

1999-2017 Bellevue Salmon Spawner Surveys

Kelsey Creek, West Tributary,
Richards Creek, and Coal Creek

Prepared for

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CONTENTS

EXECUTIVE SUMMARY	5
1. INTRODUCTION	6
2. SPAWNER SURVEYS AND RESULTS	8
2.1 PROFESSIONAL SURVEY METHODS	8
2.2 SALMON WATCHERS PROGRAM METHODS	8
2.3 PROFESSIONAL SURVEY RESULTS	12
2.4 SALMON WATCHERS PROGRAM	16
3. SUMMARY	18
3.1 CHINOOK USE	18
3.2 SOCKEYE USE	20
3.3 COHO USE	22
3.4 COMPARISONS WITH SALMON WATCHER OBSERVATIONS	23
3.5 RECOMMENDATIONS	24
4. REFERENCES	25
5. APPENDIX	27
5-1 STREAM DESCRIPTIONS AND TYPICAL HABITAT PHOTOS	31
5-1.a Kelsey Creek	31
5-1.c West Tributary	36
5-1.c Richards Creek	39
5-1.d Coal Creek	41

FIGURES

Figure 1-1. Salmon path from Puget Sound to Bellevue Streams.	7
Figure 2-1. Map of 2017 survey reaches in the Kelsey Creek watershed.	9
Figure 2-2. Map of 2017 survey reaches in the Kelsey Creek watershed.	10
Figure 2-3. Salmon Watcher site locations, City of Bellevue, Washington 2017.	11

Figure 2-4.	Number and species of live fish counted by volunteer observers in all City of Bellevue streams between 2011 and 2017. High coho observations in 2013 and 2014 (denoted by stars) were the result of adult coho hatchery plants that occurred in those years (see Table 2-4).....	17
Figure 3-1.	Adult Chinook returns to the Lake Washington basin.....	18
Figure 3-2.	Aerial view of Mercer Slough and the lower Kelsey Creek wetlands, areas that may be inhibiting Chinook migration to upstream spawning areas in some years.	19
Figure 3-3.	Abundance of naturally spawning Chinook and percent Natural-Origin and Hatchery-Origin spawners in the Sammamish River basin.	20
Figure 3-4.	Abundance of naturally spawning Chinook and percent Natural-Origin and Hatchery-Origin spawners in the Cedar River basin.	20
Figure 3-5.	Number of sockeye adults counted passing through the Ballard Locks (red), and the number of naturally spawning sockeye adults observed in the Cedar River (blue)..	21
Figure 3-6.	Lake Washington coho returns (Natural-Origin and Hatchery-Origin) based on fish counts at Ballard Locks.	23
Figure 5-1.	Typical habitat in Kelsey Creek Reach 7, 21 December 2017.	32
Figure 5-2.	Typical habitat in Kelsey Creek Reach 6, 3 January 2018.	32
Figure 5-3.	Kelsey Creek, upstream survey end of Reach 5, 14 December 2017.....	33
Figure 5-4.	Typical habitat in Kelsey Creek, Reaches 4 and 5, 14 December 2017.	33
Figure 5-5.	Kelsey Creek, downstream end of the Wetland Reach, 4 January 2018 (looking at culvert under Lake Hills Connector).	34
Figure 5-6.	Typical habitat in Kelsey Creek, Reaches 2 and 3 in the Glendale Golf Course, 14 December 2017.....	34
Figure 5-7.	Typical habitat in Kelsey Creek, Reaches A and 1, in the Kelsey Creek Farm, 14 December 2017.	35
Figure 5-8.	Beaver dam in Kelsey Creek; Reach A, 2 October 2017.	35
Figure 5-9.	Typical habitat in West Tributary Reach 5, 3 January 2018.	37
Figure 5-10.	Typical habitat in West Tributary Reach 4, in the Glendale Golf Course, 3 January 2018.....	37
Figure 5-11.	Typical habitat in West Tributary Reach 3 near the downstream end, 7 December 2017.....	38
Figure 5-12.	Typical habitat in West Tributary, with large woody debris in Reach 2, 3 January 2018.....	38

Figure 5-13.	Typical habitat in West Tributary Reach 1 near the lowest footbridge in the Kelsey Creek Farm, 5 September 2017.	39
Figure 5-14.	Typical habitat in the Richards Creek confluence reach, 12 September 2017.	40
Figure 5-15.	Typical habitat in the Richards Creek confluence reach, 7 December 2017.	40
Figure 5-16.	Beaver activity in the Richards Creek confluence reach, 2 October 2017.	41
Figure 5-17.	Coal Creek typical habitat in Reach 2b, 26 September 2017.	42
Figure 5-18.	Coal Creek lower end of Reach 2, 3 October 2017, very low streamflow.	42
Figure 5-19.	Coal Creek Typical habitat in Reach 1, 19 September 2017.	43
Figure 5-20.	Construction weir blocking fish passage in Reach A, Coal Creek 6 September 2017.	43

TABLES

Table 2-1.	Summary of fish observations in Kelsey Creek.	13
Table 2-2.	Summary of fish observations in Coal Creek.	14
Table 2-3.	Periodicity (timing) of adult anadromous salmonid stream habitat use in the Kelsey and Coal creek sub-basins. Mean weekly counts (1999-2017) of live fish (adult migration) and redds (spawning) were used for this table.	15
Table 2-4.	Location and dates of adult Coho plants from Issaquah Hatchery to the Kelsey Creek basin and Coal Creek in 2013 and 2014.	16
Table 5-1.	Volunteer observers who reported data during the 2011-2017 seasons.	27
Table 5-2.	Counts of live, dead, and redds for Chinook Salmon in Bellevue streams for years 1999-2017. Color indicates a survey was performed.	28
Table 5-3.	City of Bellevue anadromous salmonid spawning ground survey implementation information (1999-2017).	29
Table 5-4.	Survey Reach Descriptions.	30

EXECUTIVE SUMMARY

The City of Bellevue has monitored salmon spawning activity in the Bellevue streams since 1999. Two types of monitoring activities have been employed: 1) Spawning surveys by professional biologists and 2) Volunteer observations from the Salmon Watcher program. Professional spawning surveys involve walking all known spawning reaches within each stream system on a weekly basis, counting live fish, sampling carcasses and documenting salmon redds. Salmon Watcher Program information consists of volunteer observations of salmon activity from fixed sites located along the stream system. Volunteers are trained each year in salmon identification, and monitor established sites for at least 15 minutes twice a week.

The Kelsey Creek and Coal Creek basins, like many other mid-sized, independent tributaries in the Lake Washington watershed, provide spawning and rearing habitat for Chinook, sockeye, and coho salmon. The number of salmon spawning in Bellevue streams is affected by the abundance of the overall salmon return (including hatchery and natural-origin) to the Lake Washington system, and is also influenced by the physical characteristics of each stream system (such as physical barriers to adult migration). The relatively large salmon returns to the Kelsey Creek system between 2004 and 2007 were heavily influenced by the large numbers of hatchery fish to return to the Lake Washington basin during those years.

Physical barriers to fish migration, including dense mats of aquatic vegetation in Mercer Slough and beaver dams in the lower Kelsey Creek wetland complex may be inhibiting adult Chinook from migrating into spawning areas located in the upper reaches of Kelsey Creek resulting in the low salmon runs observed in the Kelsey system over the past decade. Addressing salmon migration issues and working on habitat and water quality enhancements throughout the basin may increase salmon use of Bellevue streams in future years.

1. INTRODUCTION

Chinook, sockeye, and coho salmon inhabit the Lake Washington watershed, and each of these species use City of Bellevue streams, streams in the Kelsey Creek basin and the Coal Creek basin, for spawning and rearing. Chum and pink salmon do not inhabit the Lake Washington watershed, and were not present historically.

The Lake Washington watershed (Watershed Resource Inventory Area [WRIA] 8) is among the most highly urbanized freshwater systems within the Puget Sound Evolutionarily Significant Unit (ESU) for Chinook (Puget Sound Indian Tribe and WDFW 2017). In 1917, stream delta and lake littoral habitat was lost after the water surface elevation of Lake Washington was lowered 9 feet in order to create the Ship Canal. At the same time, the Cedar River was diverted from the Black River to flow directly into Lake Washington. The original outlet of Lake Washington, the Black River, was dammed and the river drained. Since then, anadromous salmonids have entered the Lake Washington watershed through the Ballard Locks and the Lake Washington Ship Canal.

City of Bellevue stream systems, like many in the Puget Sound Region, are negatively affected by urban development and increasing population growth. Increases in impervious surfaces result in altered flow regimes, impaired water quality (i.e. increased stream temperatures), and changes to natural stream processes that impact ecological structure and function (Richey 1982; Scott et al. 1986). Anadromous (returning from saltwater) and adfluvial (returning from a lake) salmonids enter the Kelsey Creek subbasin from Lake Washington through the Mercer Slough, and enter Coal Creek directly from Lake Washington, during late summer and early to late fall. Chinook and Sockeye typically enter the creeks early in September and spawn into late October and early November. Coho typically enter in October and spawn through December. Migratory Coastal Cutthroat Trout generally enter in mid-December with spawning continuing through April or May (Table 2-1).

The City of Bellevue has monitored salmon spawning activity in Bellevue streams since 1999 by conducting professional biologist spawning ground surveys, and has coordinated these results with State and Tribal biologists that monitor salmon returns throughout the Lake Washington watershed. Professional biologist survey information provides a strong foundation for assessing trends in salmon use within Bellevue's streams and comparing them to overall salmon returns throughout the Lake Washington basin.

Concurrent with the professional surveys, Bellevue has also received fish use information for many years through the Salmon Watcher program (King County 2016). This 20-year-old program involves trained volunteers watching streams for salmon spawning activity in King and Snohomish Counties. Salmon Watcher data is useful in identifying the timing and presence of spawning salmon in Bellevue streams. Salmon Watcher volunteers collect fish-use observations

in areas and on days not already covered by biologist surveys, and may see fish before the biologists or in stream sections located outside of index reaches surveyed by the biologists.

This document reports on adult salmonid spawning activity observed in the Kelsey and Coal creek subbasins during the years 1999-2017, with particular emphasis on 2017 surveys.

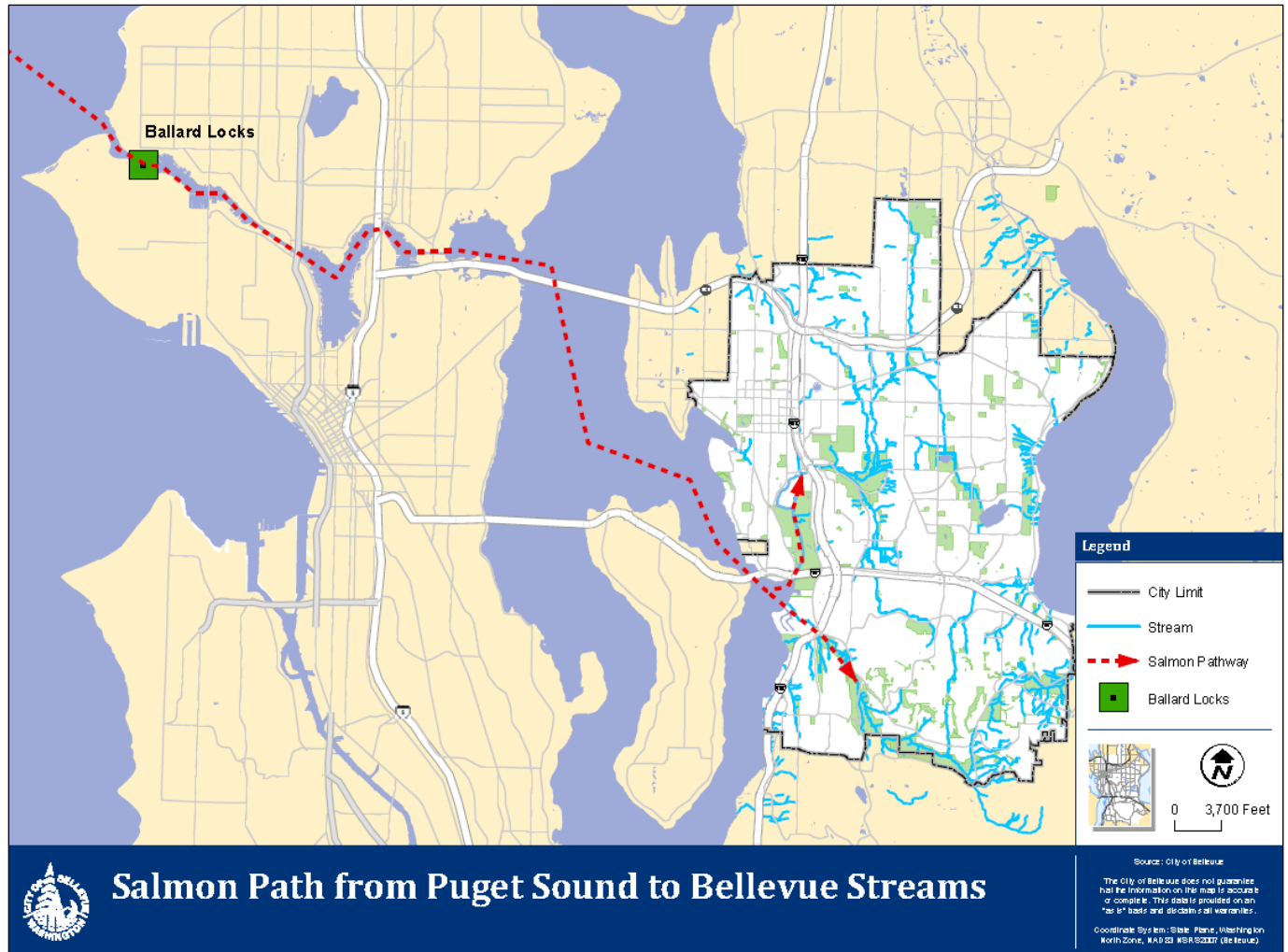


Figure 1-1. Salmon path from Puget Sound to Bellevue Streams.

2. SPAWNER SURVEYS AND RESULTS

2.1 PROFESSIONAL SURVEY METHODS

Spawning ground surveys for salmon in Bellevue streams begin in late-August/early-September, and surveys are conducted weekly until late December. During the surveys, counts of live and dead fish are enumerated for all salmonid species, and redds constructed by Chinook and coho are recorded. The location of individual salmon redds are recorded using handheld GPS units. Sockeye redds are not recorded as sockeye often spawn close together with numerous overlapping redds that are difficult to count accurately. All salmon carcasses are assessed for length, gender, origin (natural versus hatchery), age, and egg retention. Index reaches were established for Bellevue streams during the early 2000's (Figures 2-1 & 2-2). Eight index reaches were delineated in Kelsey Creek (Reach A, 1-7), five in the West Tributary (Reach 1-5), five in Richards Creek (only the Confluence reach was consistently surveyed), and four in Coal Creek (Reach A, 1, 2, and 2b). Various new index reaches were later added, including West Tributary Reach-5 and Coal Creek Reach 2 in 2011, Coal Creek Reach A in 2013, and Coal Creek Reach 2B in 2014.

2.2 SALMON WATCHERS PROGRAM METHODS

All Salmon Watcher volunteers attend a two hour training program their first year and at least every other year thereafter. The volunteers are taught how to identify adult spawning salmon species, provided training materials and instructions on recording data, and assistance choosing an appropriate viewing site or sites. Volunteers watch from mid-September through mid-December depending on weather conditions, and how late into the season fish are observed in the stream. Recorded data includes: site number, start/end times, number of live and dead salmon, presence or absence of adipose fins, how many citizens they talked to and additional notes as needed. The volunteers are encouraged to check their sites twice a week for at least 15 minutes (Figure 2-3). Throughout the spawning period, information about where fish have been seen is shared between the professional surveyors and the volunteer coordinator so both know what to expect and where.

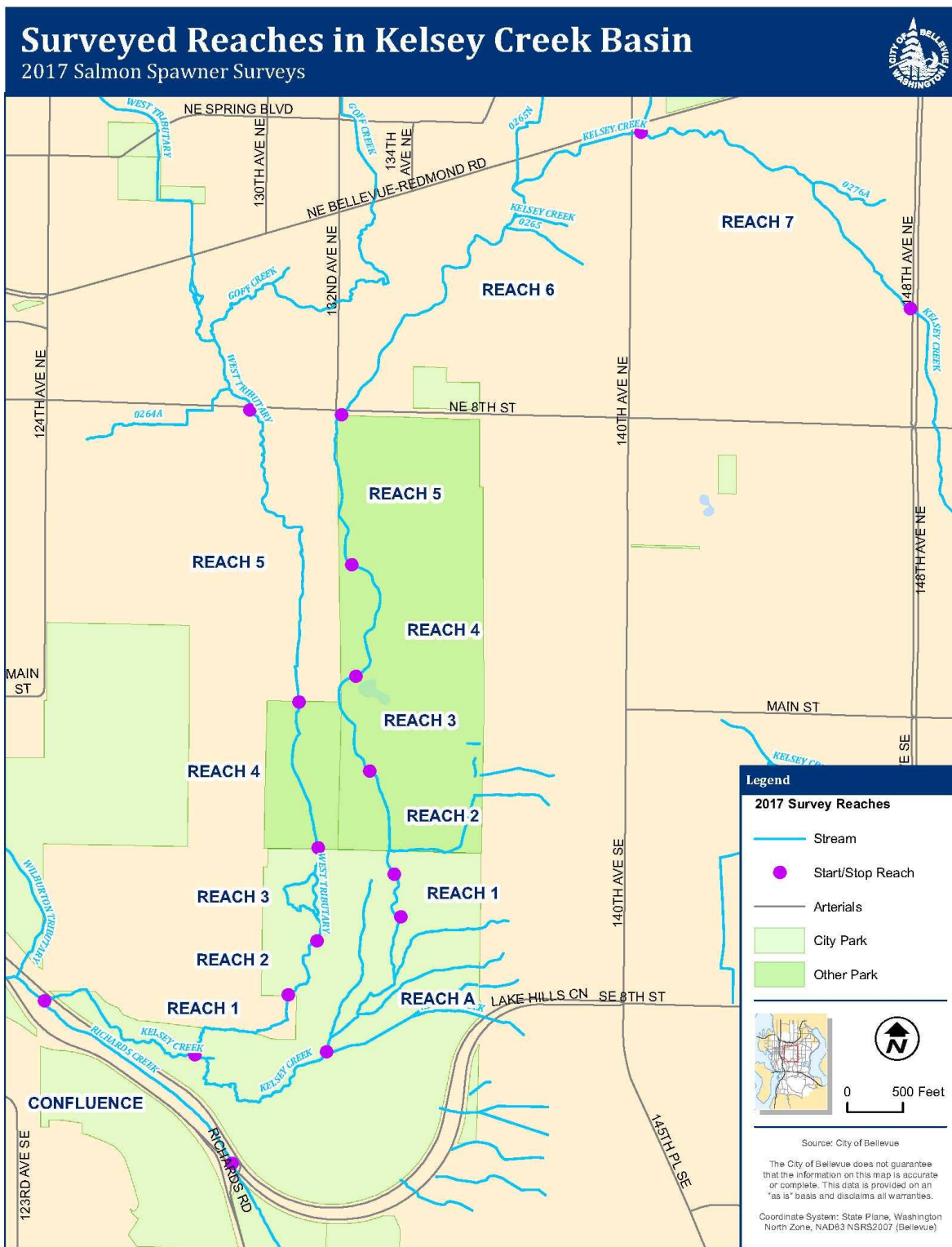
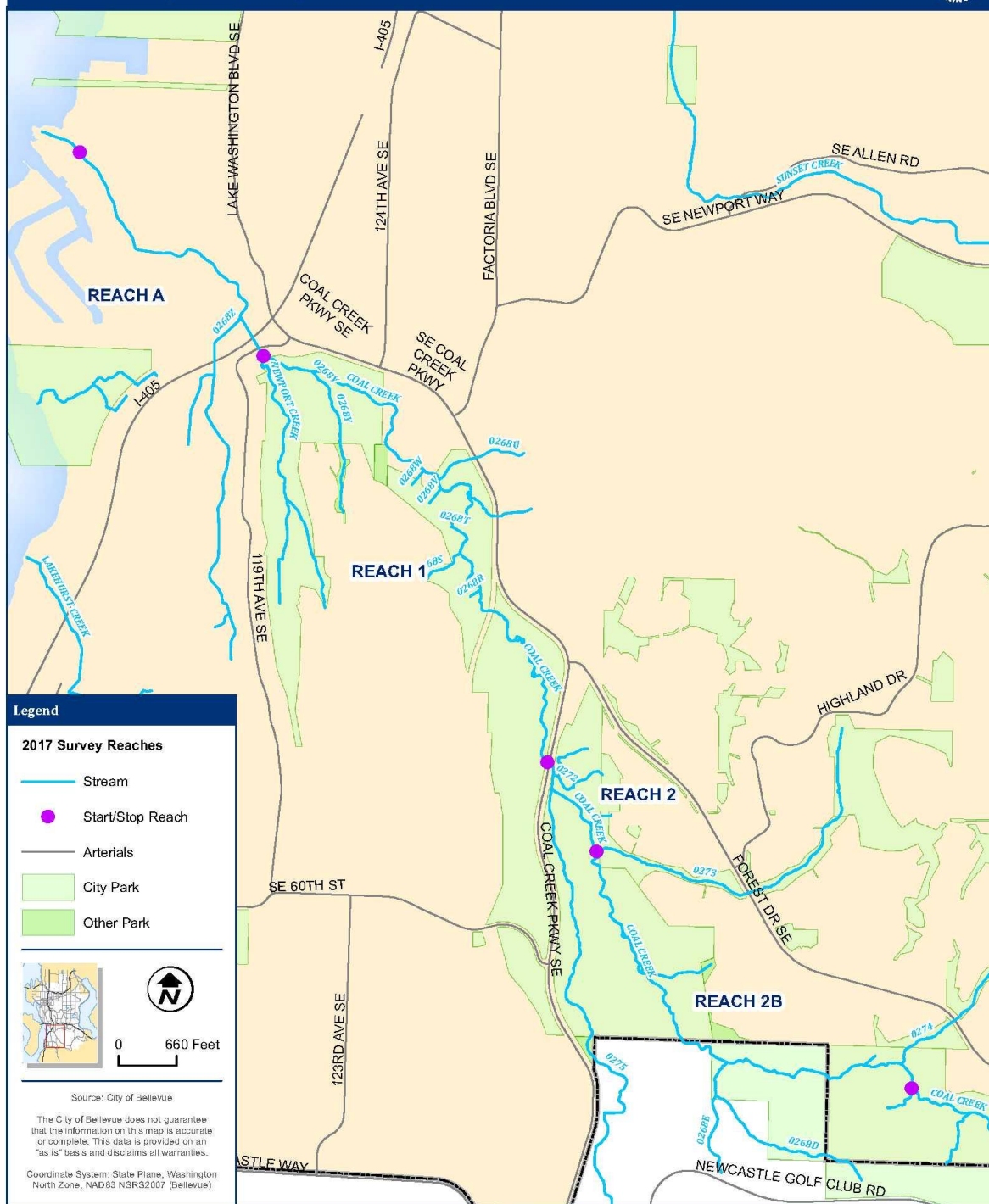


Figure 2-1. Map of 2017 survey reaches in the Kelsey Creek watershed.

Surveyed Reaches in Coal Creek Basin

2017 Salmon Spawner Surveys



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Figure 2-2. Map of 2017 survey reaches in the Kelsey Creek watershed.



Figure 2-3. Salmon Watcher site locations, City of Bellevue, Washington 2017.

2.3 PROFESSIONAL SURVEY RESULTS

Kelsey Creek Basin (including the West Tributary and Richards Creek)

Chinook Salmon: Chinook use in the Kelsey Creek basin was slightly higher in 2017 than it has been in recent years (Table 2-1) with 13 live fish sightings, 10 carcasses recovered, and 2 redds recorded. However, all 2017 Chinook activity occurred very low in Kelsey Creek (near the Richards Creek confluence where Kelsey Creek becomes Mercer Creek) or in the lowermost reach of Richards Creek (Confluence Reach). Chinook were not observed in 2017 upstream of the beaver dam wetland complex located in lower Kelsey Creek near the West Tributary confluence. The two Chinook redds that were recorded in 2017 were found in lower Richards Creek (the Confluence reach).

Past spawning surveys (since 1999) indicate that large numbers of Chinook salmon do spawn in the Kelsey Creek watershed in some years. The most recent spike in Chinook spawning activity occurred in 2006 and 2007 when 90 and 77 Chinook redds were observed in Kelsey Creek (Table 2-1). However, few Chinook have been observed in Kelsey Creek during the most recent 10-year time period (2008-2017). When Chinook are in the Kelsey Creek basin, most spawn in the Kelsey Creek mainstem; small numbers of Chinook are observed spawning in the West Tributary, and Chinook use of Richards Creek is sporadic.

Adult Chinook migration in the Kelsey Creek basin begins in early September; Chinook spawning activity begins in early October, peaks in mid-October, and is typically completed by mid-November (Table 2-3).

Sockeye Salmon: No sockeye were observed in the Kelsey Creek system in 2017. During the past 10-year period the numbers of sockeye in Kelsey Creek have consistently been very low or often zero (Table 2-1). Similar to Chinook however, significant numbers of sockeye have used the Kelsey Creek system in past years. In the year 2000, 207 live sockeye were counted in Kelsey Creek and 430 live sockeye were counted in 2006 (Table 2-1), demonstrating that the Kelsey Creek basin can support large numbers of sockeye spawners. Sockeye migration and spawn timing in the Kelsey Creek basin is similar to Chinook, adults migrating into the stream during early/mid-September, with a spawning period that peaks in mid-October and is generally completed by mid-November.

Coho Salmon: A total of 22 coho redds were recorded for Kelsey Creek in 2017, a relatively large number of redds for this system (Table 2-1). The redds were distributed throughout the Kelsey Creek mainstem and were primarily observed during mid-to-late December. It is possible that some portion of these redds were actually constructed by adfluvial cutthroat trout (mistakenly identified as coho redds), an abundant species that also spawns in Kelsey Creek during December. Coho migration and spawn timing in the Kelsey Creek basin is later than

Chinook and sockeye, with adults migrating into the stream during mid-October and spawning occurring in mid-November through early-December (Table 2-3).

Some coho spawning activity has been observed in the Kelsey Creek basin in most years that surveys were conducted (Table 2-1), but the number of coho spawning in Kelsey is generally small. Large numbers of coho were observed in 2013 and 2014 (Table 2-1) when surplus adult hatchery coho from the Issaquah Hatchery were transported and released into Kelsey Creek (Table 2-4) in an effort to improve natural spawning and smolt production. The surplus hatchery outplants were discontinued after the 2014 spawning season, and coho observations subsequently dropped to the low levels that had been observed previously. Coho spawning activity in the Kelsey Creek basin can be difficult to document because stream flows are often high during the late fall/early winter when coho spawn, making fish and redds difficult to locate. Due to the challenges involved in observing coho redds, the true number of coho spawning in the Kelsey Creek basin may be slightly higher than the survey data suggests.

Table 2-1. Summary of fish observations in Kelsey Creek.

Kelsey Creek (Including Richards Creek and West Tributary)								
Year	Chinook			Sockeye		Coho		
	Redds	Live Fish	Carcasses	Live Fish	Carcasses	Redds	Live Fish	Carcasses
1999	76	111	117	0	0	0	0	0
2000	1	17	13	207	103	0	18	13
2001	4	9	0	46	10	3	12	7
2002	5	16	12	23	6	0	0	0
2003	0	1	6	1	0	8	14	5
2004	17	20	88	12	6	0	1	0
2005	14	27	37	3	0	1	1	2
2006	90	168	220	430	162	2	2	2
2007	77	221	155	14	5	8	5	9
2008	8	25	38	0	1	12	8	0
2009	5	11	15	4	0	6	3	0
2010	0	1	1	6	0	0	0	0
2011	0	0	1	1	1	0	0	0
2012	0	0	0	0	0	9	30	2
2013	0	1	1	0	0	123	294	261
2014	0	0	0	0	0	0	138	91
2015	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0
2017	2	13	10	0	0	22	0	0

Coastal Cutthroat Trout: Coastal Cutthroat Trout are observed in the Kelsey Creek basin during salmon spawning surveys, but surveys do not extend through the duration of the cutthroat trout spawning period (Table 2-3). Small resident coastal cutthroat trout inhabit Kelsey Creek year-round, however larger adfluvial (individuals that live in Lake Washington but migrate seasonally into small streams for spawning) coastal cutthroat trout migrate into the Kelsey basin to spawn in the winter months. Adfluvial cutthroat trout migrate into the Kelsey basin in early-December and their spawning period generally starts in mid-December. The end of the cutthroat trout spawning period is not well documented in Kelsey Creek, but is likely prolonged, extending through the end of March.

Coal Creek Basin

Chinook Salmon: Three Chinook redds, 9 live Chinook, and 8 Chinook carcasses were observed in Coal Creek in 2017 (Table 2-2). Two of the three Chinook redds were located in Newport Shores in Coal Creek (Reach A) and one was higher in the stream (Reach 1). Small numbers of Chinook have been observed in Coal Creek in most years that surveys have been conducted, and the spawning activity that was observed in 2017 is generally consistent with previous observations. Chinook migration and spawn timing in Coal Creek is similar to that in the Kelsey basin, with adult migration beginning in early September and spawning activity primarily occurring in October (Table 2-3).

Table 2-2. Summary of fish observations in Coal Creek.

Coal Creek								
Year	Chinook			Sockeye		Coho		
	Redds	Live Fish	Carcasses	Live Fish	Carcasses	Redds	Live Fish	Carcasses
2008	0	0	0	0	0	6	0	3
2009	0	0	0	0	0	0	5	1
2010	1	1	0	0	0	0	1	0
2011	0	0	0	1	0	1	2	1
2012	1	19	1	66	8	2	17	2
2013	3	8	2	1	1	152	921	340
2014	2	1	0	2	0	174	1032	210
2015	2	10	3	0	0	2	8	1
2016	7	13	4	17	8	13	43	15
2017	3	9	8	6	4	21	48	12

Sockeye Salmon: Six live sockeye and 4 sockeye carcasses were observed in Coal Creek in 2017 (Table 2-2). In 2017 sockeye use of Coal Creek was similar to previous years when small numbers of sockeye were observed in the stream in most years. Sockeye adults are typically first observed in Coal Creek during early-to-mid September, and spawning activity generally peaks in mid-October and is complete by mid-November (Table 2-3).

Coho Salmon: Twenty-one coho redds and 48 live coho were observed in Coal Creek in 2017 (Table 2-2), which is slightly more coho activity than usual for Coal Creek. With the exception of 2013 and 2014 (when large numbers of surplus Issaquah Hatchery coho were released into Coal Creek (Table 2-4) to increase natural spawning and smolt production), the number of coho using Coal Creek is generally small, with no coho observed in the creek in some years. In 2017 most of the Coal Creek coho redds were observed in Reach A or Reach 1, and spawning activity began in late-October and was completed by mid-November. The 2017 coho spawn timing in Coal Creek was slightly earlier than average (Table 2-3).

Table 2-3. Periodicity (timing) of adult anadromous salmonid stream habitat use in the Kelsey and Coal creek sub-basins. Mean weekly counts (1999-2017) of live fish (adult migration) and redds (spawning) were used for this table.

SPECIES/ LIFE STAGE		September					October					November				December				
		Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45	Week 46	Week 47	Week 48	Week 49	Week 50	Week 51	Week 52	Week 1
Chinook	Migration	0	1	1	2	4	6	11	8	5	1	1	0	0	0	0	0	0	0	0
	Spawning	0	0	0	0	1	2	6	5	2	1	0	0	0	0	0	0	0	0	0
Sockeye	Migration	0	0	0	1	3	5	8	12	10	3	2	1	0	2	1	0	0	0	0
	Spawning	0	0	0	0	0	1	4	6	3	1	0	0	0	0	0	0	0	0	0
Coho	Migration	0	0	0	0	0	0	0	0	7	3	18	31	45	25	16	5	5	1	0
	Spawning	0	0	0	0	0	0	0	0	0	1	3	6	11	8	3	1	1	1	0
Cutthroat	Migration	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1
	Spawning	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	14

Table 2-4. Location and dates of adult Coho plants from Issaquah Hatchery to the Kelsey Creek basin and Coal Creek in 2013 and 2014.

Year	Stream	Dates planted	Planting location	Number of Coho planted
2013	Kelsey Creek	11/13-11/20	Reach A and 1	1,150
	West Tributary	11/13	Reach 2	100
	Coal Creek	11/21	Reach 1	742
2014	Kelsey Creek	10/23-10/24	Reach A and 1	643
	Coal Creek	10/30-11/7	Reach 1	1,573

2.4 SALMON WATCHERS PROGRAM

Volunteer Salmon Watchers were able to look for fish activity at 10 locations within the greater Kelsey Creek basin and 10 locations in the Coal Creek basin. Over 140 hours of Salmon Watching time was performed at these 20 locations during the 2017 season. In 2017, 21 volunteer Salmon Watchers made 529 site visits to the Bellevue streams. A total of 47 live fish and seven dead fish observations were made in Bellevue streams during the 2017 salmon spawning season.

Between 2011 and 2017, 74 Salmon Watchers made 3,662 site visits to Bellevue streams (Kelsey and Coal Creek basins), during which they interacted with over 600 citizens. The average number of site visits per year between 2011 and 2017 was 610. During this timeframe, a total of 401 live and 156 dead fish were counted by Salmon Watchers in the Kelsey and Coal Creek basins (Figures 2-4).

Kelsey Creek Basin: During the 2017 Salmon Watcher efforts in the Kelsey Creek mainstem, live fish were observed by volunteers in areas downstream from the professional biologist survey reaches: Four live Chinook and two live Coho were observed at site 13 (near the Wilburton trestle), and seven live Chinook at site 445 (near the Mercer Slough Fish Ladder downstream of I-405). Volunteers did not record any fish activity in the mainstem of Kelsey Creek upstream from the professional biologist survey reaches. In the West Tributary, volunteers did observe fish upstream from the professional biologist survey reaches in 2017. Live fish were recorded on October 15 and 18, and one carcass was observed on November 25 in the West Tributary (species was unidentified for these observations). Fish observation data was not available for Richards Creek as Salmon Watcher locations were not monitored in 2017.

Coal Creek: Salmon Watchers reported fish at four sites in Coal Creek in 2017 (sites 46, 442, 684, and 441). Three unidentified live fish and one sockeye at site 46 were reported. Three live Chinook, two of which were on a redd, were observed at Site 442. Site 684 had four live

Chinook, three unidentified fish and one sockeye observed. One dead Chinook was also seen at Site 684. Site 441 had nine unidentified live fish, three live Chinook, two live Coho, three unidentified dead fish and one dead Chinook.

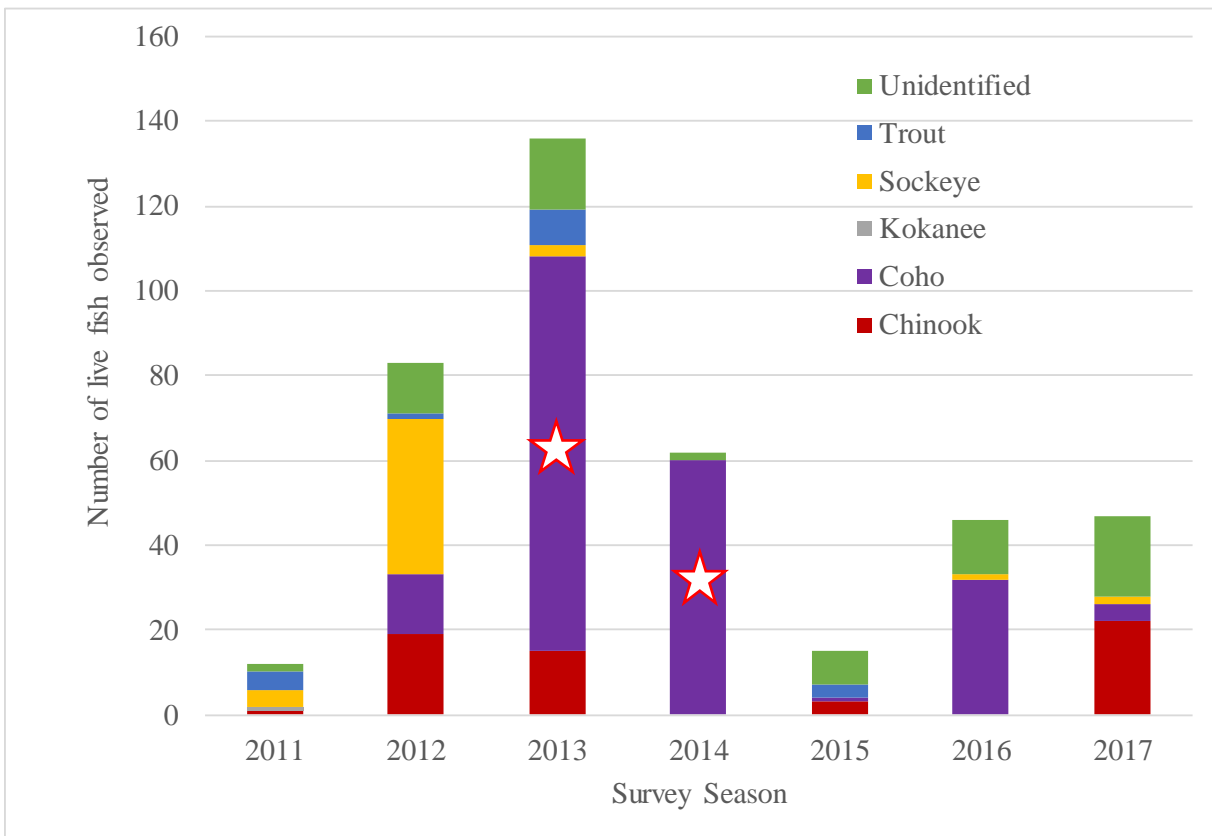


Figure 2-4. Number and species of live fish counted by volunteer observers in all City of Bellevue streams between 2011 and 2017. High coho observations in 2013 and 2014 (denoted by stars ☆) were the result of adult coho hatchery plants that occurred in those years (see Table 2-4).

3. SUMMARY

3.1 CHINOOK USE

The Lake Washington watershed is inhabited by two (Cedar and Sammamish) of 22 distinct Chinook populations that make up the Puget Sound Chinook Evolutionary Significant Unit (ESU), (Ruckleshaus et al. 2006). The Kelsey Creek and Coal Creek basins, like many other mid-sized, independent tributaries in the Lake Washington watershed, provide spawning and rearing habitat for Chinook salmon. Spawning areas for the Sammamish Chinook population are primarily located in Issaquah Creek, Big Bear Creek, and Cottage Lake Creek, and spawning for the Cedar Chinook population occurs in the Cedar River. In addition to naturally produced Chinook in the Lake Washington watershed, approximately 2 million sub-yearling Chinook smolts are released annually from the Issaquah Hatchery. The number of Chinook smolts released from the Issaquah Hatchery program is greater than the number of naturally produced smolts in the Lake Washington watershed, and the subsequent number of hatchery-origin Chinook adults that return to Lake Washington each year far outnumbers the number of natural-origin Chinook returns (Figure 3-1).

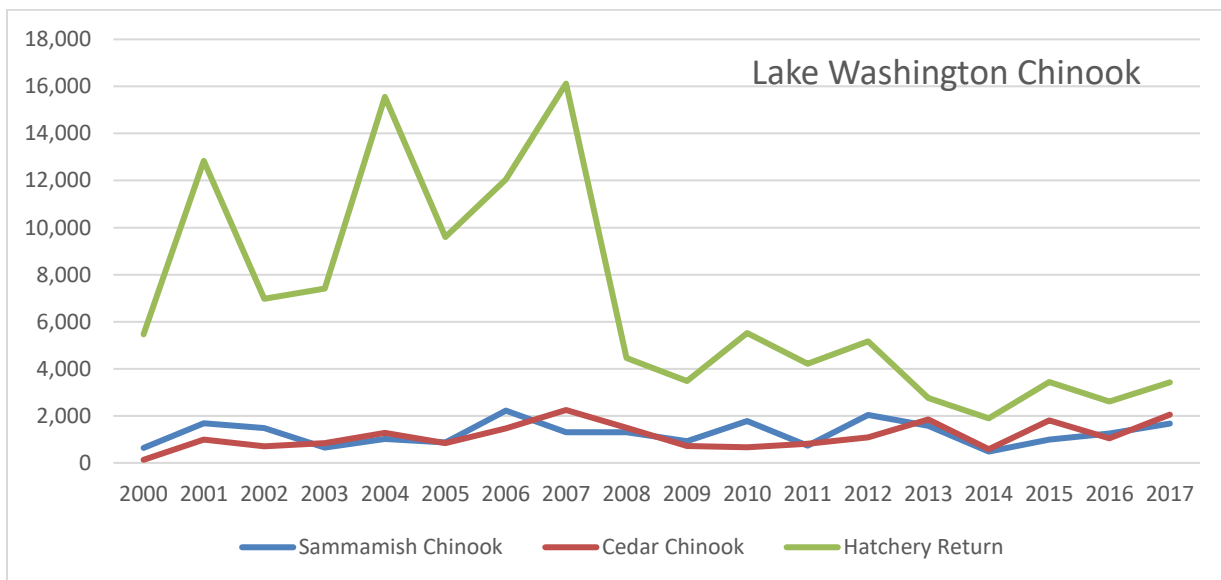


Figure 3-1. Adult Chinook returns to the Lake Washington basin.

The number of Chinook spawning in Kelsey Creek and Coal Creek is likely affected by the size of the overall Chinook return (hatchery and natural-origin combined) to Lake Washington, and is also influenced by the physical characteristics of each stream system (such as physical barriers to adult migration). The relatively large Chinook escapements to the Kelsey Creek system between 2004 and 2007 were heavily influenced by the large returns of hatchery fish to the Lake Washington basin during those years (Table 2-1, Figure 3-1). Coal Creek surveys were not conducted between 2004 and 2007, and it is not clear whether Chinook use was also high in Coal Creek during that time period. Carcass surveys from 2006 and 2007 (years when carcass sample

sizes were greatest) indicated that approximately 80% of the Chinook spawning in Kelsey Creek were hatchery-origin fish, strays from the Issaquah program. Since 2007, overall Chinook returns to Lake Washington have been smaller, largely due to lower survival of the hatchery smolts combined with reductions in the numbers of smolts released. The lack of Chinook spawning activity in the Kelsey basin since 2007 is likely a result of the lower overall Lake Washington returns from 2008 to 2017, however habitat conditions, including water quality and altered flow, in Kelsey Creek may be inhibiting Chinook use. Dense mats of aquatic vegetation in Mercer Slough during the adult migration period may prevent some Chinook from entering Kelsey Creek in some years (Figure 3-2). Because of the nature of urban flows in low gradient areas, beaver activity in lower Kelsey wetland may also be inhibiting adult Chinook from migrating into spawning areas located in the upper reaches of Kelsey Creek (Figure 3-2). Beaver activity is generally a beneficial condition for salmon, improving water quality and providing pools, except in low gradient, urban flow conditions. Aquatic vegetation in Mercer Slough and the beaver activity in lower Kelsey Creek are likely exacerbated in years with low stream flows during the Chinook migration period (September).

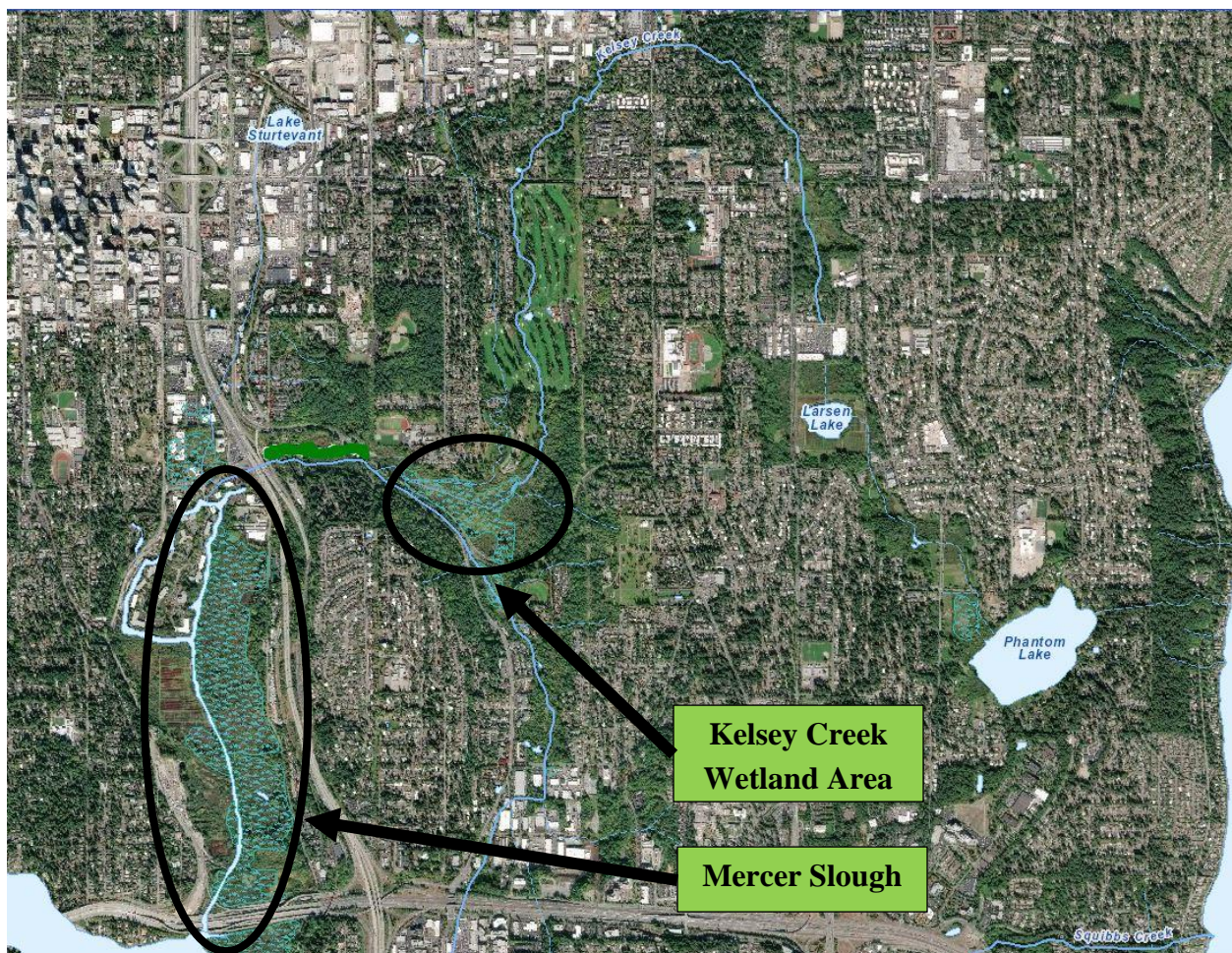


Figure 3-2. Aerial view of Mercer Slough and the lower Kelsey Creek wetlands, areas that may be inhibiting Chinook migration to upstream spawning areas in some years.

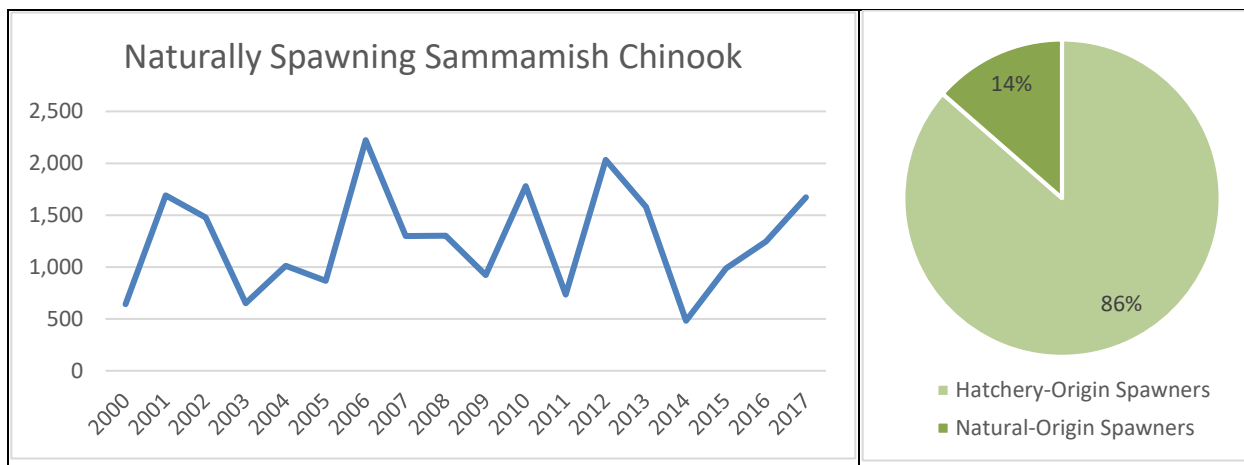


Figure 3-3. Abundance of naturally spawning Chinook and percent Natural-Origin and Hatchery-Origin spawners in the Sammamish River basin.

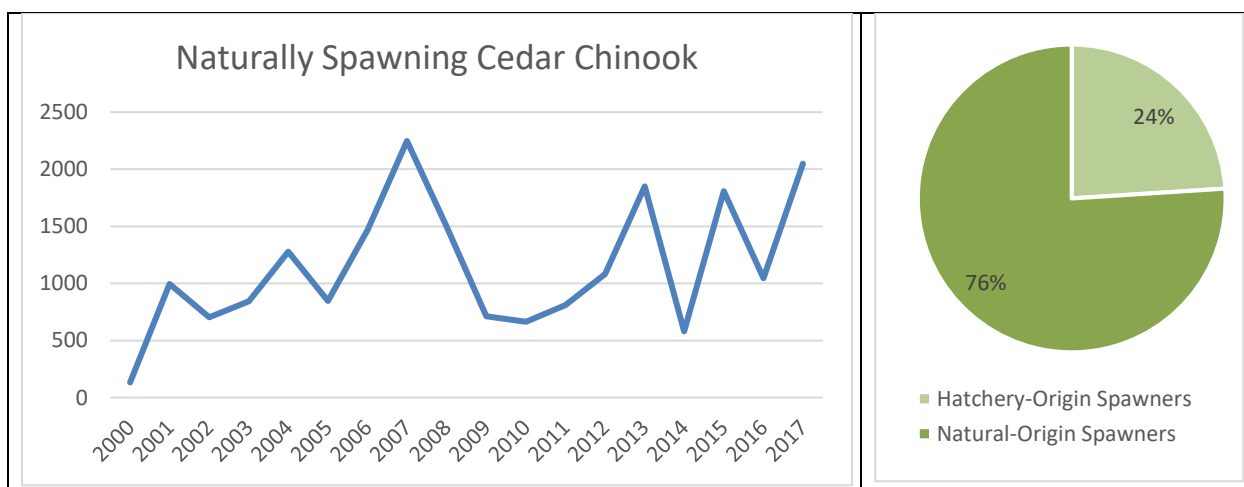


Figure 3-4. Abundance of naturally spawning Chinook and percent Natural-Origin and Hatchery-Origin spawners in the Cedar River basin.

Figures 3-3 and 3-4 show the numbers of naturally spawning Chinook adults that were observed in the Sammamish River and Cedar River between 2000 and 2017. Sammamish Chinook spawn in Big Bear Creek, Cottage Lake Creek, and lower Issaquah Creek, and the Chinook that use these spawning areas resemble Kelsey Creek Chinook in that most of the naturally spawning adults (more than 80%) are hatchery-origin fish (Figure 3-3). The Cedar River Chinook population differs in that most naturally spawning adults (more than 75%) are natural-origin fish (Figure 3-4).

3.2 SOCKEYE USE

As with Chinook, Kelsey Creek and Coal Creek each provide spawning and rearing habitat for sockeye salmon, but do not support self-supporting populations of sockeye. Two populations of

sockeye salmon inhabit the Lake Washington basin. One population is relatively small (1,000-5,000 spawners per year) and spawns in tributaries to the Sammamish River (Big Bear, Little Bear, Cottage Lake, and North Creeks). The second sockeye population is larger (10,000-100,000 spawners per year) and spawns in the Cedar River. In addition to the two naturally spawning populations, a hatchery program in the Cedar River also releases sockeye hatchery fry (release sizes range from 2 to 20 million fry) into the Cedar River each year. Most adult sockeye returning to the Lake Washington watershed are natural-origin fish from the Cedar River; adult hatchery-origin sockeye from the Cedar Hatchery are a close second in terms of abundance, and natural-origin sockeye returning to the Sammamish River tributaries are a distant third in terms of abundance. In past years sockeye (numbering from 500 to 5,000 fish) spawned in shallow-water areas with cold water upwelling around Lake Washington (primarily around Mercer Island), however sockeye have not been observed spawning along the Lake Washington lakeshore in recent years.

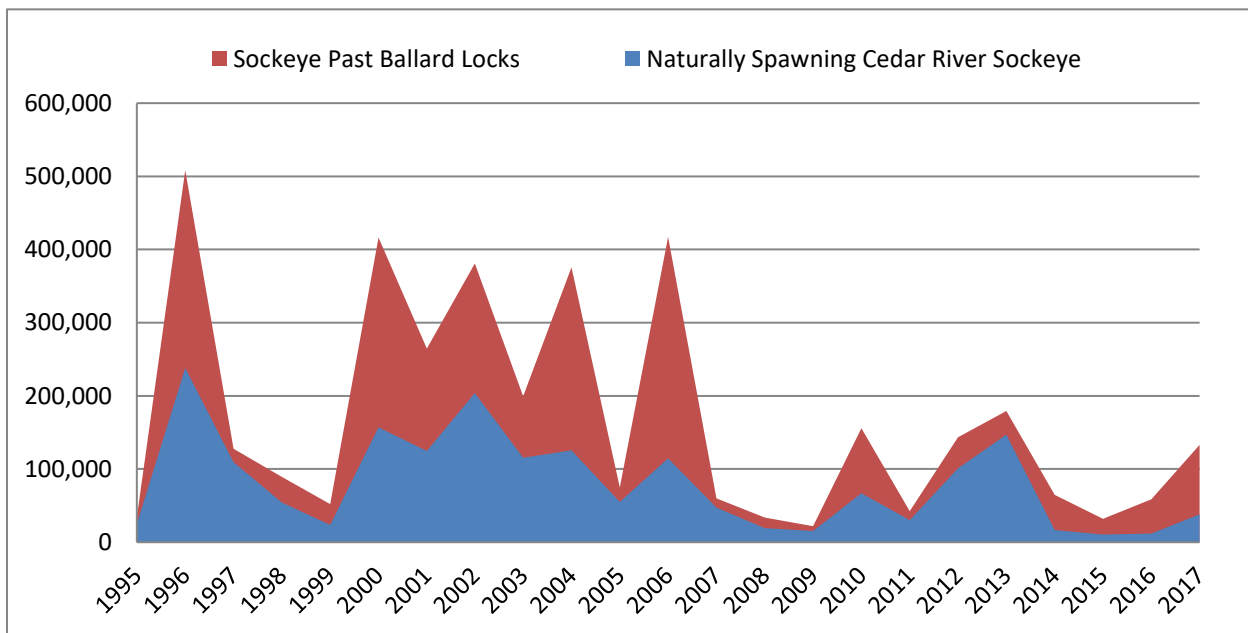


Figure 3-5. Number of sockeye adults counted passing through the Ballard Locks (red), and the number of naturally spawning sockeye adults observed in the Cedar River (blue)..

Sockeye that use Kelsey and Coal Creeks for spawning are likely adult fish from the Cedar River population (of both natural and hatchery origin) that strayed into Bellevue streams. Years with higher levels of sockeye spawning activity in Kelsey Creek and Coal Creek are likely associated with years when there are large overall sockeye returns to Lake Washington. Relatively large numbers of sockeye were observed in Kelsey Creek in 2000 and 2006 (Table 2-1), years when there were high overall returns to Lake Washington (Figure 3-6). However, years with high overall sockeye returns to Lake Washington do not always translate into large sockeye spawning in Bellevue streams, indicating that local conditions (habitat and water quality conditions or

barriers to migration) within Kelsey Creek or Coal Creek may also affect the number of sockeye that spawn there. For example, in both 2002 and 2004 large numbers of sockeye returned to Lake Washington, yet relatively small numbers of sockeye were observed in the Kelsey basin.

3.3 COHO USE

Naturally spawning coho are not well monitored in the Lake Washington watershed, however fish counts at the Ballard Locks indicate that most (85-90%, Figure 3-5) adult coho entering the Lake Washington system are hatchery-origin fish returning to Issaquah Hatchery. Coho that use Kelsey Creek and Coal Creek are likely a combination of hatchery fish straying from the Issaquah hatchery program and naturally spawned fish from these basins. Kelsey and Coal Creek each provide spawning and rearing habitat that is used by naturally spawning coho. It is likely that some natural-origin coho returning to these stream systems were spawned there.

In 2013 and 2014, the City of Bellevue worked with the Muckleshoot Indian Fisheries staff to release adult coho salmon from the Issaquah Hatchery into Kelsey and Coal Creeks. This project clearly illustrated the reduced spawning success in Kelsey Creek. In Kelsey Creek, 1150 coho were released in 2013, resulting in 113 redds (approximately 0.03% spawning success). In 2014, 643 coho were released, but no fish were observed in the system after four days, and no redds were found (0% spawning success). In comparison, 742 coho were released in Coal Creek in 2013, resulting in 152 redds (41% spawning success). In 2014, 1573 coho were released, resulting in 173 redds (22% spawning success).

Recent research by NOAA Fisheries, US Fish and Wildlife, and WSU have found that highway and dense urban street runoff is correlated with coho pre-spawn mortality (coho returning to the stream but dying before they can spawn). They have determined that urban runoff is toxic at acute (lethal) and chronic levels. If the coho eggs and juveniles survive, common sub-lethal effects include developmental delays, reduced eye size, swelling around the heart, and deformed jaws and hearts. However, when the urban runoff is filtered through a sand and compost mixture, all the coho survived and most sub-lethal effects were avoided. Additional studies are being conducted in Bellevue to determine the potential for these new techniques to reverse the pre-spawn mortality problems in urban streams.

The higher-than-average adult coho returns to Bellevue streams (especially Coal Creek) observed in 2016 and 2017 were likely a result of the hatchery coho adult out-planting that occurred in 2013 and 2014 (Table 2-4). This outcome suggests Bellevue streams are capable of producing natural-origin coho, and that the practice of using adult outplants from Issaquah Hatchery may be an effective tool for augmenting coho returns in these streams.

Small numbers of coho fry from the Issaquah Hatchery have been released at various locations during most years by Salmon in the Classroom programs, as well as by private individuals. All coho fry released into the Bellevue streams are hatched from eggs taken from the Issaquah Hatchery, most allocations are about 200 eggs for classroom programs and 5,000 eggs for private incubation projects. Coho fry releases typically experience poor survival to adulthood, however some fry released by private individuals are reared for short time periods prior to release in hopes of slightly higher survival rates. One of these private release sites is located in Reach 7 of Kelsey Creek and another is located near the mouth of Coal Creek. Hatchery-origin coho released from these sites are not marked and therefore returning adults are counted as natural-origin fish.

One advantage to the coho life history strategy is that adults migrate into the Bellevue streams in late October when higher stream flows allow them to more easily bypass physical barriers, such as the aquatic vegetation in Mercer Slough and the lower Kelsey Creek beaver wetland complex. One disadvantage is that adult coho using urban streams for spawning tend to be more highly affected by pre-spawn mortality, which is associated with poor water quality in storm-water run-off.

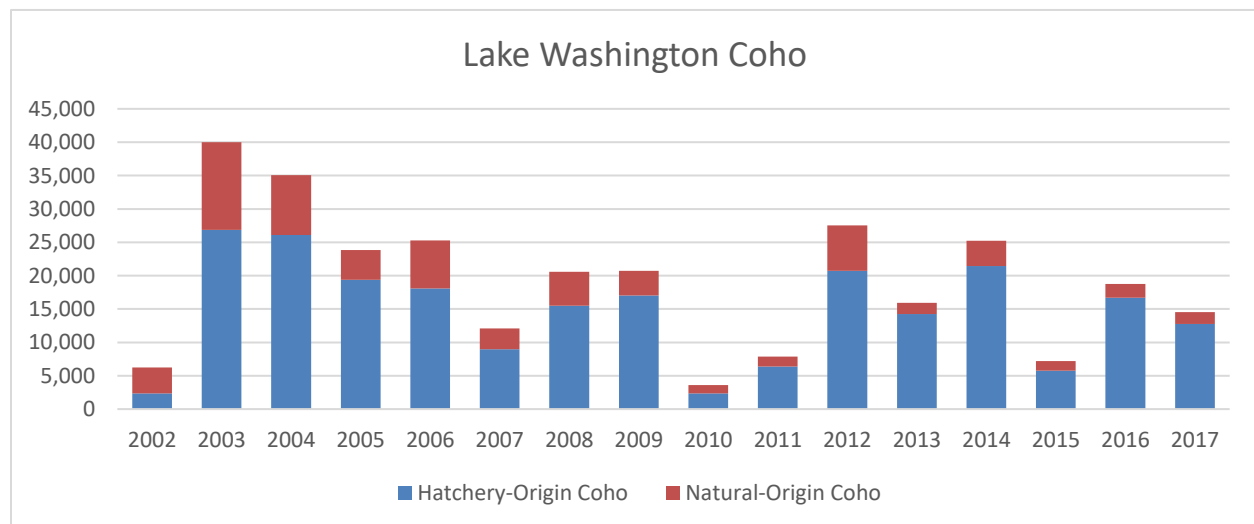


Figure 3-6. Lake Washington coho returns (Natural-Origin and Hatchery-Origin) based on fish counts at Ballard Locks.

3.4 COMPARISONS WITH SALMON WATCHER OBSERVATIONS

Salmon Watcher data in Kelsey and the West Tributary was consistent with WDFW surveys but allowed for a greater survey area. An important volunteer observation of live and dead fish above the WDFW reaches was made in the West Tributary. While these fish were not positively identified to species, based on behavior and timing, they were likely coho salmon, and would not

have been counted by WDFW surveyors. In 2017, the timing of volunteer fish observations in Coal Creek matched WDFW observations, but species identification was not always consistent. Chinook, sockeye and coho salmon may all be present concurrently in Coal Creek, making identification difficult.

3.5 RECOMMENDATIONS

Maintaining and restoring streams and riparian corridors is an increasingly difficult task in urban stream systems like the Kelsey Creek and Coal Creek watersheds. Sustaining stream systems that continue to support salmon use maintains public interest in salmon and inspires people to work toward preserving this important natural resource. The following recommendations, used in conjunction with on-going stream habitat restoration work, will help maintain and enhance public interest in salmon, and salmon use of Bellevue streams.

- Monitor migratory passage for Chinook and sockeye through the Mercer Slough and the wetland beaver complex in lower Kelsey Creek each year during the adult migration season (mid-August through September).
- Encourage land owner best management practices for overall watershed health, with specific emphasis on streamside properties (i.e. riparian plantings, eliminating use of pesticides/herbicides, cleaning up after pets, minimization of site disturbance/erosion, etc.).
- Continue to experiment with the transport and release of adult surplus hatchery coho from the Issaquah Hatchery.
- Look for ways to monitor fry and smolt production from the Kelsey Creek and Coal Creek systems. Continue monitoring adult returns for salmon using both professional and volunteer programs.
- Continue implementing fish passage, water quality retrofit, and stream habitat restoration projects for salmon.

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5. APPENDIX

Table 5-1. Volunteer observers who reported data during the 2011-2017 seasons.

Peggy Albin	Faye Haas	Ed Niblock
Marisol Asselta	Erica Halford	Betty Peltzer
Kathleen Auld	Cameron Haslam	Cindy Reed
Hilary Barnes	Evelyn Heath	David Reitz
Diane Bell	Jana Hindman	Kevin Ruuhela
Marilyn & Tom Blue	Jeff Hsia	Phil Sandifer
Cindy Boyer	Bev Jennings	Martha Schindler
Richard Brashen	Jeremy Jones	Henry Shirinyan
Joe Carrol	Kevin Jones	Neil & Tim Skilton
Heather, Eric, James & Michael Chaney	Leah Juhle	Scott Smouse
Kellene Collins	Tatsu Komada	John Spilker
Nancy Daar	Janusz Komorowski	Catherine Spurgeon
Karen Dawson	John Komorowski	Brent Spurgeon
Tianmin & Siyao Ding	Tommy Kraft	John, Johnny & Becky Stephenson
Harry Dursch	Ronan Larrivee	Krys Tierney
Ilya Elkin	Jim Laughlin	Kay Tokuda
Gary Emerson	Rich Leighton	Gary Tribble
Kelly Fine	Ken Mackey	Calvin Wang
Ernie Frankenberg	Alina Marshall	Leslie Waters
Hon Cheung Fung	Lynn McKay	Nancy Weisel
Jeannette Gaines	Jim McRoberts	Steve Williams
Audrey Gao	Jeff Mendenhall	Barb Williams
Preston Glidden	Dave Mickelson	Gregg Wilson
Laurie Gogic	Chris Mitchell	Karen Winter
Doug Greaves	Mary Alice Moran	Kyoko Yoshikawa
Ron Green	Danny & Anna Murray	Jon Aaron Yurchak

Table 5-2. Counts of live, dead, and redds for Chinook Salmon in Bellevue streams for years 1999-2017. Color indicates a survey was performed.

Bellevue Streams Chinook		AUG	SEPTEMBER					OCTOBER					NOVEMBER				DECEMBER				JANUARY		TOTALS
		Week 35	Week 36	Week 37	Week 38	Week 39	Week 40	Week 41	Week 42	Week 43	Week 44	Week 45	Week 46	Week 47	Week 48	Week 49	Week 50	Week 51	Week 52	Week 1	Week 2		
Live	1999					11		69	31													111	
	2000				0	1	4	4	3	2	1	2	0	0	0	0	0					17	
	2001						4	1	1	1	2	0	0	0	0	0	0	0	0			9	
	2002			0	1	4	0	5	3	2	0	1	0	0	0	0	0					16	
	2003					0	0	0	1	0	0	0	0	0	0	0	0	0	0			1	
	2004			0	2	0	0	2	2	9	2	3	0	0	0	0	0					20	
	2005		0	3	2	2	11	2	3	2	2	0	0	0	0	0	0	0	0			27	
	2006				12	29	10	35	51	31	0		0	0	0		0					168	
	2007		5	3	15	17	55	72	23	22	9	0	0	0	0	0	0	0				221	
	2008					6	9	2	6	2	0	0	0	0	0	0	0	0	0			25	
	2009	0	0	1	3	0	3	2	2	0	0	0	0	0	0	0	0	0	0	0	0	11	
	2010			0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	2	
	2011		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	
	2012			0	0	0	0	0	5	3	4	5	0	0	2	0	0	0	0			19	
	2013			1	0	1	6	0	0	0	0	0	1	0	0	0	0	0	0	0	0	9	
	2014			0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	2015		0	0	0	0	1	0	5	4	0	0	0	0	0	0		0	0	0	0	10	
	2016		0	0	0	1	0	1	2	6	2	1	0									13	
	2017		0	0	0	0	4	8	6	4	0	0	0		0	0	0	0	0	0	0	22	
Carcass	1999					5		39	73												117		
	2000				0	0	1	3	2	3	3	1	0	0	0	0	0					13	
	2001						0	0	0	0	0	0	0	0	0	0	0	0	0			0	
	2002			0	1	1	0	0	4	6	0		0	0	0	0	0					12	
	2003					0	0	0	0	3	1	2	0	0	0	0	0	0	0			6	
	2004			0	2	2	4	0	5	22	8	37	8	0	0	0						88	
	2005		0	1	2	0	13	8	9	2	1	1	0	0	0	0	0	0				37	
	2006				23	18	17	22	84	37	17		1	0		1	0					220	
	2007		1	0	5	7	15	18	64	24	16	4	1	0	0	0	0	0				155	
	2008					6	4	20	2	2	1	2	0	1	0	0	0	0	0			38	
	2009	0	0	0	1	1	4	5	3	0	1	0	0	0	0	0	0	0	0	0	0	15	
	2010			0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	2011		0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0			1	
	2012			0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0			1	
	2013			0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	
	2014			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	2015		0	0	0	0	0	0	1	1	0	0	0	0	1	0		0	0	0	0	3	
	2016		0	0	0	0	1	0	0	0	3	0	0									4	
	2017		0	0	0	0	1	5	6	6	0	0	0		0	0	0	0	0	0	0	18	
Redd	1999					1		45	30													76	
	2000											1										1	
	2001						1	0	1	0	1	0	1	0	0	0	0	0	0			4	
	2002			0	0	0	0	1	1	3	0	0	0	0	0	0	0	0				5	
	2003					0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	
	2004			0	0	0	0	1	3	10	1	2	0	0	0	0						17	
	2005		0	0	0	0	3	4	5	2	0	0	0	0	0	0	0	0				14	
	2006				4	10	14	12	36	12	2		0	0	0		0					90	
	2007		0	0	0	4	9	34	15	12	3	0	0	0	0	0	0	0				77	
	2008					0	4	2	0	2	0	0	0	0	0	0	0	0	0			8	
	2009	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	3	
	2010			0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	
	2011		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	
	2012			0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0			1	
	2013			0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	3	
	2014			0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	
	2015		0	0	0	0	0	0	1	1	0	0	0	0	0	0		0	0	0	0	2	
	2016		0	0	0	0	2	0	2	2	1	0	0									7	
	2017		0	0	0	0	1	1	1	2	0	0	0		0	0	0	0	0	0	0	5	

Table 5-3. City of Bellevue anadromous salmonid spawning ground survey implementation information (1999-2017).

Year	Kelsey Creek	West Tributary	Richards Creek	Coal Creek	Data Format	Surveyor	Reporting Agency
1999	X				Excel	?	
2000	X		X		Excel	?	
2001	X	X	X	X	SGS / Excel	Taylor Assoc.?	
2002	X	X	X		Excel	Watershed Co.	Watershed Co.
2003	X	X	X		Excel	Watershed Co.	Watershed Co.
2004	X	X	X		Excel	Watershed Co.	Watershed Co.
2005	X	X	X		Excel	Watershed Co.	Watershed Co.
2006	X	X	X		Excel	Watershed Co.	Watershed Co.
2007	X	X	X		Excel	Watershed Co.	Watershed Co.
2008	X	X	X	X	Excel	Watershed Co.	Watershed Co.
2009	X	X	X	X	Excel	Watershed Co.	Watershed Co.
2010	X	X	X	X	SGS / Excel	WDFW	
2011	X	X	X	X	SGS / Excel	WDFW	Anchor QEA
2012	X	X	X	X	SGS / Excel	WDFW	
2013	X	X	X	X	SGS / Excel	WDFW	
2014	X	X	X	X	SGS / Excel	WDFW	
2015	X	X	X	X	SGS / Excel	WDFW	
2016	X	X	X	X	SGS / Excel	WDFW	
2017	X	X	X	X	SGS / Excel	WDFW	WDFW

Source: WDFW Spawning Ground Survey (SGS) database, Anchor 2012, The Watershed Company 2008.

Table 5-4. Survey Reach Descriptions.

Stream	Reach	Reach Description	RM Start	RM Stop
Kelsey Creek	Reach A	Kelsey Creel Farm to footpath on right.	3	3.2
Kelsey Creek	Reach 1	Foot path on right to KCP footbridge.	3.2	3.4
Kelsey Creek	Reach 2	Footbridge to third bridge on golf course.	3.4	3.6
Kelsey Creek	Reach 3	Third golf course bridge to first cement weir/pump house on river left.	3.6	3.8
Kelsey Creek	Reach 4	First cement weir to brown bridge with stone posts.	3.8	4
Kelsey Creek	Reach 5	Brown bridge with stone posts to NE 8th St culvert.	4	4.4
Kelsey Creek	Reach 6	NE 8th St (at 132nd) to Valley Creek/140 th Ave NE.	4.4	5.1
Kelsey Creek	Reach 7	Valley Cr/ 140th Ave NE to 148th Ave NE.	5.1	5.8
Richards Creek	Confluence	Confluence with Kelsey Creek to intersection of Lake Hills Connector Rd and Richards Rd.	0	0.3
West Tributary	Reach 1	Confluence with Kelsey Creek to first footbridge in KCP.	0	0.3
West Tributary	Reach 2	First footbridge to second footbridge.	0.3	0.5
West Tributary	Reach 3	Second footbridge to golf course boundary.	0.5	0.7
West Tributary	Reach 4	Golf course southern boundary to northern boundary.	0.7	0.9
West Tributary	Reach 5	Private property to NE 8th St.	0.9	1.3
Coal Creek	Reach A	Skagit Key to culvert before I-405.	0	0.8
Coal Creek	Reach 1	119th Ave SE to Coal Creek Parkway.	0.8	1.7
Coal Creek	Reach 2	Coal Creek Parkway to footbridge on left (second tributary on the left as walking upstream).	1.7	2
Coal Creek	Reach 2b	Footbridge to splintered tree (or upstream bend).	2	2.7
Coal Creek	NP-1	Newport tributary from mouth at Coal Creek upstream.	0	varied

5-1 STREAM DESCRIPTIONS AND TYPICAL HABITAT PHOTOS

5-1.a Kelsey Creek

The headwaters of Kelsey Creek are located in the Lake Hills Greenbelt near Phantom Lake, and the stream flows downstream into Larsen Lake (Figure 2-1) in Bellevue, Washington. From Larsen Lake, Kelsey Creek flows northwest, through the dense mixed-forest and extensive wetlands and beaver ponds. The uppermost survey reach, Reach 7, begins at the crossing of 148th Ave NE and continues down to 140th Ave NE. Habitat in Reach 7 is characterized by high quality gravel pools and riffles, with dense and diverse riparian (streamside) vegetation (Figure 2-2). 140th Ave NE marks the upper end of Reach 6, where Kelsey turns to the southwest and flows through patches of dense mixed forest, single-family residences, apartments, and commercial spaces, downstream to NE 8th Street. Habitat in Reach 6 is also characterized by high quality pools and riffles, with abundant spawning gravel interspersed with exposed clay deposits. However, more road crossing structures, and highly modified, channel-confining structures are present in Reach 6 than in Reach 7 (Figure 2-3). NE 8th Street marks the upstream end of Reach 5.

Reaches 5 through 2 flow south through the Glendale Golf Course. Stream habitat within the course ranges from sand and gravel glides, to gravel and boulder riffles (Figures 2-4 to 2-7). Several sediment bars create short pools in these reaches. A majority of the riparian area is composed of grassy stream banks, interspersed with mixed conifer and hardwood stands, with some riparian shrubbery.

Reaches 1 and A flow along the east side of the Kelsey Creek Farm. This is a lower gradient section with habitat ranging from sand and gravel riffles, to deeply scoured plunge pools with an abundance of woody debris. A majority of the riparian area is composed of grassy stream banks with hardwood stands and dense woody shrubs (Figure 2-8). Kelsey Creek continues downstream of the Kelsey Creek Farm property into an expansive wetland. Numerous beaver dams seasonally limited upstream movement by adult salmon in the wetland until fall rains increase flows and enable accessibility to upstream habitats (Figure 2-9). Downstream of the wetland, Kelsey Creek flows under Interstate 405, where it becomes Mercer Slough, eventually draining into Lake Washington.



Figure 5-1. Typical habitat in Kelsey Creek Reach 7, 21 December 2017.



Figure 5-2. Typical habitat in Kelsey Creek Reach 6, 3 January 2018.



Figure 5-3. Kelsey Creek, upstream survey end of Reach 5, 14 December 2017.



Figure 5-4. Typical habitat in Kelsey Creek, Reaches 4 and 5, 14 December 2017.



Figure 5-5. Kelsey Creek, downstream end of the Wetland Reach, 4 January 2018 (looking at culvert under Lake Hills Connector).



Figure 5-6. Typical habitat in Kelsey Creek, Reaches 2 and 3 in the Glendale Golf Course, 14 December 2017.



Figure 5-7. Typical habitat in Kelsey Creek, Reaches A and 1, in the Kelsey Creek Farm, 14 December 2017.



Figure 5-8. Beaver dam in Kelsey Creek; Reach A, 2 October 2017.

5-1.c West Tributary

The headwaters of West Tributary (a tributary to Kelsey Creek) begin near Bridle Trails State Park (north Bellevue). The creek flows south through a mixture of forest, residential, commercial, and industrial spaces until it enters, and flows through, the Glendale Golf Course, subsequently converging with Kelsey Creek near Kelsey Creek Farm (Figure 2-1). Reach 5 begins in a residential neighborhood at NE 8th St. and flows between RM 1.3 and 0.9 (Figures 2-10). The channel in Reach 5 is frequently lined with riprap and other bank armoring, and habitat consists of low gradient gravel and cobble pools and riffles. Riparian vegetation consists mainly of mature landscape trees and non-native landscaping plants including bamboo and other shrubs. Reach 4 flows from the north at RM 0.9, at the Glendale Golf Course northern boundary, south through the golf course to RM 0.7 (Figure 2-11). This reach consists of long gravel runs with occasional pools. The riparian zone is primarily open with little overhead vegetation, except an approximately 100-yard section with mature conifer trees. There is little to no instream cover in the form of woody debris or undercut banks.

Reach 3 of West Tributary flows through the upstream part of the Kelsey Creek Farm, between RM 0.7 and 0.5 (Figure 2-12). This section has thick streamside willow and other riparian vegetation, and the streambed substrate is comprised predominantly of gravel and sand. Reach 2 continues through the downstream part of the Kelsey Creek Farm, between RM 0.5 and 0.3 (Figure 2-13). Reach 1 flows through the south boundary of the Kelsey Creek Farm to the confluence with Kelsey Creek (Figure 2-14). Habitat in reaches 1 and 2 is similar, with beaver activity often impounding the streamflow, willow and other shrubs and small trees. Substrates range from silt and sand to large gravel.



Figure 5-9. Typical habitat in West Tributary Reach 5, 3 January 2018.



Figure 5-10. Typical habitat in West Tributary Reach 4, in the Glendale Golf Course, 3 January 2018.



Figure 5-11. Typical habitat in West Tributary Reach 3 near the downstream end, 7 December 2017.



Figure 5-12. Typical habitat in West Tributary, with large woody debris in Reach 2, 3 January 2018.



Figure 5-13. Typical habitat in West Tributary Reach 1 near the lowest footbridge in the Kelsey Creek Farm, 5 September 2017.

5-1.c Richards Creek

The headwaters of Richards Creek begin to the east near Bellevue College, and south near Eastgate Park and Factoria. The creek flows north under Interstate 90 (Figure 2-1). On the north side of Interstate 90, Richards Creek flows through commercial and industrial space as it intersects with the upper end of Reach 4. The upper end of Reach 3 starts at SE 26th St, where it enters a forested area that continues downstream to the upper end of Reach 1. The upper end of the Confluence Reach is located at RM 0.3. The Confluence Reach is constrained on either side by the lanes of Lake Hills Connector, and flows through low gradient sandy habitat with some gravel and cobble riffles, with a thin stand of hardwood buffer (Figures 2-15 to 2-17).



Figure 5-14. Typical habitat in the Richards Creek confluence reach, 12 September 2017.



Figure 5-15. Typical habitat in the Richards Creek confluence reach, 7 December 2017.



Figure 5-16. Beaver activity in the Richards Creek confluence reach, 2 October 2017.

5-1.d Coal Creek

Coal Creek drains from the west slopes of Cougar Mountain Regional Wildland Park, and flows generally northwest into Lake Washington (Figure 2-18). The upper end of Reach 2b is located at RM 2.7. The upper end of Reach 2 is located at RM 2.0, at a right bank tributary junction. Reaches 2 and 2b flow through a confined valley. Habitat consists of moderate gradient gravel and cobble pools and riffles with dense mixed forest canopy and riparian shrubs (Figures 2-19 and 2-20).

The upper end of Reach 1 starts at the Upper Coal Creek Trail West Trailhead off Coal Creek Parkway at RM 1.7. Reach 1 flows through the Coal Creek Natural Area along dense mixed forest canopy and riparian shrubs, with some residential space (Figure 2-21). Habitat consists of cobble and gravel pools and riffles, including a number of sediment bars that create short pools. The lower end of Reach 1 is located on the east (upstream) side of Interstate 405 near the Coal Creek Trailhead at RM 0.8. The upper end of Reach A is located on the west (downstream) side of Interstate 405. Reach A flows through a relatively well-forested buffer, and cuts through the Newport Shores housing development and into Lake Washington. Habitat consists of sand to gravel riffles and glides, with a number of channel modifications, and sediment bars located in a confined stretch of stream that have caused debris jams and during some years can limit salmonid migration (Figure 2-22). Some of the road crossings (and associated culverts) over the stream in the neighborhood have been or are planning to be replaced with fish-friendly passage options.



Figure 5-17. Coal Creek typical habitat in Reach 2b, 26 September 2017.



Figure 5-18. Coal Creek lower end of Reach 2, 3 October 2017, very low streamflow.



Figure 5-19. Coal Creek Typical habitat in Reach 1, 19 September 2017.



Figure 5-20. Construction weir blocking fish passage in Reach A, Coal Creek 6 September 2017.