

Distribution of Fish and Crayfish, and Measurement of Available Habitat in the
Tualatin River Basin

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ABSTRACT

We conducted fish, habitat, and water quality surveys on seven tributaries of the lower Tualatin River as part of an effort to assess the biotic health of the watershed. We surveyed lower, middle, and upper reaches of most streams. Habitat surveys were conducted in summer 1999, whereas fish and water quality surveys were conducted in summer, spring, winter, and fall 1999-2000. This project is a follow up to a similar one conducted from 1993-95. Industrial and residential developments, as well as efforts to restore water quality and riparian habitat have continued since the 1993-95 surveys; therefore, periodic monitoring is needed to ensure that important habitat and existing populations of native fish are protected. The number of species collected increased from 21 to 22 in the seven streams; additionally, the number of introduced species increased from 10 to 11. The native reticulate sculpin *Cottus perplexus* remains the most abundant and widely distributed species. Introduced species contributed 6.4% of the total catch. Native and introduced species tolerant of habitat degradation accounted for 17.7% of the total catch, whereas native species sensitive to habitat degradation accounted for only 6.7% of the catch. The majority of the catch (75.5%) consisted of species considered intermediate in their response to habitat degradation. Habitat changed little from previous surveys. Glides were the most common habitat type, and soil was the most common substrate. Little woody debris was found in any stream. Similar surveys will be conducted on an additional nine streams in 2000-01. Upon completion of all surveys, various indices of fish community health will be used in conjunction with habitat and water quality information to comprehensively assess changes in fish communities in all 16 streams since previous surveys.

INTRODUCTION

The Tualatin River and its tributaries have been greatly influenced by urban development brought about by increased population. In addition, industrial and agricultural practices have significantly affected the hydrology of the basin, modifying original channels and inundating natural floodplains (Shively 1993). The Oregon Department of Fish and Wildlife (ODFW) and the Unified Sewerage Agency (USA) are concerned with the affects these changes have on water quality, fish habitat, and fish assemblages.

Extensive water quality investigations have been conducted in the Tualatin River Basin in recent years (Ervin et al. 1993); however, historic information on fish assemblages and aquatic habitat is scarce. ODFW has conducted occasional fish inventories, and The Oregon Fish Commission conducted fish and habitat surveys in 1958-59 (Willis et al. 1960). The occasional fish inventories were limited to single day, non-replicated samples in the mainstem Tualatin River, and emphasized salmonids. From 1993-95, ODFW conducted the first round of comprehensive fish and habitat surveys to establish a baseline condition of 15 streams in the Tualatin basin (Friesen and Ward 1996).

Residential, commercial, and agricultural growth and development continue throughout the Tualatin River drainage. In contrast, preservation and restoration efforts for fish habitat have begun. Objectives of this study are to (1) seasonally sample throughout the Tualatin River drainage to evaluate the abundance and distribution of fish and crayfish species, (2) conduct aquatic inventory surveys in the Tualatin River drainage to collect information on available aquatic habitat and, (3) identify relationships between aquatic habitat characteristics and fish species abundance in the Tualatin River drainage. In this report we begin to compare the current status and condition of fish assemblages and habitat to that found during the 1993-95 surveys (Friesen et al. 1994, Ward 1995, Friesen and Ward 1996). These findings will help ODFW meet its goal to maintain optimum populations and distribution of the basin's fish resources to provide the greatest recreational, commercial, economic, and nonconsumptive benefits to future and present generations of Oregon citizens (ODFW 1993).

Study Area

The Tualatin River flows in an easterly direction from its headwaters in the Coast Range of Northwestern Oregon to its confluence with the Willamette River at river kilometer (RKm) 46.1 (Figure 1). The Tualatin River drainage is almost entirely within Washington County. Portions of the tributaries we sampled flow through the Portland metropolitan area growth boundary. These tributaries are characterized by having low gradient, and experiencing heavy siltation, temperature extremes, and seasonal flooding, most often in the lower reaches.

The study area included seven primary tributaries of the Tualatin River: Hedges Creek, Fanno Creek, Rock Creek (designated as South Rock Creek), Chicken Creek, Butternut Creek, Rock Creek (designated as North Rock Creek), and Dairy Creek (Figure1; Table 1). We

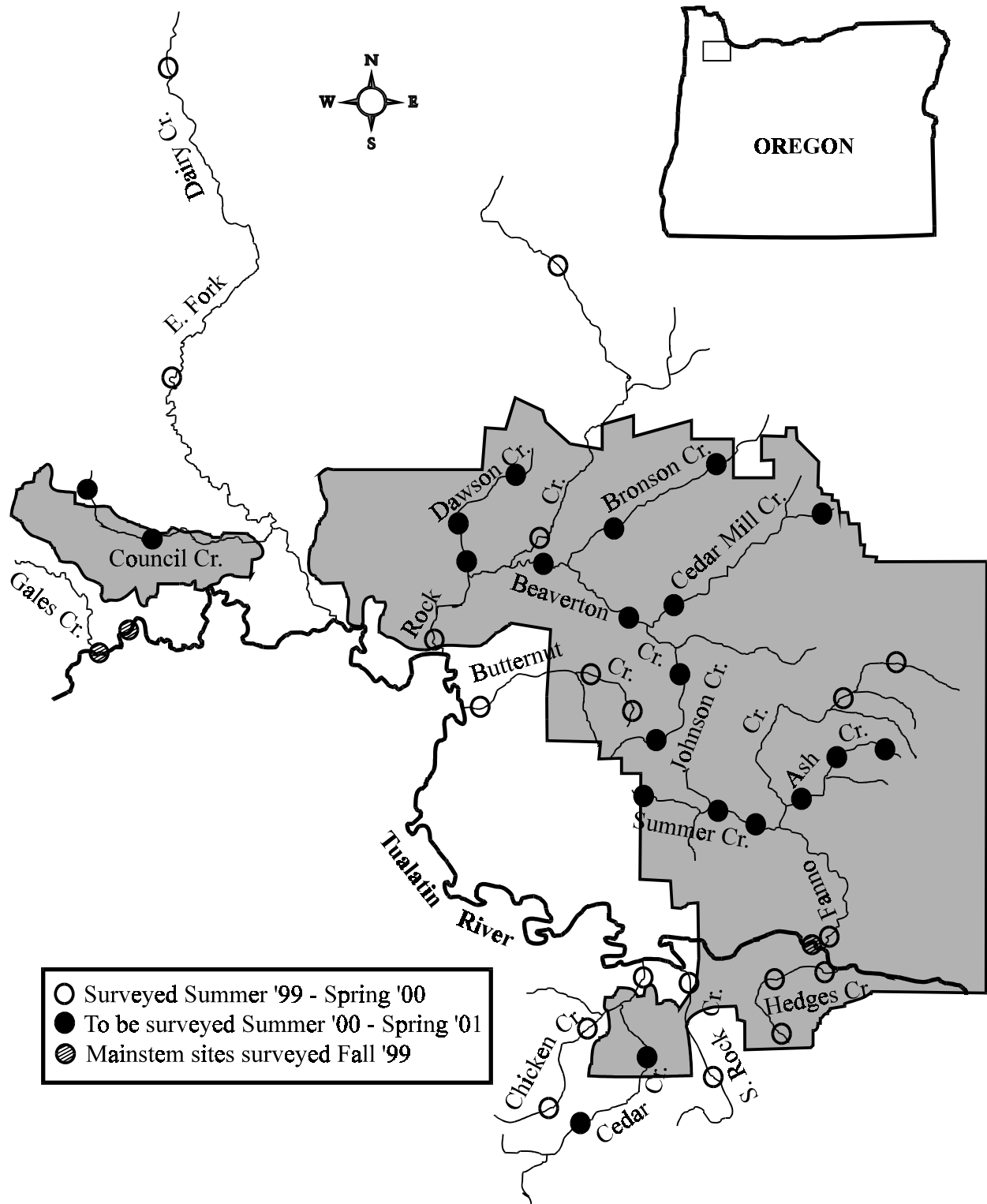


Figure 1. Tualatin River and tributaries surveyed, 1999-2000. Urban growth boundary of Washington County contained within shaded area.

Table 1. Tributaries of the Tualatin River sampled in 1999-2000. Location of confluence is given as river kilometer of the Tualatin River. Stream order as defined by Orth (1983).

Creek	Location of Confluence	Order at Mouth	Main-stem length (km)
Hedges	14.0	2	3.8
Fanno	15.0	3	21.7
South Rock	24.5	3	8.4
Chicken	25.9	4	9.7
Butternut	57.3	2	8.4
North Rock	61.3	4	28.7
Dairy	72.1	5	42.2

identified and sampled 19 reaches within these streams. The reaches ranged in length from 178-2102 meters (Appendix A), and were located near the mouth, middle and headwaters of each stream. We also sampled three sites on the mainstem Tualatin River: Spring Hill pumping plant (RKm 90.1), the confluence of Fanno Creek (RKm 15.0), and the confluence of Gales Creek (RKm 90.9) (Appendix A).

METHODS

Fish Surveys

A 100m section was selected for each reach based on accessibility and as a representation of the reach. We used a model 12 Smith-Root backpack electrofisher to sample each section once in summer, fall, winter, and spring. The voltage, pulse rate, and pulse width settings varied depending on water conductivity and fish recovery. Block nets were used at both ends of the section to ensure population enclosure, except when prevented by high stream flows. We made at least two passes starting at the downstream end and working upstream. If we captured a salmonid on the second pass, then a third pass was made.

During each pass crayfish were enumerated and fish were collected. After each pass, fish were identified to species. We measured (fork length to the nearest millimeter) a maximum of 50 individuals from each species. Each fish was counted and inspected for anomalies such as parasites, tumors and physical damage. If block nets were used the fish were returned (outside of the sample area) to the stream prior to the next pass; otherwise, fish were held until all passes were completed for that reach.

We used an electrofishing boat to sample the mainstem sites. These sites were sampled once in fall. A 900 second run was made to include the area above, below, and into the mouths of the creeks if possible. During each run all fish were collected. Species were identified, counted and released.

Habitat Surveys

During the summer of 1999 we conducted fish habitat surveys on each of the seven primary tributaries. We used standardized protocols developed by ODFW to describe and quantify stream habitat. The methods were developed by Bisson et al. (1982) and Hankin and Reeves (1988), and modified by Moore et al. (1997).

We surveyed three reaches of each stream, except South Rock and Dairy creeks where we surveyed two reaches (Figure 1). Reaches were selected to represent lower, middle, and upper sections of the streams. Reach lengths were determined by accessibility.

At the downstream end of each reach we described general physical characteristics such as channel and valley form, vegetation class, land use, water temperature and stream flow. Each reach was further divided into habitat units such as pool, riffle, glide, etc. For each habitat unit we measured length, width, and depth. Unit length was limited to 100m for long stretches of homogeneous habitat. Within each habitat unit we visually estimated the substrate composition, percentage of actively eroding banks, and percentage of undercut banks. Using a clinometer we measured the degree of slope and percentage of shade. We also noted habitat features such as beaver activity, culverts, and possible fish passage barriers.

Every habitat unit was given a woody debris rating depending on wood composition as it relates to fish habitat. A rating of one to five was given, with one being little or no wood, and five being large amounts of wood creating cover and refuge. In addition, we noted the configuration, type, location, and size of root wads and pieces of wood measuring at least 1.5-3.0 cm in width and 3m in length.

Water Quality

Within each reach we selected a site with similar characteristics as the whole reach and collected a set of basic water quality measurements. This was done once in summer, fall, winter, and spring concurrent with the fish surveys. Variables included pH, turbidity, dissolved oxygen, temperature, velocity, conductivity, salinity, and total dissolved solids. Water quality was collected on the mainstem sites concurrent with the electrofishing boat runs.

RESULTS

Fish Surveys

We conducted 70 electrofishing surveys in 7 streams during summer, fall, winter, and spring, 1999-2000. A total of 8,111 fish were collected representing 22 species and 10 families (Table 2; Appendix B). Number of individual fish collected was highest in Butternut Creek (1,595). We found the most species (14) in Butternut and S. Rock creeks. Reticulate sculpin comprised the greatest percent of our total catch (61.7%), followed by threespine stickleback (10.8%), speckled dace (6.3%), and cutthroat trout (5.8%). Introduced species contributed 6.4% of the total catch, with mosquitofish being the most numerous (4.2%). The upper reaches contained more salmonids than other reaches, whereas the lower reaches had more stickleback and lamprey (Figure 2). Centrarchids and mosquitofish were most numerous in the middle reaches.

Species tolerant of warm temperatures, organic pollution, and sediment accounted for 17.7% of the total catch (Table 2), with the majority of these being threespine stickleback. Other tolerant species included mosquitofish, brown bullhead, largescale sucker, and numerous cyprinids and centrarchids. The only species sensitive to degraded habitat were salmonids (6.7%), with the majority being cutthroat trout (5.8%). Species considered intermediate in their response to degraded habitat comprised 75.5% of the catch, with the majority of these being reticulate sculpin.

Most of the fish collected were insectivores (Table 2). The few omnivores included goldfish, carp, fathead minnow, and largescale suckers. Pacific lamprey and largemouth bass were the only two piscivorous species collected.

Fish with anomalies were very rare and comprised 1.3% of the total catch (Table 3). Most of the anomalies were in the form of parasites and were found mostly during spring sampling. Other anomalies included fin damage, scars, and deformities. Anomalies were most common in reaches of North Rock and Fanno creeks, and least common in Dairy and Hedges creeks.

We counted the most crayfish (16) in lower Chicken Creek, but found none in middle Chicken, middle Hedges, and upper S. Rock creeks (Appendix B). The majority of crayfish were seen in summer, and only two were counted during winter sampling.

We found 11 species in the mainstem sites (Table 4). Largescale suckers were the most abundant, followed by cutthroat trout and largemouth bass. With the exception of salmonids, all species collected were moderate to very tolerant species.

Habitat Surveys

Glides (characterized by uniform depth and flow) were the most common habitat type in all lower and middle reaches and in 4 of 7 upper reaches (Figure 3; Appendix C). Riffles (faster flow and higher gradient) were the next most common habitat type, being found mostly in upper reaches. Pools (low gradient, non-uniform depth) were most common in lower reaches. The "Other" category consisted mostly of steps (short units with abrupt, discrete breaks in channel

Table 2. Fish collected in 19 reaches of 7 tributaries of the Tualatin River in summer, fall, winter, and spring 1999-2000. Relative tolerance and trophic group classifications from Zaroban et al. (1999).

Family, Species	Relative tolerance	Adult trophic group	Percent of Catch	No. of streams (reaches)
Petromyzontidae				
Western Brook lamprey <i>Lampetra richardsoni</i>	Intermediate	-- ^a	2.12	7(14)
Pacific lamprey <i>Lampetra tridentata</i>	Intermediate	Piscivore	0.07	2(2)
Unidentified <i>Lampetra</i> spp.	Intermediate	--	0.05	2(3)
Salmonidae				
Unidentified Salmonidae	Sensitive	Insectivore	0.17	2(3)
Cutthroat trout <i>Oncorhynchus clarkii</i>	Sensitive	Insectivore	5.79	7(12)
Rainbow trout <i>Oncorhynchus mykiss</i>	Sensitive	Insectivore	0.78	6(6)
Cyprinidae				
Redside shiner <i>Richardsonius balteatus</i>	Intermediate	Insectivore	4.06	5(8)
Speckled dace <i>Rinichthys osculus</i>	Intermediate	Insectivore	6.26	3(5)
Goldfish <i>Carassius auratus</i> ^b	Tolerant	Omnivore	0.07	1(1)
Common carp <i>Cyprinus carpio</i> ^b	Tolerant	Omnivore	0.01	1(1)
Fathead Minnow <i>Pimephales promelas</i> ^b	Tolerant	Omnivore	0.88	1(2)
Catostomidae				
Largescale sucker <i>Catostomus macrocheilus</i>	Tolerant	Omnivore	0.54	5(6)
Ictaluridae^c				
Brown bullhead <i>Ameiurus nebulosus</i>	Tolerant	Insectivore	0.12	3(3)
Poeciliidae^c				
Mosquitofish <i>Gambusia affinis</i>	Tolerant	Insectivore	4.19	6(10)
Gasterosteidae				
Threespine stickleback <i>Gasterosteus aculeatus</i>	Tolerant	Insectivore	10.82	4(7)
Centrarchidae^c				
Unidentified <i>Lepomis</i> spp.	Tolerant		0.01	1(1)
Bluegill <i>Lepomis macrochirus</i>	Tolerant	Insectivore	0.26	5(6)
Pumpkinseed <i>Lepomis gibbosus</i>	Tolerant	Insectivore	0.09	4(4)
Warmouth <i>Lepomis gulosus</i>	Tolerant	Piscivore	0.01	1(1)
Largemouth bass <i>Micropterus salmoides</i>	Tolerant	Piscivore	0.70	6(7)
White Crappie <i>Promoxis annularis</i>	Tolerant	Insectivore	0.01	1(1)
Percidae^c				
Yellow perch <i>Perca flavescens</i>	Intermediate	Piscivore	0.04	1(1)
Cottidae				
Unidentified <i>Cottus</i> spp.	--	Insectivore	0.01	1(1)
Reticulate sculpin <i>Cottus perplexus</i>	Intermediate	Insectivore	61.73	7(19)
Torrent sculpin <i>Cottus rhotheus</i>	Intermediate	Piscivore	1.15	1(1)
Prickly sculpin <i>Cottus asper</i>	Intermediate	Insectivore	0.04	2(2)

^a Adults do not feed

^b Introduced species

^c Introduced family

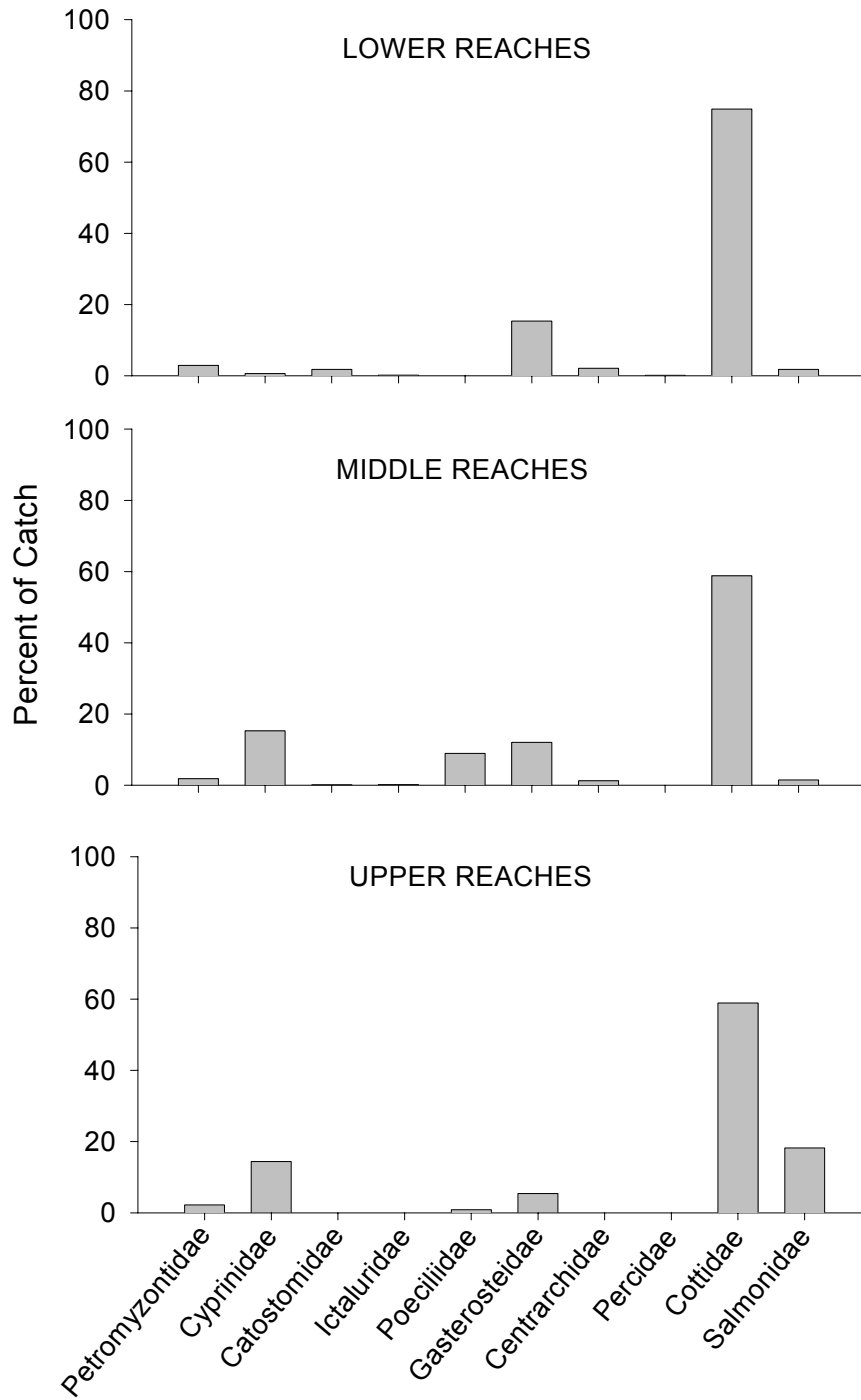


Figure 2. Family composition by reach for fish collected in tributaries of the Tualatin River.

Table 3. Anomalies found in fish collected from seven tributaries of the Tualatin River, 1999-2000.

Stream, reach	Anomalies		
	Number of fish (% of catch)	Number with parasites	Number with deformities
Butternut			
Lower	1 (0.5)	0	1
Middle	1 (0.1)	0	1
Upper	5 (1.1)	5	0
Chicken			
Lower	14 (2.5)	10	4
Middle	6 (1.4)	6	0
Upper	3 (1.0)	2	1
Dairy			
Middle	0 (0.0)	0	0
Upper	4 (0.6)	0	4
Fanno			
Lower	9 (3.5)	8	1
Middle	29 (3.7)	25	2
Upper	0 (0.0)	0	0
Hedges			
Lower	1 (0.1)	0	1
Middle	3 (1.0)	2	1
Upper	0 (0.0)	0	0
N. Rock			
Lower	0 (0.0)	0	0
Middle	13 (5.0)	10	3
Upper	1 (0.3)	1	0
S. Rock			
Middle	9 (1.5)	3	6
Upper	2 (1.5)	1	1

gradient), and were most abundant in upper reaches. Only two reaches (upper Hedges and upper Dairy) had any rapids (Figure 3).

Soil, which consisted of silt/organic material and sand, was the most abundant substrate type and dominated the lower and middle reaches (Figure 3; Appendix C). Rock, a combination of gravel and cobble, was most common in upper reaches. Boulder and bedrock substrate types were rare and were also found mostly in upper reaches.

Table 4. Fish species caught at the three mainstem Tualatin River sites, fall 1999.

Species caught	Spring Hill pumping station	Mouth of Gales Creek	Mouth of Fanno Creek
Salmonidae			
Unidentified Salmonid	0	5	0
Cutthroat trout	0	7	0
Coho salmon	0	1	0
Chinook salmon	2	1	0
Cyprinidae			
Redside shiner	0	0	0
Common carp	1	0	6
Catostomidae			
Largescale sucker	5	26	2
Centrarchidae			
Largemouth Bass	2	0	6
Pumpkinseed	0	0	1
Cottidae			
Unidentified sculpin	0	0	1
Percidae			
Yellow perch	0	0	7

Actively eroding banks were most common in lower and middle reaches (Figure 3), and comprised more than 50% of the bank in 7 of 19 reaches. For all 7 of those reaches, at least 80% of the substrate was soil. Undercut banks comprised <20% of the total area in all reaches except two (lower Butternut and middle S. Rock). Shade exceeded 50 % in most streams; however, percent shade was higher in lower (63%) and upper (59%) reaches than in middle reaches (43%) (Figure 3). The index of woody debris was low (<2.0) for all streams and reaches.

Water Quality

Water quality varied among streams and seasons (Appendix D). Summer water temperatures were highest in Hedges and Fanno creeks, and lowest in the upper reaches of North Rock and Chicken creeks. Dissolved oxygen levels were highest in the cooler streams. Water temperatures generally dropped during fall and winter, but rose again in spring. We found little variation in pH among streams and seasons (range 6.4-7.8) other than one very low reading of

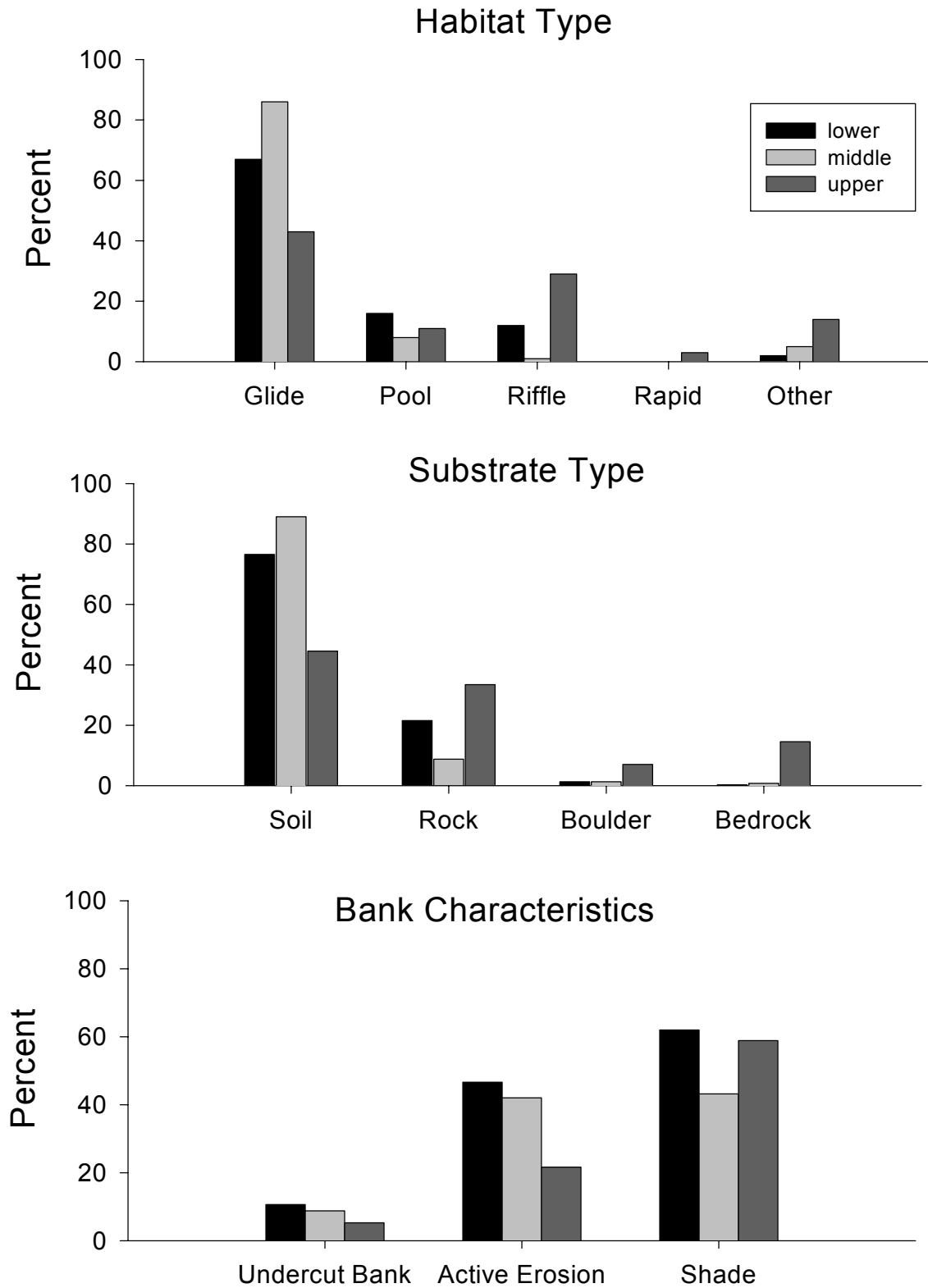


Figure 3. Habitat variables from 19 reaches of 7 tributaries of the lower Tualatin River as percent of total.

5.0 in Hedges Creek during spring. The water quality parameters on the mainstem sites were comparable to those from the lower reaches of the tributaries in fall (Table 5).

DISCUSSION

The fish assemblages in tributaries of the lower Tualatin River have changed little since previous surveys in 1993-95 (Ward 1995). The number of species collected increased from 21 to 22 compared to previous surveys of these seven streams; additionally, the number of exotic species increased from 10 to 11. Species undetected now but found previously include coho salmon *O. kisutch*, northern pikeminnow *Ptychocheilus oregonensis*, yellow bullhead *Amerius natalis*, and black crappie *Pomoxis nigromaculatus*. Only the northern pikeminnow is native to the Tualatin River drainage, and we found only one individual in 1993-95. Coho salmon are found in the Willamette River basin but were not historically present in the Tualatin River drainage. Releases of hatchery fish into the Tualatin River drainage have recently been discontinued. Species found that were previously undetected include goldfish, carp, white crappie, and yellow perch; however, all but carp were previously found in nearby streams. None of these fish are native, and we found few individuals of any of these species.

The reticulate sculpin, found in all seven streams surveyed, remains the most abundant and widely distributed fish in tributaries of the lower Tualatin River. We also found trout and western brook lamprey in all seven streams, but in fewer reaches and in much lower abundance. Trout were not found in Hedges Creek previously. Torrent sculpin were again found only in one reach of Dairy Creek. Pacific lamprey, previously found in all seven streams, were found only in the lower reaches of Fanno and Chicken creeks, indicating a possible decline in their abundance. The large increase in the numbers of largescale suckers in lower Chicken Creek during spring may indicate the importance of this reach to spawning.

General habitat conditions remain similar to those from previous surveys (Friesen et al. 1994). Glides continue to be the dominant habitat type, and soil the dominant substrate type, especially in lower and middle stream reaches. The amount of shade has changed little; however, the amount of woody debris has decreased in Fanno, Chicken, and N. Rock creeks.

The temperature limit to support salmonid spawning and rearing should not exceed 12.8°C, and anything above 20°C has detrimental effects on cold-water species (DEQ 2000). None of the streams surveyed were above lethal limits (range 4.2-19.0°C). No reaches during winter and only two reaches during fall sampling were measured above 12.8°C. In the spring and summer, 5 and 16 reaches respectively were above 12.8°C.

Dissolved oxygen levels should be above 11mg/L to support salmonid spawning and rearing and above 5.5mg/L to support warm water aquatic resources (DEQ 2000). Dissolved oxygen levels were higher than 11mg/L in 21 of 70 of our seasonal site surveys. Most dissolved oxygen levels above 11mg/L occurred during winter and spring. During summer surveys only three sites were

Table 5. Water quality measurements at the three mainstem Tualatin River sites, fall 1999.

Water Quality	Spring Hill pumping station	Mouth of Gales Creek	Mouth of Fanno Creek
Temperature	14.3	14.4	13.9
Dissolved Oxygen	9.4	9.6	5.1
Salinity	0.0	0.0	0.1
Total Dissolved Solids	33.5	36.6	91.6
Turbidity	6.1	6.2	4.4
Flow	0.0	2.5	1.8

above 11mg/L, and three sites were below 5.5mg/L. Dissolved oxygen was below 5.5mg/L at three sites during fall.

Most stream pH levels fall between 6.5 and 8.5 (DEQ 2000). Of the sites sampled only two were lower than 6.5, middle Hedges (5.0) and upper South Rock (6.4) creeks. We found no pH higher than 8.5.

We will conduct fish, habitat and water quality surveys on the remaining nine streams (Figure 1) in 2000-01. These streams were all surveyed in 1993-95 (Ward 1995) with the exception of Council Creek. Fish surveys will be conducted in summer, fall, winter, and spring, whereas habitat surveys will be completed in summer.

Information from summer fish inventories in all 16 streams will be used to calculate an index of biotic integrity (IBI; Karr 1981; Hughes et al. 1998), and we will compare current IBI's to those found in previous surveys. IBI scores and other measures of fish community health will be used in conjunction with habitat information to comprehensively assess changes in fish communities in all 16 streams since previous surveys.

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APPENDIX A

Stream Reach Locations

Appendix Table A-1. Locations of habitat surveys conducted in 1999-2000. Fish surveys were conducted in a 100 meter-long site within each reach.

Stream	Reach	Location	Reach Length (meters)
Hedges	Lower	Mouth to Boones Ferry Road	574
	Middle	Teton Road to 108 th Street	215
	Upper	105 th Street to 489 meters upstream	492
Fanno	Lower	Mouth to Durham Road	2050
	Middle	Oregon Episcopal School to Oleson Road	1668
	Upper	39 th Street to 404 meters downstream	559
S. Rock	Middle	Highway 99W to 300 meters upstream	311
	Upper	Tualatin-Sherwood Road to Oregon Street	650
Chicken	Lower	Mouth to 585 meters upstream	605
	Middle	Edy Road to 510 meters upstream	514
	Upper	Kruger Road to 285 meters upstream	762
Butternut	Lower	Mouth to River Road	358
	Middle	Butternut Park to 185 th Street	651
	Upper	Farmington Road to Oak Street	341
N. Rock	Lower	Mouth to River Road	911
	Middle	Cornell Road to Evergreen Parkway	215
	Upper	Tributary crossing at Rock Creek Road to 400meters upstream	402
Dairy	Middle	Roy Road to railroad bridge	1005
	Upper	Greener Road to Little Bend Park	449

Appendix Table A-2. Mainstem Tualatin River site designations.

Site	Designation	River Kilometer (mile)
1	Spring Hill pumping station	90.1 (56.0)
2	Mouth of Gales Creek	90.9 (56.5)
3	Mouth of Fanno Creek	9.3 (15.0)

APPENDIX B

Fish Survey Data

Appendix Table B-1. Number of fish and crayfish collected in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	8	1	1	9	0	7	1	11
Pacific lamprey	0	0	0	0	0	0	0	0	5	0	0
Unidentified lamprey	0	0	0	1	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	0	6	6	0	0	19	9	18
Rainbow trout	0	0	0	0	0	0	1	0	0	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	5	73	6	0	0	2	34	0
Speckled dace	0	0	0	2	0	0	0	0	0	0	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	1	0	0	0	0	0	0	0
Brown bullhead	0	0	0	1	0	0	0	0	0	0	0
Mosquitofish	0	71	0	0	7	1	0	8	0	0	0
Threespine stickleback	106	22	0	0	0	0	12	23	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	0	0	0	0	0	0	0	0
Pumpkinseed	1	0	0	0	0	0	1	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	2	4	0	15	0	0	13	0	6	0	0
Unidentified <i>Lepomis</i>	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	120	15	210	86	248	121	27	1	107	104	89
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	1	0	8	2	2	3	2	0	16	1	2

Appendix Table B-1 (continued). Number of fish and crayfish collected in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Western brook lamprey	6	0	0	11	3	2	5	1
Pacific lamprey	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0
Cutthroat trout	0	0	0	3	0	19	1	132
Rainbow trout	0	0	0	0	0	0	0	16
Unidentified trout	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	0	0	0	0
Speckled dace	0	7	58	0	0	0	0	0
Goldfish	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	1	0	0	0
Brown bullhead	3	0	0	0	0	0	0	0
Mosquitofish	1	29	0	0	3	0	3	0
Threespine stickleback	0	52	18	0	0	0	0	0
White crappie	0	0	0	0	0	0	0	0
Bluegill	0	0	0	5	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	0	0
Largemouth bass	2	0	0	2	3	0	0	0
Unidentified <i>Lepomis</i>	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0
Reticulate sculpin	71	23	10	203	92	132	75	72
Torrent sculpin	0	0	0	0	0	0	0	32
Prickly sculpin	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	1	0
Crayfish	2	2	0	--	2	14	3	6

Appendix Table B-2. Number of fish and crayfish collected in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	1	0	0	10	0	0	1	5
Pacific lamprey	0	0	0	0	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	1	0	0	0	0	0	0
Cutthroat trout	0	0	0	0	4	3	0	0	3	9	9
Rainbow trout	0	0	0	0	0	0	0	0	7	0	0
Unidentified trout	0	0	0	0	0	0	0	0	0	0	0
Redside shiner	0	0	0	0	36	1	0	1	0	48	0
Speckled dace	0	0	0	0	0	0	0	0	0	1	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	2	0	0	0
Brown bullhead	0	0	0	0	0	0	0	0	0	0	0
Mosquitofish	0	104	0	0	14	0	0	9	0	0	0
Threespine stickleback	138	2	0	0	0	0	15	58	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	0	0	2	0	0	0	0	1	0	0
Pumpkinseed	0	0	0	0	0	0	2	0	2	0	0
Warmouth	0	0	0	0	0	0	0	0	0	0	0
Largemouth bass	1	0	0	2	0	0	0	0	1	0	0
Unidentified <i>Lepomis</i>	0	1	0	0	0	0	0	0	0	0	0
Yellow perch	0	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	71	2	82	53	150	36	132	19	39	62	35
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	0	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	0	0	1	8	0	3	1	0	0	5	7

Appendix Table B-2 (continued). Number of fish and crayfish collected in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek								
	Butternut			N. Rock			Dairy		
	L	M	U	L	M	U	M	U	
Western brook lamprey	2	0	0	1	--	1	0	1	
Pacific lamprey	0	0	0	0	--	0	0	0	
Unidentified lamprey	0	0	0	0	--	0	0	0	
Cutthroat trout	0	0	0	1	--	5	0	90	
Rainbow trout	0	0	0	0	--	0	0	16	
Unidentified trout	0	0	0	0	--	0	0	0	
Redside shiner	0	0	0	0	--	0	0	0	
Speckled dace	0	28	3	0	--	0	0	0	
Goldfish	0	2	0	0	--	0	0	0	
Common carp	0	0	0	0	--	0	0	0	
Fathead minnow	0	0	0	0	--	0	0	0	
Largescale sucker	0	0	0	0	--	0	0	0	
Brown bullhead	0	0	0	0	--	0	0	0	
Mosquitofish	0	76	4	0	--	0	0	0	
Threespine stickleback	0	99	6	0	--	0	0	0	
White crappie	0	0	0	0	--	0	0	0	
Bluegill	0	8	0	0	--	0	0	0	
Pumpkinseed	0	0	0	0	--	0	0	0	
Warmouth	0	0	0	0	--	0	0	0	
Largemouth bass	1	0	0	0	--	0	0	0	
Unidentified <i>Lepomis</i>	0	0	0	0	--	0	0	0	
Yellow perch	0	0	0	0	--	0	0	0	
Reticulate sculpin	28	29	8	24	--	44	22	41	
Torrent sculpin	0	0	0	0	--	0	0	24	
Prickly sculpin	0	0	0	0	--	0	0	0	
Unidentified sculpin	0	0	0	0	--	0	0	0	
Crayfish	1	3	0	0	--	3	0	1	

Appendix Table B-3. Number of fish and crayfish collected in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	0	--	0	0	0	--	0	0	0
Pacific lamprey	0	0	0	--	0	0	0	--	0	0	0
Unidentified lamprey	0	0	1	--	1	0	0	--	0	0	0
Cutthroat trout	1	0	0	--	2	11	5	--	0	0	3
Rainbow trout	0	0	2	--	0	3	0	--	1	0	0
Unidentified trout	0	0	0	--	0	0	0	--	0	0	0
Redside shiner	0	0	0	--	38	0	0	--	0	5	0
Speckled dace	0	0	0	--	0	0	0	--	0	0	0
Goldfish	0	0	0	--	0	0	0	--	0	0	0
Common carp	0	0	0	--	0	0	0	--	0	0	0
Fathead minnow	0	0	0	--	0	0	0	--	0	0	0
Largescale sucker	0	0	0	--	0	0	0	--	0	0	0
Brown bullhead	0	0	0	--	0	0	1	--	0	0	0
Mosquitofish	0	0	0	--	0	0	0	--	0	0	0
Threespine stickleback	5	0	0	--	0	0	6	--	0	0	0
White crappie	0	0	0	--	0	0	0	--	0	0	0
Bluegill	0	0	0	--	0	0	2	--	0	0	0
Pumpkinseed	0	0	0	--	0	0	0	--	0	0	0
Warmouth	0	0	0	--	0	0	0	--	0	0	0
Largemouth bass	0	0	0	--	0	0	1	--	0	0	0
Unidentified <i>Lepomis</i>	0	0	0	--	0	0	0	--	0	0	0
Yellow perch	0	0	0	--	0	0	0	--	0	0	0
Reticulate sculpin	1	1	27	--	9	11	52	--	13	6	2
Torrent sculpin	0	0	0	--	0	0	0	--	0	0	0
Prickly sculpin	0	1	0	--	0	0	0	--	0	0	0
Unidentified sculpin	0	0	0	--	0	0	0	--	0	0	0
Crayfish	0	0	0	--	--	2	0	0	0	0	0

Appendix Table B-3 (continued). Number of fish and crayfish collected in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Western brook lamprey	0	0	0	--	--	0	--	0
Pacific lamprey	0	0	0	--	--	0	--	0
Unidentified lamprey	0	0	0	--	--	0	--	0
Cutthroat trout	0	0	0	--	--	5	--	2
Rainbow trout	0	0	0	--	--	5	--	6
Unidentified trout	0	0	0	--	--	0	--	0
Redside shiner	0	0	0	--	--	0	--	0
Speckled dace	0	40	196	--	--	0	--	0
Goldfish	0	0	0	--	--	0	--	0
Common carp	0	0	0	--	--	0	--	0
Fathead minnow	0	68	0	--	--	0	--	0
Largescale sucker	0	0	0	--	--	0	--	0
Brown bullhead	0	0	0	--	--	0	--	0
Mosquitofish	0	5	0	--	--	0	--	0
Threespine stickleback	0	106	18	--	--	0	--	0
White crappie	0	1	0	--	--	0	--	0
Bluegill	0	0	0	--	--	0	--	0
Pumpkinseed	0	0	0	--	--	0	--	0
Warmouth	0	0	0	--	--	0	--	0
Largemouth bass	0	0	0	--	--	0	--	0
Unidentified <i>Lepomis</i>	0	0	0	--	--	0	--	0
Yellow perch	0	0	0	--	--	0	--	0
Reticulate sculpin	0	19	10	--	--	14	--	4
Torrent sculpin	0	0	0	--	--	0	--	1
Prickly sculpin	0	0	0	--	--	0	--	0
Unidentified sculpin	0	0	0	--	--	0	--	0
Crayfish	0	0	0	--	--	0	--	0

Appendix Table B-4. Number of fish and crayfish collected in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Western brook lamprey	0	0	1	5	6	1	2	0	11	24	2
Pacific lamprey	0	0	0	1	0	0	0	0	0	0	0
Unidentified lamprey	0	0	0	0	0	0	0	0	0	0	0
Cutthroat trout	1	0	0	0	5	8	0	0	0	9	33
Rainbow trout	0	0	0	0	0	0	0	0	2	0	0
Unidentified trout	0	0	0	0	2	4	0	0	0	0	0
Redside shiner	0	0	0	1	49	1	0	0	2	21	0
Speckled dace	0	0	0	0	0	1	0	0	0	2	0
Goldfish	0	0	0	0	0	0	0	0	0	0	0
Common carp	0	0	0	0	0	0	0	0	0	0	0
Fathead minnow	0	0	0	0	0	0	0	0	0	0	0
Largescale sucker	0	0	0	0	0	0	0	0	35	1	0
Brown bullhead	0	0	0	0	0	0	5	0	0	0	0
Mosquitofish	0	3	0	1	0	0	0	0	0	0	0
Threespine stickleback	68	16	0	0	0	0	25	10	0	0	0
White crappie	0	0	0	0	0	0	0	0	0	0	0
Bluegill	0	1	0	0	0	0	5	0	0	0	0
Pumpkinseed	0	0	0	0	0	0	0	0	0	0	0
Warmouth	0	0	0	0	0	0	1	0	0	0	0
Largemouth bass	3	1	0	0	0	0	1	0	0	0	0
Unidentified <i>Lepomis</i>	0	0	0	0	0	0	0	0	0	0	0
Yellow perch	3	0	0	0	0	0	0	0	0	0	0
Reticulate sculpin	280	0	107	76	225	86	276	0	307	107	90
Torrent sculpin	0	0	0	0	0	0	0	0	0	0	0
Prickly sculpin	0	0	0	0	0	0	2	0	0	0	0
Unidentified sculpin	0	0	0	0	0	0	0	0	0	0	0
Crayfish	0	0	1	2	2	2	2	0	4	4	8

Appendix Table B-4 (continued). Number of fish and crayfish collected in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

Species	Creek								
	Butternut			N. Rock			Dairy		
	L	M	U	L	M	U	M	U	
Western brook lamprey	4	0	0	8	1	0	1	29	
Pacific lamprey	0	0	0	0	0	0	0	0	
Unidentified lamprey	0	0	0	0	0	0	0	0	
Cutthroat trout	1	0	0	0	0	25	2	24	
Rainbow trout	0	0	0	0	0	0	0	4	
Unidentified trout	0	0	0	0	0	0	0	8	
Redside shiner	0	0	0	0	4	0	0	0	
Speckled dace	0	78	92	0	0	0	0	0	
Goldfish	0	4	0	0	0	0	0	0	
Common carp	1	0	0	0	0	0	0	0	
Fathead minnow	0	0	0	0	0	0	0	0	
Largescale sucker	1	0	0	0	3	0	0	0	
Brown bullhead	0	0	0	0	0	0	0	0	
Mosquitofish	0	1	0	0	0	0	0	0	
Threespine stickleback	0	67	14	0	4	0	0	0	
White crappie	0	0	0	0	0	0	0	0	
Bluegill	2	0	0	0	0	0	0	0	
Pumpkinseed	0	0	0	1	0	0	0	0	
Warmouth	0	0	0	0	0	0	0	0	
Largemouth bass	1	0	0	0	0	0	0	0	
Unidentified <i>Lepomis</i>	0	0	0	0	0	0	0	0	
Yellow perch	0	0	0	0	0	0	0	0	
Reticulate sculpin	87	193	0	179	147	62	61	85	
Torrent sculpin	0	0	0	0	0	0	0	36	
Prickly sculpin	0	0	0	0	0	0	0	0	
Unidentified sculpin	0	0	0	0	0	0	0	0	
Crayfish	4	3	0	6	1	2	2	0	

APPENDIX C
Habitat Survey Data

Appendix Table C-1. Habitat summary for reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach. Woody debris is a rating of wood complexity as it relates to fish habitat and ranges from 1 to 5 with 5 being the most complex (Moore et al. 1993).

	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Meters sampled	574	215	492	2050	1668	559	311	650	605	514	762
Habitat type (%)											
Glide	76.2	100.0	73.6	53.9	87.9	63.6	99.7	24.1	54.7	87.4	29.1
Pool	13.2	0.0	2.6	30.0	6.5	13.4	0.0	34.1	25.3	9.9	0.0
Riffle	8.1	0.0	16.0	15.4	4.1	20.4	0.0	0.0	16.5	0.0	57.3
Rapid	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	2.5	0.0	6.8	0.7	1.5	2.5	0.3	41.8	3.5	2.6	13.6
Substrate (%)											
Soil	70.4	99.8	78.3	48.2	83.2	45.3	95.6	93.1	90.9	85.5	15.4
Rock	26.9	0.2	16.0	50.6	11.8	54.1	4.3	1.1	9.1	6.1	58.1
Boulder	1.4	0.0	4.0	1.2	4.8	0.7	0.1	4.4	0.0	3.0	14.2
Bedrock	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.3	12.0
Bank type (%)											
Eroding	2.4	0.0	33.7	20.9	65.1	23.1	76.3	60.0	77.8	32.9	1.2
Undercut	3.6	0.0	11.9	6.8	8.7	7.9	35.4	2.4	17.8	7.3	1.7
Shade (%)	51.3	6.8	62.6	62.7	68.1	63.4	27.5	16.5	60.8	44.8	74.2
Gradient (%)	1.1	0.7	0.7	0.4	0.3	1.0	0.2	0.1	0.5	0.3	3.0
Woody debris	1.0	1.0	1.7	1.5	1.5	1.2	1.0	1.0	1.7	1.8	1.5

Appendix Table C-1 (continued). Habitat summary for reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach. Woody debris is a rating of wood complexity as it relates to fish habitat and ranges from 1 to 5 with 5 being the most complex (Moore et al. 1993).

	Creek							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Meters sampled	358	651	341	911	215	402	1005	449
Habitat type (%)								
Glide	72.5	66.1	67.1	80.0	69.9	27.4	91.4	15.9
Pool	7.4	1.9	0.0	4.9	29.4	3.7	5.2	21.6
Riffle	9.2	1.1	5.1	13.3	0.1	66.0	2.6	35.7
Rapid	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.5
Other	11.0	31.0	27.9	1.8	0.6	2.9	0.9	3.3
Substrate (%)								
Soil	92.8	67.3	71.5	80.3	93.7	5.5	98	2.7
Rock	3.2	32.3	22.9	17.9	5.4	27.8	1.2	54.1
Boulder	2.8	0.3	5.6	1.0	0.9	5.9	0.0	14.4
Bedrock	1.2	0.0	0.0	0.0	0.0	60.9	0.0	28.9
Bank type (%)								
Eroding	59.0	4.5	6.1	73.3	32.8	21.9	82.5	5.6
Undercut	21.2	0.0	2.7	3.5	10.3	3.0	0.0	7.1
Shade (%)	66.1	65.7	37.8	68.9	39.6	78.7	49.9	79.0
Gradient (%)	1.2	0.1	0.2	0.3	0.2	2.2	0.1	2.2
Woody debris	1.5	1.0	1.0	1.8	1.3	1.0	1.0	1.5

APPENDIX D
Water Quality Data

Appendix Table D-1. Water quality measurements in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	12.9	65.9	31.6	4.7	13.0	4.9	4.2	37.4	12.5	17.2	10.2
Oxygen saturation (%)	54.2	30.4	103.8	73.1	85.3	101.7	60.0	47.1	80.5	85.2	121.0
Dissolved oxygen (mg/L)	5.8	3.9	10.2	6.7	8.1	10.0	6.3	4.4	9.0	10.1	13.3
Temperature (°C)	17.0	19.0	16.5	16.5	17.8	16.6	13.2	16.6	16.0	12.0	12.0
Mean velocity (m/s)	2.0	0.0	1.7	2.5	2.4	2.3	0.8	0.0	0.6	0.8	2.7
Maximum velocity (m/s)	3.5	0.0	2.2	8.3	3.6	5.1	3.0	0.0	1.7	1.6	4.9
Conductivity (µS)	173.7	221.0	206.0	239.0	224.0	171.7	342.0	265.0	173.2	88.5	67.9
Total dissolved solids (mg/L)	82.9	105.6	98.6	114.6	107.4	82.0	164.8	127.2	82.7	41.9	32.0
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
pH	--	--	--	--	--	--	--	--	--	--	--

Appendix Table D-1 (continued). Water quality measurements in reaches of Tualatin River tributaries, summer 1999. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Turbidity (NTU)	7.8	3.8	8.0	--	3.8	2.2	6.6	2.5
Oxygen saturation (%)	86.3	15.3	100.7	--	43.8	120.0	105.7	116.2
Dissolved oxygen (mg/L)	8.9	1.5	10.4	8.4	4.3	13.5	10.9	12.1
Temperature (°C)	14.2	16.5	13.7	17.6	16.2	12.0	14.5	13.4
Mean velocity (m/s)	0.0	0.0	0.0	--	0.0	0.0	2.7	2.7
Maximum velocity (m/s)	0.0	0.0	0.0	--	0.0	0.0	4.3	5.1
Conductivity (µS)	288.0	181.9	156.9	--	266.0	107.7	70.5	64.5
Total dissolved solids (mg/L)	138.2	86.9	74.8	--	127.9	51.1	33.3	30.4
Salinity (ppt)	0.1	0.1	0.1	--	0.1	0.1	0.0	0.0
pH	--	--	--	7.4	--	--	--	--

Appendix Table D-2. Water quality measurements in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	4.3	6.3	6.0	7.6	26.1	13.3	7.0	11.5	20.3	14.1	7.9
Oxygen saturation (%)	32.9	64.5	97.7	90.1	81.5	94.7	93.5	98.4	96.6	--	113.5
Dissolved oxygen (mg/L)	3.8	6.6	10.6	10.1	9.4	10.4	10.0	10.3	10.7	11.5	13.0
Temperature (°C)	10.3	13.7	11.5	10.5	11.2	11.2	11.2	13.8	11.1	9.6	9.4
Mean velocity (m/s)	1.7	0.0	1.2	3.2	2.4	2.5	2.6	0.0	1.3	0.9	3.0
Maximum velocity (m/s)	3.4	0.0	1.8	11.1	3.8	2.7	4.3	0.0	2.1	1.3	4.3
Conductivity (µS)	175.9	198.1	172.1	270.0	125.4	115.4	298.0	268.0	112.0	89.0	68.1
Total dissolved solids (mg/L)	84.0	94.7	82.2	129.8	50.0	54.8	143.1	128.7	53.2	42.1	32.1
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
pH	--	--	--	--	--	--	--	--	7.2	--	--

Appendix Table D-2 (continued). Water quality measurements in reaches of Tualatin River tributaries, fall 1999. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek							
	Butternut			N. Rock			Dairy	
	L	M	U	L	M	U	M	U
Turbidity (NTU)	6.7	23.2	14.0	15.2	17.6	2.7	3.1	0.7
Oxygen saturation (%)	96.9	--	--	81.0	27.6	80.2	98.4	75.2
Dissolved oxygen (mg/L)	11.3	4.5	7.7	8.6	3.1	9.2	8.9	9.1
Temperature (°C)	8.5	9.5	8.3	12.4	10.2	6.8	8.9	7.3
Mean velocity (m/s)	5.1	0.0	0.0	2.9	0.0	0.0	2.8	5.3
Maximum velocity (m/s)	11.1	0.0	0.0	4.6	0.0	0.0	2.8	5.3
Conductivity (µS)	299.0	191.1	149.7	216.0	290.0	111.8	72.7	65.7
Total dissolved solids (mg/L)	143.9	91.4	71.4	103.5	139.1	53.1	34.3	31.0
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0
pH	--	--	--	7.3	--	--	--	--

Appendix Table D-3. Water quality measurements in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	25.6	51.9	14.3	--	25.9	25.6	17.6	4.2	23.6	11.4	10.8
Oxygen saturation (%)	73.5	81.9	92.5	--	85.2	93.3	79.8	49.7	89.4	92.2	89.2
Dissolved oxygen (mg/L)	9.3	10.6	10.8	--	10.5	11.4	9.6	6.5	11.1	11.4	11.7
Temperature (°C)	4.9	4.7	8.5	--	6.5	6.7	7.5	4.2	5.9	6.4	7.9
Mean velocity (m/s)	2.0	2.0	1.4	--	1.8	3.0	2.5	0.5	5.5	2.8	3.5
Maximum velocity (m/s)	3.9	2.8	2.7	--	2.9	4.4	3.7	1.5	8.4	3.8	6.4
Conductivity (µS)	99.1	77.4	101.7	--	105.4	84.6	111.6	76.4	66.4	52.5	50.4
Total dissolved solids (mg/L)	47.0	36.6	48.2	--	50.0	40.0	53.0	36.1	31.3	24.6	23.6
Salinity (ppt)	0.1	0.0	0.1	--	0.1	0.0	0.1	0.0	0.0	0.0	0.0
pH	7.1	6.9	7.1	--	7.3	7.4	6.7	6.4	7.3	7.2	7.2

Appendix Table D-3 (continued). Water quality measurements in reaches of Tualatin River tributaries, winter 2000. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek								
	Butternut			N. Rock			Dairy		
	L	M	U	L	M	U	M	U	
Turbidity (NTU)	13.9	25.4	14.8	--	--	14.2	--	4.9	
Oxygen saturation (%)	82.0	96.2	100.5	--	--	95.8	--	96.3	
Dissolved oxygen (mg/L)	11.4	11.5	11.4	--	--	12.3	--	12.4	
Temperature (°C)	6.9	7.6	10.0	--	--	5.0	--	5.8	
Mean velocity (m/s)	0.5	0.3	1.3	--	--	2.2	--	7.6	
Maximum velocity (m/s)	1.0	0.6	2.0	--	--	3.1	--	10.6	
Conductivity (µS)	135.0	163.3	142.0	--	--	20.1	--	44.0	
Total dissolved solids (mg/L)	64.3	77.9	67.6	--	--	9.1	--	20.5	
Salinity (ppt)	0.1	0.1	0.1	--	--	0.0	--	0.0	
pH	7.4	7.2	7.3	--	--	7.3	--	7.1	

Appendix Table D-4. Water quality measurements in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek										
	Hedges			Fanno			S. Rock		Chicken		
	L	M	U	L	M	U	M	U	L	M	U
Turbidity (NTU)	18.7	8.5	4.3	9.5	12.5	5.8	6.2	6.7	7.3	8.1	10.8
Oxygen saturation (%)	73.8	87.4	96.1	94.1	95.2	102.2	88.9	79.6	99.7	100.0	107.7
Dissolved oxygen (mg/L)	8.1	10.1	10.9	9.4	10.7	10.5	10.0	8.8	10.6	11.3	11.6
Temperature (°C)	11.3	9.1	9.7	14.7	10.1	10.0	10.2	11.1	12.3	9.9	12.3
Mean velocity (m/s)	2.3	0.0	0.6	0.3	0.7	0.6	1.1	0.6	1.3	2.5	1.6
Maximum velocity (m/s)	3.5	0.0	1.0	2.4	1.2	1.2	2.0	0.9	2.5	4.6	3.1
Conductivity (µS)	165.7	176.1	169.0	201.0	127.6	196.5	159.2	102.3	98.6	61.3	52.6
Total dissolved solids (mg/L)	79.0	84.1	80.7	96.2	60.7	94.0	76.0	48.6	46.7	28.8	24.7
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0
pH	6.9	5.0	7.4	7.8	7.2	7.7	6.9	6.7	7.5	7.3	7.6

Appendix Table D-4 (continued). Water quality measurements in reaches of Tualatin River tributaries, spring 2000. L = lower reach, M = middle reach, and U = upper reach.

Parameter	Creek								
	Butternut			N. Rock			Dairy		
	L	M	U	L	M	U	M	U	
Turbidity (NTU)	3.7	11.1	5.3	6.5	8.9	7.0	5.4	2.3	
Oxygen saturation (%)	89.4	115.6	108.5	80.8	88.7	99.4	96.7	104.2	
Dissolved oxygen (mg/L)	9.0	12.0	11.6	7.5	9.8	11.3	9.8	13.2	
Temperature (°C)	14.7	13.6	12.1	18.6	11.5	10.9	15.0	5.5	
Mean velocity (m/s)	0.0	0.5	0.0	0.9	0.7	1.6	2.5	3.7	
Maximum velocity (m/s)	0.0	0.7	0.0	2.5	1.2	2.0	3.9	6.3	
Conductivity (µS)	260.0	212.0	164.0	287.0	168.5	47.0	62.8	52.6	
Total dissolved solids (mg/L)	125.0	101.4	78.3	138.0	80.5	22.0	29.6	24.7	
Salinity (ppt)	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	
pH	7.5	7.6	7.6	7.4	7.6	7.2	7.3	7.8	