ABUNDANCE AND DISTRIBUTION OF FISH SPECIES IN WEST LINN STREAMS

FINAL REPORT 2003-04

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EXECUTIVE SUMMARY

From summer 2003 through spring 2004, the Oregon Department of Fish and Wildlife (ODFW) investigated and inventoried fish communities in seven streams within the city of West Linn: 1) Unnamed Creek, which drains into the Tualatin River, 2) Tanner Creek, which drains into the Willamette River, 3) Salamo Creek, which drains into Tanner Creek, 4) Mary S. Young Creek, which drains into the Willamette River, 5) Trillium Creek, which drains into the Willamette River, 6) Fern Creek, which drains into the Willamette River, and 7) Arbor Creek, which drains into Fern Creek. None of these streams, except for the lower portion of Unnamed Creek, have been previously surveyed.

We sampled the seven streams in 79 reach/time surveys, collecting and examining over 1200 individuals. Among the fish collected, more than three-quarters (91%) were reticulate sculpin *Cottus perplexus*, 4% were western brook lamprey *Lampetra richardsoni*, and 3.5% were salmon and trout. We identified seven native species from four families. We identified three alien species from three families, which constituted about 1.5% of the total catch.

Cutthroat trout *Oncorhynchus clarki* were the most common salmonid and were present in Unnamed and Trillium Creeks. We found juvenile rainbow/steelhead *Oncorhynchus mykiss* in Unnamed Creek, juvenile Chinook salmon *Oncorhynchus tshawytscha* in Mary S. Young and Trillium Creeks, and juvenile coho salmon *Oncorhynchus kisutch* in Mary S. Young Creek. Western brook lamprey were observed throughout the year in Unnamed Creek.

Index of Biotic Integrity (IBI) scores for all sampling efforts in fish-bearing streams ranged from 10 to 68. The mean IBI for all sampling efforts per stream reach indicated all reaches were severely impaired. No IBI scores were considered acceptable.

Despite extensive urban development, West Linn streams still contain some native fish species, including salmonids. Fish assemblages have obviously changed throughout the period of urban development, but persistence of native species, especially those most sensitive to habitat degradation, confirms the potential benefits of habitat protection and restoration.

INTRODUCTION

As population and industrial use have increased, water quality and habitat in streams of the Portland Metropolitan area, including West Linn, have been degraded. Little information exists about the historical and current presence, distribution, and abundance of fish species in West Linn streams. Surveys in similar streams throughout Clackamas, Multnomah, and Washington counties have documented widespread distribution of anadromous and resident salmonids, including species listed under the Endangered Species Act (ESA). In 2003, the Oregon Department of Fish and Wildlife (ODFW) and the City of West Linn identified a need to conduct initial surveys in West Linn streams. Information from West Linn stream surveys will help complete information on fish presence in streams of the Portland Metropolitan area, and may assist managers to set priorities on aquatic habitat protection and restoration work. The objectives of this study are to 1) evaluate the presence and distribution of fish species in West Linn streams, 2) evaluate seasonal habitat use of stream reaches by fish, 3) calculate an Index of Biotic Integrity for specific stream reaches, and 4) determine seasonal distribution and abundance of sensitive species in specific stream reaches.

Urban stream surveys conducted within the Portland metropolitan area (Ward 1995; Friesen and Ward 1996; Leader 2001a; Leader 2001b; Graham and Ward 2002; Tinus et al. 2003a), and within Clackamas County specifically (Friesen and Zimmerman 1999, Tinus et al. 2003b) documented numerous salmonid species including cutthroat trout *Oncorhynchus clarki*, rainbow/steelhead trout *O. mykiss*, coho salmon *O. kisutch*, and Chinook salmon *O. tshawytscha*. Currently, lower Columbia River and upper Willamette River Chinook salmon evolutionarily significant units (ESU), and lower Columbia River and upper Willamette River steelhead ESUs are listed under the federal ESA as threatened (NOAA 1999). In addition, lower Columbia River coho salmon are listed as an endangered species under the Oregon state ESA (Chilcote 1999).

Other species of interest include lamprey *Lampetra spp.* Lampreys require a diversity of habitat types depending on life history stage and are sensitive to habitat degradation and pollution. They have possibly declined throughout much of their historic range in western North America (Close et al. 1995; Vella et al. 1999). Western brook lamprey *L. richardsoni* and Pacific lamprey *L. tridentata* live within the study area. All Portland area lamprey species have been petitioned for listing under the federal ESA.

METHODS

Study Area

We conducted fish surveys in seven streams within the City of West Linn (Figure 1). Four of these streams are direct tributaries to the Willamette River, including Tanner Creek, Mary S. Young Creek, Trillium Creek, and Fern Creek. One stream, Unnamed Creek, is a tributary to the Tualatin River. The other two streams, Salamo Creek and Arbor Creek, are tributaries to Tanner Creek and Fern Creek, respectively.

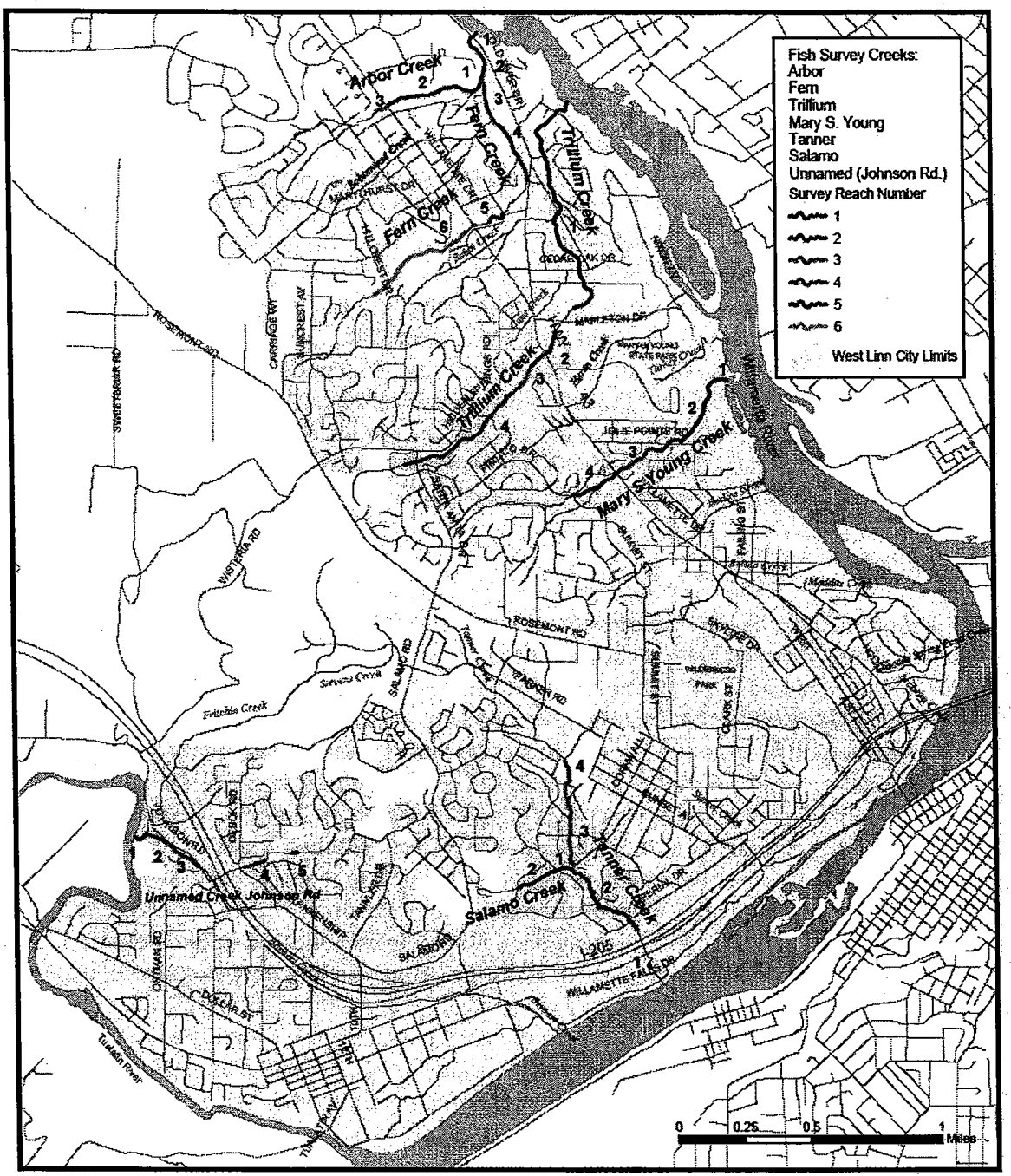

Figure 1. Location of streams and reaches surveyed in West Linn, summer 2003 – spring 2004.

Field Sampling

Presence/Absence Sampling

We conducted fish presence/absence surveys during low flows in summer 2003 to evaluate the presence and distribution of fish species. Within each stream reach, we used backpack electrofishing to sample approximately 20% of the pools, riffles and glides (Hankin and Reeves 1988). Individual stream reaches were delineated by significant landscape changes, major tributaries, or fish passage barriers (Moore 2001) (Table 1). We randomly selected one of the first five units of each habitat type as a starting point for sampling each reach, then sampled every fifth unit of each habitat type. The backpack electrofisher was set at 30 Hz DC, and output ranged from 200 – 400 volts depending on water conductivity. Electrofishing was conducted in a downstream to upstream direction and limited to one pass through each designated habitat unit. Length and width of each unit were measured to calculate the total surface area electrofished. Fish collected from each habitat unit were identified, measured, and examined for anomalies. Fish were then released back into the habitat unit where they were collected.

Seasonal Sampling

We conducted multiple pass electrofishing surveys each season from summer 2003 through spring 2004 to evaluate seasonal habitat use by fish species, and to determine salmonid population abundance. We selected 100 m of representative stream habitat within select stream reaches surveyed during presence/absence surveys. Because several stream reaches did not contain fish or were too difficult to access, not all stream reaches were surveyed by multiple pass electrofishing. Stream reaches not surveyed included: Unnamed Creek reach 5, Tanner Creek reaches 1 and 4, Salamo Creek reach 1, Mary S. Young Creek reaches 2 and 3, Trillium Creek reaches 2 and 3, Fern Creek reaches 1, 4 and 6, and Arbor Creek reaches 2 and 3. Prior to sampling, we placed block nets at both ends of the 100-m sampling reach to prevent fish from entering or leaving the sampling area. Electrofishing began at the downstream net and ended at the upstream net. During the first electrofishing pass, all fish were collected in the 100-m sampling reach, and if salmonids were captured, additional electrofishing passes were conducted until salmonids were no longer present (up to three passes). Only salmonids were collected during additional electrofishing passes. At the end of each pass, fish were identified, measured, and examined for anomalies. Lifestage was not determined for fish, with the exception of brook lamprey. Brook lamprey were classified as adult or ammocoete (juvenile) based upon the development of eyes. After measurements, fish were released back into the stream, below the downstream net.

Data Analyses

Index of Biotic Integrity

We calculated an Index of Biotic Integrity (IBI) for each stream reach sampled during presence/absence surveys and for each stream reach sampled during multiple pass

Table 1. Description of stream reaches sampled during presence/absence surveys in West Linn, summer 2003.

Stream	Reach	Description
Unnamed Creek	1	Mouth to Fritchie Creek
Unnamed Creek	2	Fritchie Creek to 1st culvert
Unnamed Creek	3	1st culvert to pipe under Johnson Rd
Unnamed Creek	5	Willamette View condos to about 50m upstream
Tanner Creek	1	West side of lagoon to vertical rock wall
Tanner Creek	2	Pipe end (below Imperial Dr.) to Salamo Creek
Tanner Creek	3	Salamo Creek to Stonegate Ln
Tanner Creek	4	Pond beyond Stonegate Ln to Beacon Hill Ln
Salamo Creek	1	Mouth to Beacon Hill Dr.
Salamo Creek	2	Beacon Hill Dr. to Barrington Dr.
Mary S. Young Creek	1	Mouth to 2nd culvert (in park)
Mary S. Young Creek	2	2nd culvert to Jolie Point Rd
Mary S. Young Creek	3	Jolie Point Rd to Willamette Drive
Mary S. Young Creek	4	Willamette Drive to Summit St
Trillium Creek	1	Mouth to pipe between Kenthorpe Way and Mapleton
Trillium Creek	2	Park limits closest to Mapleton Dr to Willamette Dr
Trillium Creek	3	Willamette Dr to tributary
Trillium Creek	4	Tributary to about 100m above Santa Anita Dr
Fern Creek	1	Mouth to Old River Road
Fern Creek	2	Old River Road to Arbor Creek
Fern Creek	3	Arbor Creek to Robinwood Creek
Fern Creek	4	Robinwood Creek to Chippewa Ct
Fern Creek	5	Rose Way to pipe
Fern Creek	6	Pipe after Willamette Dr to Woodhaven Circle
Arbor Creek	1	Mouth to culvert
Arbor Creek	2	Culvert to Willamette Dr
Arbor Creek	3	Willamette Dr to about 100m above Willamette Dr

surveys. An IBI is a complex measure of the ability of a habitat to support a species composition comparable with that of natural habitats in the region. High IBI scores indicate a diverse assemblage of native fish are present and thus a healthy stream ecosystem. This makes the IBI a useful tool for assessing the impacts of anthropogenic disturbances on fish communities. We generated IBIs for West Linn streams by applying our fish collection data to a set of 12 metrics (Table 2; Hughes et al. 1998). All fish collected during presence/absence surveys and the first pass of electrofishing during multiple pass surveys were used to calculate IBI scores. IBI scores range from 0 to 100, where streams with an IBI $\leq$50 are considered severely impaired, streams scoring 51-74 are marginally impaired, and streams with a score $\geq$75 are considered acceptable. IBI scores could not be calculated for streams without fish. In several streams, we captured sculpins and lamprey too small to be identified; these fish were considered reticulate sculpin (*Cottus perplexus*) and western brook lamprey (*Lampetra richardsoni*) in the calculation of IBIs because all adult sculpin captured were reticulate sculpin, and all adult lamprey captured were western brook lamprey.

Table 2. IBI scoring criteria used for West Linn streams, 2003-2004, 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.

	Raw values	
Metric	Stream order 1	Stream orders 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[a]	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[b]	0 – 100	0 – 100
(12) Percent of individuals with anomalies	2 – 0	2 – 0

[a]Species that create nests in gravel or smaller substrates to spawn.
[b]Lunkers are large individuals of the following species and sizes: rainbow/steelhead trout *Oncorhynchus mykiss* (300 mm), and cutthroat trout *O. clarki* (250 mm).

As an example of how IBI scores are calculated, we will look at reach 1 & 2 of Unnamed Creek (2nd order stream) during summer presence/absence surveys where we captured 1 cutthroat trout, 20 brook lamprey, and 22 reticulate sculpin. These fish were considered in the 12 metrics listed above and points or percentages were assigned for each metric. For example, for metric 1, which is the number of native families of fish present in the stream reach, we had 3 native families present, thus metric 1 was assigned 3 points. Likewise, for metric 2 (native species), we had 3 native species present, thus metric 2 was also assigned 3 points. We continued assigning points in this way for metrics 1 – 7. For metrics 8 – 12, we calculated a percentage based on the total number of fish caught. Thus for the percent of filter feeders, we divided the number of filter feeders captured by the total number of fish captured and multiplied by 100. In reach 1 & 2 of

Unnamed Creek, this was 20 divided by 43, multiplied by 100, for 46.5%. Fish classifications came from Hughes et al. (1989). Once all points and percentages were assigned to each metric, the points were transformed into scores for each metric (maximum score of 10 for each metric). Point values for metrics 1 – 7 were divided by the upper threshold of points possible for the metric (Table 2) and multiplied by 10. For example, for metric 1 (native families), with a stream order of 2, the upper threshold is 7 native families, thus our assigned point value of 3 from above, was divided into 7 and multiplied by 10 to result in a score of 4.3. For metrics 8-12, the percentage was divided by 10. Thus for metric 9 from above (filter-feeders), the percentage of 46.5 was divided by 10 for a score of 4.7. For metrics 7, 10, and 12, which depict non-healthy stream conditions (tolerant individuals, omnivores, and fish with anomalies), the score was subtracted from 1 and multiplied by 10, to give high values to a stream for not containing fish indicative of non-healthy stream conditions. Thus for metric 8 (tolerant individuals), zero was divided by 10 to get 0, but then we subtracted zero from 1 for a value of 1, which we multiplied by 10, for a score of 10. Once scores were calculated for each of the 12 metrics, the 12 scores were summed, divided by the total number of points possible (120), and multiplied by 100 to obtain the final IBI score. For reaches 1 & 2 of Unnamed Creek, this resulted in 65.3 divided by 120, multiplied by 100 to obtain a final IBI score of 54.

Fish distribution near culverts along the three salmonid-bearing creeks was also analyzed using the data from summer presence/absence surveys. IBI scores were calculated for 10-m stream lengths upstream and downstream of each culvert on Mary S. Young and Trillium Creeks, and 15-m stream lengths upstream and downstream of each culvert on Unnamed Creek. These stream lengths were the minimum length sampled between two culverts on each creek.

Abundance and Seasonal Distribution of Sensitive Species

We calculated the abundance of salmonids for each multiple pass sampling reach with a population estimate model designed specifically for multiple pass electrofishing surveys (Armour et al. 1983). We were unable to use the model to calculate salmonid abundance in surveys where salmonid catch did not decline with additional electrofishing passes.

We looked at the seasonal distribution of salmonid and lamprey species for each sampling reach as well. This information was used to determine which part of the year sensitive species utilized individual stream reaches.

RESULTS

Presence/Absence Sampling

During summer 2003, we sampled 27 stream reaches in 7 different streams within the City of West Linn. We captured 323 fish from six species (Table 3). Unidentified sculpin were considered reticulate sculpin and unidentified lamprey were considered brook lamprey because there was no evidence that other species from those genuses were present. Reticulate sculpin made up the majority of the catch, followed by brook lamprey, cutthroat trout, coho salmon, Chinook salmon, and mosquitofish. All species, with the exception of mosquitofish, are native

Table 3. Fish collected during presence/absence (P/A) and the first pass of multiple-pass removal (MPR) sampling in West Linn streams, summer 2003 – spring 2004.

Family, Species	Catch		Proportion of Total	
	P/A	MPR	P/A	MPR
Petromyzontidae				
Brook lamprey *Lampetra richardsoni*	0	14	0	0.015
Unidentified lamprey *Lampetra* spp.[a]	20	20	0.062	0.022
Salmonidae				
Cutthroat trout *Onchorhynchus clarki*	7	6	0.022	0.007
Coho salmon *Onchorhynchus kisutch*	5	0	0.015	0
Rainbow trout/steelhead *Onchorhynchus mykiss*	0	6	0	0.007
Chinook salmon *Onchorhynchus tshawytscha*	1	3	0.003	0.003
Unidentified salmonids *Salmonidae* spp.	0	15	0	0.017
Fundulidae[b]				
Banded killifish *Fundulus diaphanous*	0	4	0	0.004
Poeciliidae[b]				
Mosquitofish *Gambusia affinis*	1	0	0.003	0
Gasterosteidae				
Three-spined stickleback *Gasterosteus aculeatus*	0	1	0	0.001
Cottidae				
Reticulate sculpin *Cottus perplexus*	142	536	0.440	0.593
Unidentified sculpins *Cottidae* spp.	147	286	0.455	0.316
Centrarchidae[b]				
Smallmouth bass *Micropterus dolomieu*	0	13	0	0.014
Total	323	904	1.0	1.0

[a]Ammocoetes were not keyed to species.
[b]Non-native families or species.

to Oregon. Species sensitive to habitat disturbance (salmonids, lamprey) made up 10.2% of the catch. Although 5 of the 7 streams (Unnamed Creek, Mary S. Young Creek, Trillium Creek, Fern Creek, and Arbor Creek) contained fish, most fish were found only in the lower reaches of each stream. We found fish in only 9 of 27 stream reaches sampled (Figure 2).

Reticulate sculpin were found in all five of the fish-bearing streams, especially in the lower reaches. Western brook lamprey were observed in the lower two reaches of Unnamed Creek. The one nonnative species, mosquitofish, was found in the third reach of Tanner Creek. This

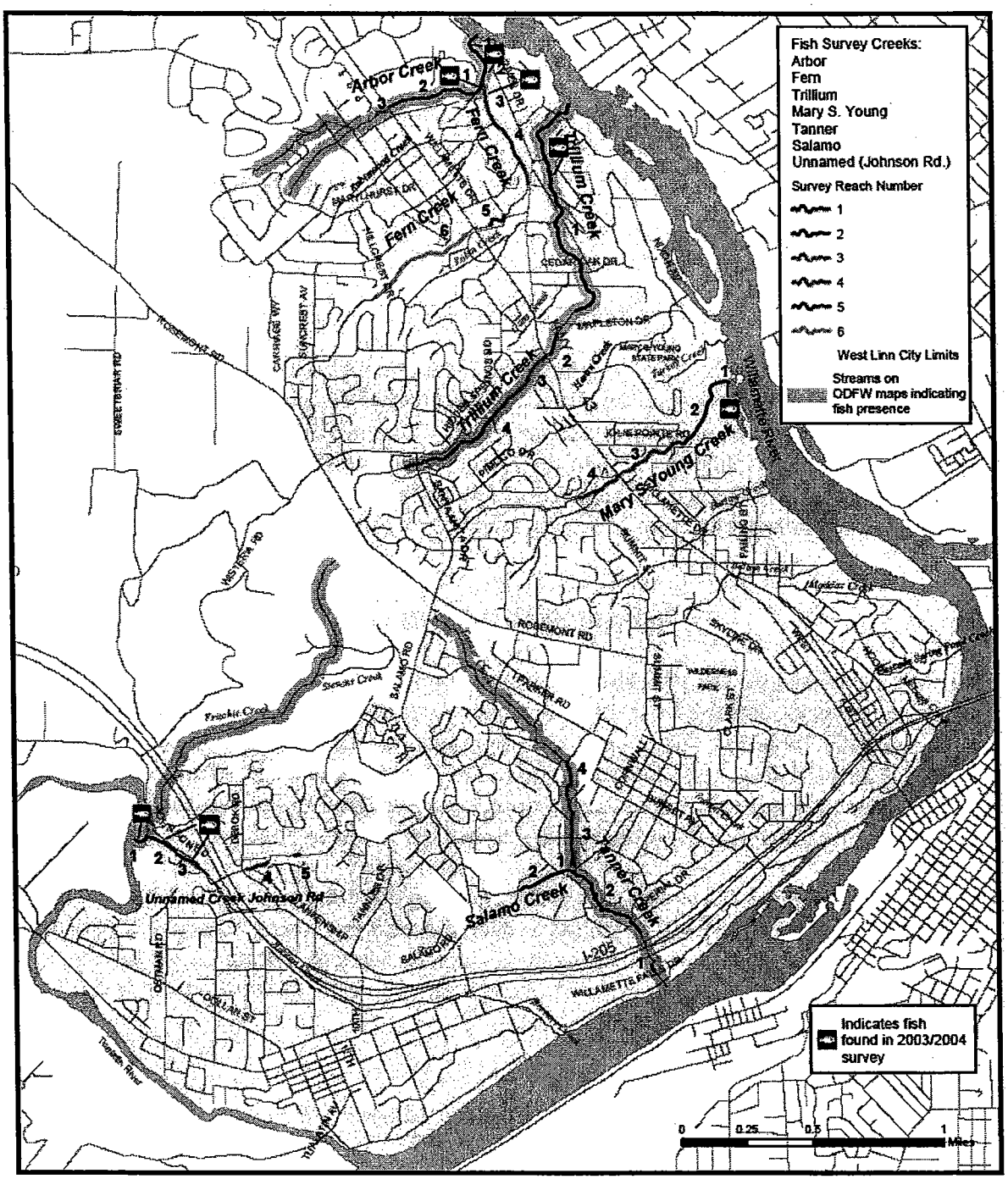

Figure 2. Location of streams and reaches containing fish found during stream surveys in West Linn, summer 2003 – spring 2004.

was the only fish observed throughout Tanner Creek during the entire sampling period, thus Tanner Creek is listed as containing no fish.

Salmonids were observed in three of the seven streams. Cutthroat trout, the most common salmonid species observed, were present in the lower reaches of Trillium Creek and Unnamed Creek. Juvenile coho salmon and Chinook salmon were present in the lower reaches of Trillium Creek and Mary S. Young Creek.

Seasonal Sampling

Between summer 2003 and spring 2004 we surveyed 13 stream reaches within the 7 streams by conducting multiple pass removal surveys. We captured 904 fish from eight species (Table 3). Reticulate sculpin made up the majority of captured fish. Non-native species made up 1.9% of the catch. Sensitive species made up 7.1% of the catch. We found fish in just over half of the sampled reaches (7 of 13). Average fork lengths of fish tended to be higher in Unnamed Creek, with the exception of cutthroat trout fork lengths, which were higher in Trillium Creek (Table 4).

Index of Biotic Integrity

IBI scores were calculated for the 10 fish-bearing stream reaches observed during presence/absence surveys, and the 7 fish-bearing stream reaches sampled during multiple pass surveys (Appendix C; Table 5). IBI scores for all sampling efforts in West Linn streams ranged from 10 to 68. Mean IBI scores indicated all sampled reaches were considered severely impaired. No IBI scores were considered acceptable, and only 11 of 45 IBI scores were considered marginally impaired. IBI scores tended to be higher during winter.

Fish distribution (reflected as IBI scores) near culverts along three streams showed some definite trends (Figure 3). In general, IBI scores tended to decrease with increasing numbers of culverts until fish populations disappeared. Exceptions to this include Mary S. Young Creek and the stream length between the third and fourth culvert on Trillium Creek. Cutthroat trout were observed up to the fourth culvert in Trillium Creek.

Seasonal Distribution and Abundance of Sensitive Species

Sensitive species were observed in three of the seven streams, and seasonal distribution varied among streams (Table 6). Cutthroat trout were found in every season except spring in Trillium Creek, but only in summer in Unnamed Creek. Rainbow trout were found in every season except spring in Unnamed Creek, and were most abundant in winter. In Mary S. Young Creek, salmonids and lamprey too small to be identified were observed in winter, and juvenile Chinook salmon were observed in spring. Western brook lamprey were observed in Unnamed Creek year-round, however catch was highest in summer and fall.

Table 4. Average fork length of each fish species captured during multiple pass removal surveys in West Linn streams, summer 2003 - spring 2004. Life stage was determined for brook lamprey only. Length ranges are shown in parentheses. N = number of fish captured.

Stream	Species	Average fork length (mm)	N
Unnamed	Rainbow trout	110 (70-160)	6
	Cutthroat trout	78	1
	Brook lamprey (ad)	114 (82-142)	14
	Brook lamprey (jv)	89 (42-130)	18
	Reticulate sculpin	61 (45-95)	199
	Unidentified sculpin	35 (21-45)	75
	Smallmouth bass	68 (63-78)	4
Mary S. Young	Chinook salmon	50 (45-55)	3
	Unidentified salmon	42 (38-49)	15
	Brook lamprey (jv)	106 (86-125)	2
	Reticulate sculpin	57 (47-78)	20
	Unidentified sculpin	39 (34-44)	3
	Smallmouth bass	61 (47-66)	9
	Banded killifish	52 (45-60)	4
	Three-spine stickleback	62	1
Trillium	Cutthroat trout	158 (80-248)	5
	Reticulate sculpin	58 (46-91)	55
	Unidentified sculpin	33 (20-45)	22
Fern	Reticulate sculpin	56 (46-86)	180
	Unidentified sculpin	38 (21-45)	119
Arbor	Reticulate sculpin	54 (46-75)	82
	Unidentified sculpin	38 (21-45)	67

Salmonid numbers were low in all stream reaches. Cutthroat trout abundance was highest during summer and fall in Trillium Creek (Table 7). Rainbow trout abundance was highest during fall and winter in Unnamed Creek. Abundance of salmonids too small for identification was greatest in Mary S. Young Creek during winter. Chinook salmon were present in reach 1 of Mary S. Young Creek during spring only, however because the catch of salmon did not decrease with additional passes during multiple pass surveys, we could not calculate a population estimate.

Table 5. Index of Biotic Integrity scores by stream reach and season in West Linn, summer 2003 – spring 2004. P/A = presence/absence sampling. NF = no fish. N/A = not applicable. Mean is calculated for multiple pass removal surveys only.

Stream	Reach	Stream order	P/A	Summer	Fall	Winter	Spring	Mean
Unnamed	1 & 2	2	54	52	53	51	41	49
	3	1	34	49	34	51	34	42
Tanner	3	1	10	NF	NF	NF	NF	N/A
Mary S. Young	1	1	48	34	25	59	58	44
Trillium	1	1	68	51	51	51	34	47
Fern	1	2	30	N/A	N/A	N/A	N/A	N/A
	2	2	30	30	30	30	30	30
	3	2	30	30	30	30	30	30
Arbor	1	1	34	34	34	34	34	34

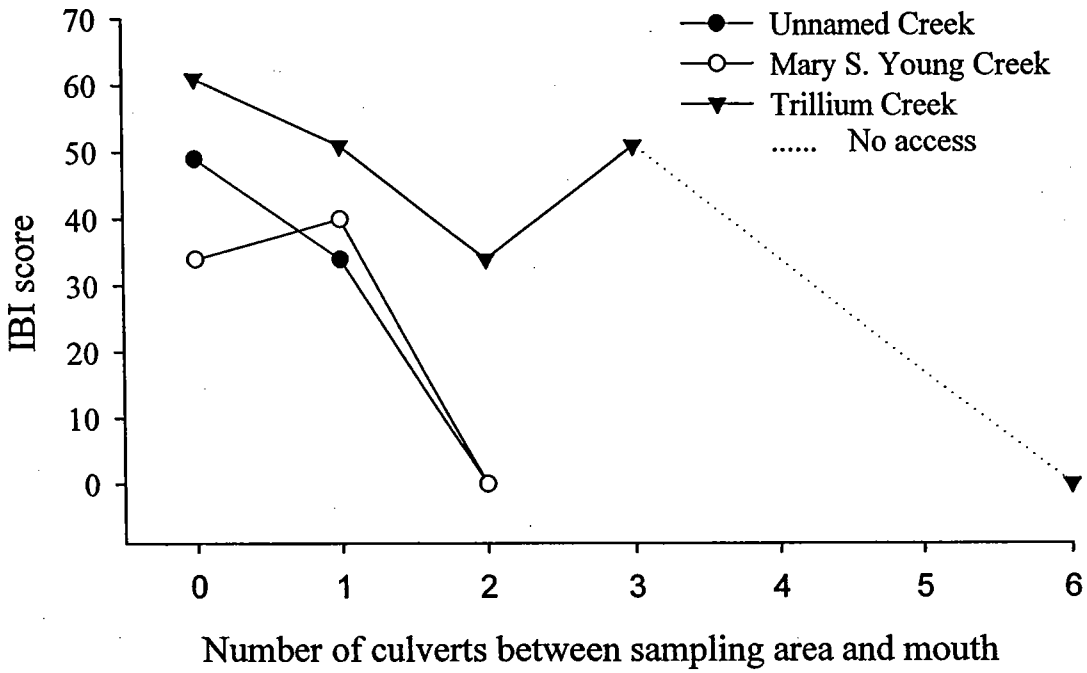

Figure 3. Index of biotic integrity scores for stream lengths above culverts on salmonid-bearing streams. Property owners upstream of culverts four and five on Trillium Creek denied us access to their property; thus no data on fish distribution are available for those sections.

Table 6. Seasonal catch of salmonids and lamprey by species and stream in West Linn, summer 2003 – spring 2004. P/A = presence/absence sampling.

Species, Stream	P/A	Season				Total
		Summer	Fall	Winter	Spring	
Cutthroat trout						
Trillium Creek	0	2	2	1	0	5
Unnamed Creek	0	1	0	0	0	1
Rainbow trout						
Unnamed Creek	0	1	2	3	0	6
Chinook salmon						
Mary S. Young	0	0	0	0	3	3
Coho salmon						
Mary S. Young	3	0	0	0	0	3
Trillium	2	0	0	0	0	2
Unidentified salmon						
Mary S. Young	0	0	0	15	0	15
Western brook lamprey						
Unnamed Creek	0	11	12	2	7	32
Mary S. Young	0	0	0	2	0	2

Table 7. Abundance estimates (and 95% confidence intervals) for salmonids within 100-m stream lengths surveyed seasonally by multiple-pass removal, West Linn urban streams, summer 2003 – spring 2004.

Stream	Reach	Summer	Fall	Winter	Spring
Cutthroat trout					
Trillium Creek	1	2 (±0)	2 (±1)	1 (±0)	0
Unnamed Creek	1 & 2	1 (±0)	0	0	0
Rainbow trout					
Unnamed Creek	1 & 2	1 (±0)	2 (±0)	2 (±0)	0
Unnamed Creek	3	0	0	1 (±0)	0
Chinook salmon					
Mary S. Young	1	0	0	0	N/A
Unidentified salmon					
Mary S Young	1	0	0	15 (±2)	0

DISCUSSION

Despite extensive urban development, a couple of West Linn streams still contain a relatively diverse assemblage of native fish species, including salmonids. The persistence of native species, especially those most sensitive to habitat degradation, confirms the potential benefits of habitat protection and restoration in West Linn.

Trillium Creek contained cutthroat trout in the lower reach during most of the year. Cutthroat were not observed during spring, possibly due to trout moving out of the sampling reach for migratory and/or spawning purposes. Other salmonid species, including juvenile coho and Chinook salmon, were observed downstream of the first culvert during summer. Because these species were not observed upstream of the first culvert, it is likely the culvert blocked their passage. These results suggest the lower reach of Trillium Creek could support a population of salmonids with some restoration work.

Unnamed Creek contained rainbow trout/steelhead downstream of the first culvert during most of the year. The only season rainbow trout were not observed in the stream was spring, however this again could be due to trout moving out of the sampling reach for migratory and/or spawning purposes. Rainbow trout were most often associated with woody debris and overhanging root structures.

The presence of lamprey adults and ammocoetes year-round in Unnamed Creek indicated adult lamprey were spawning throughout the area downstream of the first culvert. The first culvert likely blocks passage for lamprey and salmonids because they were rarely seen upstream of the culvert. Previous surveys from 2002-2003 (Tinus et al. 2003) along reach 1 of this creek showed the same fish species were present, with the addition of northern pikeminnow, *Ptychocheilus oregonensis*. The previous surveys also showed different seasonal distributions of trout; cutthroat trout utilized the stream in summer and winter, and rainbow trout utilized the stream in spring only. This creek could benefit from habitat restoration work.

Mary S. Young Creek contained juvenile salmonids during several different seasons. These juvenile salmon were likely utilizing this reach for rearing and to escape from high river velocities. Unfortunately, the presence of two perched culverts relatively close to the mouth, and the steep slope of the drainage, will make it difficult to open up much habitat for salmonid use in this creek.

Mary S. Young Creek contained non-native species every season except spring. Like the native salmonids, these fish could also be using the creek for rearing and to escape from high river velocities. All non-native species we collected (except smallmouth bass) are considered tolerant by Zarboban et al. (1999). Because 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.

Urban stream surveys have been conducted in several Clackamas County streams, which include tributaries to the Willamette and Tualatin Rivers (Friesen and Zimmerman 1999, Tinus et al.

2003). In all studies, reticulate sculpin was the most abundant and widely distributed fish species, which we found to be true in fish-bearing West Linn streams as well. All fish species observed in West Linn were also observed in the other surveys. Native fish species from other surveys in Clackamas County not observed in West Linn included pacific lamprey *Lampetra tridentata*, northern pikeminnow *Ptychocheilus oregonensis*, longnose dace *Rhinichthys cataractae,* speckled dace *Rhinichthys osculus*, redside shiner *Richardsonius balteatus,* largescale sucker *Catostomus macrocheilus,* prickly sculpin *Cottus asper,* riffle sculpin *Cottus gulosus,* and torrent sculpin *Cottus rhotheus.*

Low IBI scores throughout West Linn streams can probably be attributed to barriers and environmental disturbances, although some small watersheds may have inherently low IBIs, even when relatively intact (Reynolds et al. 2003). In Unnamed Creek, IBIs are low and considered marginally to severely impaired, even though the stream supports rainbow trout most of the year. It is possible that small tributaries of the Tualatin River might naturally have few fish species and therefore low IBIs.

Seasonally varying IBI scores may be a result of fish behavior. Differential habitat or even whole-stream use may vary by species among seasons (Healy 1991). Such is apparently the case with salmonids in Mary S. Young, Trillium, and Unnamed Creeks. Juvenile salmonids rearing in freshwater will often seek out different habitats in the winter (Healey 1991; Sandercock 1991). These habitats provide refuge from extreme flow events and predation, and offer cover and food opportunities.

Seasonal surveys are a snapshot in time taken four days a year over a relatively short distance within each stream reach. Although we believe presence and distribution of most species have been adequately determined, detection of uncommon or rare fish, particularly alien species, is subject to bias associated with minimal effort in each stream. Species observed from P/A surveys were generally similar to those of summer MPR surveys with a couple exceptions: 1) During P/A surveys of Trillium Creek, we observed coho and Chinook salmon near the mouth, but did not find them upstream of the 1st culvert, which is where we conducted MPR surveys; this is likely because the salmonids were unable to pass through the 1st culvert. The first culvert along Trillium Creek has a relatively steep slope (approximately 6%) that can create velocities too great for passage by juvenile salmonids. 2) During P/A surveys of Mary S. Young, we observed coho salmon between the first two culverts, in subsequent surveys[1]. We recognize that relative abundance of species collected may not reflect actual relative abundance because behavior and vulnerability to sampling gear vary among species. For example, benthic species such as sculpins and lampreys can be more difficult to capture than water column species such as salmonids.

[1] The coho likely passed through the first culvert during high winter flows, when the entire area up to the first culvert is flooded.

Recommendations

- Trillium Creek appears to be the most promising stream on which to focus restoration efforts. If passage could be improved through the first culvert, a good amount of stream habitat could be opened up for anadromous salmonids. This section of stream already supports cutthroat trout, and should be able to support anadromous salmonids as well.

- Remove non-native vegetation (Himalayan blackberry and English Ivy) along lower stream reaches and replace with native vegetation.

- In conjunction with other stakeholders develop priorities for habitat protection and restoration in West Linn. Include short term (instream improvements), medium term (habitat protection), and long term (land-use planning) objectives, strategies, and actions.

- Conduct fish and habitat inventories at regular intervals (3-5 years) to evaluate trends and provide information for pre- and post-treatment evaluations.

- Conduct intensive surveys to evaluate abundance, biomass, spatial structure, habitat use, and movements of salmonids in Trillium and Unnamed Creeks.

- Continue to monitor and evaluate habitat improvement projects, and use results from intensive fish surveys to evaluate relationships between changes in habitat and changes in fish populations.

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APPENDIX A

Fish Collected in Summer Presence/Absence Surveys

Appendix Table A-1. Number of fish collected during summer 2003 presence/absence sampling in West Linn streams.

	Stream, reach							
	Unnamed Creek				Tanner Creek			
Species	1	2	3	5	1	2	3	4
Unidentified lamprey	20	0	0	0	0	0	0	0
Cutthroat trout	1	0	0	0	0	0	0	0
Mosquitofish[a]	0	0	0	0	0	0	1	0
Reticulate sculpin	14	2	4	0	0	0	0	0
Unidentified sculpin	5	1	2	0	0	0	0	0

[a]Non-native species

Appendix Table A-1 (continued).

	Stream, reach							
	Mary S. Young Creek				Trillium Creek			
Species	1	2	3	5	1	2	3	4
Cutthroat trout	0	0	0	0	6	0	0	0
Coho salmon	3	0	0	0	2	0	0	0
Chinook salmon	0	0	0	0	1	0	0	0
Reticulate sculpin	1	0	0	0	39	0	0	0
Unidentified sculpin	4	0	0	0	39	0	0	0

Appendix Table A-1 (continued).

	Stream, reach					
	Fern Creek					
Species	1	2	3	4	5	6
Reticulate sculpin	3	33	9	1	0	0
Unidentified sculpin	1	48	26	0	0	0

Appendix Table A-1 (continued).

	Stream, reach				
	Salamo Creek		Arbor Creek		
Species	1	2	1	2	3
Reticulate sculpin	0	0	36	0	0
Unidentified sculpin	0	0	21	0	0

APPENDIX B

Fish Collected in Multiple-Pass Removal Surveys

Appendix Table B-1. Number of fish collected during summer 2003 multiple-pass removal sampling in West Linn streams.

	Stream, reach						
	Unnamed		Tanner		Salamo	Mary S. Young	
Species	1&2	3	2	3	2	1	4
Western brook lamprey	4	0	0	0	0	0	0
Unidentified lamprey	6	1	0	0	0	0	0
Cutthroat trout	1	0	0	0	0	0	0
Rainbow trout/steelhead	1	0	0	0	0	0	0
Reticulate sculpin	45	20	0	0	0	5	0
Unidentified sculpin	21	19	0	0	0	3	0
Smallmouth bass[a]	0	0	0	0	0	3	0

[a]Non-native species

Appendix Table B-1 (continued).

	Stream, reach					
	Trillium		Fern			Arbor
Species	1	4	2	3	6	1
Cutthroat trout	2	0				
Reticulate sculpin	31	0	25	32	0	18
Unidentified sculpin	10	0	18	44	0	31

Appendix Table B-2. Number of fish collected during fall 2003 multiple-pass removal sampling in West Linn streams.

	Stream, reach						
	Unnamed		Tanner		Salamo	Mary S. Young	
Species	1&2	3	2	3	2	1	4
Western brook lamprey	8	0	0	0	0	0	0
Unidentified lamprey	4	1	0	0	0	0	0
Rainbow trout/steelhead	2	0	0	0	0	0	0
Reticulate sculpin	22	17	0	0	0	6	0
Unidentified sculpin	7	11	0	0	0	0	0
Smallmouth bass[a]	0	0	0	0	0	6	0

[a]Non-native species

Appendix Table B-2 (continued).

	Stream, reach					
	Trillium		Fern			Arbor
Species	1	4	2	3	6	1
Cutthroat trout	2	0	0	0	0	0
Reticulate sculpin	6	0	19	28	0	19
Unidentified sculpin	9	0	9	23	0	22

Appendix Table B-3. Number of fish collected during winter 2004 multiple-pass removal sampling in West Linn streams.

	Stream, reach						
	Unnamed		Tanner		Salamo	Mary S. Young	
Species	1&2	3	2	3	2	1	4
Western brook lamprey	1	0	0	0	0	0	0
Unidentified lamprey	1	0	0	0	0	2	0
Rainbow trout/steelhead	2	1	0	0	0	0	0
Unidentified salmonids	0	0	0	0	0	15	0
Banded killifish[a]	0	0	0	0	0	4	0
Reticulate sculpin	17	15	0	0	0	5	0
Unidentified sculpin	3	11	0	0	0	0	0
Smallmouth bass[a]	4	0	0	0	0	0	0

[a]Non-native species

Appendix Table B-3 (continued).

	Stream, reach					
	Trillium		Fern			Arbor
Species	1	4	2	3	6	1
Cutthroat trout	1	0	0	0	0	0
Reticulate sculpin	6	0	2	30	0	14
Unidentified sculpin	3	0	2	11	0	7

Appendix Table B-4. Number of fish collected during spring 2004 multiple-pass removal sampling in West Linn streams.

	Stream, reach						
	Unnamed		Tanner		Salamo	Mary S. Young	
Species	1&2	3	2	3	2	1	4
Western brook lamprey	1	0	0	0	0	0	0
Unidentified lamprey	6	0	0	0	0	0	0
Chinook salmon	0	0	0	0	0	3	0
Three-spine stickleback	0	0	0	0	0	1	0
Reticulate sculpin	34	29	0	0	0	4	0
Unidentified sculpin	2	1	0	0	0	0	0

Appendix Table B-4 (continued).

	Stream, reach					
	Trillium		Fern			Arbor
Species	1	4	2	3	6	1
Reticulate sculpin	12	0	11	33	0	31
Unidentified sculpin	0	0	4	8	0	7

APPENDIX C

Index of Biotic Integrity Scores

Appendix Table C-1. Raw data used to calculate Index of Biotic Integrity Scores for reaches 1 & 2 and 3 of Unnamed Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Reach 1&2					Reach 3				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	3	3	3	3	2	1	2	1	2	1
Native species	3	3	3	3	2	1	2	1	2	1
Native benthic species	2	2	2	2	2	1	2	1	1	1
Native water column species	1	1	1	1	0	0	0	0	1	0
Hider species	3	3	3	3	2	1	2	1	2	1
Sensitive species	2	2	2	2	1	0	1	0	1	0
Native nonguarding lithophil nester species	2	2	2	2	1	0	1	0	1	0
Percent tolerant individuals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent filter-feeding individuals	46.5	11.8	27.9	7.4	16.3	0.0	2.5	0.0	0.0	0.0
Percent omnivores	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent lunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix Table C-2. Raw data used to calculate Index of Biotic Integrity Scores for reach 1 of Mary S. Young Creek and reach 1 of Trillium Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Mary S. Young, reach 1					Trillium, reach 1				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	2	1	1	3	3	2	2	2	2	1
Native species	2	1	1	3	3	4	2	2	2	1
Native benthic species	1	1	1	2	1	1	1	1	1	1
Native water column species	1	0	0	1	2	3	1	1	1	0
Hider species	1	1	1	3	2	2	2	2	2	1
Sensitive species	1	0	0	2	1	3	1	1	1	0
Native nonguarding lithophil nester species	0	0	0	2	1	3	1	1	1	0
Percent tolerant individuals	0.0	0.0	0.0	19.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent filter-feeding individuals	0.0	0.0	0.0	9.5	0.0	0.0	0.0	0.0	0.0	0.0
Percent omnivores	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent lunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix Table C-3. Raw data used to calculate Index of Biotic Integrity Scores for reach 1 and 2 of Fern Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Reach 1					Reach 2				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	1	--	--	--	--	1	1	1	1	1
Native species	1	--	--	--	--	1	1	1	1	1
Native benthic species	1	--	--	--	--	1	1	1	1	1
Native water column species	0	--	--	--	--	0	0	0	0	0
Hider species	1	--	--	--	--	1	1	1	1	1
Sensitive species	0	--	--	--	--	0	0	0	0	0
Native nonguarding lithophil nester species	0	--	--	--	--	0	0	0	0	0
Percent tolerant individuals	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent filter-feeding individuals	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent omnivores	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent lunkers	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0

Appendix Table C-4. Raw data used to calculate Index of Biotic Integrity Scores for reach 3 of Fern Creek and reach 1 of Arbor Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Fern, reach 3					Arbor, reach 1				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	1	1	1	1	1	1	1	1	1	1
Native species	1	1	1	1	1	1	1	1	1	1
Native benthic species	1	1	1	1	1	1	1	1	1	1
Native water column species	0	0	0	0	0	0	0	0	0	0
Hider species	1	1	1	1	1	1	1	1	1	1
Sensitive species	0	0	0	0	0	0	0	0	0	0
Native nonguarding lithophil nester species	0	0	0	0	0	0	0	0	0	0
Percent tolerant individuals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent filter-feeding individuals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent omnivores	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent lunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix Table C-5. Metric scores used to calculate Index of Biotic Integrity Scores for reaches 1 & 2 and 3 of Unnamed Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Reach 1&2 (2nd order)					Reach 3 (1st order)				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	4.3	4.3	4.3	4.3	2.9	2.5	5.0	2.5	5.0	2.5
Native species	2.7	2.7	2.7	2.7	1.8	2.0	4.0	2.0	4.0	2.0
Native benthic species	2.9	2.9	2.9	2.9	2.9	3.3	6.7	3.3	3.3	3.3
Native water column species	2.5	2.5	2.5	2.5	0.0	0.0	0.0	0.0	5.0	0.0
Hider species	7.5	7.5	7.5	7.5	5.0	2.5	5.0	2.5	5.0	2.5
Sensitive species	4.0	4.0	4.0	4.0	2.0	0.0	5.0	0.0	5.0	0.0
Native nonguarding lithophil nester species	6.7	6.7	6.7	6.7	3.3	0.0	3.3	0.0	3.3	0.0
Percent tolerant individuals	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Percent filter-feeding individuals	4.7	1.2	2.8	0.7	1.6	0.0	0.3	0.0	0.0	0.0
Percent omnivores	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Percent lunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total	65.3	61.8	63.4	61.3	49.5	40.3	59.3	40.3	60.6	40.3
Final IBI Score	54	52	53	51	41	34	49	34	51	34

Appendix Table C-6. Metric scores used to calculate Index of Biotic Integrity Scores for reach 1 of Mary S. Young Creek and reach 1 of Trillium Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Mary S. Young, reach 1 (1st order)					Trillium, reach 1 (1st order)				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	5.0	2.5	2.5	7.5	7.5	5.0	5.0	5.0	5.0	2.5
Native species	4.0	2.0	2.0	6.0	6.0	8.0	4.0	4.0	4.0	2.0
Native benthic species	3.3	3.3	3.3	6.7	3.3	3.3	3.3	3.3	3.3	3.3
Native water column species	5.0	0.0	0.0	5.0	10.0	10.0	5.0	5.0	5.0	0.0
Hider species	2.5	2.5	2.5	7.5	5.0	5.0	5.0	5.0	5.0	2.5
Sensitive species	5.0	0.0	0.0	10.0	5.0	10.0	5.0	5.0	5.0	0.0
Native nonguarding lithophil nester species	3.3	0.0	0.0	6.7	3.3	10.0	3.3	3.3	3.3	0.0
Percent tolerant individuals	10.0	10.0	10.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0
Percent filter-feeding individuals	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent omnivores	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Percent lunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	10.0	10.0	0.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total	58.1	40.3	30.3	70.4	70.1	81.3	60.6	60.6	60.6	40.3
Final IBI Score	48	34	25	59	58	68	51	51	51	34

Appendix Table C-7. Metric scores used to calculate Index of Biotic Integrity Scores for reach 1 and 2 of Fern Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Reach 1 (2nd order)					Reach 2 (2nd order)				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	1.4	--	--	--	--	1.4	1.4	1.4	1.4	1.4
Native species	0.9	--	--	--	--	0.9	0.9	0.9	0.9	0.9
Native benthic species	1.4	--	--	--	--	1.4	1.4	1.4	1.4	1.4
Native water column species	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Hider species	2.5	--	--	--	--	2.5	2.5	2.5	2.5	2.5
Sensitive species	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Native nonguarding lithophil nester species	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent tolerant individuals	10.0	--	--	--	--	10.0	10.0	10.0	10.0	10.0
Percent filter-feeding individuals	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent omnivores	10.0	--	--	--	--	10.0	10.0	10.0	10.0	10.0
Percent lunkers	0.0	--	--	--	--	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	10.0	--	--	--	--	10.0	10.0	10.0	10.0	10.0
Total	36.2					36.2	36.2	36.2	36.2	36.2
Final IBI score	30					30	30	30	30	30

Appendix Table C-8. Metric scores used to calculate Index of Biotic Integrity Scores for reach 3 of Fern Creek and reach 1 of Arbor Creek, summer 2003 – spring 2004. Presence/absence (P/A) surveys were conducted in summer.

	Fern, reach 3 (2nd order)					Arbor, reach 1 (1st order)				
Metric	P/A	Summer	Fall	Winter	Spring	P/A	Summer	Fall	Winter	Spring
Native families	1.4	1.4	1.4	1.4	1.4	2.5	2.5	2.5	2.5	2.5
Native species	0.9	0.9	0.9	0.9	0.9	2.0	2.0	2.0	2.0	2.0
Native benthic species	1.4	1.4	1.4	1.4	1.4	3.3	3.3	3.3	3.3	3.3
Native water column species	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hider species	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Sensitive species	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Native nonguarding lithophil nester species	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent tolerant individuals	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Percent filter-feeding individuals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent omnivores	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Percent lunkers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Percent with anomalies	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total	36.2	36.2	36.2	36.2	36.2	40.3	40.3	40.3	40.3	40.3
Final IBI score	30	30	30	30	30	34	34	34	34	34

APPENDIX D

Stream Reach Locations

Appendix Table D-1. Approximate locations of West Linn stream reaches surveyed from summer 2003 through spring 2004.

Stream	Reach	Description
Unnamed Creek[a]	1 & 2	Mouth to 1st culvert
Unnamed Creek	3	1st culvert to pipe under Johnson Rd
Tanner Creek	2	Pipe end (below Imperial Dr.) to Salamo Creek
Tanner Creek	3	Salamo Creek to Stonegate Ln
Salamo Creek	2	Beacon Hill Dr. to Barrington Dr.
Mary S Young	1	Mouth to 2nd culvert (in Mary S. Young State Park)
Mary S Young	4	Willamette Drive to Summit St
Trillium Creek	1	Mouth to pipe between Kenthorpe Way and Mapleton
Trillium Creek	4	Tributary to about 100m above Santa Anita Dr
Fern Creek	2	Old River Road to Arbor Creek
Fern Creek	3	Arbor Creek to Robinwood Creek
Fern Creek	6	Pipe after Willamette Dr to Woodhaven Circle
Arbor Creek	1	Mouth to culvert

[a] Reaches 1 and 2 were combined because each reach was too short to sample alone