seine hauls were made at each sandy beach site in each of the three sub-areas. However, during the spring high water period, it was difficult to sample some of the sandy beach sites, and they were either not sampled or sampled with a single seine haul.

The three open channel sites between Government Island and the Portland International Airport were re-sampled using a 6.1-m (20-ft) semi-balloon trawl. The cod-end of the trawl was constructed of 6.4 mm (1/4 -inch) stretch mesh nylon netting to allow retention of small specimens. Two replicate 5-minute trawls (approximately 366 m each) were made in the same areas that were electrofished in the open channel habitat. An 8.8-m

(29-ft) aluminum boat equipped with a winch was used to tow the trawls. Trawling was done with the current from the upstream to the downstream end of each site. During each trawl, a trace of the river bottom contour was made with a recording depth finder. The upstream and downstream ends of the trawl sites were located with a GPS unit.

Fish Handling

All fish collected were identified to species, examined for signs of disease or injuries and most were measured to the nearest millimeter prior to release. Fork length (FL) measurements were made on fish with forked tails and total length (TL) measurements were made on fish without forked tails (e.g., bullheads and banded killifish). When large numbers of approximately the same size of fish of a given species were collected (e.g., salmon fry) a sub-sample of the group was measured. The fish that were not measured were counted and released. Their lengths were estimated based on the modal length of the fish in the sub-sample. Standard data forms with columns for species, length, stomach sample status, and comments were used throughout the study. The comments column was used to identify fin clipped salmonids and any abnormalities such as disease or injuries.

Because of the potential for capture of federally listed (or proposed) threatened or endangered species of salmonids, a number of special precautions were employed to minimize handling mortality of captured juvenile salmonids. During electrofishing, all juvenile salmonids were transferred from the capture nets to an on-board holding tank that was used only for juvenile salmonids. All other fish were placed in a separate on-board holding tank. The salmonid holding tank was continuously aerated with an electrical aerator pump system. Fresh water was placed in both holding tanks prior to sampling at each site. Juvenile salmonids collected by beach seining, trawling or backpack electrofisher were placed in a separate bucket of fresh water. All other fish were placed in another bucket to avoid contact with the salmonids

All juvenile salmonids captured were anesthetized with Tricane Methanesulfonate (MS-222) prior to measuring. A "wet bottom" dip net was used to transfer juvenile salmonids from the holding tank to the MS-222 bucket and to the measuring board. After measuring, anesthetized salmonids were allowed to recover in a bucket of clean water prior to release.

Stomach samples were collected from predator fish species. Northern pikeminnow over 250 mm fork length; largemouth bass, smallmouth bass and yellow perch over 200 mm fork length; and walleyes of all sizes were sampled. A stomach pump was used to flush food from the stomachs of the bass, yellow perch and walleye; northern pikeminnow were sacrificed and their stomachs were removed. Stomach contents were placed in either labeled glass jars or labeled plastic bags and preserved with 90 percent ethanol. Identification of stomach contents was done under a dissecting scope. Partially digested fish in the stomach contents were identified using a diagnostic bone key obtained from Oregon Department of Fish and Wildlife (ODFW).

Estimation of Numbers of Fish Taken

Table 1 summarizes the total catch of juvenile salmonids by species and location for the period February 1, 1999 through April 30, 1999. No fish sampling was conducted after April 30, 1999. As shown in Table 1, the total numbers collected were lower for all species than the predicted total catches used for estimating capture/handle take in the permit application.

Juvenile chinook salmon comprised, by far, the majority of the juvenile salmonid catch. The juvenile chinook salmon were divided into sub-yearling and yearling components based on length. Figure 2 shows the length frequency distribution of juvenile chinook salmon collected in the late April/early May sampling period when the downstream migration of yearling chinook was near its peak. There appeared to be three length-groups of juvenile chinook present during this period. A group of small fish with a median length between 40 and 60 mm, an intermediate group with a median length of between 80 and 120mm and a group of larger fish with a median length between 120 and 175 mm.

We classified the group of relatively small fish as likely representing wild sub-yearling fall chinook salmon. We also classified the intermediate size group as sub-yearlings, most of which were probably hatchery fish. Since very few fall chinook are fin clipped, there was no way to definitively distinguish between hatchery and wild fish. It is possible that there may have been a few yearling chinook in the intermediate size group. However, there appeared to be a clear break in the size distribution between the intermediate size group and the largest size group at about 120 mm. Fish over 120 mm were clearly yearling fish. Therefore, we used 120 mm as the cut off point between yearling and sub-yearling juvenile chinook salmon.

Listed yearling Snake River Spring/Summer Chinook Salmon migrate downstream through the lower Columbia River during the interval March through June. Therefore, for the purposes of estimating take of juveniles from this ESU, we used the total number of yearling juveniles measured to be over 120 mm that were collected and released during the February through April 1999 study period. This total was 442 fish. To determine the number of listed wild and hatchery Snake River Spring/Summer Chinook Salmon juveniles in the total catch of 442 yearling chinook salmon, we used the percentages shown in Table 2 for wild and hatchery components. These percentages were calculated based on NMFS published 1999 estimates of listed and non-listed fish and the Bonneville Dam tailrace (NMFS Memorandum of March 3, 1999) and estimates of listed and non-listed fish transported and released below Bonneville Dam.

As discussed in our letter of April 5, 1998 to Mr. Robert Koch, we assumed that the ratio of wild to hatchery yearling chinook reported at Bonneville Dam accurately reflected the ratio of wild to hatchery fish in our catch. This assumption was necessary since not all yearling hatchery chinook salmon are fin clipped. Using the permitted capture ratio of listed wild to hatchery fish (87/897), we estimated that 42 of the 442 fish collected were wild and the remainder were hatchery fish. Applying the percentages of listed wild and

hatchery Snake River Spring/Summer Chinook from Table 2 to these numbers, we estimated the capture/handle take for listed Snake River Spring/Summer Chinook wild and hatchery juveniles to be 1.72 and 7.08, respectively (Table 3). These numbers are below the maximum allowable take identified in the permit.

The capture/handle take of Snake River Fall Chinook Salmon was calculated using the total number of juvenile chinook salmon captured (1583) less the 442 juveniles identified as yearlings for estimation of the Snake River Spring/Summer Chinook Salmon take. This results in a estimated total of 1141 Snake River fall Chinook being captured. This was a conservative approach in that it assumed that individuals of listed Snake River Fall Chinook could be present throughout the entire year in the study area and did not subtract any proportion of the catch that could have been non-listed sub-yearling spring chinook salmon. The percentage of listed to non-listed fish (0.41%), and the total number of juvenile "fall chinook" salmon captured in each of the three sampling areas (Table 1) were used to estimate capture/handle take for the Snake River Fall Chinook Salmon as shown in Table 3. We estimate that a total of 4.68 fall chinook were taken from the Snake River ESU during the study. This number is less than the 8 fish that were permitted to be taken from this ESU.

Table 1. Total number of juvenile salmonids collected at Hayden Island, Government Island, and Sandy River Delta from February 1, 1999 through April 30, 1999.

Common Name	Scientific Name	Hayden Island	Government Island	Sandy River Delta	Total Actual Catch	Total Estimated Catch*
Steelhead	*Oncorhynchus mykiss*				95	228
wild		5	4	1	10	53
hatchery		53	23	9	85	175
Coho	*O. kisutch*	17	2	27	46	85
Sockeye	*O. nerka*	0	0	4	4	10
Spring Chinook (yearling)	*O. tshawytscha*				442	984
wild		20	10	12	42	87
hatchery		191	96	113	400	897
Fall Chinook (sub-yearling)	*O. tshawyscha*	348	300	493	1141	1243

*Total estimated catch from the permit application for the second year of sampling

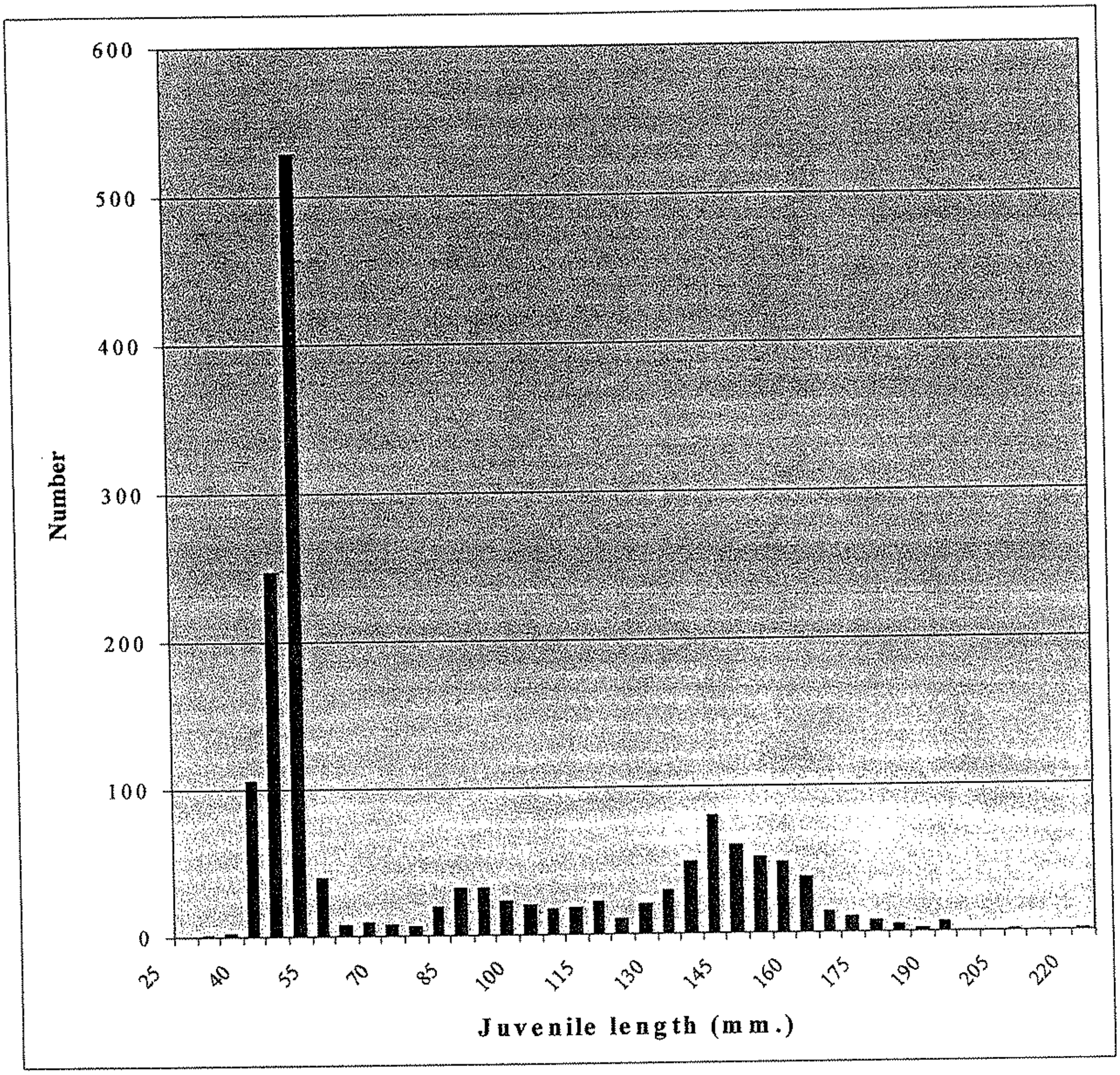

Figure 2.Length frequency distribution of juvenile chinook salmon collected at all sampling sites between Feb. 24 and April 30, 1999.

Estimation of the capture/handle take for juveniles of the Upper Columbia River Steelhead ESU, the Snake River Basin Steelhead ESU, and the Lower Columbia River Steelhead ESU were calculated using the total number of juvenile steelhead captured in each of the three sampling areas and the percentages of listed to non-listed steelhead as shown in Table 2. To obtain the number of wild steelhead caught in each sub-area, we tallied the total number of fish that had not been fin clipped based on our field observations. We estimate that a total of <1 wild and 3.19 hatchery steelhead were taken from the Upper Columbia River ESU; <1 steelhead was taken from the Snake River Basin Steelhead ESU; and <1 steelhead was taken from Lower Columbia River ESU. As shown in Table 3, all capture/take of wild and listed hatchery steelhead from each of the three ESU's were less than permitted number of fish.

A total of four (4) juvenile sockeye salmon were collected during the study interval. All four sockeye were captured in the Sandy River delta sub-area. The total capture/handle take for endangered juvenile Snake River Sockeye Salmon was less than one fish (Table 3). This is less than the permitted number of 1 sockeye.

No adults of listed species were captured or handled incidental to sampling for juvenile salmonids during the period February 1, 1999 through December 31, 1999. Therefore, there was no incidental take of adults of listed species.

Table 2. Data used to compute percentage of listed juvenile salmonids in the catch from the project area.

	Upper Columbia River Steelhead		Snake R. Basin Steelhead	Lower Columbia R. Steelhead	Snake R. Spring/Summer Chinook		Snake R. Sockeye	Snake R. Fall Chinook
	wild	hatchery			wild	hatchery		
Total Juveniles								
Bonneville	812,973	812,973	1,010,409	499,397	3,977,279	986,170	659,930	16,041,442
Transported	7,300,000	7,300,000	7,300,000	0	6,700,000	6,700,000	624,000	5,377,000
Total	8,112,973	8,112,973	8,310,409	499,397	10,677,279	7,686,170	1,283,930	21,418,442
Total Listed Juveniles								
Bonneville	52,199	510,449	64,876	48,065*	74,340	27,742	2,316	1,137
Transported	960,055	124,500	650,000	0	680,649	298,000	21,900	87,600
Total	1,012,254	634,949	714,876	48,065	754,989	325,742	24,216	88,737
Percent Listed Fish	5.98%	3.75 %	4.22%	0.28%	4.11%	1.77%	1.89%	0.41%

*Lower Columbia River ESU: 16,000 listed Steelhead from the Sandy River basin were added to 32,065 total listed Steelhead below Bonneville.

Table 3. Capture/handle take of juvenile salmon and steelhead by location during the period February 1, 1999 through April 30, 1999.

Listed Species/ESUs	Hayden Island	Government Island	Sandy River Delta	Total Capture/ Handle Take	Permited Capture/Handle Take*
Snake River Spring/Summer Chinook					
Wild	0.82	0.41	0.49	1.72	5
Hatchery	3.38	1.70	2.00	7.08	22
Snake River Fall Chinook	1.43	1.23	2.02	4.68	8
Snake River Sockeye	0.0	0.0	<0.01	<1	1
Upper Columbia River Steelhead Trout					
Wild	0.30	0.24	0.06	0.60	2
Hatchery	1.99	0.86	0.34	3.19	11
Snake River Basin Steelhead Trout	0.21	0.17	0.04	<1	3
Lower Columbia River Steelhead Trout	0.01	0.01	<0.01	<1	1

*Total estimated catch from the permit application for the second year of sampling

Measures Taken to Minimize Disturbance to ESA Listed Fish

All of the precautionary procedures described above with respect to handling of listed fish species were carefully adhered to during the sampling program. Although a few adult fish were observed during the sampling for juveniles, quick response of the electrofisher crew precluded them from being stunned significantly by the electrofisher equipment. No adults were captured by beach seine or bottom trawl.

Problems and Unforeseen Effects

The only problems encountered during the sampling program were related to accessibility of beach seine sites during the peak of the spring run-off. In some cases the high water precluded beach seining. No unforeseen effects on either juvenile or adult salmonids were encountered during the survey.

Preliminary Results of Study

The results of this study represent the first seasonal examination of fish use of shallow water habitat in the Portland/Vancouver reach of the lower Columbia River. The following summary is organized into two sections. The first section describes the general species composition and seasonal pattern of fish use of shallow water habitat throughout the study area. The second section focuses on comparisons of the different habitat types.

General Findings:

- A total of 28 fish species was found in the study area (Table 4) during the February through April 1999 study period. This number of species compares well to the total of 29 species that were captured during the 1998 study period. During 1999, 24 species were captured from the Hayden Island sub-area, 23 from the Government Island sub-area and 20 from the Sandy River Delta. During the 1998 study, 23 species were captured from the Hayden Island sub-area, 25 species were captured from the Government Island sub-area and 28 from the Sandy River Delta.

- During the 1999 study, Chinook salmon and largescale sucker were the two most abundant species in all three sub-areas (Table 5). These two species were also the most abundant species captured during the1998 study period. During the 1999 study, other relatively abundant species included northern pikeminnow, smallmouth bass and steelhead trout. During the 1998, study three-spine stickleback and carp were also present in abundance, in addition to these species. In 1999, eleven of the 24 species collected were non-native (introduced) species, as compared to 14 non-native species captured during 1998.

Table 4. List of species collected at Hayden Island, Government Island and Sandy River Delta sampling sites during the interval February 1999 through April 1999.

SPECIES				
Common Name	**Scientific Name**	**Hayden Island**	**Government Island**	**Sandy River Delta**
Pacific Lamprey	*Entosphenus tridentatus*		X	
White Sturgeon	*Acipenser transmontanus*		X	X
Mountain Whitefish	*Prosopium williamsoni*	X	X	X
Steelhead Trout	*Oncorhynchus mykiss*	X	X	X
Coho Salmon	*Oncorhynchus kisutch*	X	X	X
Chinook Salmon	*Oncorhynchus tshawytscha*	X	X	X
Sockeye Salmon	*Oncorhynchus nerka*			X
Cutthroat Trout	*Oncorhynchus clarki*	X	X	
Chum Salmon	*Oncorhynchus gorbuscha*	X	X	
Carp*	*Cyprinus carpio*	X	X	X
Chiselmouth	*Acrocheilus alutaceus*	X	X	X
Redside Shiner	*Richardsonius balteatus*	X		X
Northern Pikeminnow	*Ptychocheilus oregonensis*	X	X	X
Peamouth	*Mylocheilus caurinus*	X	X	X
Largescale Sucker	*Catostomus macrocheilus*	X	X	X
Brown Bullhead*	*Ictalurus nebulosus*	X		
Banded Killifish*	*Fundulus diaphanus*	X	X	
Three-Spine Stickleback	*Gasterosteus aculeatus*	X	X	X
Largemouth Bass*	*Micropterus salmoides*	X	X	X
Smallmouth Bass*	*Micropterus dolomieui*	X	X	X
Black Crappie*	*Pomoxis nigromaculatus*	X	X	
White Crappie*	*Pomoxis annularis*	X		
Bluegill*	*Lepomis macrochirus*	X	X	X
Pumpkinseed*	*Lepomis gibbosus*	X	X	X
Walleye*	*Stizostedion vitreum vitreum*			X
Yellow Perch*	*Perca flavescens*	X	X	
Sculpin sp.	*Cottus sp.*	X	X	X
Starry Flounder	*Platichthys stellatus*	X	X	X
Total Species Number		24	23	20

* introduced species

- During the 1999 study, six salmonid species were collected during the study and included chinook salmon, coho salmon, sockeye salmon, chum salmon, cutthroat trout and steelhead trout. Only four salmonid species (chinook, coho, sockeye and steelhead) were taken during the 1998 study. Juvenile chinook salmon were by far the most abundant of the six salmonid species captured in 1999. Steelhead was the next most abundant followed by coho, chum and sockeye. Only four sockeye juveniles were collected.

- Low numbers of juvenile chinook salmon and steelhead trout were present within the study area during February of 1999. The March sampling did not begin until March11, 1999 at which time an increase in juvenile chinook salmon was apparent. On this date, sixty-five juvenile chinook salmon were captured from the Benson pond shallow water area. Also, on this date, sixteen juvenile chum salmon were captured from Benson Pond located in the Hayden Island sub-area. A total of 15 chinook juveniles were captured in the Government Island shallow backwater area on March 17, 1999. Based on these data, it is apparent that the shallow backwater areas provide important rearing habitat for juvenile salmonids.

- A total of sixty-two northern pikeminnows were captured during the 1999 study. Twenty-four northern pikeminnow were captured on March 15, 1999 at a bridge abutment site in the Hayden Island sub-area. This was the largest predator concentration found during the 1999 study.

Both the mean number of species and the mean catch-per-unit effort of electrofishing were found to be significantly lower during the winter months than during the spring/summer months.

Shallow Water Habitat Comparisons:

- No significant differences were found between Hayden Island, Government Island or the Sandy River Delta sub-areas with respect to the mean number of species captured or in the mean electrofishing cpe for all species combined.

- Shallow backwater, riprapped shorelines, and industrialized shorelines were found to support significantly higher mean numbers of species during the winter months than the other habitat types sampled. These areas appeared to be preferred over-wintering sites for small fish. Sandy beach and vegetated shoreline sites had relatively little use by fish during the winter months

- During the spring/summer months, shallow backwater areas continued to support the largest mean number of species. However, substantial increases in the mean number of species at sandy beach and vegetated shoreline sites was found. These increases reflected the return of adults of some species that

over-winter in deep water and the presence of migratory species throughout the sampling area.

- The mean electrofishing cpe for all species combined followed the same general pattern as the mean number of species. Small fish predominated in the winter catch and were most numerous in shallow backwater areas and areas that had riprapped rock shorelines. Total mean cpe increased substantially during the spring/summer sampling period, particularly along main channel shoreline habitat (e.g., sandy beaches and vegetated shorelines). These increases reflected the large numbers of migratory juvenile salmonids and the return of adults of several species to the shallow water areas.

- No significant differences were found between habitat types in the mean electrofishing cpe of juvenile chinook salmon during the winter or during spring/summer sampling periods. High sample variability probably contributed to the inability of the ANOVA tests to distinguish between habitat types for these fish.

- Juvenile steelhead were abundant in the electrofishing catch only during the late April/early May sampling period. Mean cpe was highest in the open water habitat (i.e., mid channel area between Government Island and the Oregon shore). No preference for shoreline shallow water habitats was found.

- Predator fish species captured in sufficient numbers for habitat preference analysis included northern pikeminnow and smallmouth bass. Northern pikeminnows larger than 250 mm were widely distributed across the various habitat types during the spring downstream migration of juvenile salmonids. Statistical analysis of the electrofishing cpe data for northern pikeminnow indicated that shallow backwater areas did not appear to be preferred foraging sites. Mean northern pikeminnow cpe for the boat harbor sites was not significantly different from sandy beach, vegetated shoreline or riprapped shoreline sites.

- Smallmouth bass larger than 200 mm appeared to prefer shallow backwater and riprapped shoreline sites. Mean cpe values for sandy beach and vegetated shoreline sites for all sub-areas combined were substantially lower than mean cpe values for shallow backwater, riprapped shoreline, industrialized shoreline and boat harbors. Although smallmouth bass were commonly encountered in boat harbors, their abundance in the boat harbors was not significantly different from other habitat types at Hayden Island.

- Juvenile smallmouth bass (< 200 mm) were much more abundant at sites with rock riprap present. They appear to use the spaces between rocks in the riprap for cover.

Steps That Have Been and Will Be Taken to Coordinate Research With Other Researchers

The only other fish survey work that is being conducted in the vicinity of the study area is the annual predator survey conducted by Oregon Department of Fish and Wildlife (ODFW). We have had contact on several occasions with Mr. David Ward, the ODFW project leader for the predator survey, to inform him of our progress. In compliance with ODFW scientific collectors permit requirements, an annual report was submitted to ODFW listing the number of species collected, methods of capture and locations of capture. The information developed in this study will be made available to NMFS researchers working in the lower Columbia River and will be provided to the State of Oregon to help in development of a management plan for the Lower Columbia River Steelhead ESU.

Table 5. Total numbers of each species and their percentage compostition of the electrofishing catch for February 24 through April 30, 1999.

Hayden Island			Government Island			Sandy River Delta		
Species	Number	%Comp.	Species	Number	%Comp.	Species	Number	%Comp.
Chinook Salmon	550	47.25	Chinook Salmon	421	56.66	Chinook Salmon	612	62.45
Largescale sucker	348	29.90	Largescale sucker	153	20.59	Largescale sucker	257	26.22
Steelhead	58	4.98	Smallmouth Bass	59	7.94	Peamouth	28	2.86
Northern pikeminnow	51	4.38	Steelhead	27	3.63	Coho Salmon	27	2.76
Smallmouth Bass	23	1.98	Sculpin sp.	18	2.42	Steelhead	10	1.02
Sculpin sp.	22	1.89	Peamouth	16	2.15	Northern pikeminnow	9	0.92
Coho Salmon	17	1.46	Carp	12	1.62	Mountain Whitefish	9	0.92
Chum Salmon	16	1.37	White Sturgeon	6	0.81	Sockeye Salmon	4	0.41
Peamouth	13	1.11	Starry Flounder	6	0.81	Chiselmouth	4	0.41
Bluegill	12	1.03	Largemouth Bass	4	0.54	Largemouth Bass	4	0.41
3-Spine Sticklebacks	10	0.86	3-Spine Sticklebacks	3	0.40	Carp	3	0.31
Yellow Perch	10	0.86	Bluegill	3	0.40	Sculpin sp.	3	0.31
Pumpkinseed Sunfish	10	0.86	Coho Salmon	2	0.28	Smallmouth Bass	2	0.20
Largemouth Bass	4	0.34	Northern pikeminnow	2	0.28	Pumpkinseed Sunfish	2	0.20
Banded Killifish	4	0.34	Pumpkinseed Sunfish	2	0.28	3-Spine Sticklebacks	1	0.10
Carp	3	0.26	Black Crappie	2	0.28	Redside Shiner	1	0.10
Starry Flounder	3	0.26	Yellow Perch	1	0.13	White Strurgeon	1	0.10
Cutthroat Trout	2	0.17	Banded Killifish	1	0.13	Starry Flounder	1	0.10
Mountain Whitefish	2	0.17	Chiselmouth	1	0.13	Walleye	1	0.10
Redside Shiner	2	0.17	Mountain Whitefish	1	0.13	Bluegill	1	0.10
Black Crappie	1	0.09	Chum Salmon	1	0.13			
White Crappie	1	0.09	Cutthroat Trout	1	0.13			
Brown Bullhead	1	0.09	Pacific Lamprey	1	0.13			
Chiselmouth	1	0.09						
Total	**1164**	100%		**743**	100%		**980**	100%

APPENDIX A

ELECTROFISHING LOG

Appendix A. 1999 Electrofishing Log for Permit #1131

Date	River	Location	Time (military)	Water Temp. (C)	Conductivity (Micro seimens)	Amps.	Pulse Rate (D.C.)	Output Voltage	% of Range	Fish Response	Distance Fish Attracted
2-24-99	Columbia River	Government Is.	1300	5.5	175	4	120	50-500	50%	Partial Stun	10 ft.
2-25-99	Columbia River	Government Is.	0900	5.0	170	4	120	50-500	40%	Partial Stun	9 ft.
2-26-99	Columbia River	Gov. Island	No data	No data	No data	No data	No data	No data	No data	No data	
3-11-99	Columbia River	Hayden Is.	1430	6.0	165	3.8	60	50-500	100%	Partial Stun	10 ft.
3-12-99	Columbia River	Hayden Is.	1400	6.0	160	4	60	50-500	100%	Partial Stun	11 ft.
3-15-99	Columbia River	Hayden Is.	1200	6.0	164	4	60	50-500	80%	Partial Stun	12 ft.
3-16-99	Columbia River	Gov. Island	1230	6.0	167	4	60	50-500	90%	Partial Stun	12 ft.
3-17-99	Columbia River	Gov. Island	1100	5.5	162	4	60	50-500	100%	Partial Stun	11 ft.
3-18-99	Columbia River	Sandy River Delta	1430	6.5	160	4	60	50-500	100%	Partial Stun	10 ft.
4-15-99	Columbia River	Gov. Island.	0930	11.0	154	4	120	50-500	50%	Partial Stun	10 ft.
4-16-99	Columbia River	Gov. Island	1030	11.0	155	4	120	50-500	40%	Partial Stun	10 ft.
4-17-99	Columbia River	Hayden Is.	0945	11.0	157	4	120	50-500	40%	Partial Stun	13 ft.
4-19-99	Columbia	Hayden Is.	1145	11.0	153	4	120	50-500	40%	Partial	

	River									Stun	
4-22-99	Columbia River	Hayden Is.	1330	10.0	152	4	60	50-500	80%	Partial Stun	12 ft.
4-23-99	Columbia River	Hayden Is.	1430	10.5	154	4	120	50-500	40%	Partial Stun	12 ft.
4-29-99	Columbia River	Hayden Is.	1430	11.0	153	4	60	50-500	95%	Partial Stun	14 ft.
4-30-99	Columbia River	Sandy River Delta	1400	11.0	150	4	60	50-500	100%	Partial Stun	12 ft.

#3

PORT OF PORTLAND

March 29, 2000

Writer's Direct Line: (503) 944-7019
Writer's Fax Line: (503) 944-7038
Writer's Email Address: quinna@portptld.com

Mr. Robert Koch
National Marine Fisheries Service
525 NE Oregon Street, Suite 500
Portland, Oregon 97232-2737

Re: Annual Report for Scientific Take Permit No. 1131

Dear Robert:

Enclosed is the Port of Portland's Annual Report for Scientific Taking Permit No. 1131. This Report covers the period of February 1, 1999 through December 31, 1999. Please do not hesitate to contact met at 944-7033 if you have any questions.

Very truly yours,

J.W. Ring
Assistant General Counsel

Enclosure
Cc: Ms. Dorothy Sperry (w/o encl.)
Dr. Robert Ellis (w/o encl.)
Mr. Michael O'Connell (w/o encl.)

-#3

ANNUAL REPORT FOR SCIENTIFIC TAKING PERMIT NO. 1131
(Reporting Period: February 1, 1999 through December 31, 1999)

INTRODUCTION

This is the second annual report for fish collection activity on permit # 1131. The two-year permit was issued on April 24, 1998 by the National Marine Fisheries Service (NMFS) to the Port of Portland, 700 NE Multnomah Avenue, Box 3529, Portland, Oregon 97208 for the take of specified numbers of listed juvenile and adult threatened and endangered salmonid species while conducting research in the Columbia River between River Mile (RM) 104 and RM 125. This report summarizes the catch of salmonid fish species for the interval February 1, 1999 through December 31, 1999 (the second year of the permit) and estimates the number of federally listed threatened and endangered fish captured and released during that interval. In addition, the report addresses each of the other reporting requirements for reauthorization listed in Section C of the permit. The numbers of threatened and endangered fish collected and released were all within the take limits specified in the permit.

Specific objectives of the study are as follows:

- To better understand seasonal use patterns of shallow water habitat by juvenile salmonids and other important components of the lower Columbia River fish fauna.
- To compare different types of shallow water habitats with respect to fish species diversity, relative abundance of species, and catch-per-unit-effort (cpe).
- To determine whether the various types of shallow water habitat differ with respect to abundance of fish predators such as northern pikeminnow, smallmouth bass, and largemouth bass.
- To determine whether a gradient in species composition and/or relative abundance of species can be detected between the upstream and downstream ends of the study area.
- To compare habitat and fish fauna in the vicinity of proposed Port shoreline developments on and adjacent to Hayden Island with similar habitat types in other parts of the study area.
- To evaluate shallow water habitat conditions around Hayden Island with respect to species richness and abundance of benthic macroinvertebrates (fish food organisms).

STUDY DESIGN AND SAMPLING SITES

A total of 45 sampling sites was established within the entire study area (Figure 1). Each sampling site was identified by a 3-letter code followed by a number. The first letter of the site code represented the sub-area (i.e., H = Hayden Island, G = Government Island and S = Sandy River Delta). The second and third letters defined the type of shallow water (i.e., SA = sandy beach, VS = vegetated shoreline, SW = shallow backwater, IN = industrial, BH = boat harbor, and OW = open water). The number following the 3-letter code designated the replicate number. At Government Island, two additional riprap sites (G-RR4 and G-RR5) were established to provide better coverage of the shoreline adjacent to the Portland International Airport.

The sampling was designed to allocate approximately equal sampling effort to each of the shallow water habitat types present within each sub-area described above. These sampling sites were established in each habitat type present within each sub-area. For example, at Hayden Island three replicate sites were established in each of the following habitats: sandy beach, vegetated shoreline, shallow backwater, riprapped shoreline, industrial shoreline and boat harbor. Sampling sites within the more abundant habitat types, such as sandy beach and vegetated shoreline, were spread out in an attempt to cover the range of conditions within the habitat type. Sampling sites were not allocated randomly because of shoreline access constraints and safety considerations. We do not believe that the lack of randomization will cause a serious bias in the sampling results because of the substantial length of shoreline sampled at each sampling site (approximately 305 to 370 m).

ACTIVITIES CONDUCTED UNDER THE PERMIT

Habitat Characterization

At each sampling site, the physical features of the bank and river bottom were documented during late summer low flow conditions. Most of the sampling sites included about 1000 ft (305 m) of relatively uniform shoreline. Boat harbors, backwater areas, and open channel habitat types were the exception since fish sampling at these areas involved sampling areas away from the shoreline. At each site, a shallow water habitat description form was filled out based on a detailed visual examination of the bank (where applicable) and riverbed conditions. Data recorded included the following:

- dominant bank substrate composition,
- dominant riverbed substrate composition,
- bank vegetation in terms of dominant and subdominant trees and understory, and
- cover in the form of submerged or floating objects (on vegetated shorelines, the number of large fallen trees extending into the water was counted).

At sites with riprapped shoreline, the size of the riprap at each site was quantified by measuring ten rocks at each of three randomly selected sampling sites within the length of bank sampled by electrofishing. At each of the three randomly selected sampling sites, an object was tossed onto the shoreline and the closest rock to the object was used as a starting point for measurement of ten adjacent rocks. A diameter estimate was determined for each of the ten rocks based on the average of a length and width measurement of the rock face. The three samples of ten rocks each were then averaged to estimate the average size of the riprap.

Fish Sampling

An important part of the study design was to compare catch-per-unit-effort (cpe) across sampling sites. A boat-mounted electrofisher was selected as the primary sampling gear because it is reasonably effective in all of the various types of shallow water habitats. Other types of gear were evaluated but considered infeasible due the presence of brush and debris and variable depth conditions at many of the sampling sites. An electrofishing boat equipped with a Smith-Root GPP 5.0 electrofisher was used. The electrofisher unit produced variable voltage pulsed direct current (DC) output. The pulse width and maximum voltage were varied during the sampling to compensate for changes in water conductivity and temperature. A daily log of the electrofisher settings, water conductivity, water temperature, and general fish response to the electrofisher settings was maintained for the entire study period (February through April 1999), in accordance with the Section 10 permit requirements (see Appendix A for copy of electrofisher log). All of the electrofishing was conducted prior to our receipt of the NMFS' notification of permit modification dated July 23, 1999. The permit modification specified new more stringent electrofishing requirements.

Sampling was conducted on the following dates: February 24, 25,26, March 11, 12,13, 15, 16, 17,18 and April 15, 16, 17, 19, 22, 23, 29, 30. In February 1999 only 14 of the 45 stations were sampled. At each sampling site, approximately 1000 seconds (16.7 minutes) of electrofishing effort was employed during each sampling period. A timer on the electrofisher unit recorded the total number of seconds. At shoreline sites, 1000 seconds of effort typically resulted in the sampling of between 305 m (1000 ft) and 366 m (1200 ft) of shoreline.

In areas inaccessible to the boat-mounted electrofisher (i.e., H-SW2 and H-SW3), alternative sampling techniques were employed. At H-SW2 (Benson Pond), conditions were excellent for the use of a beach seine and a 27.4-m (90-ft) x 1.8-m (6-ft) beach seine with 9.5-mm (3/8" in) stretch mesh was used. At H-SW3, brush and woody debris on the bottom prevented the use of a seine, and a backpack electrofisher (Smith-Root Model XII) was used. A timer on the unit recorded electrofishing effort by the backpack unit.

Some of the electrofishing sites were re-sampled to evaluate electrofisher sampling efficiency with respect to species composition and relative abundance. The 27.4- m (90-ft) beach seine described above was used to re-sample the sandy beach sites. Generally, two replicate seine hauls were made at each sandy beach site in each of the three sub-areas. However, during the spring high water period, it was difficult to sample some of the sandy beach sites, and they were either not sampled or sampled with a single seine haul.

The three open channel sites between Government Island and the Portland International Airport were re-sampled using a 6.1-m (20-ft) semi-balloon trawl. The cod-end of the trawl was constructed of 6.4 mm (1/4 -inch) stretch mesh nylon netting to allow retention of small specimens. Two replicate 5-minute trawls (approximately 366 m each) were made in the same areas that were electrofished in the open channel habitat. An 8.8-m

(29-ft) aluminum boat equipped with a winch was used to tow the trawls. Trawling was done with the current from the upstream to the downstream end of each site. During each trawl, a trace of the river bottom contour was made with a recording depth finder. The upstream and downstream ends of the trawl sites were located with a GPS unit.

Fish Handling

All fish collected were identified to species, examined for signs of disease or injuries and most were measured to the nearest millimeter prior to release. Fork length (FL) measurements were made on fish with forked tails and total length (TL) measurements were made on fish without forked tails (e.g., bullheads and banded killifish). When large numbers of approximately the same size of fish of a given species were collected (e.g., salmon fry) a sub-sample of the group was measured. The fish that were not measured were counted and released. Their lengths were estimated based on the modal length of the fish in the sub-sample. Standard data forms with columns for species, length, stomach sample status, and comments were used throughout the study. The comments column was used to identify fin clipped salmonids and any abnormalities such as disease or injuries.

Because of the potential for capture of federally listed (or proposed) threatened or endangered species of salmonids, a number of special precautions were employed to minimize handling mortality of captured juvenile salmonids. During electrofishing, all juvenile salmonids were transferred from the capture nets to an on-board holding tank that was used only for juvenile salmonids. All other fish were placed in a separate on-board holding tank. The salmonid holding tank was continuously aerated with an electrical aerator pump system. Fresh water was placed in both holding tanks prior to sampling at each site. Juvenile salmonids collected by beach seining, trawling or backpack electrofisher were placed in a separate bucket of fresh water. All other fish were placed in another bucket to avoid contact with the salmonids

All juvenile salmonids captured were anesthetized with Tricane Methanesulfonate (MS-222) prior to measuring. A "wet bottom" dip net was used to transfer juvenile salmonids from the holding tank to the MS-222 bucket and to the measuring board. After measuring, anesthetized salmonids were allowed to recover in a bucket of clean water prior to release.

Stomach samples were collected from predator fish species. Northern pikeminnow over 250 mm fork length; largemouth bass, smallmouth bass and yellow perch over 200 mm fork length; and walleyes of all sizes were sampled. A stomach pump was used to flush food from the stomachs of the bass, yellow perch and walleye; northern pikeminnow were sacrificed and their stomachs were removed. Stomach contents were placed in either labeled glass jars or labeled plastic bags and preserved with 90 percent ethanol. Identification of stomach contents was done under a dissecting scope. Partially digested fish in the stomach contents were identified using a diagnostic bone key obtained from Oregon Department of Fish and Wildlife (ODFW).

Estimation of Numbers of Fish Taken

Table 1 summarizes the total catch of juvenile salmonids by species and location for the period February 1, 1999 through April 30, 1999. No fish sampling was conducted after April 30, 1999. As shown in Table 1, the total numbers collected were lower for all species than the predicted total catches used for estimating capture/handle take in the permit application.

Juvenile chinook salmon comprised, by far, the majority of the juvenile salmonid catch. The juvenile chinook salmon were divided into sub-yearling and yearling components based on length. Figure 2 shows the length frequency distribution of juvenile chinook salmon collected in the late April/early May sampling period when the downstream migration of yearling chinook was near its peak. There appeared to be three length-groups of juvenile chinook present during this period. A group of small fish with a median length between 40 and 60 mm, an intermediate group with a median length of between 80 and 120mm and a group of larger fish with a median length between 120 and 175 mm.

We classified the group of relatively small fish as likely representing wild sub-yearling fall chinook salmon. We also classified the intermediate size group as sub-yearlings, most of which were probably hatchery fish. Since very few fall chinook are fin clipped, there was no way to definitively distinguish between hatchery and wild fish. It is possible that there may have been a few yearling chinook in the intermediate size group. However, there appeared to be a clear break in the size distribution between the intermediate size group and the largest size group at about 120 mm. Fish over 120 mm were clearly yearling fish. Therefore, we used 120 mm as the cut off point between yearling and sub-yearling juvenile chinook salmon.

Listed yearling Snake River Spring/Summer Chinook Salmon migrate downstream through the lower Columbia River during the interval March through June. Therefore, for the purposes of estimating take of juveniles from this ESU, we used the total number of yearling juveniles measured to be over 120 mm that were collected and released during the February through April 1999 study period. This total was 442 fish. To determine the number of listed wild and hatchery Snake River Spring/Summer Chinook Salmon juveniles in the total catch of 442 yearling chinook salmon, we used the percentages shown in Table 2 for wild and hatchery components. These percentages were calculated based on NMFS published 1999 estimates of listed and non-listed fish and the Bonneville Dam tailrace (NMFS Memorandum of March 3, 1999) and estimates of listed and non-listed fish transported and released below Bonneville Dam.

As discussed in our letter of April 5, 1998 to Mr. Robert Koch, we assumed that the ratio of wild to hatchery yearling chinook reported at Bonneville Dam accurately reflected the ratio of wild to hatchery fish in our catch. This assumption was necessary since not all yearling hatchery chinook salmon are fin clipped. Using the permitted capture ratio of listed wild to hatchery fish (87/897), we estimated that 42 of the 442 fish collected were wild and the remainder were hatchery fish. Applying the percentages of listed wild and hatchery Snake River Spring/Summer Chinook from Table 2 to these numbers, we estimated the capture/handle take for listed Snake River Spring/Summer Chinook wild and hatchery juveniles to be 1.72 and 7.08, respectively (Table 3). These numbers are below the maximum allowable take identified in the permit.

The capture/handle take of Snake River Fall Chinook Salmon was calculated using the total number of juvenile chinook salmon captured (1583) less the 442 juveniles identified as yearlings for estimation of the Snake River Spring/Summer Chinook Salmon take. This results in a estimated total of 1141 Snake River fall Chinook being captured. This was a conservative approach in that it assumed that individuals of listed Snake River Fall Chinook could be present throughout the entire year in the study area and did not subtract any proportion of the catch that could have been non-listed sub-yearling spring chinook salmon. The percentage of listed to non-listed fish (0.41%), and the total number of juvenile "fall chinook" salmon captured in each of the three sampling areas (Table 1) were used to estimate capture/handle take for the Snake River Fall Chinook Salmon as shown in Table 3. We estimate that a total of 4.68 fall chinook were taken from the Snake River ESU during the study. This number is less than the 8 fish that were permitted to be taken from this ESU.

Table 1. Total number of juvenile salmonids collected at Hayden Island, Government Island, and Sandy River Delta from February 1, 1999 through April 30, 1999.

Common Name	Scientific Name	Hayden Island	Government Island	Sandy River Delta	Total Actual Catch	Total Estimated Catch*
Steelhead	*Oncorhynchus mykiss*				95	228
wild		5	4	1	10	53
hatchery		53	23	9	85	175
Coho	*O. kisutch*	17	2	27	46	85
Sockeye	*O. nerka*	0	0	4	4	10
Spring Chinook (yearling)	*O. tshawytscha*				442	984
wild		20	10	12	42	87
hatchery		191	96	113	400	897
Fall Chinook (sub-yearling)	*O. tshawyscha*	348	300	493	1141	1243

*Total estimated catch from the permit application for the second year of sampling

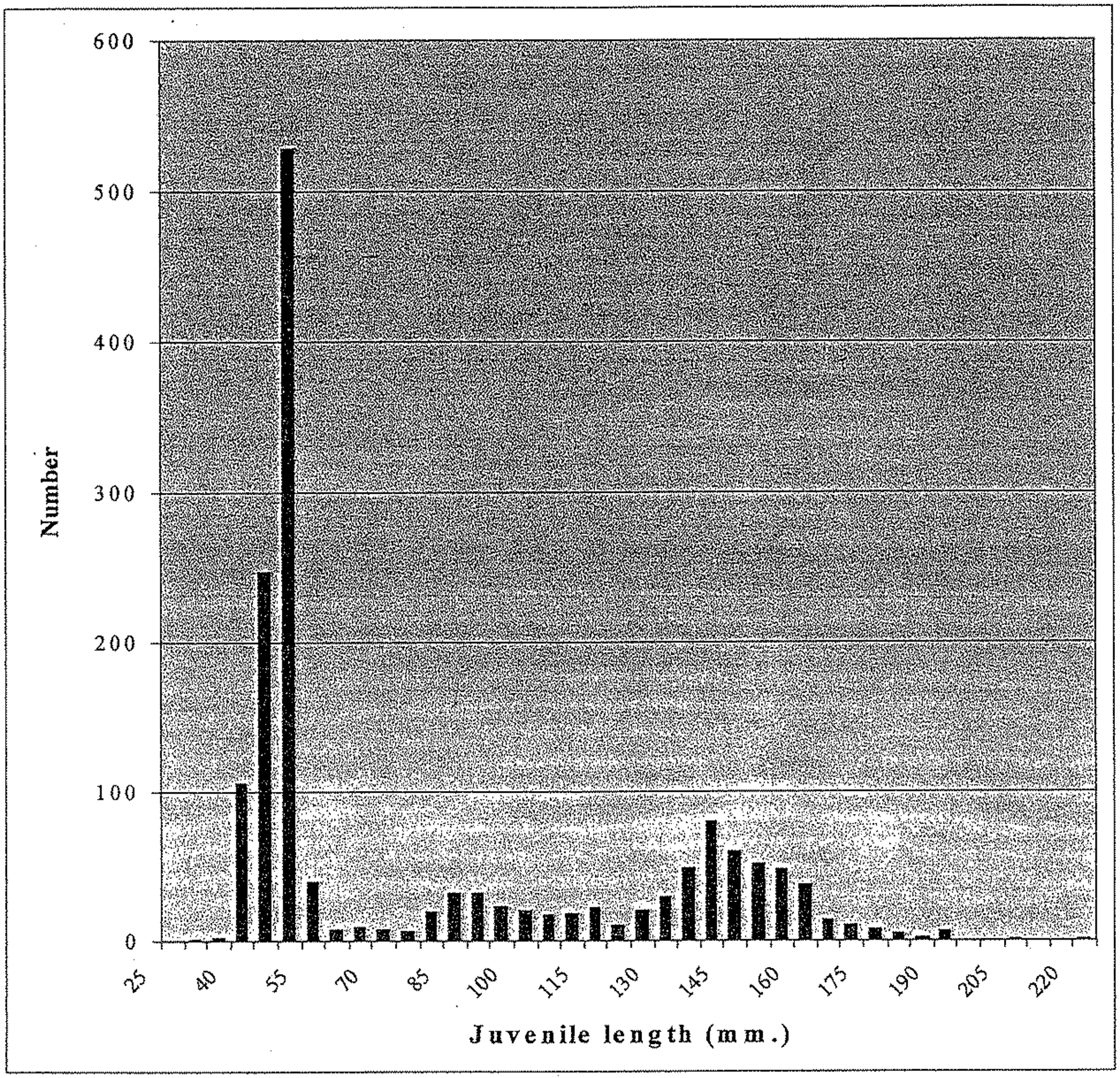

Figure 2.Length frequency distribution of juvenile chinook salmon collected at all sampling sites between Feb. 24 and April 30, 1999.

Estimation of the capture/handle take for juveniles of the Upper Columbia River Steelhead ESU, the Snake River Basin Steelhead ESU, and the Lower Columbia River Steelhead ESU were calculated using the total number of juvenile steelhead captured in each of the three sampling areas and the percentages of listed to non-listed steelhead as shown in Table 2. To obtain the number of wild steelhead caught in each sub-area, we tallied the total number of fish that had not been fin clipped based on our field observations. We estimate that a total of <1 wild and 3.19 hatchery steelhead were taken from the Upper Columbia River ESU; <1 steelhead was taken from the Snake River Basin Steelhead ESU; and <1 steelhead was taken from Lower Columbia River ESU. As shown in Table 3, all capture/take of wild and listed hatchery steelhead from each of the three ESU's were less than permitted number of fish.

A total of four (4) juvenile sockeye salmon were collected during the study interval. All four sockeye were captured in the Sandy River delta sub-area. The total capture/handle take for endangered juvenile Snake River Sockeye Salmon was less than one fish (Table 3). This is less than the permitted number of 1 sockeye.

No adults of listed species were captured or handled incidental to sampling for juvenile salmonids during the period February 1, 1999 through December 31, 1999. Therefore, there was no incidental take of adults of listed species.

Table 2. Data used to compute percentage of listed juvenile salmonids in the catch from the project area.

	Upper Columbia River Steelhead		Snake R. Basin Steelhead	Lower Columbia R. Steelhead	Snake R. Spring/Summer Chinook		Snake R. Sockeye	Snake R. Fall Chinook
	wild	hatchery			wild	hatchery		
Total Juveniles								
Bonneville	812,973	812,973	1,010,409	499,397	3,977,279	986,170	659,930	16,041,442
Transported	7,300,000	7,300,000	7,300,000	0	6,700,000	6,700,000	624,000	5,377,000
Total	8,112,973	8,112,973	8,310,409	499,397	10,677,279	7,686,170	1,283,930	21,418,442
Total Listed Juveniles								
Bonneville	52,199	510,449	64,876	48,065*	74,340	27,742	2,316	1,137
Transported	960,055	124,500	650,000	0	680,649	298,000	21,900	87,600
Total	1,012,254	634,949	714,876	48,065	754,989	325,742	24,216	88,737
Percent Listed Fish	5.98%	3.75 %	4.22%	0.28%	4.11%	1.77%	1.89%	0.41%

*Lower Columbia River ESU: 16,000 listed Steelhead from the Sandy River basin were added to 32,065 total listed Steelhead below Bonneville.

Table 3. Capture/handle take of juvenile salmon and steelhead by location during the period February 1, 1999 through April 30, 1999.

Listed Species/ESUs	Hayden Island	Government Island	Sandy River Delta	Total Capture/ Handle Take	Permited Capture/Handle Take*
Snake River Spring/Summer Chinook					
Wild	0.82	0.41	0.49	1.72	5
Hatchery	3.38	1.70	2.00	7.08	22
Snake River Fall Chinook	1.43	1.23	2.02	4.68	8
Snake River Sockeye	0.0	0.0	<0.01	<1	1
Upper Columbia River Steelhead Trout					
Wild	0.30	0.24	0.06	0.60	2
Hatchery	1.99	0.86	0.34	3.19	11
Snake River Basin Steelhead Trout	0.21	0.17	0.04	<1	3
Lower Columbia River Steelhead Trout	0.01	0.01	<0.01	<1	1

*Total estimated catch from the permit application for the second year of sampling

Measures Taken to Minimize Disturbance to ESA Listed Fish

All of the precautionary procedures described above with respect to handling of listed fish species were carefully adhered to during the sampling program. Although a few adult fish were observed during the sampling for juveniles, quick response of the electrofisher crew precluded them from being stunned significantly by the electrofisher equipment. No adults were captured by beach seine or bottom trawl.

Problems and Unforeseen Effects

The only problems encountered during the sampling program were related to accessibility of beach seine sites during the peak of the spring run-off. In some cases the high water precluded beach seining. No unforeseen effects on either juvenile or adult salmonids were encountered during the survey.

Preliminary Results of Study

The results of this study represent the first seasonal examination of fish use of shallow water habitat in the Portland/Vancouver reach of the lower Columbia River. The following summary is organized into two sections. The first section describes the general species composition and seasonal pattern of fish use of shallow water habitat throughout the study area. The second section focuses on comparisons of the different habitat types.

General Findings:

- A total of 28 fish species was found in the study area (Table 4) during the February through April 1999 study period. This number of species compares well to the total of 29 species that were captured during the 1998 study period. During 1999, 24 species were captured from the Hayden Island sub-area, 23 from the Government Island sub-area and 20 from the Sandy River Delta. During the 1998 study, 23 species were captured from the Hayden Island sub-area, 25 species were captured from the Government Island sub-area and 28 from the Sandy River Delta.

- During the 1999 study, Chinook salmon and largescale sucker were the two most abundant species in all three sub-areas (Table 5). These two species were also the most abundant species captured during the1998 study period. During the 1999 study, other relatively abundant species included northern pikeminnow, smallmouth bass and steelhead trout. During the 1998, study three-spine stickleback and carp were also present in abundance, in addition to these species. In 1999, eleven of the 24 species collected were non-native (introduced) species, as compared to 14 non-native species captured during 1998.

Table 4. List of species collected at Hayden Island, Government Island and Sandy River Delta sampling sites during the interval February 1999 through April 1999.

SPECIES				
Common Name	**Scientific Name**	**Hayden Island**	**Government Island**	**Sandy River Delta**
Pacific Lamprey	*Entosphenus tridentatus*		X	
White Sturgeon	*Acipenser transmontanus*		X	X
Mountain Whitefish	*Prosopium williamsoni*	X	X	X
Steelhead Trout	*Oncorhynchus mykiss*	X	X	X
Coho Salmon	*Oncorhynchus kisutch*	X	X	X
Chinook Salmon	*Oncorhynchus tshawytscha*	X	X	X
Sockeye Salmon	*Oncorhynchus nerka*			X
Cutthroat Trout	*Oncorhynchus clarki*	X	X	
Chum Salmon	*Oncorhynchus gorbuscha*	X	X	
Carp*	*Cyprinus carpio*	X	X	X
Chiselmouth	*Acrocheilus alutaceus*	X	X	X
Redside Shiner	*Richardsonius balteatus*	X		X
Northern Pikeminnow	*Ptychocheilus oregonensis*	X	X	X
Peamouth	*Mylocheilus caurinus*	X	X	X
Largescale Sucker	*Catostomus macrocheilus*	X	X	X
Brown Bullhead*	*Ictalurus nebulosus*	X		
Banded Killifish*	*Fundulus diaphanus*	X	X	
Three-Spine Stickleback	*Gasterosteus aculeatus*	X	X	X
Largemouth Bass*	*Micropterus salmoides*	X	X	X
Smallmouth Bass*	*Micropterus dolomieui*	X	X	X
Black Crappie*	*Pomoxis nigromaculatus*	X	X	
White Crappie*	*Pomoxis annularis*	X		
Bluegill*	*Lepomis macrochirus*	X	X	X
Pumpkinseed*	*Lepomis gibbosus*	X	X	X
Walleye*	*Stizostedion vitreum vitreum*			X
Yellow Perch*	*Perca flavescens*	X	X	
Sculpin sp.	*Cottus sp.*	X	X	X
Starry Flounder	*Platichthys stellatus*	X	X	X
Total Species Number		24	23	20

* introduced species

- During the 1999 study, six salmonid species were collected during the study and included chinook salmon, coho salmon, sockeye salmon, chum salmon, cutthroat trout and steelhead trout. Only four salmonid species (chinook, coho, sockeye and steelhead) were taken during the 1998 study. Juvenile chinook salmon were by far the most abundant of the six salmonid species captured in 1999. Steelhead was the next most abundant followed by coho, chum and sockeye. Only four sockeye juveniles were collected.

- Low numbers of juvenile chinook salmon and steelhead trout were present within the study area during February of 1999. The March sampling did not begin until March11, 1999 at which time an increase in juvenile chinook salmon was apparent. On this date, sixty-five juvenile chinook salmon were captured from the Benson pond shallow water area. Also, on this date, sixteen juvenile chum salmon were captured from Benson Pond located in the Hayden Island sub-area. A total of 15 chinook juveniles were captured in the Government Island shallow backwater area on March 17, 1999. Based on these data, it is apparent that the shallow backwater areas provide important rearing habitat for juvenile salmonids.

- A total of sixty-two northern pikeminnows were captured during the 1999 study. Twenty-four northern pikeminnow were captured on March 15, 1999 at a bridge abutment site in the Hayden Island sub-area. This was the largest predator concentration found during the 1999 study.

Both the mean number of species and the mean catch-per-unit effort of electrofishing were found to be significantly lower during the winter months than during the spring/summer months.

Shallow Water Habitat Comparisons:

- No significant differences were found between Hayden Island, Government Island or the Sandy River Delta sub-areas with respect to the mean number of species captured or in the mean electrofishing cpe for all species combined.

- Shallow backwater, riprapped shorelines, and industrialized shorelines were found to support significantly higher mean numbers of species during the winter months than the other habitat types sampled. These areas appeared to be preferred over-wintering sites for small fish. Sandy beach and vegetated shoreline sites had relatively little use by fish during the winter months

- During the spring/summer months, shallow backwater areas continued to support the largest mean number of species. However, substantial increases in the mean number of species at sandy beach and vegetated shoreline sites was found. These increases reflected the return of adults of some species that over-winter in deep water and the presence of migratory species throughout the sampling area.

- The mean electrofishing cpe for all species combined followed the same general pattern as the mean number of species. Small fish predominated in the winter catch and were most numerous in shallow backwater areas and areas that had riprapped rock shorelines. Total mean cpe increased substantially during the spring/summer sampling period, particularly along main channel shoreline habitat (e.g., sandy beaches and vegetated shorelines). These increases reflected the large numbers of migratory juvenile salmonids and the return of adults of several species to the shallow water areas.

- No significant differences were found between habitat types in the mean electrofishing cpe of juvenile chinook salmon during the winter or during spring/summer sampling periods. High sample variability probably contributed to the inability of the ANOVA tests to distinguish between habitat types for these fish.

- Juvenile steelhead were abundant in the electrofishing catch only during the late April/early May sampling period. Mean cpe was highest in the open water habitat (i.e., mid channel area between Government Island and the Oregon shore). No preference for shoreline shallow water habitats was found.

- Predator fish species captured in sufficient numbers for habitat preference analysis included northern pikeminnow and smallmouth bass. Northern pikeminnows larger than 250 mm were widely distributed across the various habitat types during the spring downstream migration of juvenile salmonids. Statistical analysis of the electrofishing cpe data for northern pikeminnow indicated that shallow backwater areas did not appear to be preferred foraging sites. Mean northern pikeminnow cpe for the boat harbor sites was not significantly different from sandy beach, vegetated shoreline or riprapped shoreline sites.

- Smallmouth bass larger than 200 mm appeared to prefer shallow backwater and riprapped shoreline sites. Mean cpe values for sandy beach and vegetated shoreline sites for all sub-areas combined were substantially lower than mean cpe values for shallow backwater, riprapped shoreline, industrialized shoreline and boat harbors. Although smallmouth bass were commonly encountered in boat harbors, their abundance in the boat harbors was not significantly different from other habitat types at Hayden Island.

- Juvenile smallmouth bass (< 200 mm) were much more abundant at sites with rock riprap present. They appear to use the spaces between rocks in the riprap for cover.

Steps That Have Been and Will Be Taken to Coordinate Research With Other Researchers

The only other fish survey work that is being conducted in the vicinity of the study area is the annual predator survey conducted by Oregon Department of Fish and Wildlife (ODFW). We have had contact on several occasions with Mr. David Ward, the ODFW project leader for the predator survey, to inform him of our progress. In compliance with ODFW scientific collectors permit requirements, an annual report was submitted to ODFW listing the number of species collected, methods of capture and locations of capture. The information developed in this study will be made available to NMFS researchers working in the lower Columbia River and will be provided to the State of Oregon to help in development of a management plan for the Lower Columbia River Steelhead ESU.

Table 5. Total numbers of each species and their percentage compostition of the electrofishing catch for February 24 through April 30, 1999.

Hayden Island			Government Island			Sandy River Delta		
Species	Number	%Comp.	Species	Number	%Comp.	Species	Number	%Comp.
Chinook Salmon	550	47.25	Chinook Salmon	421	56.66	Chinook Salmon	612	62.45
Largescale sucker	348	29.90	Largescale sucker	153	20.59	Largescale sucker	257	26.22
Steelhead	58	4.98	Smallmouth Bass	59	7.94	Peamouth	28	2.86
Northern pikeminnow	51	4.38	Steelhead	27	3.63	Coho Salmon	27	2.76
Smallmouth Bass	23	1.98	Sculpin sp.	18	2.42	Steelhead	10	1.02
Sculpin sp.	22	1.89	Peamouth	16	2.15	Northern pikeminnow	9	0.92
Coho Salmon	17	1.46	Carp	12	1.62	Mountain Whitefish	9	0.92
Chum Salmon	16	1.37	White Sturgeon	6	0.81	Sockeye Salmon	4	0.41
Peamouth	13	1.11	Starry Flounder	6	0.81	Chiselmouth	4	0.41
Bluegill	12	1.03	Largemouth Bass	4	0.54	Largemouth Bass	4	0.41
3-Spine Sticklebacks	10	0.86	3-Spine Sticklebacks	3	0.40	Carp	3	0.31
Yellow Perch	10	0.86	Bluegill	3	0.40	Sculpin sp.	3	0.31
Pumpkinseed Sunfish	10	0.86	Coho Salmon	2	0.28	Smallmouth Bass	2	0.20
Largemouth Bass	4	0.34	Northern pikeminnow	2	0.28	Pumpkinseed Sunfish	2	0.20
Banded Killifish	4	0.34	Pumpkinseed Sunfish	2	0.28	3-Spine Sticklebacks	1	0.10
Carp	3	0.26	Black Crappie	2	0.28	Redside Shiner	1	0.10
Starry Flounder	3	0.26	Yellow Perch	1	0.13	White Strurgeon	1	0.10
Cutthroat Trout	2	0.17	Banded Killifish	1	0.13	Starry Flounder	1	0.10
Mountain Whitefish	2	0.17	Chiselmouth	1	0.13	Walleye	1	0.10
Redside Shiner	2	0.17	Mountain Whitefish	1	0.13	Bluegill	1	0.10
Black Crappie	1	0.09	Chum Salmon	1	0.13			
White Crappie	1	0.09	Cutthroat Trout	1	0.13			
Brown Bullhead	1	0.09	Pacific Lamprey	1	0.13			
Chiselmouth	1	0.09						
Total	**1164**	100%		**743**	100%		**980**	100%

APPENDIX A

ELECTROFISHING LOG

Appendix A. 1999 Electrofishing Log for Permit #1131

Date	River	Location	Time (military)	Water Temp. (C)	Conduc-tivity (Micro seimens)	Amps.	Pulse Rate (D.C.)	Output Voltage	% of Range	Fish Response	Distance Fish Attracted
2-24-99	Columbia River	Govern-ment Is.	1300	5.5	175	4	120	50-500	50%	Partial Stun	10 ft.
2-25-99	Columbia River	Govern-ment Is.	0900	5.0	170	4	120	50-500	40%	Partial Stun	9 ft.
2-26-99	Columbia River	Gov. Island	No data	No data	No data	No data	No data	No data	No data	No data	
3-11-99	Columbia River	Hayden Is.	1430	6.0	165	3.8	60	50-500	100%	Partial Stun	10 ft.
3-12-99	Columbia River	Hayden Is.	1400	6.0	160	4	60	50-500	100%	Partial Stun	11 ft.
3-15-99	Columbia River	Hayden Is.	1200	6.0	164	4	60	50-500	80%	Partial Stun	12 ft.
3-16-99	Columbia River	Gov. Island	1230	6.0	167	4	60	50-500	90%	Partial Stun	12 ft.
3-17-99	Columbia River	Gov. Island	1100	5.5	162	4	60	50-500	100%	Partial Stun	11 ft.
3-18-99	Columbia River	Sandy River Delta	1430	6.5	160	4	60	50-500	100%	Partial Stun	10 ft.
4-15-99	Columbia River	Gov. Island.	0930	11.0	154	4	120	50-500	50%	Partial Stun	10 ft.
4-16-99	Columbia River	Gov. Island	1030	11.0	155	4	120	50-500	40%	Partial Stun	10 ft.
4-17-99	Columbia River	Hayden Is.	0945	11.0	157	4	120	50-500	40%	Partial Stun	13 ft.
4-19-99	Columbia	Hayden Is.	1145	11.0	153	4	120	50-500	40%	Partial	

	River									Stun	
4-22-99	Columbia River	Hayden Is.	1330	10.0	152	4	60	50-500	80%	Partial Stun	12 ft.
4-23-99	Columbia River	Hayden Is.	1430	10.5	154	4	120	50-500	40%	Partial Stun	12 ft.
4-29-99	Columbia River	Hayden Is.	1430	11.0	153	4	60	50-500	95%	Partial Stun	14 ft.
4-30-99	Columbia River	Sandy River Delta	1400	11.0	150	4	60	50-500	100%	Partial Stun	12 ft.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

FEB 2 6 1999

Ms. Dorothy Sperry
Port of Portland
700 NE Multnomah Avenue
Box 3529
Portland, Oregon 97208

Dear Ms Sperry:

Thank you for the annual report of your activities conducted in the reporting period February 1, 1998 through January 31, 1999 under Endangered Species Act (ESA) Section 10 scientific research Permit 1131. We have reviewed the report and are hereby authorizing the continuation of the take of ESA-listed fish associated with your activities in the reporting period February 1, 1999 through January 31, 2000, as described in the permit. All special and general conditions in the permit will remain in full force and effect.

We are currently processing your request for Modification 1 to Permit 1131. We will provide comments to you for your responses when the public comment period has ended for this request.

If you have any questions regarding this authorization, please contact Robert Koch at (503) 230-5424.

Sincerely,

Kevin Collins,
Chief
Endangered Species Division

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, Maryland 20910

FEB 26 1999

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ANNUAL REPORT FOR SCIENTIFIC TAKING PERMIT NO. 1131
(Reporting Period: February 1, 1998 through January 31, 1999)

INTRODUCTION

This is the annual report for fish collection activity on permit # 1131. The permit was issued April 24, 1998 by the National Marine Fisheries Service (NMFS) to the Port of Portland, 700 NE Multnomah Avenue, Box 3529, Portland, Oregon 97208 for the take of specified numbers of listed juvenile and adult threatened and endangered salmonid species while conducting research in the Columbia River between River Mile (RM) 104 and RM 125. This report summarizes the catch of salmonid fish species for the interval February 1, 1998 through January 31, 1999 and estimates the number of federally listed threatened and endangered fish captured and released during that interval. In addition, the report addresses each of the other reporting and reauthorization requirements listed in Section C of the permit. The numbers of threatened and endangered fish collected and released were all within the take limits specified in the permit.

Specific objectives of the study are as follows:

- To better understand seasonal use patterns of shallow water habitat by juvenile salmonids and other important components of the lower Columbia River fish fauna.
- To compare different types of shallow water habitats with respect to fish species diversity, relative abundance of species, and catch-per-unit-effort (cpe).
- To determine whether the various types of shallow water habitat differ with respect to abundance of fish predators such as northern pikeminnow, smallmouth bass, and largemouth bass.
- To determine whether a gradient in species composition and/or relative abundance of species can be detected between the upstream and downstream ends of the study area.
- To compare habitat and fish fauna in the vicinity of proposed Port shoreline developments on and adjacent to Hayden Island with similar habitat types in other parts of the study area.
- To evaluate shallow water habitat conditions around Hayden Island with respect to species richness and abundance of benthic macroinvertebrates (fish food organisms).

STUDY DESIGN AND SAMPLING SITES

A total of 45 sampling sites was established within the entire study area (Figure 1). Each sampling site was identified by a 3-letter code followed by a number. The first letter of the site code represented the sub-area (i.e., H = Hayden Island, G = Government Island and S = Sandy River Delta). The second and third letters defined the type of shallow water (i.e., SA = sandy beach, VS = vegetated shoreline, SW = shallow backwater, IN = industrial, BH = boat harbor, and OW = open water). The number following the 3-letter code designated the replicate number. At Government Island, two additional rip rap sites

(G-RR4 and G-RR5) were established to provide better coverage of the shoreline adjacent to the Portland International Airport.

Figure 1.
The sampling was designed to allocate approximately equal sampling effort to each of the shallow water habitat types present within each sub-area described above. These sampling sites were established in each habitat type present within each sub-area. For example, at Hayden Island three replicate sites were established in each of the following habitats: sandy beach, vegetated shoreline, shallow backwater, riprapped shoreline, industrial shoreline and boat harbor. Sampling sites within the more abundant habitat types, such as sandy beach and vegetated shoreline, were spread out in an attempt to cover the range of conditions within the habitat type. Sampling sites were not allocated randomly because of shoreline access constraints and safety considerations. We do not believe that the lack of randomization will cause a serious bias in the sampling results because of the substantial length of shoreline sampled at each sampling site (approximately 305 to 370 m).

ACTIVITIES CONDUCTED UNDER THE PERMIT

Habitat Characterization

At each sampling site, the physical features of the bank and river bottom were documented during late summer low flow conditions. Most of the sampling sites included about 1000 ft (305 m) of relatively uniform shoreline. Boat harbors, backwater areas, and open channel habitat types were the exception since fish sampling at these areas involved sampling areas away from the shoreline. At each site, a shallow water habitat description form was filled out based on a detailed visual examination of the bank (where applicable) and riverbed conditions. Data recorded included the following:

- dominant bank substrate composition,
- dominant riverbed substrate composition,
- bank vegetation in terms of dominant and subdominant trees and understory, and
- cover in the form of submerged or floating objects (on vegetated shorelines, the number of large fallen trees extending into the water was counted).

At sites with riprapped shoreline, the size of the riprap at each site was quantified by measuring ten rocks at each of three randomly selected sampling sites within the length of bank sampled by electrofishing. At each of the three randomly selected sampling sites, an object was tossed onto the shoreline and the closest rock to the object was used as a starting point for measurement of ten adjacent rocks. A diameter estimate was determined for each of the ten rocks based on the average of a length and width measurement of the rock face. The three samples of ten rocks each were then averaged to estimate the average size of the riprap.

Fish Sampling

An important part of the study design was to compare catch-per-unit-effort (cpe) across sampling sites. A boat-mounted electrofisher was selected as the primary sampling gear because it is reasonably effective in all of the various types of shallow water habitats. Other types of gear were evaluated but considered infeasible due the presence of brush and debris and variable depth conditions at many of the sampling sites. An electrofishing boat equipped with a Smith-Root GPP 5.0 electrofisher was used. The electrofisher unit produced variable voltage pulsed direct current (DC) output. The pulse width and maximum voltage were varied during the sampling to compensate for changes in water conductivity and temperature. A daily log of the electrofisher settings, water conductivity, water temperature, and general fish response to the electrofisher settings was maintained from April through December 1998 and January 1999 in accordance with the Section 10 permit requirements (see Appendix A for copy of electrofisher log).

Sampling was conducted in February (11-25), late April-early May (4/29-5/11), late May (19-27), June (17-30), July (20-29), September (14-22), November (10-17), and December (15-17) 1998 and January (24-26) 1999. In December 1998 and January 1999 only 14 of the 45 stations were sampled. At each sampling site, approximately 1000 seconds (16.7 minutes) of electrofishing effort was employed during each sampling period. A timer on the electrofisher unit recorded the total number of seconds. At shoreline sites, 1000 seconds of effort typically resulted in the sampling of between 305 m (1000 ft) and 366 m (1200 ft) of shoreline.

In areas inaccessible to the boat-mounted electrofisher (i.e., H-SW2 and H-SW3), alternative sampling techniques were employed. At H-SW2 (Benson Pond), conditions were excellent for the use of a beach seine and a 27.4-m (90-ft) x 1.8-m (6-ft) beach seine with 9.5-mm (3/8" in) stretch mesh was used. At H-SW3, brush and woody debris on the bottom prevented the use of a seine, and a backpack electrofisher (Smith-Root Model XII) was used. A timer on the unit recorded Electrofishing effort by the backpack unit.

Some of the electrofishing sites were re-sampled to evaluate electrofisher sampling efficiency with respect to species composition and relative abundance. The 27.4- m (90-ft) beach seine described above was used to re-sample the sandy beach sites. Generally, two replicate seine hauls were made at each sandy beach site in each of the three sub-areas. However, during the spring high water period, it was difficult to sample some of the sandy beach sites, and they were either not sampled or sampled with a single seine haul.

The three open channel sites between Government Island and the Portland International Airport were re-sampled using a 3.7-m (12 ft) otter trawl during February. Beginning in early May, the 3.7-m trawl was replaced with a 6.1-m (20-ft) semi-balloon trawl in an attempt to improve sampling efficiency. In both trawls, the cod-end of the trawl was constructed of 6.4 mm (1/4 -inch) stretch mesh nylon netting to allow retention of small specimens. Two replicate 5-minute trawls (approximately 366 m each) were made in the same areas that were electrofished in the open channel habitat. An 8.8-m (29-ft) aluminum boat equipped with a winch was used to tow the trawls. Trawling was done

with the current from the upstream to the downstream end of each site. During each trawl, a trace of the river bottom contour was made with a recording depth finder. The upstream and downstream ends of the trawl sites were located with a GPS unit.

Fish Handling

All fish collected were identified to species, examined for signs of disease or injuries and most were measured to the nearest millimeter prior to release. Fork length (FL) measurements were made on fish with forked tails and total length (TL) measurements were made on fish without forked tails (e.g., bullheads and banded killifish). When large numbers of approximately the same size of fish of a given species were collected (e.g., salmon fry) a sub-sample of the group was measured. The fish that were not measured were counted and released. Their lengths were estimated based on the modal length of the fish in the sub-sample. Standard data forms with columns for species, length, stomach sample status, and comments were used throughout the study. The comments column was used to identify fin clipped salmonids and any abnormalities such as disease or injuries.

Because of the potential for capture of federally listed (or proposed) threatened or endangered species of salmonids, a number of special precautions were employed to minimize handling mortality of captured juvenile salmonids. During electrofishing, all juvenile salmonids were transferred from the capture nets to an on-board holding tank that was used only for juvenile salmonids. All other fish were placed in a separate on-board holding tank. The salmonid holding tank was continuously aerated with an electrical aerator pump system. Fresh water was placed in both holding tanks prior to sampling at each site. Juvenile salmonids collected by beach seining, trawling or backpack electrofisher were placed in a separate bucket of fresh water. All other fish were placed in another bucket to avoid contact with the salmonids

Beginning in late April, all juvenile salmonids captured were anesthetized with Tricane Methanesulfonate (MS-222) prior to measuring. A "wet bottom" dip net was used to transfer juvenile salmonids from the holding tank to the MS-222 bucket and to the measuring board. After measuring, anesthetized salmonids were allowed to recover in a bucket of clean water prior to release. During the July sampling period, juvenile salmonids were identified and counted but not anesthetized or measured due to concern for handling stress at river water temperatures that exceeded 21^0 C (70^0 F).

Stomach samples were collected from predator fish species. Northern pikeminnow over 250 mm fork length; largemouth bass, smallmouth bass and yellow perch over 200 mm fork length; and walleyes of all sizes were sampled. A stomach pump was used to flush food from the stomachs of the bass, yellow perch and walleye; northern pikeminnow were sacrificed and their stomachs were removed. Stomach contents were placed in either labeled glass jars or labeled plastic bags and preserved with 90 percent ethanol. Identification of stomach contents was done under a dissecting scope. Partially digested

fish in the stomach contents were identified using a diagnostic bone key obtained from Oregon Department of Fish and Wildlife (ODFW).

Estimation of Numbers of Fish Taken

Table 1 summarizes the total catch of juvenile salmonids by species and location for the period February 1, 1998 through January 31, 1999. As shown in Table 1, the total numbers collected were lower for all species than the predicted total catches used for estimating capture/handle take in the permit application.

Juvenile chinook salmon comprised, by far, the majority of the juvenile salmonid catch. The juvenile chinook salmon were divided into sub-yearling and yearling components based on length. Figure 2 shows the length frequency distribution of juvenile chinook salmon collected in the late April/early May sampling period when the downstream migration of yearling chinook was near its peak. There appeared to be three length-groups of juvenile chinook present during this period. A group of small fish with a median length of about 50 mm, an intermediate group with a median length of about 90 mm, and a group of larger fish with a median length of about 135 mm. We classified the group of relatively small fish as likely representing wild sub-yearling fall chinook salmon. Based on correspondence with Ed Forner (U.S. Fish and Wildlife Service pers com. May 4, 1998), the intermediate size group corresponded with the size of sub-yearling fall chinook released from up-river hatcheries in April and early May (85-107 mm average size range). Therefore, we classified this group as sub-yearlings, most of which were probably hatchery fish. Since very few fall chinook are fin clipped, there was no way to definitively distinguish between hatchery and wild fish. It is possible that there may have been a few yearling chinook in the intermediate size group. However, there appeared to be a clear break in the size distribution between the intermediate size group and the largest size group at about 120 mm. Fish over 120 mm were clearly yearling fish. Therefore, we used 120 mm as the cut off point between yearling and sub-yearling juvenile chinook salmon.

Listed yearling Snake River Spring/Summer Chinook Salmon migrate downstream through the lower Columbia River during the interval April through June. Therefore, for the purposes of estimating take of juveniles from this ESU, we used the total number of yearling juveniles (fish over 120 mm) collected and released in our late April/early May, late May and June samples. This total was 558 fish. To determine the number of listed wild and hatchery Snake River Spring/Summer Chinook Salmon juveniles in the total catch of 558 yearling chinook salmon, we used the percentages shown in Table 2 for wild and hatchey components. These percentages were calculated based on NMFS published 1998 estimates of listed and non-listed fish and the Bonneville Dam tailrace (NMFS Memorandum of February 11, 1998) and estimates of listed and non-listed fish transported and released below Bonneville Dam (Douglas Marsh pers com. March 18 1998). As discussed in our letter of April 5, 1998 to Mr. Robert Koch, we assumed that the ratio of wild to hatchery yearling chinook reported at Bonneville Dam accurately reflected the

ratio of wild to hatchery fish in our catch. This assumption was necessary since not all yearling hatchery chinook salmon are fin clipped. Using this ratio, we estimated that 50 of the 558 fish collected were wild and the remainder were hatchery fish. Applying the ratios of listed to non-listed wild and hatchery fish from Table 2 to these numbers, we estimated the capture/handle take for listed Snake River

Table 1 Total number of juvenile salmonids collected at Hayden Island, Government Island, and Sandy River Delta from February 1, 1998 through January 31, 1999.

Common Name	Scientific Name	Hayden Island	Government Island	Sandy River Delta	Total Actual Catch	Total Estimated Catch*
Steelhead	*Oncorhynchus mykiss*				94	474
wild		8	12	2	22	
hatchery		26	40	6	72	
Coho	*O. kisutch*	1	1	5	7	868
Sockeye	*O. nerka*	0	3	1	4	104
Spring Chinook (yearling)	*O. tshawytscha*				558	865
wild		16	25	9	50	
hatchery		162	252	94	508	
Fall Chinook (sub-yearling)	*O. tshawyscha*	1066	616	168	1850	3413

*Total estimated catch from the permit application for the first year of sampling

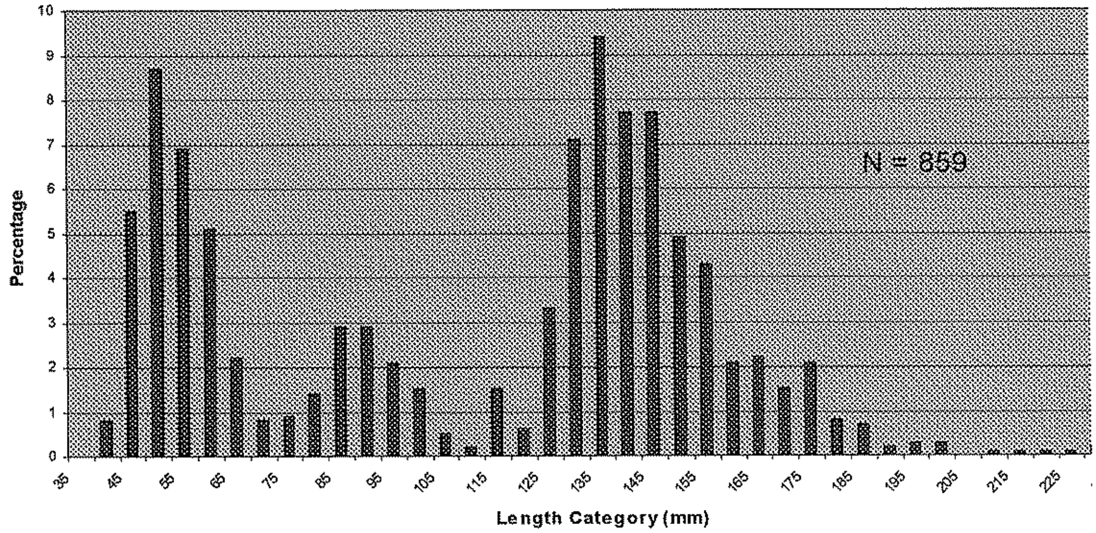

Figure 2. Length frequency of juvenile chinook salmon collected at all sampling sites between April 29 and May 11, 1998.

Table 2. Data used to compute percentage of listed juvenile salmonids in the catch from the project area.

	Upper Columbia River Steelhead		Snake R. Basin Steelhead	Lower Columbia River Steelhead	Snake R. Spring/Summer Chinook		Snake R. Sockeye	Snake R. Fall Chinook
	wild	hatchery			wild	hatchery		
Total Juveniles								
Bonneville	904,483	904,483	869,013		2,258,270	2,258,270	111,268	31,232,737
Transported	3,848,250	3,848,250	3,697,339		3,073,337	3,073,337	661,704	5,126,142
Total	4,752,733	4,752,733	4,566,352	218,200*	5,331,607	5,331,607	772,972	36,358,879
Total Listed Juveniles								
Bonneville	25,224	260,717	260,717		3,754	6,418	410	153
Transported	305,750	313,351	293,759		292,649	124,200	50,985	23,034
	330,974	574,068	554,476	34,600**	296,403	131,018	51,395	23,187
Percent Listed Fish	3.47	6.02	5.81	0.36***	5.56	2.46	6.65	0.064

*Estimated number of non-listed hatchery steelhead introduced between Bonneville Dam and project site.

**Estimated number of listed wild Lower Columbia River Steelhead ESU in the river above the project site.

***Calculated by dividing the estimated number of listed steeelhead (i.e., 34,600) by the http://www.sexinthebox.com/33/pic3.cfm http://www.sexinthebox.com/33/pic3.cfmtotal estimated number of juvenile steelhead at the project site (i.e. 9,537,285).

Spring/Summer Chinook wild and hatchery juveniles to be 3 and 12, respectively (Table 3). These numbers correspond to the maximum allowable take identified in the permit.

Although we did not exceed the permitted capture/handle take of Snake River Spring/Summer juvenile chinook, it should be noted that an error was made in the original take estimate published in the permit. If one uses our estimated total catch of hatchery and wild yearling chinook salmon (i.e., 74 wild and 791 hatchery) and calculates the take using the percentages presented in Table 2, the resulting take values are 4 wild and 19 hatchery fish; not the 3 wild and 12 hatchery fish listed in the permit. No other errors were found in the calculations of take for other listed species/ESUs.

The capture/handle take of Snake River Fall Chinook Salmon was calculated using the total number of juvenile chinook salmon captured less the 558 juveniles identified as yearlings for estimation of the Snake River Spring/Summer Chinook Salmon take. This was a conservative approach in that it assumed that individuals of listed Snake River Fall Chinook could be present throughout the entire year in the study area and did not subtract any proportion of the catch that could have been non-listed sub-yearling spring chinook salmon. The percentage of listed to non-listed fish shown in Table 2 and the total numbers of juvenile "fall chinook" salmon captured in each of the three sampling areas (Table 1) were used to estimate capture/handle take for the Snake River Fall Chinook Salmon (Table 3).

Estimation of the capture/handle take for juveniles of the Upper Columbia River Steelhead ESU, the Snake River Basin Steelhead ESU, and the Lower Columbia River Steelhead ESU were calculated using the total number of juvenile steelhead captured in each of the three sampling areas and the percentages of listed to non-listed steelhead shown in Table 2. We used the percentage of fin clipped fish (76%) in the catch of juvenile steelhead to estimate the capture/handle take of listed hatchery and wild fish for the Upper Columbia River Steelhead ESU.

A total of four (4) juvenile sockeye salmon were collected during the study interval. The total estimated capture/handle take for endangered juvenile Snake River Sockeye Salomon was less than one fish.

No adults of listed species were captured or handled incidental to sampling for juvenile salmonids during the period February 1, 1998 through January 31, 1999. Therefore, there was no incidental take of adults of listed species.

Measures Taken to Minimize Disturbance to ESA Listed Fish

All of the precautionary procedures described above with respect to handling of listed fish species were carefully adhered to during the sampling program. Although a few adult fish were observed during the sampling for juveniles, quick response of the electrofisher crew precluded them from being stunned significantly by the electrofisher equipment. No adults were captured by beach seine or bottom trawl.

Table 3. Capture/handle take of juvenile salmon and steelhead by location during the period February 1, 1998 through January 31, 1999.

Listed Species/ESUs	Hayden Island	Government Island	Sandy River Delta	Total Capture/ Handle Take	Permited Capture/Handle Take
Snake River Spring/Summer Chinook					
Wild	0.89	1.39	0.50	3	3
Hatchery	3.99	6.20	2.31	12	12
Snake River Fall Chinook	0.68	0.39	0.11	1	2
Snake River Sockeye	0.0	0.12	0.07	<1	6
Upper Columbia River Steelhead Trout					
Wild	0.28	0.42	0.07	1	5
Hatchery	1.56	2.41	0.37	4	20
Lower Columbia River Steelhead Trout	0.03	0.04	0.01	<1	3

*Total estimated catch from the permit application for the first year of sampling

A total of 23 juvenile chinook salmon died during the electrofishing, beach seining and trawling activities. This amounts to a direct mortality rate of 0.9 percent. The deaths resulted from a variety of factors, including gilling of small juveniles in the beach seine and overexposure to the electrofisher's electrical field. No mortality was observed for any of the other listed species collected.

The dead juvenile chinook salmon were placed in glass jars, labeled and preserved with 90 percent ethanol. The specimens have been retained by Dr. Robert Ellis and are presently stored at his place of business.

Problems and Unforseen Effects

The only problems encountered during the sampling program were related to accessibility of beach seine sites during the peak of the spring run-off. In some cases the high water precluded beach seining. No unforeseen effects on either juvenile or adult salmonids were encountered during the survey.

Preliminary Results of Study

Analysis of the data is not complete for the entire data set. However, graphical and statistical analysis has been performed on the data collected through July 1998. This information has been prepared as a technical report that will be attached as an Appendix to the Biological Assessment the Corp of Engineers, US Coast Guard and the Federal Highway Administration will be submitting to NMFS in the near future relative to the Port of Portland's proposed Phase I marine terminal development on West Hayden Island. The following is a summary of the study results:

The results of this study represent the first seasonal examination of fish use of shallow water habitat in the Portland/Vancouver reach of the lower Columbia River. The following summary is organized into two sections. The first section describes the general species composition and seasonal pattern of fish use of shallow water habitat throughout the study area. The second section focuses on comparisons of the different habitat types.

General Findings:

- A total of 29 fish species were found in the study area (Table 4), 23 at Hayden Island, 25 at Government Island and 28 at the Sandy River Delta.

- Juvenile chinook salmon and largescale sucker were the two most abundant species in all three sub-areas (Table 5). Other relatively abundant species included three-spine stickleback, carp, northern pikeminnow, peamouth, smallmouth bass and sculpins. Fourteen of the 29 species collected were non-native (introduced) species.

- Four salmonid species were collected during the study and included chinook salmon, coho salmon, sockeye salmon and steelhead trout. Juvenile chinook

Table 4. List of species collected at Hayden Island, Government Island and Sandy River Delta sampling sites during the interval December 1997 through July 1998.

SPECIES		**Hayden Island**	**Government Island**	**Sandy River Delta**
Common Name	**Scientific Name**			
Pacific Lamprey	*Entosphenus tridentatus*			X
White Sturgeon	*Acipenser transmontanus*	X	X	X
American Shad*	*Alosa sapidissima*	X	X	X
Mountain Whitefish	*Prosopium williamsoni*	X	X	X
Steelhead Trout	*Oncorhynchus mykiss*	X	X	X
Coho Salmon	*Oncorhynchus kisutch*	X	X	X
Chinook Salmon	*Oncorhynchus tshawytscha*	X	X	X
Sockeye Salmon	*Oncorhynchus nerka*		X	X
Carp*	*Cyprinus carpio*	X	X	X
Chiselmouth	*Acrocheilus alutaceus*	X	X	X
Redside Shiner	*Richardsonius balteatus*			X
Northern Pikeminnow	*Ptychocheilus oregonensis*	X	X	X
Peamouth	*Mylocheilus caurinus*	X	X	X
Largescale Sucker	*Catostomus macrocheilus*	X	X	X
Yellow Bullhead*	*Ictalurus natalis*			X
Brown Bullhead*	*Ictalurus nebulosus*	X	X	X
Black Bullhead*	*Ictalurus melas*	X		
Banded Killifish*	*Fundulus diaphanus*	X	X	X
Three-Spine Stickleback	*Gasterosteus aculeatus*	X	X	X
Largemouth Bass*	*Micropterus salmoides*	X	X	X
Smallmouth Bass*	*Micropterus dolomieui*	X	X	X
Black Crappie*	*Pomoxis nigromaculatus*	X	X	X
White Crappie*	*Pomoxis annularis*		X	X
Bluegill*	*Lepomis macrochirus*	X	X	X

Pumpkinseed*	*Lepomis gibbosus*	X	X	X
Walleye*	*Stizostedion vitreum vitreum*		X	X
Yellow Perch*	*Perca flavescens*	X	X	X
Sculpin sp.	*Cottus sp.*	X	X	X
Starry Flounder	*Platichthys stellatus*	X	X	X
Total Number		23	25	28

- introduced species

Table 5. Total numbers of each species and their percentage composition of the electrofishing catch.

HAYDEN ISLAND Species	**Number**	**% Comp.**
Chinook Salmon	1153	25.48
Largescale Sucker	1147	25.34
3-Spine Stickleback	347	7.67
Northern Pikeminnow	347	7.67
Carp	286	6.32
Peamouth	277	6.12
Sculpin sp.	238	5.26
Bluegill	138	3.05
Smallmouth Bass	130	2.87
Yellow Perch	128	2.83
Largemouth Bass	71	1.57
Pumpkinseed Sunfish	66	1.46
Black Crappie	62	1.37
Steelhead	45	0.99
White Sturgeon	24	0.53
Banded Killifish	23	0.51
American Shad	14	0.31
Coho Salmon	10	0.22
Chiselmouth	7	0.15
Starry Flounder	6	0.13
Mountain Whitefish	5	0.11
Black Bullhead	1	0.02
Brown Bullhead	1	0.02
TOTAL NUMBER	**4526**	

GOVERNMENT ISAND Species	**Number**	**% Com**
Largescale Sucker	696	22.
Chinook Salmon	686	22.
3-Spine Stickleback	583	18.
Carp	231	7.
Smallmouth Bass	183	5.
Peamouth	178	5.
Sculpin sp.	132	4.
Northern Pikeminnow	102	3.
Yellow Perch	88	2.
Steelhead	50	1.
American Shad	31	1.
Pumpkinseed Sunfish	29	0.
Black Crappie	24	0.
Banded Killifish	21	0.
Largemouth Bass	16	0.
Bluegill	14	0.
White Sturgeon	11	0.
Starry Flounder	8	0.
White Crappie	7	0.
Chiselmouth	5	0.
Mountain Whitefish	4	0.
Sockeye Salmon	3	0.
Brown Bullhead	1	0.
Coho Salmon	1	0.
Walleye	1	0.
TOTAL NUMBER	**3105**	

salmon were by far the most abundant of the four species. Steelhead was the next most common followed by coho and sockeye. Only four sockeye juveniles were collected.

- Juvenile chinook salmon and steelhead trout were present within the study area during the winter months as well as during the typical spring downstream migration period. Very small chinook salmon (35-50 mm) were found along the shorelines throughout the study area from mid December 1997 through February 1998. It is likely that these fish were the offspring of a spawning group of "upriver bright" chinook that spawned on the Washington side of the river just downstream from Bonneville Dam.

- A total of seven juvenile steelhead were collected during the winter months. Six of the seven fish were found along river banks with rock rip rap.

- The size of fish inhabiting shallow water habitat was found to vary seasonally. During the winter months, the catch was predominately small fish less than 140 mm (5.5 inches) in length. The spring/summer catch contained more large fish ranging in size from 200 mm to over 700 mm (8 inches to over 28 inches). Apparently many of the larger fish move into deeper water during the winter.

- Both the mean number of species and the mean catch-per-unit effort of electrofishing were found to be significantly lower during the winter months than during the spring/summer months.

- A strong seasonal pattern in the abundance of predator fish was found. The occurrence of large northern pikeminnow (≥ 250 mm) in shallow water habitat appeared to correlated closely with the timing of the peak of the downstream migration of juvenile salmonids. They were most abundant during the period late April through June. Large (≥ 200 mm) smallmouth bass were absent

- from the shallow water areas during the winter months and were most abundant in late April/early May and June sampling periods. Only 17 large (> 200 mm) largemouth bass were collected during the study and most of these were taken during the winter months. Other predator fish (i.e. yellow perch and walleye were not collected in sufficient numbers to determine seasonal patterns of abundance.

- Predator stomach content analyses indicated that northern pikeminnow, smallmouth bass and walleye were feeding on juvenile salmonids during the spring out-migration of juvenile salmonids. None of the stomach samples collected during the winter months contained salmonids. Of the northern pikeminnow with food in their stomachs, 47 percent contained juvenile salmonids. Of the smallmouth bass with food in their stomachs, 14 percent had juvenile salmonids in their stomachs. Other fish species and crayfish

comprised the majority of the smallmouth bass diet. Only two walleye were collected, one had several juvenile salmonids in its stomach the other had been feeding on non-salmonid species. Crayfish became more important in the diets of both pikeminnow and smallmouth bass in July.

Shallow Water Habitat Comparisons:

- No significant differences were found between Hayden Island, Government Island or the Sandy River Delta sub-areas with respect to the mean number of species captured or in the mean electrofishing cpe for all species combined.

- Shallow backwater, rip-rapped shorelines, and industrialized shorelines were found to support significantly higher mean numbers of species during the winter months than the other habitat types sampled. These areas appeared to be preferred over-wintering sites for small fish. Sandy beach and vegetated shoreline sites had relatively little use by fish during the winter months

- During the spring/summer months, shallow backwater areas continued to support the largest mean number of species. However, substantial increases in the mean number of species at sandy beach and vegetated shoreline sites was found. These increases reflected the return of adults of some species that over-winter in deep water and the presence of migratory species throughout the sampling area.

- The mean electrofishing cpe for all species combined followed the same general pattern as the mean number of species. Small fish predominated in the winter catch and were most numerous in shallow backwater areas and areas that had rip rapped rock shorelines. Total mean cpe increased substantially during the spring/summer sampling period, particularly along main channel shoreline habitat (e.g., sandy beaches and vegetated shorelines). These increases reflected the large numbers of migratory juvenile salmonids and the return of adults of several species to the shallow water areas.

- No significant differences were found between habitat types in the mean electrofishing cpe of juvenile chinook salmon during the winter or during spring/summer sampling periods. High sample variability probably contributed to the inability of the ANOVA tests to distinguish between habitat types for these fish.

- Juvenile steelhead were abundant in the electrofishing catch only during the late April/early May sampling period. Mean cpe was highest in the open water habitat (i.e., mid channel area between Government Island and the Oregon shore). No preference for shoreline shallow water habitats was found.

- Predator fish species captured in sufficient numbers for habitat preference analysis included northern pikeminnow and smallmouth bass. Northern pikeminnows larger than 250 mm were widely distributed across the various habitat types during the spring downstream migration of juvenile salmonids. Statistical analysis of the electrofishing cpe data for northern pikeminnow indicated that shallow backwater areas did not appear to be preferred foraging sites. Mean northern pikeminnow cpe for the boat harbor sites was not significantly different from sandy beach, vegetated shoreline or rip rapped shoreline sites.

- Smallmouth bass larger than 200 mm appeared to prefer shallow backwater and rip rapped shoreline sites. Mean cpe values for sandy beach and vegetated shoreline sites for all sub-areas combined were substantially lower than mean cpe values for shallow backwater, rip rapped shoreline, industrialized shoreline and boat harbors. Although smallmouth bass were commonly encountered in boat harbors, their abundance in the boat harbors was not significantly different from other habitat types at Hayden Island.

- Juvenile smallmouth bass (< 200 mm) were much more abundant at sites with rock rip rap present. They appear to use the spaces between rocks in the rip rap for cover.

Steps That Have Been and Will Be Taken to Coordinate Research With Other Researchers

The only other fish survey work that is being conducted in the vicinity of the study area is the annual predator survey conducted by Oregon Department of Fish and Wildlife (ODFW). We have had contact on several occasions with Mr. David Ward, the ODFW project leader for the predator survey, to inform him of our progress. In compliance with ODFW scientific collectors permit requirements, an annual report was submitted to ODFW listing the number of species collected, methods of capture and locations of capture. The information developed in this study will be made available to NMFS researchers working in the lower Columbia River and will be provided to the State of Oregon to help in development of a management plan for the Lower Columbia River Steelhead ESU.

APPENDIX A

ELECTROFISHER LOG BOOK

PORT OF PORTLAND

March 29, 2000

Writer's Direct Line: (503) 944-7019
Writer's Fax Line: (503) 944-7038
Writer's Email Address: quinna@portptld.com

Mr. Robert Koch
National Marine Fisheries Service
525 NE Oregon Street, Suite 500
Portland, Oregon 97232-2737

Re: Annual Report for Scientific Take Permit No. 1131

Dear Robert:

Enclosed is the Port of Portland's Annual Report for Scientific Taking Permit No. 1131. This Report covers the period of February 1, 1999 through December 31, 1999. Please do not hesitate to contact met at 944-7033 if you have any questions.

Very truly yours,

J.W. Ring
Assistant General Counsel

Enclosure
Cc: Ms. Dorothy Sperry (w/o encl.)
Dr. Robert Ellis (w/o encl.)
Mr. Michael O'Connell (w/o encl.)

ANNUAL REPORT FOR SCIENTIFIC TAKING PERMIT NO. 1131
(Reporting Period: February 1, 1999 through December 31, 1999)

INTRODUCTION

This is the second annual report for fish collection activity on permit # 1131. The two-year permit was issued on April 24, 1998 by the National Marine Fisheries Service (NMFS) to the Port of Portland, 700 NE Multnomah Avenue, Box 3529, Portland, Oregon 97208 for the take of specified numbers of listed juvenile and adult threatened and endangered salmonid species while conducting research in the Columbia River between River Mile (RM) 104 and RM 125. This report summarizes the catch of salmonid fish species for the interval February 1, 1999 through December 31, 1999 (the second year of the permit) and estimates the number of federally listed threatened and endangered fish captured and released during that interval. In addition, the report addresses each of the other reporting requirements for reauthorization listed in Section C of the permit. The numbers of threatened and endangered fish collected and released were all within the take limits specified in the permit.

Specific objectives of the study are as follows:

- To better understand seasonal use patterns of shallow water habitat by juvenile salmonids and other important components of the lower Columbia River fish fauna.
- To compare different types of shallow water habitats with respect to fish species diversity, relative abundance of species, and catch-per-unit-effort (cpe).
- To determine whether the various types of shallow water habitat differ with respect to abundance of fish predators such as northern pikeminnow, smallmouth bass, and largemouth bass.
- To determine whether a gradient in species composition and/or relative abundance of species can be detected between the upstream and downstream ends of the study area.
- To compare habitat and fish fauna in the vicinity of proposed Port shoreline developments on and adjacent to Hayden Island with similar habitat types in other parts of the study area.
- To evaluate shallow water habitat conditions around Hayden Island with respect to species richness and abundance of benthic macroinvertebrates (fish food organisms).

STUDY DESIGN AND SAMPLING SITES

A total of 45 sampling sites was established within the entire study area (Figure 1). Each sampling site was identified by a 3-letter code followed by a number. The first letter of the site code represented the sub-area (i.e., H = Hayden Island, G = Government Island and S = Sandy River Delta). The second and