

Distribution of Fish in Portland Tributary Streams

Annual Report 2001-02

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Funded by

City of Portland  
Endangered Species Act Program  
1120 SW 5<sup>th</sup> Avenue  
Portland, OR 97204

November 2002

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## REPORT SUMMARY

In 2001 we began a project to inventory fish communities in Portland streams to 1) evaluate abundance and distribution of fish species, 2) evaluate seasonal use of streams by fish species of special interest, and 3) calculate an index of biotic integrity (IBI) and compare biotic health among streams and reaches. We conducted fish surveys in eight Portland streams including Balch, Crystal Springs, Johnson, Kelley, Miller, Saltzman, Stephens, and Tryon creeks. In summer 2001 we used a backpack electrofisher to sample 20% of the fast water units (riffles and cascades), glides, and pools within each stream reach. In each season from summer 2001 through spring 2002 we sampled an easily accessible, representative 100-m length of each stream reach.

During extensive summer surveys we collected 2,270 fish from six families. We identified 11 native species of fish from four families and one non-native species. The majority of the fish collected were cottids (62%), followed in abundance by cyprinids (27%) and salmonids (9%). We collected 200 salmonids from four species including chinook salmon *Onchorhynchus tshawytscha*, coho salmon *O. kisutch*, cutthroat trout *O. clarki*, and rainbow trout/steelhead *O. mykiss*. We captured most cutthroat trout in Balch and Tryon creeks.

We collected 4,811 fish during intensive seasonal sampling. We identified 14 native species from five families and seven non-native species from four families. The majority of our catch was cottids at 51% and most of those (71%) were reticulate sculpin *Cottus perplexus*. Next in abundance were cyprinids (27% of the catch) and salmonids (13%). Almost 3% of the total catch was non-native species. We found the greatest diversity of native fish in Johnson and Crystal Springs creeks, with each containing 11 species, followed by Stephens Creek with nine. Miller and Stephens creeks were the only streams in which we found non-native species.

We collected 614 salmonids from four species. Cutthroat trout were most abundant (68% of the salmonid catch) followed by coho salmon (18%), chinook salmon (9%), and rainbow trout/steelhead (4%). We found 32% of the cutthroat trout in Reach 1 of Balch Creek. Salmon were most abundant in Stephens Creek, where we found 67% of the chinook salmon and 43% of the coho salmon. Salmonids composed 22% of the total catch in winter, 15% in spring, 10% in fall, and 9% in summer.

Index of Biotic Integrity scores ranged from 0 to 57 for extensive summer sampling. Scores indicated that all but four of the 23 reaches surveyed were severely impaired. No scores were considered acceptable. Seasonal IBI scores ranged from 0 to 75. Eleven scores indicated marginally impaired reaches, whereas 64 indicated severely impaired reaches.

Low IBI scores can probably be attributed to barriers and environmental disturbances in Portland streams. A 242-m cement canal running from the mouth of Saltzman Creek to Front Avenue may impede fish movement. A culvert crossing under Highway 30 on Miller Creek (about 275 m from the confluence of Miller Creek and Multnomah Channel) may impede fish movement seasonally. An impassable corrugated metal culvert located approximately 100 m upstream from the confluence with the Willamette River may completely block fish passage in Stephens Creek.

Our plans for 2002-2003 are to repeat sampling in all stream reaches. Multiple years of data will allow us to monitor and compare fish communities, compare data under variable flow and environmental conditions, and characterize population dynamics such as age, growth, and rates of recruitment.

## INTRODUCTION

In 2001, the Oregon Department of Fish and Wildlife (ODFW) and the City of Portland's Endangered Species Act Program began a project to inventory fish communities in Portland streams. Currently, very little fish presence information is available for Portland streams; however, the City of Portland's Framework for Integrated Management of Watershed and River Health requires knowledge of distribution and habitat use of fish, particularly species listed under the Federal Endangered Species Act (ESA). Fish surveys provide important baseline information on species distribution, and may assist managers with prioritizing habitat protection and restoration work.

Previous urban stream surveys conducted in Washington and Clackamas counties within the Portland metropolitan area (Ward 1995; Friesen and Ward 1996; Friesen and Zimmerman 1999; Leader 2001a; Leader 2001b) documented numerous salmonid species including cutthroat trout *Oncorhynchus clarki*, rainbow trout/steelhead *O. mykiss*, chinook salmon *O. tshawytscha*, and coho salmon *O. kisutch*. Currently, lower Columbia River and upper Willamette River chinook salmon, and lower Columbia River and upper Willamette River steelhead are federally listed under the ESA as threatened species (NOAA 1999). In 1999, lower Columbia River coho salmon were listed as an endangered species under the Oregon Endangered Species Act (Chilcote 1999).

Other species of interest include lamprey *Lampetra* spp. and torrent sculpin *Cottus rhotheus*. Lamprey are declining throughout their range in western North America (Close et al. 1995; Vella et al. 1999). Western brook lamprey *L. richardsoni* and Pacific lamprey *L. tridentata* are known to utilize habitat within the study area. Like salmonids, torrent sculpin may be sensitive to habitat degradation and pollution. Torrent sculpin have been collected in very few streams within the Portland urban area (Ward 1995; Friesen and Ward 1996; Friesen and Zimmerman 1999; Leader 2001a; Leader 2001b).

The purpose of this study is to: 1) evaluate abundance and distribution of fish species in City of Portland streams, 2) evaluate seasonal use of streams by fish species of special interest, and 3) calculate an index of biotic integrity (IBI) and compare biotic health among streams and reaches.

## STUDY AREA

We conducted fish surveys in eight Portland streams including Balch, Crystal Springs, Johnson, Kelley, Miller, Saltzman, Stephens, and Tryon creeks (Figure 1). Balch and Saltzman creeks flow through Forest Park in Portland and enter the Willamette River on the west bank. Miller Creek also flows through Forest Park but enters Multnomah Channel, which flows from the Willamette River into the Columbia River. Tryon and Stephens creeks flow into the Willamette River, on the west side, south of downtown Portland. Johnson Creek enters the Willamette River on the east side at Milwaukie. Crystal Springs and Kelley creeks are tributaries of Johnson Creek. Crystal Springs Creek is located in the Sellwood area of Portland and Kelley Creek enters Johnson Creek near Gresham. Reach descriptions and maps are given in Appendix A.

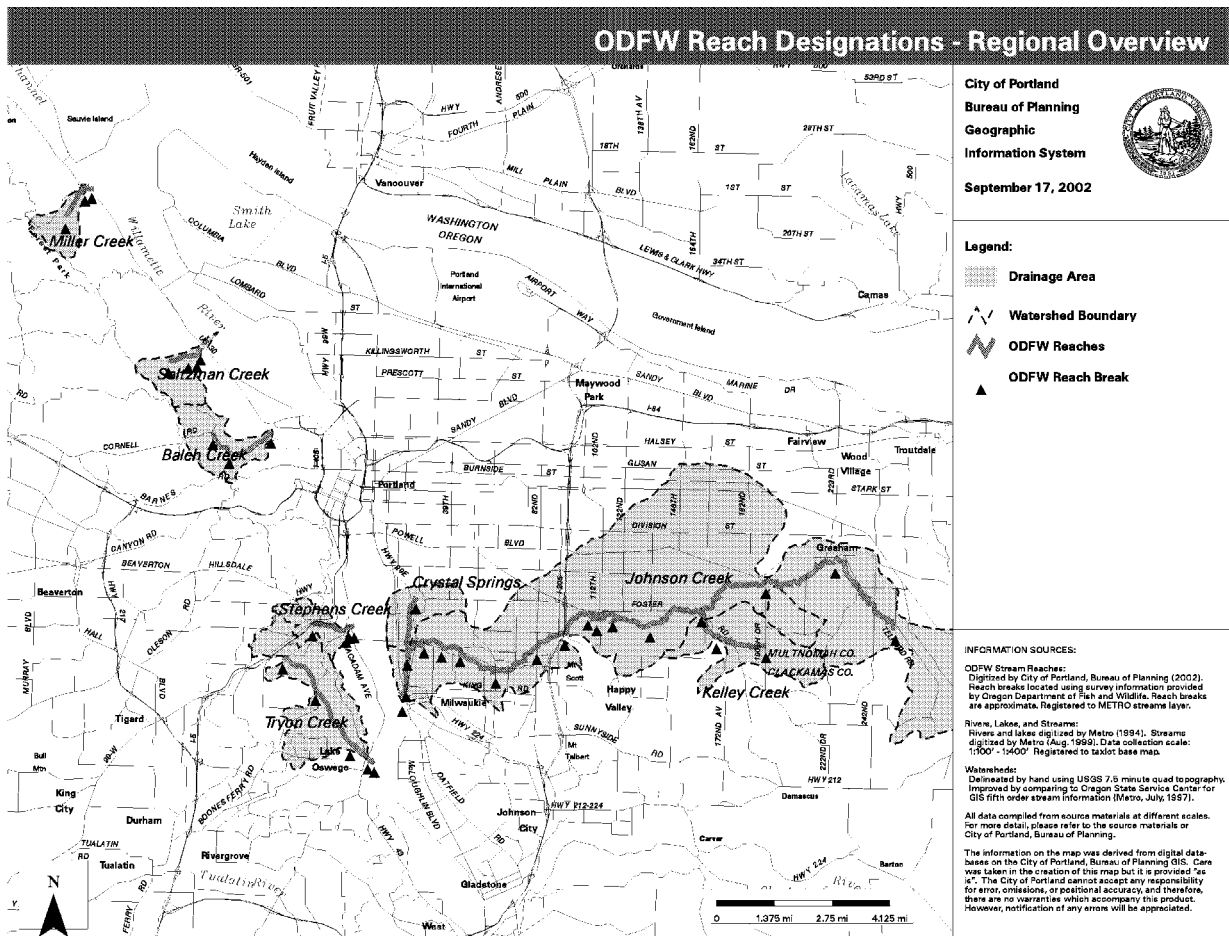
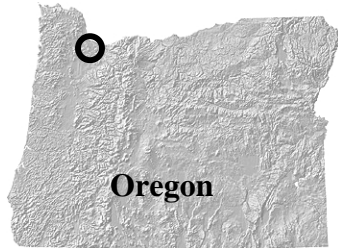


Figure 1. Portland streams surveyed in 2001-02 (Balch, Crystal Springs, Johnson, Kelley, Miller, Saltzman, Stephens, and Tryon creeks).

## **METHODS**

### **Extensive Summer Sampling**

We conducted fish surveys using a backpack electrofisher during summer at or near minimum flow levels. Backpack electrofisher settings varied from 200-400 volts at 30 Hz DC. Within each stream reach we sampled 20% of the fast water units (riffles and cascades), glides, and pools (Hankin and Reeves 1988). Reaches were delineated by significant landscape changes, major tributaries, or passage barriers (Moore et al. 1997). We randomly selected one of the first five units of each habitat type (fast water, glide, or pool) as a starting point for sampling each reach then sampled every fifth unit of each habitat type. Electrofishing was limited to one pass through each designated habitat unit. We measured length and width of each unit to calculate total surface area electrofished.

Fish collected from each sampled habitat unit were identified, measured, and checked for anomalies. Fish were then released back into the habitat unit sampled.

### **Intensive Seasonal Sampling**

During extensive surveys we identified an easily accessible, representative 100-m length of each stream reach to be sampled seasonally with the backpack electrofisher, from summer 2001 through spring 2002. Not all reaches were sampled every season due to weather constraints. Block nets were placed at the top and bottom of the sampling area to prevent fish escapement. We started surveys at the downstream end of the sampling area and worked upstream. We collected as many fish as possible and counted those that escaped. If salmonids were present, we conducted additional passes through the study area until no salmonids were captured or a maximum of three passes were completed (Armour et al. 1983).

## **Data Analysis**

### **Index of Biotic Integrity**

We calculated an index of biotic integrity (IBI) for extensive summer sampling and intensive seasonal sampling. An IBI is a scoring criteria used to rank a stream based on current biological integrity (Hughes et al. 1998). The IBI is useful for assessing the effects of humans on entire fish assemblages. We generated IBI's for Portland streams by applying our field survey data to a set of 12 metrics (Table 1). All fish collected and identified were used to calculate IBI's for extensive summer sampling. Intensive seasonal sampling IBI's were calculated using fish collected during the first pass of electrofishing only. Final IBI scores are given as a percentage of the maximum total of 120 points (10 points per metric); therefore, the maximum possible IBI score is 100. Streams with an IBI  $\leq 50$  are considered severely impaired, streams scoring 51-74 are moderately impaired, and streams with a score  $\geq 75$  are considered acceptable.

Table 1. IBI scoring criteria used for Portland streams, 2001-2002, modified from Hughes et al. (1998). Each metric is scored on a scale from 0-10. Raw data values at low end of the ranges (high end of ranges for metrics 8, 10, and 12) are scored as 0; those at the high end (low end for metrics 8, 10, and 12) are scored as 10. Scores between the upper and lower thresholds are calculated by linear interpolation. Final IBI scores are given as a percentage of the maximum total of 120.

Metric	Raw values	
	Stream order 1	Stream order 2 and 3
Taxonomic richness		
(1) Number of native families	0-4	0-7
(2) Number of native species	0-5	0-11
Habitat guilds		
(3) Number of native benthic species	0-3	0-7
(4) Number of native water column species	0-2	0-4
(5) Number of hider species	0-4	0-4
(6) Number of sensitive species	0-2	0-5
(7) Number of native nonguarding lithophil nester species <sup>a</sup>	0-3	0-3
(8) Percent tolerant individuals	10-0	10-0
Trophic guilds		
(9) Percent filter-feeding individuals	0-10	0-10
(10) Percent omnivores	10-0	10-0
Individual health and abundance		
(11) Percent of target species that include lunkers <sup>b</sup>	0-100	0-100
(12) Percent of individuals with anomalies	2-0	2-0

<sup>a</sup> Species that create nests in gravel or smaller substrate.

<sup>b</sup> Lunkers are relatively large individuals of the following species and sizes: prickly sculpin *Cottus asper* (100 mm), torrent sculpin (100 mm), rainbow trout/steelhead (300 mm), cutthroat trout (250 mm), chiselmouth *Acroheilus alutaceus* (300 mm), northern pikeminnow *Ptychocheilus oregonensis* (300 mm), and largescale sucker *Catostomus macrocheilus* (300 mm).

## **Salmonid Population Estimates**

We used a multiple pass electrofishing model by Armour et al. (1983) to estimate salmonid populations within each stream reach. When multiple salmonid species were collected, we estimated the abundance of each.

## **RESULTS**

### **Extensive Summer Sampling**

During extensive summer sampling we surveyed 7,568 m<sup>2</sup> of surface area in 23 stream reaches (Appendix B). The largest reach we sampled was Reach 16 of Johnson Creek, which included 1,330 m<sup>2</sup> or approximately 18% of the total area sampled. Reach 3 of Stephens Creek had the smallest surface area at 14 m<sup>2</sup> or less than one percent of the total area sampled.

We sampled 318 aquatic habitat units for fish presence (Appendix B). Aquatic habitat units sampled included 121 fast water units, 121 pools and 76 glides. The largest number of fast water units sampled was in Reach 16 of Johnson Creek with 20, followed by Reach 1 of Balch Creek with 17. Tryon creek had the most pools sampled with 43. Crystal Springs Creek had the fewest pools sampled with one. Of the 23 reaches we sampled, five had no glides. The largest number of glides sampled was in Reach 16 of Johnson Creek with 18, or 23.7% of all glides sampled.

During extensive summer sampling we collected 2,270 fish from six families (Table 2). We identified 11 native species of fish from four families and one non-native species (largemouth bass). Lamprey were also collected but not identified to species. The majority of fish collected were cottids (62%), followed in abundance by cyprinids (27%) and salmonids (9%). Forty-three percent of the fish we collected came from fast water habitat units, 32% from glides, and 25% from pools. Salmonids composed 25% of the total catch in pools, but only about 4% in fast water and glides.

The number of species identified per stream ranged from zero to ten with a mean of 3.4 (Appendix C). No fish were collected in Saltzman Creek or in reaches 2 and 3 of Stephens Creek. The average number of native species per stream was 3.3. Johnson Creek had the greatest species diversity with nine native species (plus unidentified lamprey) and largemouth bass. The number of families per stream ranged from zero to five with a mean of 1.8. Centrarchids were the only non-native family collected. Johnson Creek had the greatest number of families including salmonids, lamprey, cottids, cyprinids, and centrarchids.

We collected 200 salmonids from four species including cutthroat trout (183), chinook salmon (12), rainbow trout/steelhead (4), and coho salmon (1). The number of salmonid species per stream ranged from zero to three (Figure 2). Only in Johnson and Tryon creeks did we find both cutthroat trout and rainbow trout/steelhead. We found coho salmon in Johnson Creek only, whereas chinook salmon were found in Tryon and Stephens creeks. We captured most cutthroat trout in Balch (120) and Tryon creeks (50). Fork length of cutthroat trout in Balch Creek ranged from 29-230 mm with a mean of 118 mm (Figure 3). Cutthroat trout in Tryon Creek had a mean fork length of 125 mm and ranged from 52-228 mm.



Table 2. Fish collected from extensive (Ext.) and intensive (Int.) sampling in Portland streams, summer 2001 through spring 2002.

Family, Species	Catch		Percent of Catch	
	Ext.	Int.	Ext.	Int.
Petromyzontidae				
Unidentified lamprey <i>Lampretra</i> spp.	14	165	0.6%	3.4%
Cyprinidae				
Northern pikeminnow <i>Ptychocheilus oregonensis</i>	--	2	--	0.0%
Longnose dace <i>Rhinichthys cataractae</i>	144	164	6.3%	3.4%
Speckled dace <i>Rhinichthys osculus</i>	161	363	7.0%	7.5%
Redside shiner <i>Richardsonius balteatus</i>	315	759	13.8%	15.8%
Cobitidae <sup>a</sup>				
Oriental weatherfish <i>Misgurnus anguillicaudatus</i>	--	1	--	0.0%
Catostomidae				
Largescale sucker <i>Catostomus macrocheilus</i>	--	130	--	2.7%
Salmonidae				
Cutthroat trout <i>Onchorhynchus clarki</i>	183	417	8.0%	8.7%
Coho salmon <i>Onchorhynchus kisutch</i>	1	113	0.0%	2.4%
Rainbow trout/steelhead <i>Onchorhynchus mykiss</i>	4	27	0.2%	0.6%
Chinook salmon <i>Onchorhynchus tshawytscha</i>	12	52	0.5%	1.1%
Unidentified salmonids <i>Salmonidae</i> spp.--	--	5	--	0.1%
Fundulidae <sup>a</sup>				
Banded killifish <i>Fundulus diaphanus</i>	--	1	--	0.0%
Poeciliidae <sup>a</sup>				
Western mosquitofish <i>Gambusia affinis</i>	--	100	--	2.1%
Gasterosteidae				
Three-spined stickleback <i>Gasterosteus aculeatus</i>	2	14	0.1%	0.3%
Cottidae				
Prickly sculpin <i>Cottus asper</i>	10	81	0.4%	1.7%
Riffle sculpin <i>Cottus gulosus</i>	32	117	0.1%	2.4%
Reticulate sculpin <i>Cottus perplexus</i>	1,030	1,757	45.0%	36.5%
Torrent sculpin <i>Cottus rhotheus</i>	--	6	--	0.1%
Unidentified sculpins <i>Cottidae</i> spp.	361	510	16.0%	10.6%

Table 2 (continued).

Centrarchidae <sup>a</sup>					
Pumpkinseed	<i>Lepomis gibbosus</i>	--	7	--	0.2%
Bluegill	<i>Lepomis macrochirus</i>	--	1	--	0.0%
Smallmouth bass	<i>Micropterus dolomieu</i>	--	7	--	0.2%
Largemouth bass	<i>Micropterus salmoides</i>	1	--	0.0%	--
White crappie	<i>Pomoxis annularis</i>	--	12	--	0.2%

<sup>a</sup>Non-native families

We found few other species of special interest. Lamprey were limited to reaches 8, 14, and 16 of Johnson Creek. We did not collect any torrent sculpin during extensive summer sampling.

### Intensive Seasonal Sampling

#### Overall Catch

We completed 145 electrofishing passes in 22 stream reaches from August 2001 through June 2002. In summer, fall, winter, and spring, we conducted 43, 36, 20, and 46 electrofishing passes respectively. We sampled all reaches each season except winter, when high flows and turbidity limited sampling to 11 reaches. No sampling was conducted in Tryon Creek, and only Reach 2 of Johnson Creek was sampled in winter.

We collected 4,811 fish from all electrofishing passes completed during intensive seasonal sampling. We identified 14 native species from five families and seven non-native species from four families (Table 2). Lamprey were also collected in all seasons but not identified to species. The majority of our catch was cottids at 51% and most of those (71%) were reticulate sculpin. Next in abundance were cyprinids (27% of the catch) and salmonids (13%). Almost 3% of the total catch was non-native species, including oriental weatherfish, banded killifish, western mosquitofish, pumpkinseed, bluegill, smallmouth bass, largemouth bass, and white crappie.

We identified 4,002 native fish to species (Appendix D). The average number of native fish species per stream was 6.0, and the average number of native families was 2.6. The number of species per stream ranged from 0-15, with the number of native fish species ranging from 0-11. We found the greatest diversity of native fish in Johnson and Crystal Springs creeks, with each containing 11, followed by Stephens Creek with nine. We collected no fish in Saltzman Creek and only cutthroat trout were present in Balch Creek. Our largest catches were in the Johnson Creek drainage. We collected 1,626 native fish in Johnson Creek, followed by Kelley Creek with 904 and Crystal Springs Creek with 868.

Miller and Stephens creeks were the only streams in which we found non-native species (Appendix D). We collected and identified a total of 131 non-native fish, all from the lowest reach of each stream. We collected banded killifish, oriental weatherfish, and bluegill in Miller Creek, and pumpkinseed, smallmouth bass, and white crappie in Stephens Creek.

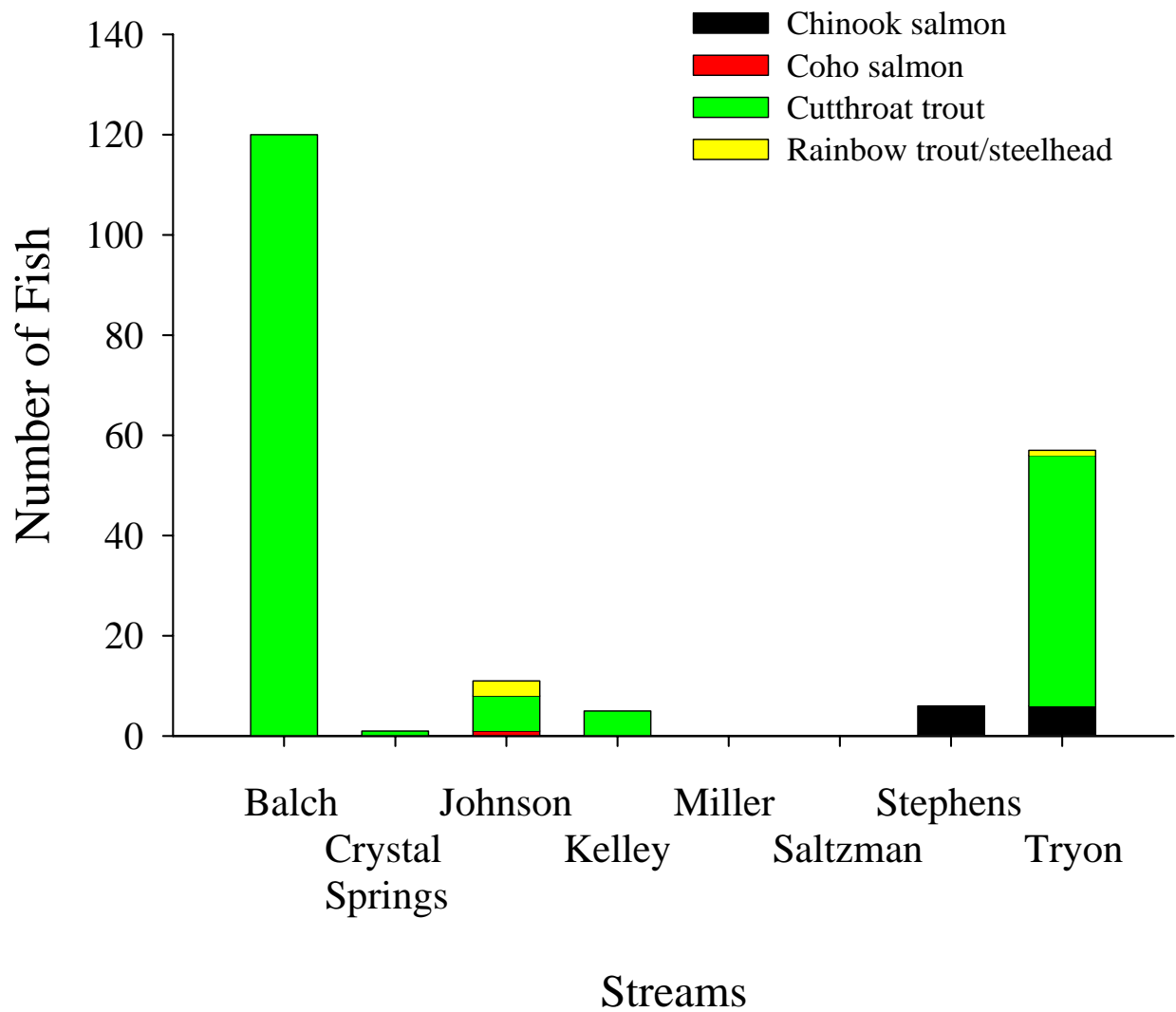


Figure 2. Number of salmonids captured during extensive summer sampling in Portland streams, 2001. Data represent salmonids present in all reaches combined.

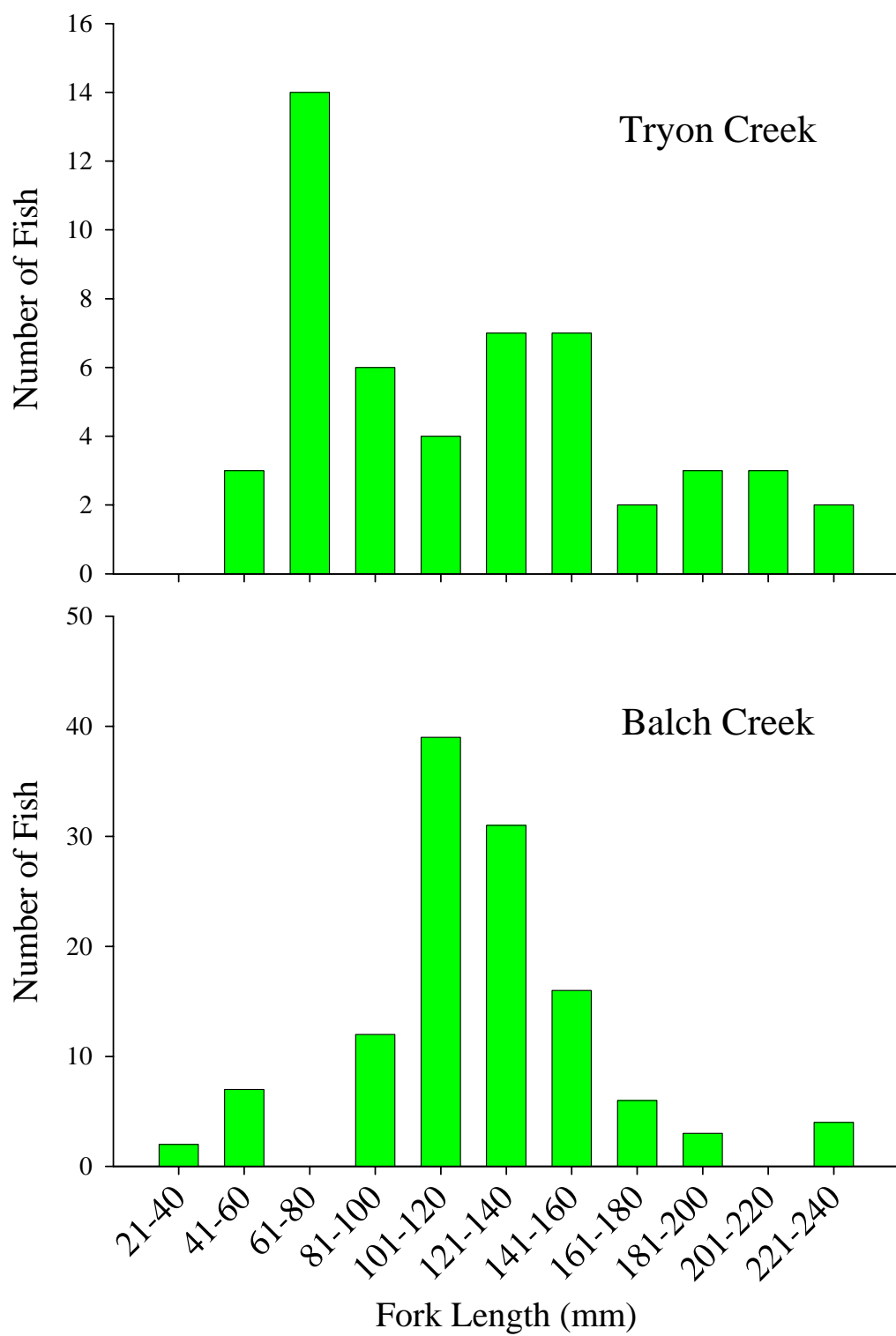


Figure 3. Length frequency of cutthroat trout captured in Balch and Tryon Creeks during extensive summer sampling, 2001.

We collected 614 salmonids from four species within the study area (Figure 4). We collected salmonids in 15 of the 22 reaches. The number of salmonid species per stream ranged from zero to 4 with a mean of 1.2. Cutthroat trout were most abundant (68% of the salmonid catch) followed by coho salmon (18%), chinook salmon (9%), and rainbow trout/steelhead (4%). We found 32% of the cutthroat trout in Reach 1 of Balch Creek. Salmon were most abundant in Stephens Creek, where we found 67% of the chinook salmon and 43% of the coho salmon.

All lamprey were collected in Crystal Springs, Johnson, Kelley, and Stephens creeks. Lamprey were most abundant in Kelley Creek with 132, followed by Stephens Creek (35), Johnson Creek (19) and Crystal Springs Creek (12). We collected six torrent sculpin in Reach 1 of Tryon Creek. Torrent sculpin were not identified in any other Portland stream.

### **Seasonal Catch**

Relative abundance of salmonids varied among seasons. Salmonids composed 22% of the total catch in winter, 15% in spring, 10% in fall, and 9% in summer. All four salmonid species were found during all seasons except rainbow trout/steelhead, which were not collected in summer. Catches of some species were particularly seasonal, with 71% of coho salmon caught in spring, and 63% of chinook salmon caught in winter. Cutthroat trout were the most abundant salmonid in each season, and displayed the greatest range of lengths. Seasonal length frequencies show multiple age classes of cutthroat trout within Balch Creek year around (Figure 5).

Cottids were the most commonly collected fish in every season, constituting 58%, 45%, 43%, and 43% of the catch in summer, fall, spring, and winter. Cyprinids composed 26% to 34% of the catch each season. Non-native fish made up < 1% of the catch each season except fall, when 11% of our total catch was non-native fish. All these were caught in Stephens Creek. Species collected included western mosquitofish, smallmouth bass, white crappie, and pumpkinseed.

Lamprey were collected in all seasons. We collected 107 of the 165 lamprey (65%) in the spring followed by 38 (23%) in winter, 17 (10%) in summer, and 3 (2%) in fall. Of the six torrent sculpin found in Tryon Creek, we collected two in fall and four in summer.

### **Index of Biotic Integrity**

Index of Biotic Integrity scores ranged from 0 to 57 for extensive summer sampling (Table 3), with the lowest scores from Saltzman and Stephens creeks, and the highest scores from Johnson Creek. The mean score was 31 for all stream reaches, and 42 for reaches containing fish. Excluding reaches without fish, the largest range within a stream was from 33 to 50 in Tryon Creek. Scores ranged from 42 to 57 within Johnson Creek. Scores indicated that 21 of the 23 reaches surveyed were severely impaired. Marginally impaired reaches were limited to Johnson Creek (reaches 2 and 16). No scores were considered acceptable.

Seasonal IBI scores ranged from 0 to 75. Excluding reaches without fish, summer scores ranged from 28 (Reach 1 of Miller Creek) to 61 (Reach 1 of Tryon Creek); fall scores ranged from 23 (Reach 1 of Stephens Creek) to 75 (Reach 1 of Tryon Creek); winter scores ranged from 30 (Reach 2 of Miller Creek) to 58 (Reach 1 of Crystal Springs Creek); and spring scores ranged from 30 (Reach 6 of Johnson Creek) to 66 (Reach 1 of Crystal Springs Creek). Scores in Balch

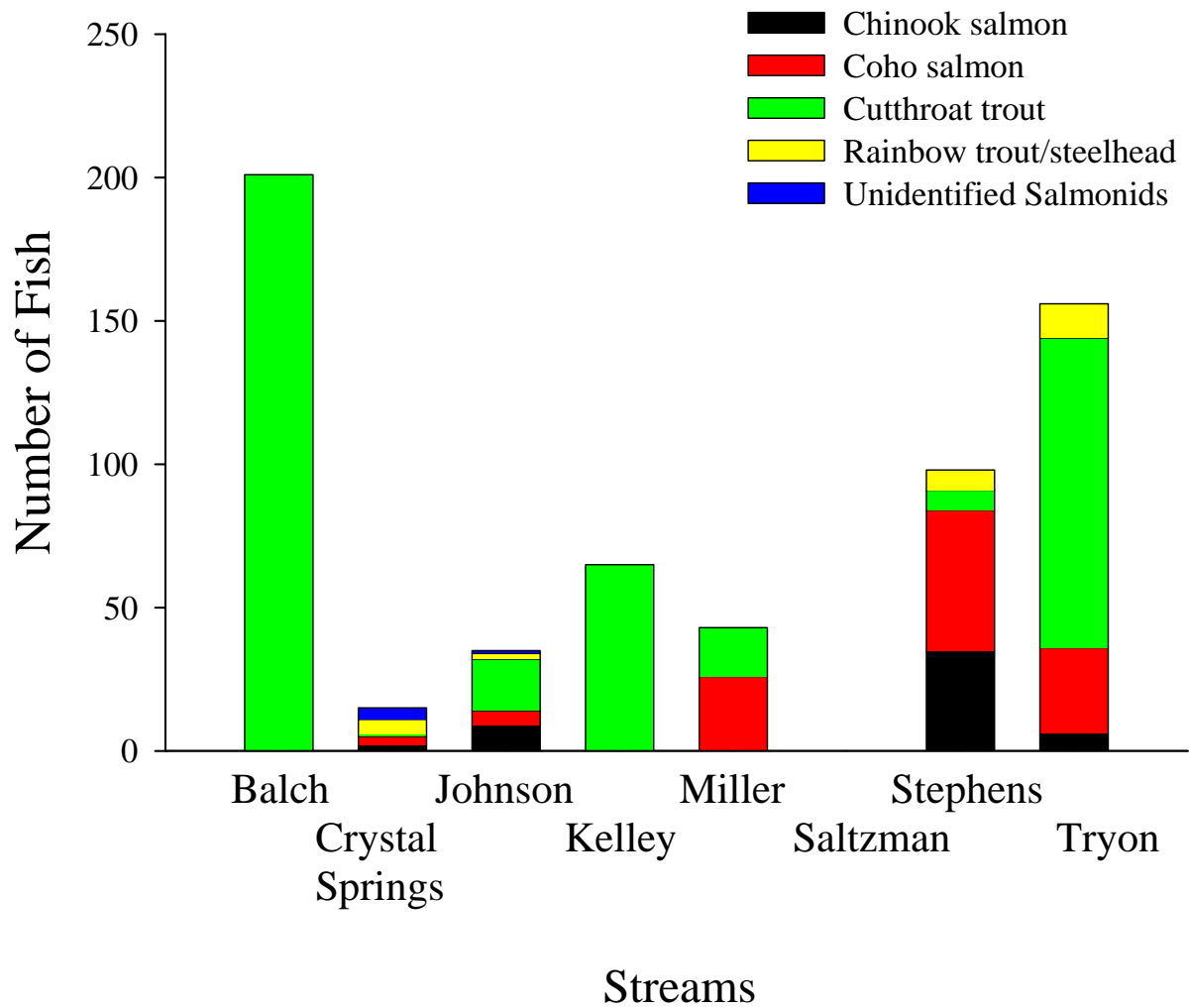


Figure 4. Number of salmonids captured during intensive seasonal sampling in Portland streams, summer 2001 through spring 2002. Data represent salmonids present in all reaches combined.

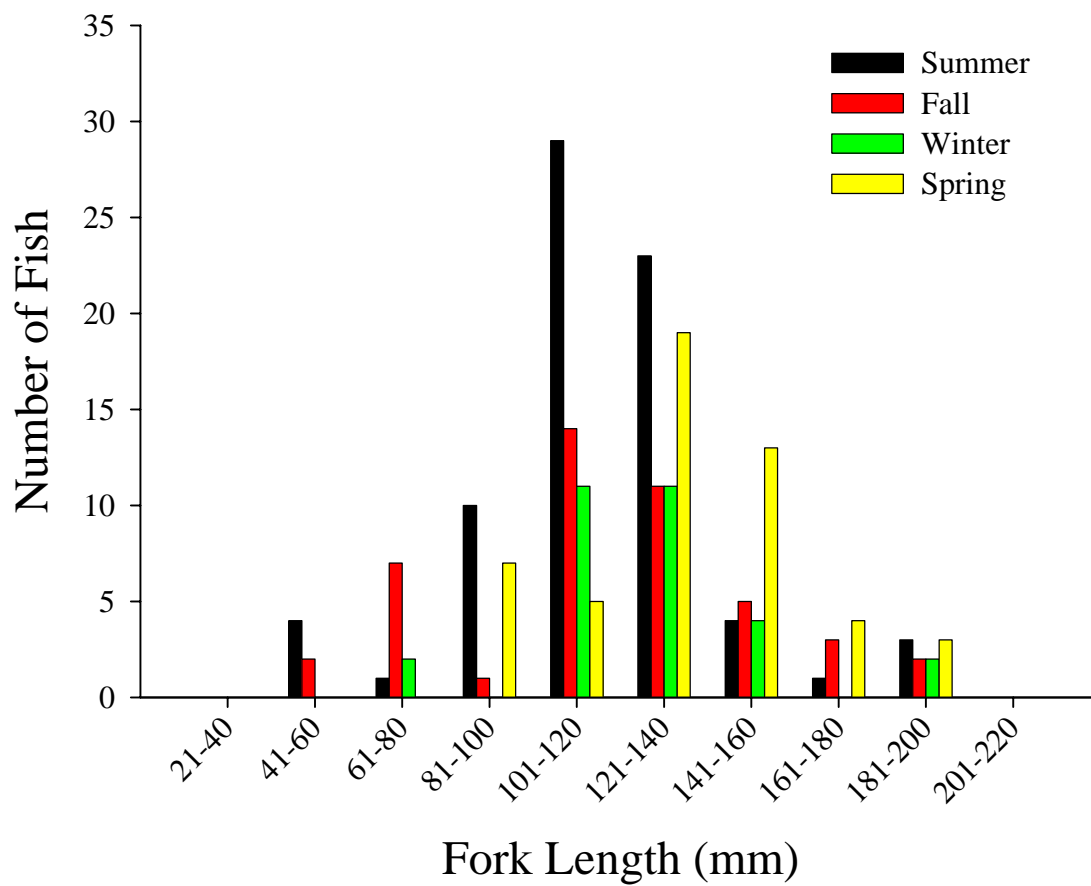


Figure 5. Seasonal length frequency of cutthroat trout in Balch Creek, summer 2001 through spring 2002. Data represent all reaches combined.

Table 3. Index of biotic integrity scores for extensive summer and intensive seasonal sampling in Portland streams, summer 2001 through spring 2002. N.S.= no survey; 0=no fish.

Stream	Reach	IBI Score					
		Extensive	Intensive				Mean
		Summer	Summer	Fall	Winter	Spring	
Balch	1	32	36	36	36	36	36
	2	36	36	36	36	36	36
Crystal Springs	1	43	40	42	58	66	52
Johnson	2	57	45	46	N.S.	49	46
	4	42	36	42	N.S.	45	41
	6	45	44	38	N.S.	30	37
	8	45	44	34	N.S.	46	41
	10	42	N.S.	N.S.	N.S.	N.S.	--
	12	N.S.	45	34	N.S.	40	40
	14	43	30	34	N.S.	31	32
	16	52	41	46	N.S.	50	42
Kelley	1	41	51	49	49	48	49
	2	N.S.	30	56	57	59	51
Miller	1	36	28	30	36	56	38
	2	30	30	32	30	41	33
Saltzman	2	0	0	0	0	0	0
	3	0	0	0	0	0	0
Stephens	1	40	47	23	55	44	45
	2	0	0	0	N.S.	0	0
	3	0	N.S.	N.S.	N.S.	N.S.	--
Tryon	1	50	61	75	N.S.	61	65
	2	41	41	54	N.S.	41	45
	3	50	41	43	N.S.	41	42
	4	33	41	43	N.S.	41	42



Creek did not vary among seasons. The largest variation among seasons was in Reach 2 of Kelley Creek, where IBI scores ranged from 30 in summer to 59 in spring. Scores were generally highest in Tryon Creek. Only one IBI score was considered acceptable (Reach 1 of Tryon Creek in fall). Eleven scores indicated marginally impaired reaches, whereas 64 indicated severely impaired reaches. Reach 1 of Tryon Creek was the only reach not to be considered severely impaired during at least one season.

### **Salmonid Population Estimates**

We were able to estimate abundance of salmonids in a number of stream reaches (Table 4). Abundance of cutthroat trout was highest in Balch, Tryon, and Kelley creeks. Coho salmon and chinook salmon were most abundant in Reach 1 of Stephens Creek. Cutthroat trout were generally found year-round, whereas most coho salmon were observed in spring, and most chinook salmon were observed in seasons other than spring.

### **DISCUSSION**

Our largest catches were in the Johnson Creek watershed (Johnson, Crystal Springs, and Kelley creeks). This is not surprising, because Johnson Creek is the longest stream sampled by far, and usually has the highest flow of any stream surveyed.

Salmonids were present in most streams sampled, with cutthroat trout being most abundant. Presence of cutthroat trout < 60 mm fork length in summer indicates that natural production is occurring in Balch and Tryon creeks. Because Balch Creek is no longer accessible from the Willamette River, and has no other fish species present, this resident population may have been stocked at one time. Another possibility is that cutthroat trout, unlike other species that may have inhabited the stream, have persisted in isolation. Potential effects of this isolation on genetic characteristics of the cutthroat population in Balch Creek should be investigated.

Cutthroat trout populations in Kelley Creek are of particular interest because of a potential impassable barrier. Although our surveys did not reveal an impassable barrier, local residents feel there is a fish passage barrier in Reach 2. We collected fish < 60 mm fork length upstream from this potential barrier, and observed numerous redds during winter sampling.

We found large numbers of lamprey in Reach 2 of Kelley Creek throughout the year. All lamprey collected were in the ammocete lifestage. If any of these were Pacific lamprey, then the potential barrier on Kelley Creek is not impassable to lamprey.

Distribution of torrent sculpin is apparently limited to Tryon Creek. In previous surveys of urban streams in the Portland metropolitan area (Friesen and Zimmerman 1999; Leader 2001a; Leader 2001b) torrent sculpin were collected only in a few relatively undisturbed streams. Although Hughes et al. (1998) classified torrent sculpin as a sensitive species, Zaroban et al. (1999) classified them as a species of intermediate tolerance.

Based on our findings, non-native species have limited distributions within Portland streams. All non-native species we collected are considered tolerant by Zarboban et al. (1999); however, Hughes et al. (1998) classified smallmouth bass and pumpkinseed as intermediate. Because

Table 4. Estimated number of salmonids (and 95% confidence limits) per 100-m sampling site for Portland streams, summer 2001 through spring 2002.

Stream, reach	Season	Species			
		Cutthroat trout	Rainbow trout/steelhead	Coho salmon	Chinook salmon
Balch 1	Summer	50 (40-60)	0	0	0
	Fall	34 (31-36)	0	0	0
	Winter	52 (0-152)	0	0	0
	Spring	32 (29-35)	0	0	0
Balch 2	Summer	33 (29-26)	0	0	0
	Fall	12 (12-12)	0	0	0
	Winter	9 (8-10)	0	0	0
	Spring	21 (20-22)	0	0	0
Crystal Springs 1	Summer	0	0	0	0
	Fall	0	0	0	0
	Winter	0	0	1 (1-1)	0
	Spring	0	0	3 (3-3)	2 (2-2)
Johnson 2	Summer	0	0	0	0
	Fall	0	0	0	1 (1-1)
	Winter	0	0	0	
	Spring	0	1 (0-1)	1 (1-1)	14 <sup>a</sup>
Johnson 4	Summer	0	0	0	0
	Fall	1 (1-1)	0	0	0
	Winter	--	--	--	--
	Spring	0	0	0	0
Johnson 6, 8, 10, and 14	Summer	0	0	0	0
	Fall	0	0	0	0
	Winter	--	--	--	--
	Spring	0	0	0	0
Johnson 16	Summer	1 (1-1)	0	0	0
	Fall	8 (7-9)	0	0	0
	Winter	--	--	--	--
	Spring	7 (5-9)	0	0	0
Kelley 1	Summer	8 (8-8)	0	0	0
	Fall	19 (18-21)	0	0	0
	Winter	12 (0-27)	0	0	0
	Spring	8 (7-9)	0	0	0
Kelley 2	Summer	0	0	0	0
	Fall	1 (1-1)	0	0	0
	Winter	15 (12-17)	--	--	--
	Spring	31 <sup>a</sup>	0	0	0

Table 4 (continued).

Stream, reach	Season	Species			
		Cutthroat trout	Rainbow trout/steelhead	Coho salmon	Chinook salmon
Miller 1	Summer	0	0	0	0
	Fall	0	0	0	0
	Winter	15 (12-17)	0	0	0
	Spring	19 (18-21)	0	0	0
Miller 2	Summer	0	0	0	0
	Fall	0	0	0	0
	Winter	0	0	0	0
	Spring	1 (1-1)	0	0	0
Saltzman 2 and 3	Summer	0	0	0	0
	Fall	0	0	0	0
	Winter	0	0	0	0
	Spring	0	0	0	0
Stephens 1	Summer	0	0	0	3 (3-3)
	Fall	0	0	0	2 (2-2)
	Winter	0	7 (6-9)	0	29 (28-30)
	Spring	0	1 (1-1)	49 (46-53)	0
Stephens 2	Summer	0	0	0	0
	Fall	0	0	0	0
	Winter	--	--	--	--
	Spring	0	0	0	0
Tryon 1	Summer	7 (5-9)	0	23 (0-110)	1 (1-1)
	Fall	4 (3-6)	4 (0-9)	4 (0-9)	6 (2-10)
	Winter	--	--	--	--
	Spring	4 (3-5)	5 (4-7)	18 (17-19)	0
Tryon 2	Summer	7 (4-9)	0	0	0
	Fall	6 (5-7)	4 (2-6)	0	0
	Winter	--	--	--	--
	Spring	4 (4-4)	0	0	0
Tryon 3	Summer	5 (5-5)	0	0	0
	Fall	6 (5-7)	0	0	0
	Winter	--	--	--	--
	Spring	34 (28-40)	0	0	0
Tryon 4	Summer	17 (14-20)	0	0	0
	Fall	8 (8-8)	0	0	0
	Winter	--	--	--	--
	Spring	11 (10-12)	0	0	0

<sup>a</sup> Data given is upper confidence limit; distribution of catch among passes resulted in a negative abundance estimate.

tolerant species are able to persist in warm temperatures, sedimentation, and organic pollution (Hughes et al. 1998), non-native species may be able to out-compete native species in degraded streams. Further habitat degradation may therefore result in wider distribution of non-native species.

Total or seasonal barriers to fish movement are present in many Portland streams. It appears that a 242-m cement canal on Saltzman Creek below Highway 30 may act as an impassable barrier to fish movement. Currently, the canal acts as a shallow glide. Improving fish passage may require the canal to be removed and replaced with a low-gradient canal with weir-like baffles to allow pooling and increased depth.

The culvert crossing under Highway 30 on Miller Creek may act as a seasonal barrier to fish movement. No salmonid species were captured above highway 30 except one cutthroat trout during spring. Weir-type baffles could be added to increase pooling and decrease velocities in the culvert. The culvert exits also need improvement to enhance fish passage.

Stephens Creek has an impassable corrugated metal culvert in Reach 1 approximately 100 m upstream of the Willamette River. Based on ODFW Guidelines and Criteria for Stream-Road Crossings (ODFW 1997) the maximum jump from water to culvert for adult salmon and steelhead is one foot, with a maximum of six inches for trout and juvenile salmon and steelhead. The Stephens Creek culvert is more than one foot above stream level in all seasons.

Extensive summer sampling may not be an accurate way to document presence of anadromous salmonids in Portland streams. Factors influencing residence times include life history characteristics such as age or size, and seasonal habitat requirements (Healy 1998). Coho salmon may not be present in many streams during the summer because of low flows and lack of potential rearing areas (Sandercock 1998); however, coho salmon may be present during winter and fall because of suitable habitat, food sources, and temperature.

Urban stream surveys have been conducted in Clackamas County streams (Friesen and Zimmerman 1999) and tributaries of the Tualatin River (Leader 2001a; Leader 2001b). Reticulate sculpin and native cyprinids were found to be the most abundant species in all studies. We collected banded killifish and riffle sculpin, which were not found in the other surveys. Some native species found in other surveys that were absent from our collection include peamouth chub *Mylocheilus caurinus* and chislemouth *Acrocheilus alutaceus*. Numerous non-native species were collected in other surveys that we did not find, including goldfish *Carassius auratus*, common carp *Cyprinus carpio*, fathead minnow *Pimephales promelas*, yellow bullhead *Ameiurus natalis*, brown bullhead *Ameiurus nebulosus*, brook trout *Salvelinus fontinalis*, black crappie *Promoxis nigromaculatus*, and warmouth *Lepomis gulosus*.

Low IBI scores can probably be attributed to barriers and environmental disturbances in Portland streams. Balch and Saltzman creeks have adequate fish habitat that could potentially hold a healthy fish community. Because of environmental disturbances, restoration efforts in Johnson Creek should be concentrated in middle reaches, which are deep, lack cover, and are channelized by Work Progress Administration tiling. Addition of large woody debris would improve habitat complexity and increase cover for fish. Steps should also be taken to protect and improve stream reaches in all creeks near the Willamette River. These reaches may act as important refugia for native salmonids, providing shelter from main river flow, and possibly providing cooler water during summer. These lower stream reaches may be important feeding and resting areas during downstream migration.

Our plans for 2002-2003 are to repeat sampling in all stream reaches. Multiple years of data will allow us to monitor and compare fish communities, compare data under variable flow and environmental conditions, and characterize population dynamics such as age, growth, and rates of recruitment.

## **ACKNOWLEDGMENTS**

We thank the many individuals and agencies that contributed time and expertise to make this project possible. Martyne Reesman of ODFW spent many hours in the field and office collecting and verifying data. Virgil Lee Watts of ODFW also helped with field sampling. Mike Reed of the City of Portland provided detailed review of project design and reports. Eric Tinus of ODFW and Cynthia Studebaker of the City of Portland also reviewed earlier drafts of this report. Mike Reed and Jim Middaugh of the City of Portland helped obtain funding for the project. Chad Smith of the City of Portland provided GIS maps of all stream reaches. We also thank all property owners that allowed access to streams.

## **REFERENCES**

- Armour, C. L., K. P. Burnham, and W. S. Platts. 1983. Field methods and statistical analyses for monitoring small salmonid streams. U.S. Fish and Wildlife Service. FWS/OBS-83/33.
- Chilcote, M. W. 1999. Conservation status of lower Columbia River coho salmon. Information Report 99-3. Oregon Department of Fish and Wildlife, Portland.
- Close, D. A., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (*Lampetra tridentata*) in the Columbia River Basin. Project # 9402600. Bonneville Power Administration, Portland, Oregon.
- Friesen, T. A., and D. L. Ward. 1996. Status and condition of fish assemblages in streams of the Tualatin River Basin, Oregon. *Northwest Science* 70:120-131.
- Friesen, T. A., and M. P. Zimmerman. 1999. Distribution of fish and crayfish, and measurement of available habitat in urban streams of north Clackamas County. Oregon Department of Fish and Wildlife, Annual Report to Water Environmental Services, Clackamas County, Oregon.
- Hankin, D. G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. *Canadian Journal of Fisheries and Aquatic Sciences* 45:834-844.
- Healey, M. C. 1998. Life history of chinook salmon. In C. Groot and L. Margolis (editors.) *Pacific salmon life histories*, UBS Press, Vancouver, Canada. Pp 312-393.
- Hughes, R. M., P. R. Kaufmann, A. T. Herlihy, T. M. Kincaid, L. Reynolds, and D. P. Larsen. 1998. A process for developing and evaluating indices of fish assemblage integrity. *Canadian Journal of Fisheries and Aquatic Sciences* 55:1618-1631.

- Leader, K. A. 2001a. Distribution and abundance of fish, and measurement of available habitat in the Tualatin River Basin outside of the urban growth boundry. Oregon Department of Fish and Wildlife, Annual Report to Tualatin River Watershed Council, Hillsboro, Oregon.
- Leader, K. A. 2001b. Distribution of fish and crayfish, and measurement of available habitat in the Tualatin River Basin. Oregon Department of Fish and Wildlife, Annual Report to Clean Water Services, Hillsboro, Oregon.
- Moore, K. M. S., K. K. Jones, and J. M. Dambacher. 1997. Methods for stream habitat surveys. Information Report 97-4. Oregon Department of Fish and Wildlife, Portland.
- NOAA. 1999. Endangered and threatened species: threatened status for three chinook salmon evolutionarily significant units in Washington and Oregon, and endangered status of one chinook salmon ESU in Washington. Federal Register 64:14307-14328.
- ODFW. 1997. Oregon Department of Fish and Wildlife guidelines and criteria for stream-road crossings. Oregon Department of Fish and Wildlife, Portland.
- Sandercock, F. K. 1998. Life history of coho salmon. *In* C. Groot and L. Margolis (editors.) Pacific salmon life histories, UBS Press, Vancouver, Canada.
- Vella, J., L. Steuhrenberg, and T. C. Bjornn. 1999. Migration patterns of Pacific lamprey (*Lampetra tridentata*) in the lower Columbia River, 1997. Annual Report of Research to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.
- Ward, D. L., editor. 1995. Distribution of fish and crayfish, and measurement of available habitat in the Tualatin River Basin. Oregon Department of Fish and Wildlife, Final Report to Unified Sewerage Agency, Hillsboro, Oregon.
- Zaroban, D. W., M. P. Mulvey, T. R. Maret, R. M. Hughes, and G. D. Merritt. 1999. Classifications of species attributes of Pacific northwest freshwater fishes. Northwest Science 73:81-93.

## **APPENDIX A**

### **Stream Reach Locations**

Appendix Table A-1. Approximate locations of Portland stream reaches surveyed in 2001 and 2002.

Stream	Reach	Location
Balch	1	Lower Macleay Park to NW Cornell Road culvert crossing
	2	NW Cornell Road culvert crossing to NW Cornell Road crossing near Thompson Road
Crystal Springs	1	Confluence with Johnson Creek to Reed College lake
Johnson	2	Highway 224 overpass to Crystal Springs tributary junction
	4	Old Tacoma Bridge crossing at East Moreland golf course to Tideman-Johnson rail and footbridges
	6	Johnson Creek Boulevard bridge to Linwood Avenue bridge
	8	82nd Avenue bridge to I-205 bridges
	10	106th Avenue bridge to 110th Avenue bridge
	12	Brookside restoration project site to 132nd Avenue bridge
	14	Kelley Creek tributary to 190th Avenue bridge
Kelley	16	Springwater corridor bridge to Palmblad Road bridge
	1	Confluence with Johnson Creek to Mitchell Creek tributary junction
Miller	2	Mitchell Creek tributary junction to 190th Avenue culvert
	1	Confluence with Multnomah Channel at Fred's Marina to west end of U.S. Highway 30 culvert
Saltzman	2	West end of U.S.Highway 30 culvert to unmarked tributary entrance
	2	East side of Saltzman Road at brush guarded culvert to first tributary entrance
	3	First tributary entrance to second tributary entrance
	4	Second tributary entrance to Leif Erickson Road

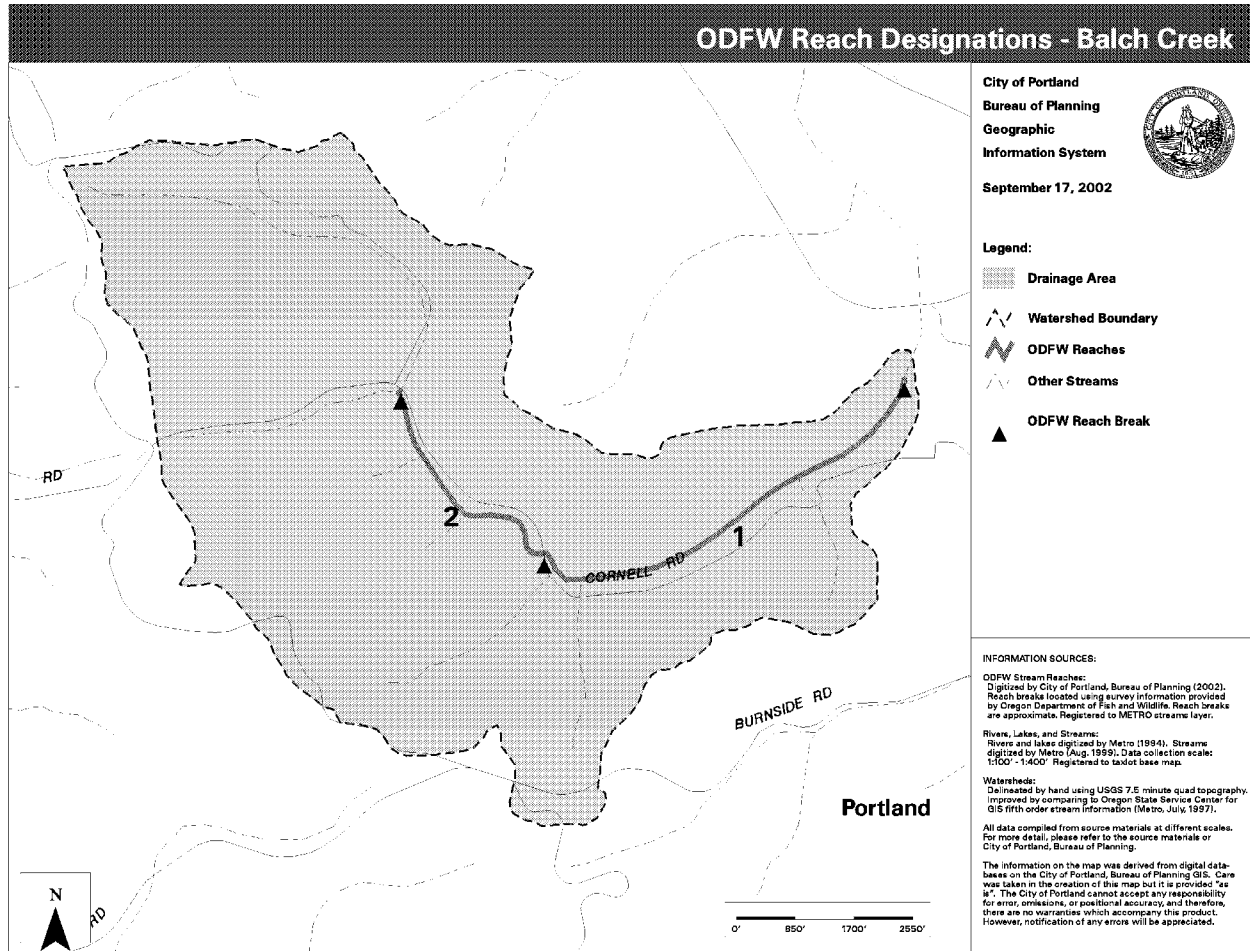


Appendix Table A-1 (continued). Approximate locations of Portland stream reaches, 2001-2002.

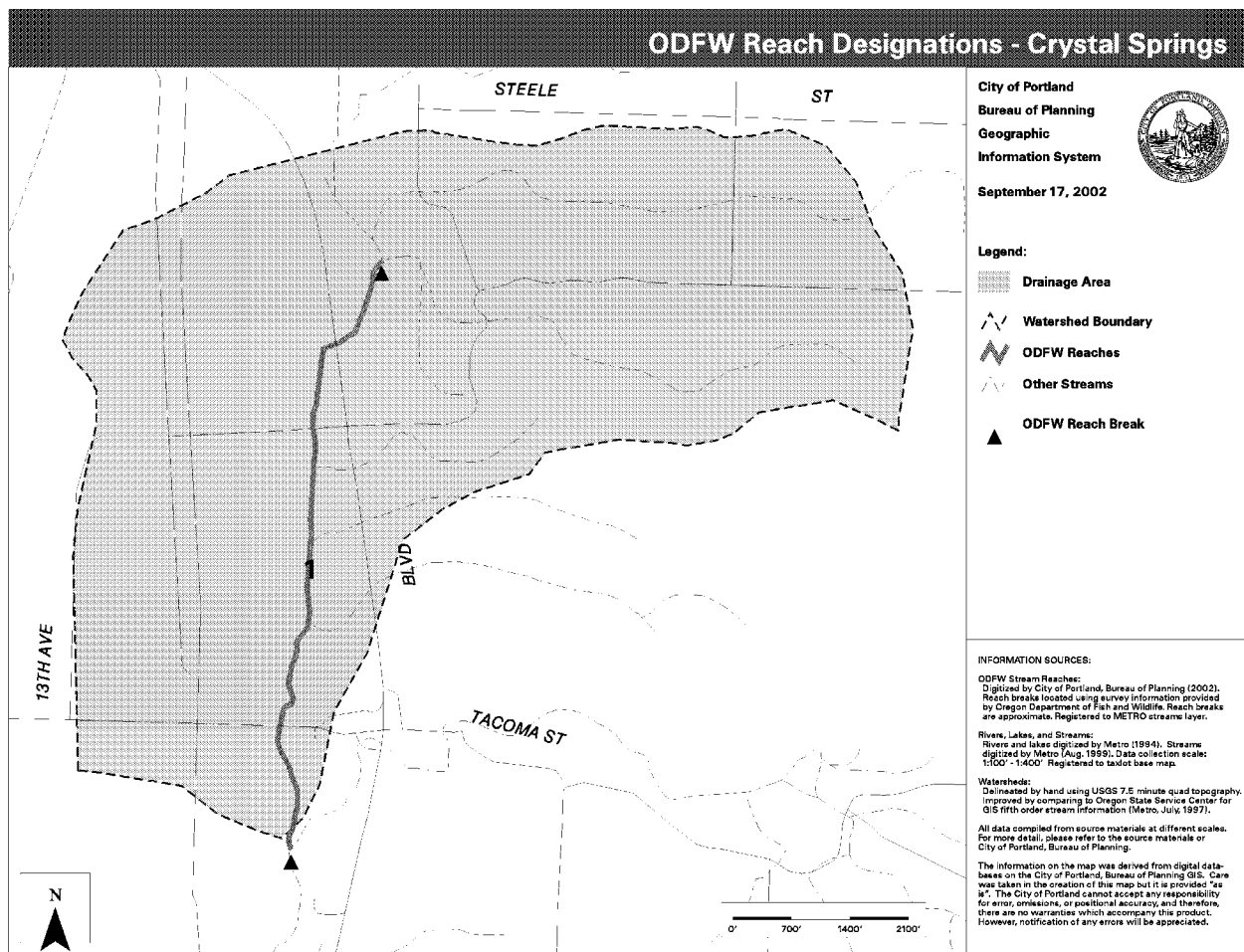
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Stephens	1	Confluence with Willamette River to Macadam Avenue culvert
	2	Macadam Avenue culvert to first tributary entrance in River View Cemetery
	3	First tributary entrance inside River View Cemetery to Burlington Road
Tryon	1	Willamette River confluence to east side of State Highway 43 culvert
	2	West side of State Highway 43 culvert to tributary entrance downstream of Iron Mountain Bridge
	3	Tributary entrance downstream of Iron Mountain Bridge to Arnold Creek tributary junction
	4	Arnold Creek tributary junction to tributary junction upstream of Southwest Lancaster Road

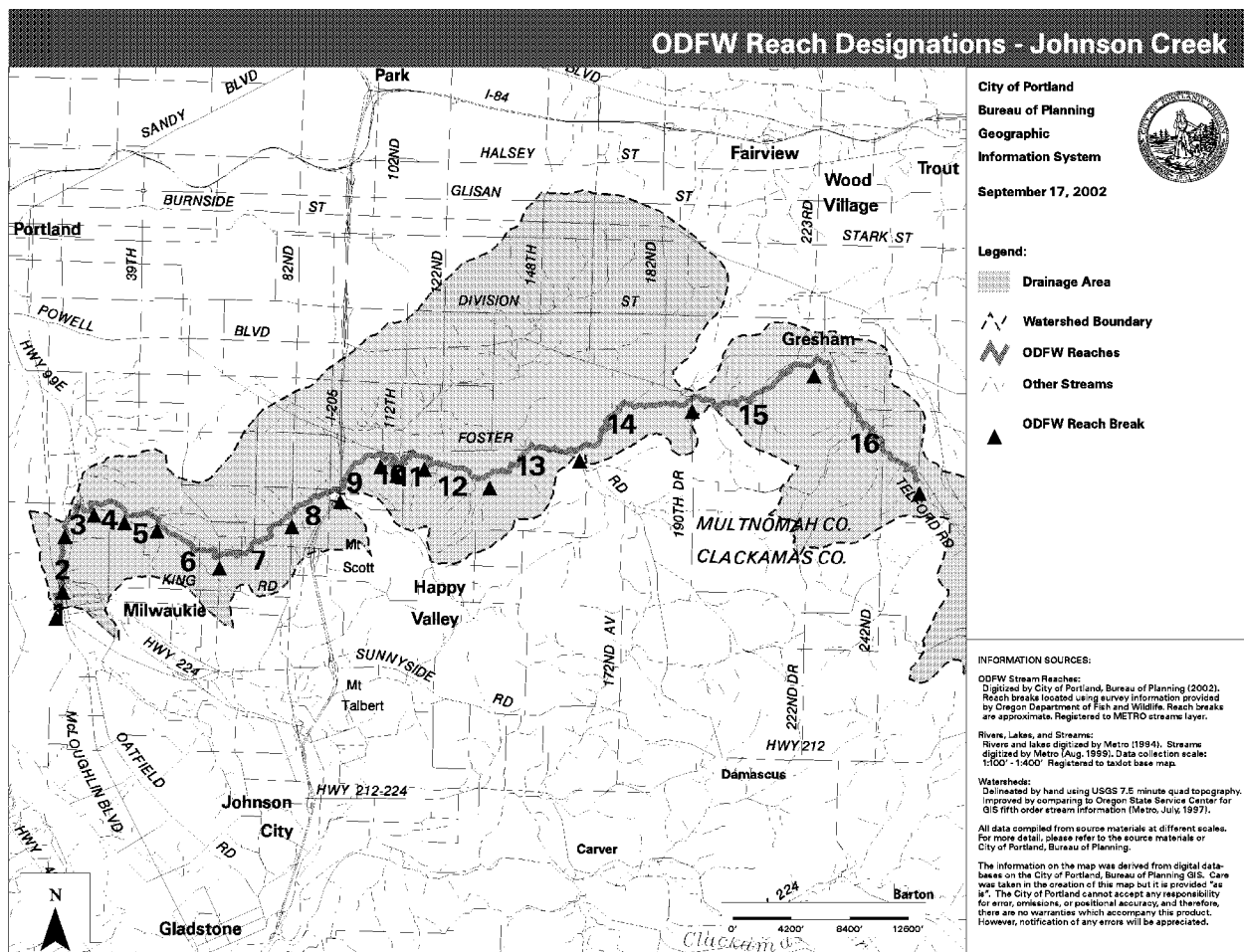
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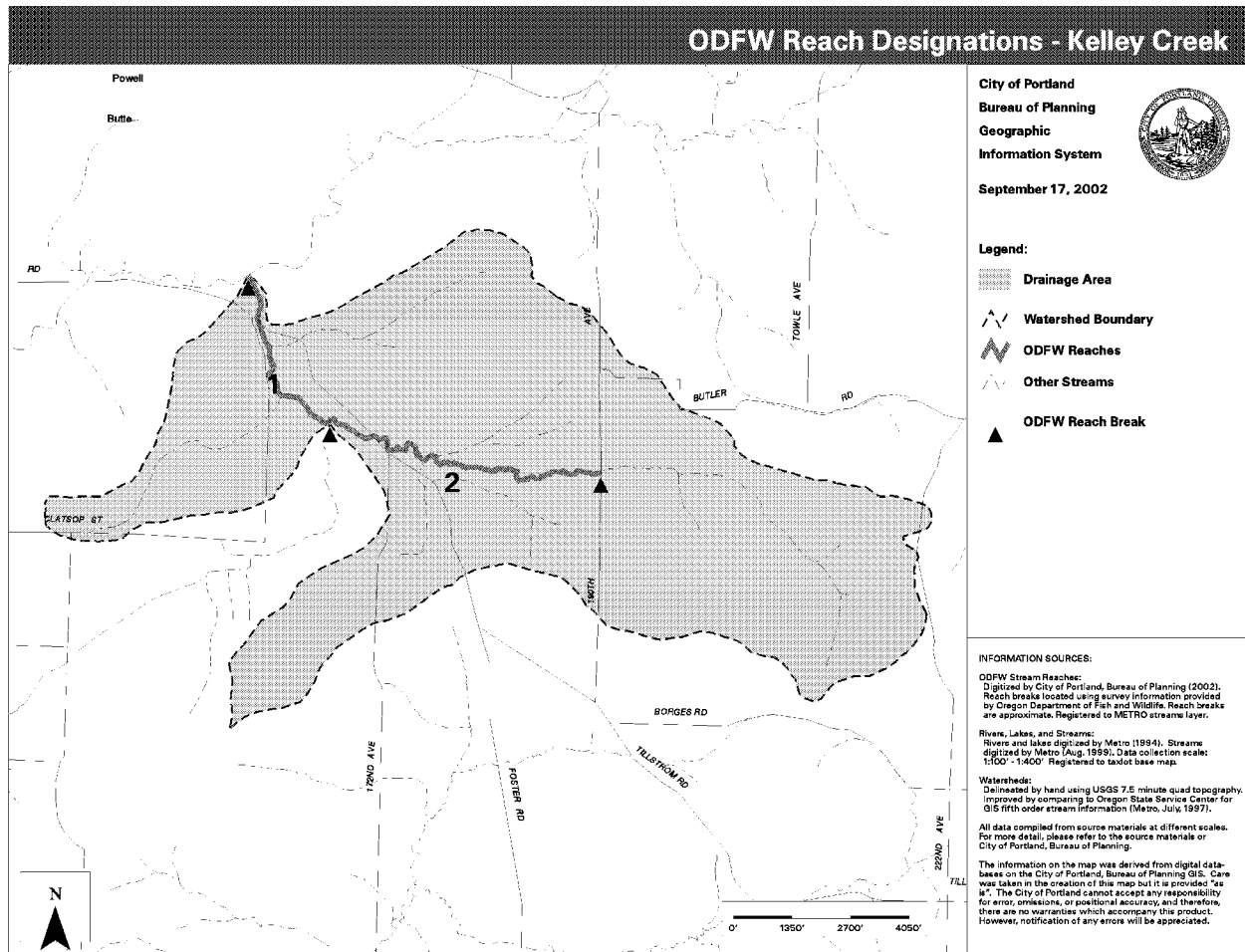
Appendix Figure A-1. GIS map of the Balch Creek watershed, showing reaches surveyed.



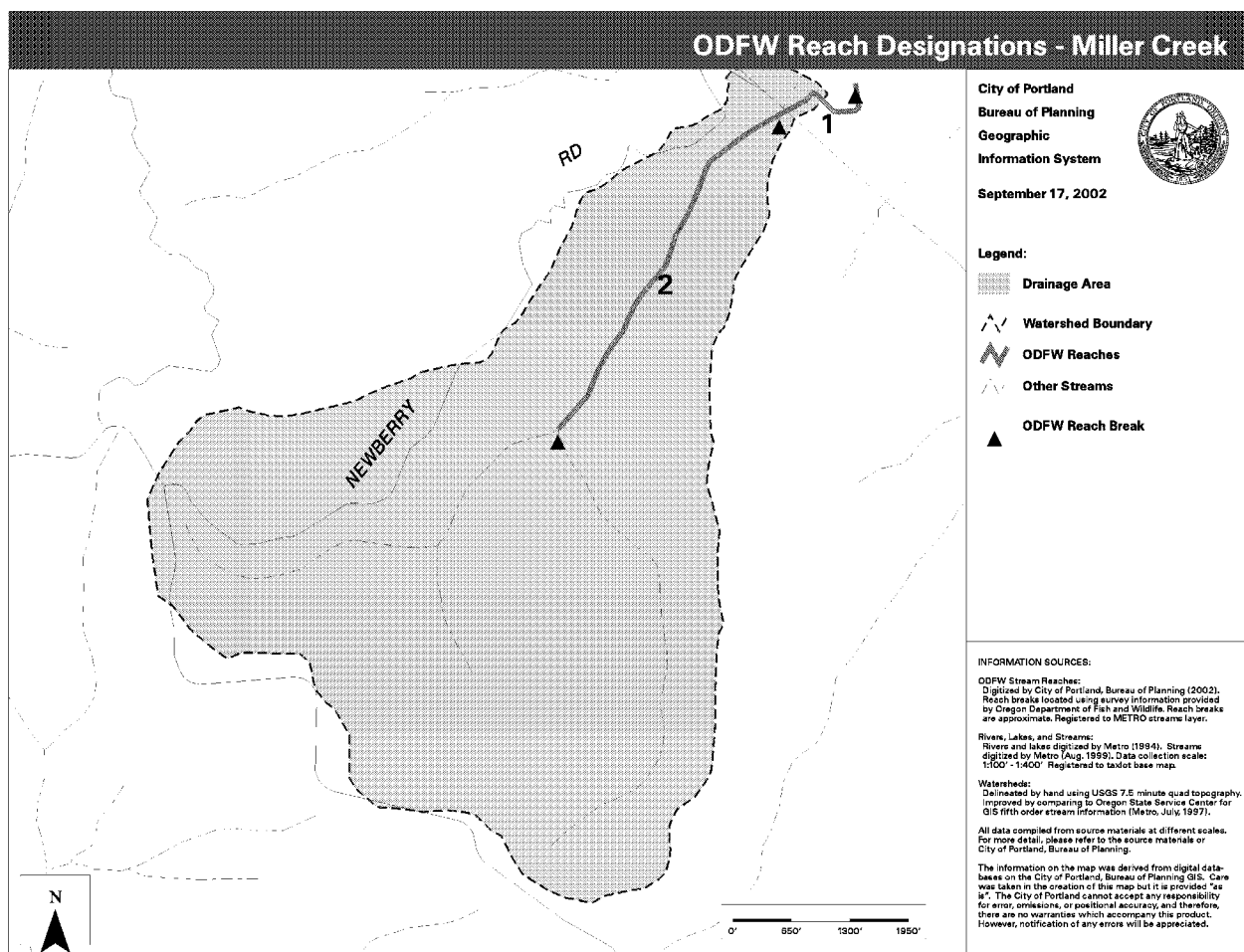
Appendix Figure A-2. GIS map of the Crystal Springs Creek watershed, showing the reach surveyed.



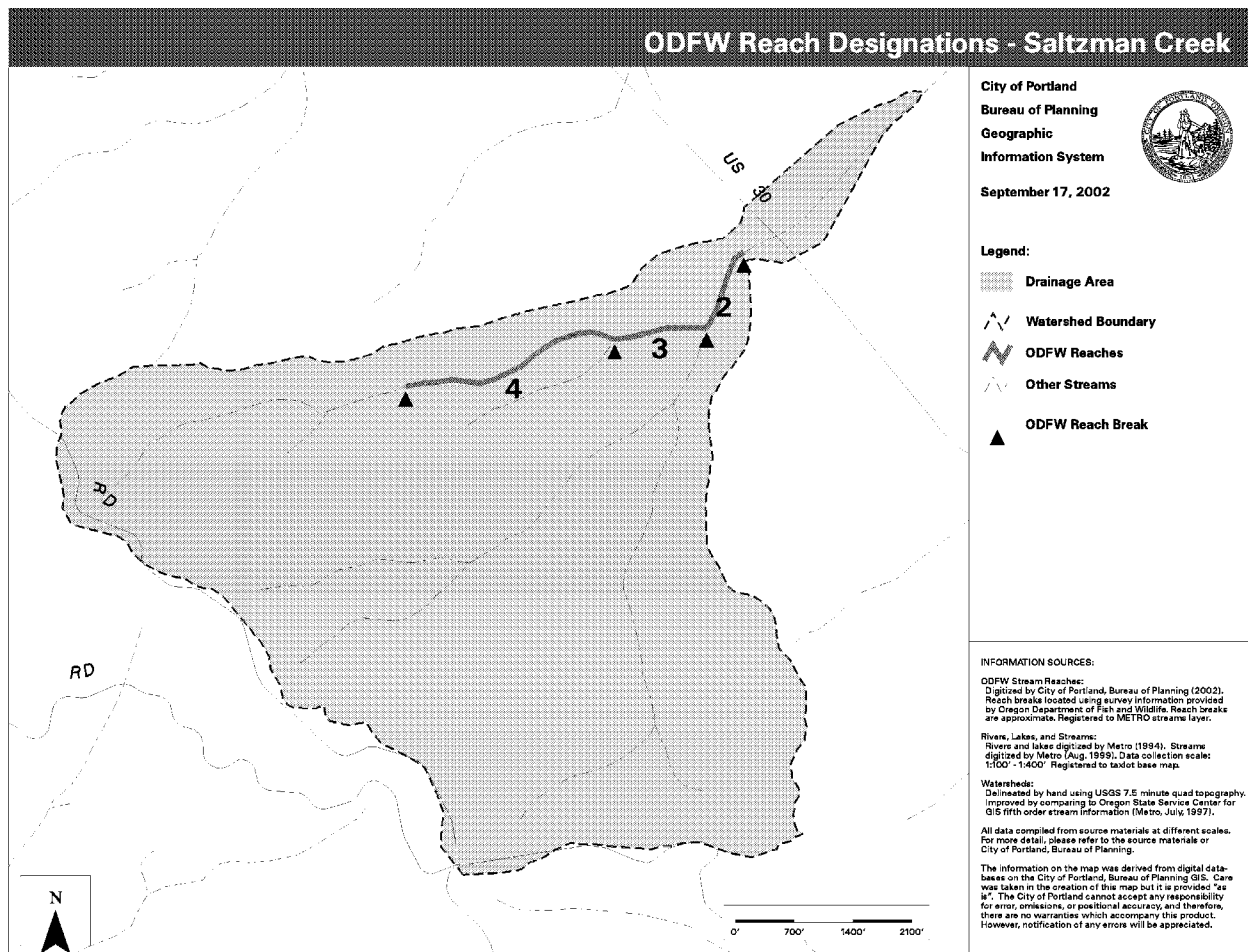
Appendix Figure A-3. GIS map of the Johnson Creek watershed, showing the reaches surveyed.



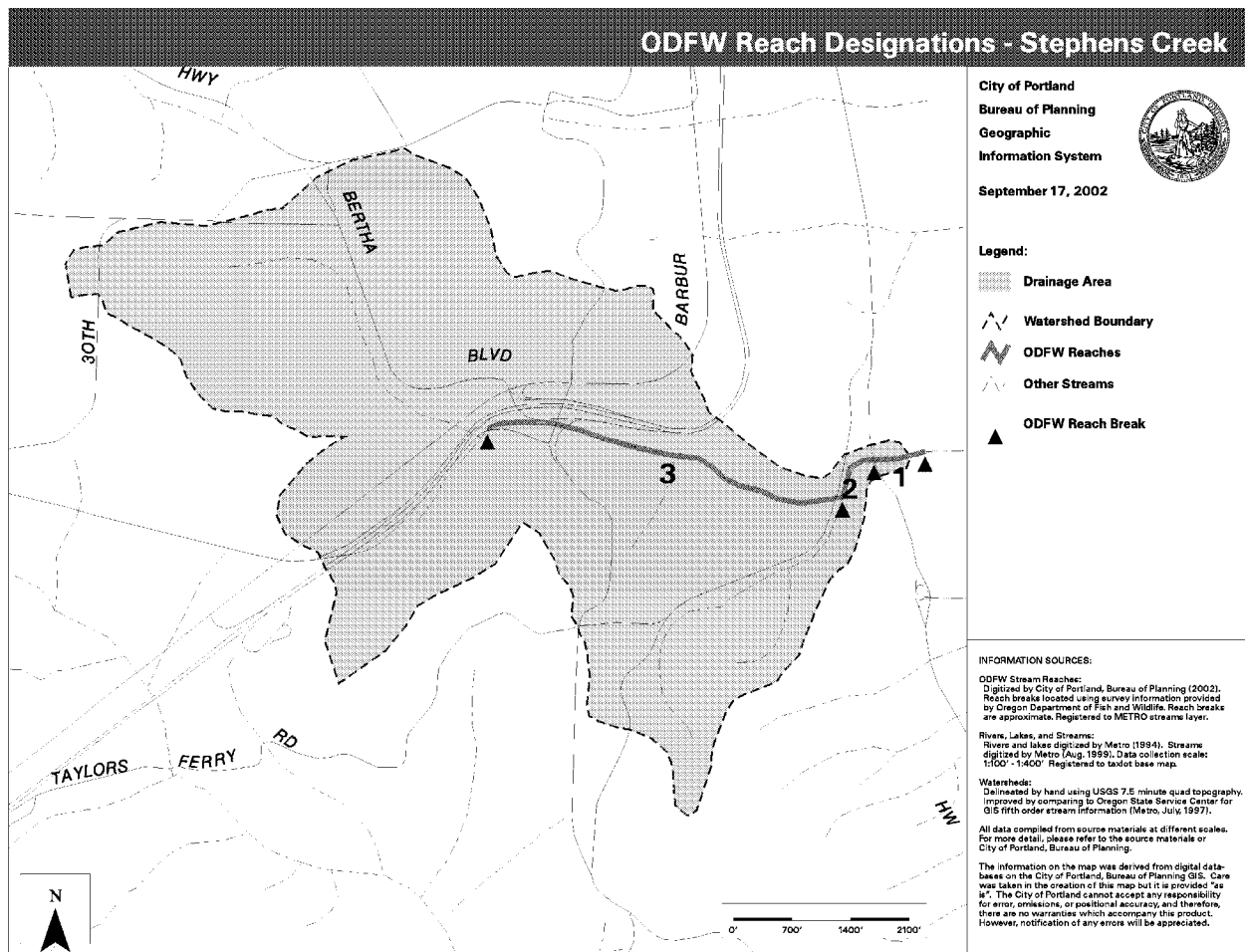
Appendix Figure A-4. GIS map of the Kelley Creek watershed, showing the reaches surveyed.



Appendix Figure A-5. GIS map of the Miller Creek watershed, showing the reaches surveyed.

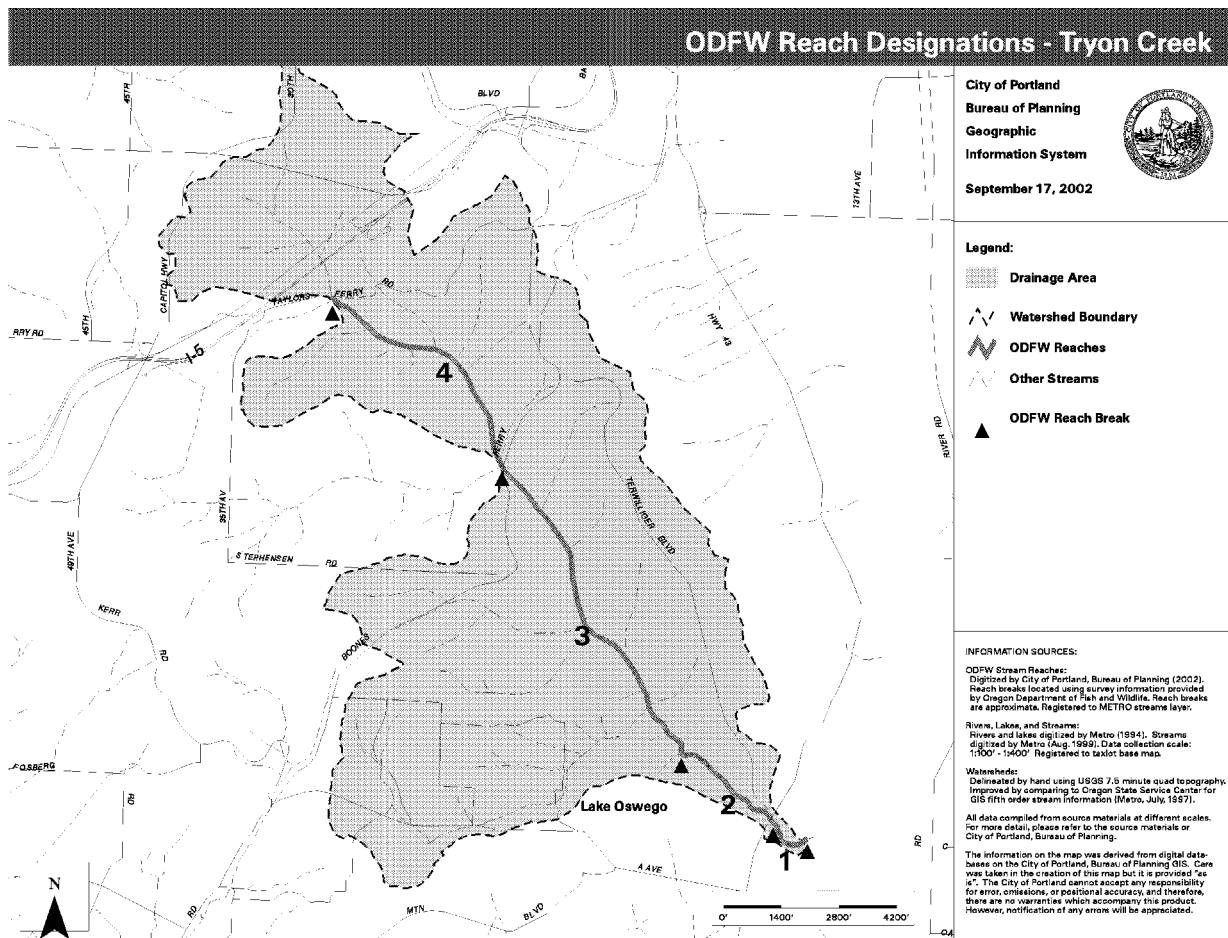


Appendix Figure A-6. GIS map of the Saltzman Creek watershed, showing the reaches surveyed.



Appendix Figure A-7. GIS map of the Stephens Creek watershed, showing the reaches surveyed.





Appendix Figure A-8. GIS map of the Tryon Creek watershed, showing the reaches surveyed.

## **APPENDIX B**

### Aquatic Habitat Data

Appendix Table B-1. Aquatic habitat data observed and surveyed during summer 2001 extensive sampling of Portland streams. “Data not collected” indicates that unlike most reaches, aquatic habitat surveys were not conducted as part of a separate project.

Stream	Reach	Stream Order	Units Observed			Units Sampled			Surface Area (m <sup>2</sup> )
			Fast Water	Glide	Pool	Fast Water	Glide	Pool	
Balch	1	2	86	31	83	17	5	13	400
	2	2	13	4	9	3	1	2	33
Crystal Springs	1	2	5	11	1	3	3	1	105
Johnson	2	3	12	11	1	3	2	0	620
	4	3	14	13	9	3	3	2	623
	6	3	32	30	15	6	6	3	682
	8	3	9	15	11	2	3	1	644
	10	3	5	2	7	0	1	1	102
	14	2	7	29	14	3	5	4	649
	16	2	91	89	37	20	18	7	1,330
Kelley	1	2	12	9	3	2	2	1	60
Miller	1	1	Data not collected			1	1	2	--
	2	1	Data not collected			7	0	4	--
Saltzman	2	2	Data not collected			0	0	6	--
	3	1	Data not collected			3	2	14	--
	4	1	Data not collected			0	0	9	--
Stephens	1	1	7	4	3	1	1	1	64
	2	1	25	1	26	8	0	5	55
	3	1	7	1	4	2	0	2	14
Tryon	1	2	17	7	16	3	1	3	163
	2	2	36	19	29	8	4	6	469
	3	2	83	52	108	16	10	21	880
	4	1	75	43	56	10	8	13	675

## **APPENDIX C**

### Extensive Fish Survey Data

Appendix Table C-1. Number of fish collected during summer 2001 extensive sampling in Balch, Crystal Springs, and Johnson creeks.

Species	Creek, reach									
	Balch		Crystal Springs	Johnson						
	1	2	1	2	4	6	8	10	14	16
Unidentified lamprey	0	0	0	0	0	0	10	0	3	1
Northern pikeminnow	0	0	0	0	0	0	0	0	0	0
Longnose dace	0	0	0	15	0	102	19	3	1	4
Speckled dace	0	0	1	15	4	17	4	1	15	104
Redside shiner	0	0	16	30	17	81	17	8	47	99
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	119	1	1	0	0	0	0	0	0	7
Coho salmon	0	0	0	1	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	0	0	0	3	0	0	0	0
Chinook salmon	0	0	0	0	0	0	0	0	0	0
Unidentified salmonids	0	0	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	2	6	0	0	0	0	0	0
Reticulate sculpin	0	0	24	105	62	134	37	3	39	253
Riffle sculpin	0	0	0	28	4	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified cottids	0	0	14	68	53	25	14	2	13	119
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	1	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table C-1 (continued). Number of fish collected during summer 2001 extensive sampling in Kelley, Miller, Saltzman, and Stephens creeks.

Species	Creek, reach								
	Kelley	Miller		Saltzman			Stephens		
	1	1	2	2	3	4	1	2	3
Unidentified lamprey	0	0	0	0	0	0	0	0	0
Northern pikeminnow	0	0	0	0	0	0	0	0	0
Longnose dace	0	0	0	0	0	0	0	0	0
Speckled dace	0	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	0	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0	0
Cutthroat trout	5	0	0	0	0	0	0	0	0
Coho salmon	0	0	0	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	0	0	0	0	0	0	0
Chinook salmon	0	0	0	0	0	0	6	0	0
Unidentified salmonids	0	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	1	0	0
Reticulate sculpin	26	32	2	0	0	0	0	0	0
Riffle sculpin	0	0	0	0	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0	0
Unidentified cottids	17	1	0	0	0	0	0	0	0
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table C-1 (continued). Number of fish collected during summer 2001 extensive sampling in Tryon Creek.

Species	Creek, reach			
	Tryon			
	1	2	3	4
Unidentified lamprey	0	0	0	0
Northern pikeminnow	0	0	0	0
Longnose dace	0	0	0	0
Speckled dace	0	0	0	0
Redside shiner	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0
Largescale sucker	0	0	0	0
Cutthroat trout	1	10	27	12
Coho salmon	0	0	0	0
Rainbow trout/steelhead	0	0	1	0
Chinook salmon	6	0	0	0
Unidentified salmonids	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0
Three-spined stickleback	0	0	0	0
Prickly sculpin	1	0	0	0
Reticulate sculpin	35	82	196	0
Riffle sculpin	0	0	0	0
Torrent sculpin	0	0	0	0
Unidentified cottids	0	8	27	0
Pumpkinseed <sup>a</sup>	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0

<sup>a</sup>Non-native species

## **APPENDIX D**

### Intensive Fish Survey Data



Appendix Table D-1. Number of fish collected (first electrofishing pass) during summer 2001 intensive sampling in Balch, Crystal Springs, and Johnson creeks.

Species	Creek, reach									
	Balch		Crystal Springs	Johnson						
	1	2	1	2	4	6	8	12	14	16
Unidentified lamprey	0	0	1	0	0	2	1	6	0	0
Northern pikeminnow	0	0	0	0	0	0	0	0	0	0
Longnose dace	0	0	13	6	15	4	11	3	0	0
Speckled dace	0	0	0	17	15	35	26	5	5	2
Redside shiner	0	0	5	19	25	69	44	15	20	19
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	1	0	0	0	0	0	0
Cutthroat trout	28	21	0	0	0	0	0	0	0	1
Coho salmon	0	0	0	1	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	0	0	0	0	0	0	0	0
Chinook salmon	0	0	0	0	0	0	0	0	0	0
Unidentified salmonids	0	0	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	3	3	0	0	0	0	0
Reticulate sculpin	0	0	71	13	27	38	15	25	10	15
Riffle sculpin	0	0	0	0	0	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified cottids	0	0	58	11	24	6	11	12	6	9
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-1 (continued). Number of fish collected (first electrofishing pass) during summer 2001 intensive sampling in Kelley, Miller, Saltzman, and Stephens creeks.

Species	Creek, reach							
	Kelley		Miller		Saltzman		Stephens	
	1	2	1	2	2	3	1	2
Unidentified lamprey	6	0	0	0	0	0	0	0
Northern pikeminnow	0	0	0	0	0	0	0	0
Longnose dace	0	0	0	0	0	0	0	0
Speckled dace	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	0	0	1	0
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0
Cutthroat trout	8	0	0	0	0	0	2	0
Coho salmon	0	0	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	0	0	0	0	0	0
Chinook salmon	0	0	0	0	0	0	3	0
Unidentified salmonids	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	1	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0
Reticulate sculpin	58	11	41	2	0	0	0	0
Riffle sculpin	0	0	0	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0
Unidentified cottids	0	0	11	19	0	0	1	0
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-1 (continued). Number of fish collected (first electrofishing pass) during summer 2001 intensive sampling in Tryon Creek.

Species	Creek, reach			
	Tryon			
	1	2	3	4
Unidentified lamprey	0	0	0	0
Northern pikeminnow	0	0	0	0
Longnose dace	0	0	0	0
Speckled dace	0	0	0	0
Redside shiner	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0
Largescale sucker	1	0	0	0
Cutthroat trout	5	4	5	12
Coho salmon	4	0	0	0
Rainbow trout/steelhead	0	0	0	0
Chinook salmon	1	0	0	0
Unidentified salmonids	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0
Three-spined stickleback	0	0	0	0
Prickly sculpin	3	0	0	0
Reticulate sculpin	22	69	26	28
Riffle sculpin	3	0	0	0
Torrent sculpin	3	0	0	0
Unidentified cottids	12	4	7	16
Pumpkinseed <sup>a</sup>	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-2. Number of fish collected (first electrofishing pass) during fall 2001 intensive sampling in Balch, Crystal Springs, and Johnson creeks.

Species	Creek, reach									
	Balch		Crystal Springs	Johnson						
	1	2	1	2	4	6	8	12	14	16
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0
Northern pikeminnow	0	0	0	0	0	0	0	0	0	0
Longnose dace	0	0	6	2	2	6	4	38	0	22
Speckled dace	0	0	7	2	5	8	43	33	0	1
Redside shiner	0	0	2	0	0	7	29	33	1	12
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	91	0	0	0	0	5	0	2
Cutthroat trout	27	12	0	0	1	0	0	0	0	6
Coho salmon	0	0	0	0	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	1	0	0	0	0	0	0	0
Chinook salmon	0	0	0	1	0	0	0	0	0	0
Unidentified salmonids	0	0	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	2	0	0	0	0	0	0
Reticulate sculpin	0	0	65	10	11	6	14	14	4	36
Riffle sculpin	0	0	53	6	0	4	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified cottids	0	0	3	0	10	2	11	9	0	3
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-2 (continued). Number of fish collected (first electrofishing pass) during fall 2001 intensive sampling in Kelley, Miller, Saltzman, and Stephens creeks.

Species	Creek, reach							
	Kelley		Miller		Saltzman		Stephens	
	1	2	1	2	2	3	1	2
Unidentified lamprey	1	2	0	0	0	0	0	0
Northern pikeminnow	0	0	0	0	0	0	0	0
Longnose dace	0	0	0	0	0	0	0	0
Speckled dace	1	7	0	0	0	0	0	0
Redside shiner	0	0	0	0	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0
Cutthroat trout	15	1	0	0	0	0	0	0
Coho salmon	0	0	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	0	0	0	0	0	0
Chinook salmon	0	0	0	0	0	0	2	0
Unidentified salmonids	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	90	0
Three-spined stickleback	0	0	0	0	0	0	1	0
Prickly sculpin	0	0	0	1	0	0	0	0
Reticulate sculpin	48	46	6	2	0	0	0	0
Riffle sculpin	6	0	0	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0
Unidentified cottids	8	21	0	0	0	0	0	0
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	7	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	3	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	10	0

<sup>a</sup>Non-native species

Appendix Table D-2 (continued). Number of fish collected (first electrofishing pass) during fall 2001 intensive sampling in Tryon Creek.

Species	Creek, reach			
	Tryon			
	1	2	3	4
Unidentified lamprey	0	0	0	0
Northern pikeminnow	0	0	0	0
Longnose dace	0	0	0	0
Speckled dace	0	0	0	0
Redside shiner	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0
Largescale sucker	0	0	0	0
Cutthroat trout	2	4	4	8
Coho salmon	2	0	0	0
Rainbow trout/steelhead	1	3	0	0
Chinook salmon	3	0	0	0
Unidentified salmonids	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0
Three-spined stickleback	0	0	0	0
Prickly sculpin	2	0	0	0
Reticulate sculpin	6	17	22	15
Riffle sculpin	6	5	0	0
Torrent sculpin	2	0	0	0
Unidentified cottids	1	4	1	1
Pumpkinseed <sup>a</sup>	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-3. Number of fish collected (first electrofishing pass) during winter 2002 intensive sampling in Balch, Crystal Springs, Kelley, and Miller creeks.

Species	Creek, reach						
	Balch		Crystal Springs	Kelley		Miller	
	1	2	1	1	2	1	2
Unidentified lamprey	0	0	1	2	8	1	0
Northern pikeminnow	0	0	0	0	0	0	0
Longnose dace	0	0	1	0	0	0	0
Speckled dace	0	0	1	1	14	0	0
Redside shiner	0	0	71	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0
Largescale sucker	0	0	18	0	0	0	0
Cutthroat trout	9	7	1	4	9	0	0
Coho salmon	0	0	0	0	0	10	0
Rainbow trout/steelhead	0	0	4	0	0	0	0
Chinook salmon	0	0	0	0	0	0	0
Unidentified salmonids	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	1	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0
Three-spined stickleback	0	0	0	0	0	0	0
Prickly sculpin	0	0	1	0	0	1	0
Reticulate sculpin	0	0	35	4	46	13	2
Riffle sculpin	0	0	14	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0
Unidentified cottids	0	0	5	0	27	0	0
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-3 (continued) Number of fish collected (first electrofishing pass) during winter 2002 intensive sampling in Saltzman, and Stephens creeks.

Species	Creek, reach		
	Saltzman		Stephens
	2	3	1
Unidentified lamprey	0	0	0
Northern pikeminnow	0	0	1
Longnose dace	0	0	0
Speckled dace	0	0	0
Redside shiner	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0
Largescale sucker	0	0	0
Cutthroat trout	0	0	0
Coho salmon	0	0	0
Rainbow trout/steelhead	0	0	4
Chinook salmon	0	0	24
Unidentified salmonids	0	0	0
Banded killifish <sup>a</sup>	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0
Three-spined stickleback	0	0	0
Prickly sculpin	0	0	3
Reticulate sculpin	0	0	2
Riffle sculpin	0	0	0
Torrent sculpin	0	0	0
Unidentified cottids	0	0	0
Pumpkinseed <sup>a</sup>	0	0	0
Bluegill <sup>a</sup>	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0
Largemouth bass <sup>a</sup>	0	0	0
White crappie <sup>a</sup>	0	0	0

<sup>a</sup>Non-native species



Appendix Table D-4. Number of fish collected (first electrofishing pass) during spring 2002 intensive sampling in Balch, Crystal Springs, and Johnson creeks.

Species	Creek, reach									
	Balch		Crystal Springs	Johnson						
	1	2	1	2	4	6	8	12	14	16
Unidentified lamprey	0	0	6	0	3	0	1	2	0	3
Northern pikeminnow	0	0	0	0	0	0	0	0	0	0
Longnose dace	0	0	4	0	4	0	1	0	0	0
Speckled dace	0	0	16	8	4	9	1	17	1	9
Redside shiner	0	0	87	1	23	7	75	29	28	64
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	3	1	1	0	1	0	1	4
Cutthroat trout	22	18	0	0	0	0	0	0	0	6
Coho salmon	0	0	3	1	0	0	0	0	0	0
Rainbow trout/steelhead	0	0	0	0	0	0	0	0	0	0
Chinook salmon	0	0	2	2	0	0	0	0	0	0
Unidentified salmonids	0	0	2	1	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	6	0	0	0	0	0	0
Reticulate sculpin	0	0	148	23	8	7	9	8	11	13
Riffle sculpin	0	0	7	0	0	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0	0	0
Unidentified cottids	0	0	4	0	1	0	1	3	0	1
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-4 (continued). Number of fish collected (first electrofishing pass) during spring 2002 intensive sampling in Kelley, Miller, Saltzman, and Stephens creeks.

Species	Creek, reach							
	Kelley		Miller		Saltzman		Stephens	
	1	2	1	2	2	3	1	2
Unidentified lamprey	4	29	0	0	0	0	0	0
Northern pikeminnow	0	0	0	0	0	0	1	0
Longnose dace	0	0	0	0	0	0	0	0
Speckled dace	17	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0
Cutthroat trout	6	3	14	1	0	0	0	0
Coho salmon	0	0	5	0	0	0	37	0
Rainbow trout/steelhead	0	0	0	0	0	0	1	0
Chinook salmon	0	0	0	0	0	0	0	0
Unidentified salmonids	0	0	0	0	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0	0	0	0	0
Three-spined stickleback	0	0	6	0	0	0	0	0
Prickly sculpin	0	0	2	0	0	0	9	0
Reticulate sculpin	39	44	31	3	0	0	1	0
Riffle sculpin	0	0	0	0	0	0	0	0
Torrent sculpin	0	0	0	0	0	0	0	0
Unidentified cottids	3	50	2	0	0	0	1	0
Pumpkinseed <sup>a</sup>	0	0	0	0	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0	0	0	2	0
Largemouth bass <sup>a</sup>	0	0	0	0	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0	0	0	0	0

<sup>a</sup>Non-native species

Appendix Table D-4 (continued). Number of fish collected (first electrofishing pass) during spring 2002 intensive sampling in Tryon Creek.

Species	Creek, reach			
	Tryon			
	1	2	3	4
Unidentified lamprey	0	0	0	0
Northern pikeminnow	0	0	0	0
Longnose dace	0	0	0	0
Speckled dace	0	0	0	0
Redside shiner	0	0	0	0
Oriental weatherfish <sup>a</sup>	0	0	0	0
Largescale sucker	0	0	0	0
Cutthroat trout	3	4	19	8
Coho salmon	15	0	0	0
Rainbow trout/steelhead	4	0	0	0
Chinook salmon	0	0	0	0
Unidentified salmonids	0	0	0	0
Banded killifish <sup>a</sup>	0	0	0	0
Western mosquitofish <sup>a</sup>	0	0	0	0
Three-spined stickleback	0	0	0	0
Prickly sculpin	10	0	0	0
Reticulate sculpin	28	15	34	17
Riffle sculpin	0	0	0	0
Torrent sculpin	0	0	0	0
Unidentified cottids	1	0	0	0
Pumpkinseed <sup>a</sup>	0	0	0	0
Bluegill <sup>a</sup>	0	0	0	0
Smallmouth bass <sup>a</sup>	0	0	0	0
Largemouth bass <sup>a</sup>	0	0	0	0
White crappie <sup>a</sup>	0	0	0	0

<sup>a</sup>Non-native species