2008 SALMON SPAWNER SURVEYS

Kelsey Creek, West Tributary, Richards Creek and Coal Creek

March 2009

The Watershed Company

Prepared for:

The City of Bellevue
Contracting Services
Service First Desk
450 110th Avenue NE
Service First Desk
Bellevue WA 98004

SALMON SPAWNER SURVEY 2008: KELSEY CREEK, TRIBUTARIES, AND COAL CREEK

Prepared for:

City of Bellevue, Utilities Department
450 110th Avenue NE
PO Box 90012
Bellevue, WA 98009-9012

Prepared by:

THE WATERSHED COMPANY

750 Sixth Street South, Kirkland WA 98033

March 2009

TABLE OF CONTENTS

LIST OF FIGURES Page No.

LIST OF TABLES

SALMON SPAWNER SURVEY 2008
KELSEY CREEK, TRIBUTARIES, AND COAL CREEK

1. ABSTRACT

The City of Bellevue monitored spawning activity in the Kelsey Creek watershed in 2008, marking the eighth consecutive year that this information has been collected. Weekly foot surveys were conducted on Kelsey Creek mainstem and the West Tributary between September 2 and December 23, 2008; bi-weekly surveys were conducted on Richards Creek between September 18 and December 10, 2008, and four surveys were conducted on Coal Creek between October 10 and December 19, 2008. The chinook run was relatively weak this year when compared to the 2006 and 2007 returns and adult salmon access into the Kelsey Creek system was constrained this season by low precipitation and flow conditions, making typically passable beaver dams into episodic migration barriers. Spawning escapement for the Kelsey system index area (based on cumulative redd counts) is estimated at 20 chinook, 25 coho, and 0 sockeye in 2008. Most spawning activity occurred in the Kelsey Creek mainstem, where 8 chinook redds and 10 coho redds were recorded. Two coho redds were constructed in the West Tributary, two chinook redds in Richards Creek and six coho redds in Coal Creek. Carcass counts (n=45) indicated that 16 percent of the chinook salmon in the overall 2008 return were wild fish (unclipped), 53 percent were hatchery fish (clipped), and 31 percent were unknown.

The spawning estimates identified in this report do not comprise the total escapement for the Kelsey Creek watershed. The regional Salmon Watcher Program and the Washington Department of Fish and Wildlife documented salmon upstream of the Kelsey Creek and West Tributary index reaches. For more information about the Salmon Watcher Program and the 2008 Salmon Watcher Report, visit http://dnr.metrokc.gov/wlr/waterres/salmon/.

2. INTRODUCTION

The Puget Sound region supports a number of cultural, recreational, and commercially important salmonid species. Chinook salmon grow to be the largest, and are one of the most well known, species of salmonid. Listed under the Endangered Species Act in 1999 and reaffirmed as "threatened" in 2005 (U.S. Federal Register, 28 June 2005), the Puget Sound chinook salmon Evolutionarily Significant Unit (ESU) is composed of 22 distinct chinook salmon populations (Ruckleshaus et al. 2006; Puget Sound Salmon Recovery Plan 2007). Sixteen additional chinook salmon populations historically inhabiting Puget Sound have been lost and are now extinct (Ruckleshaus et al. 2006).

Partially motivated by the federal ESA listing of chinook salmon, a number of salmon conservation planning efforts were initiated in the Puget Sound region, each designed to guide salmon restoration actions ranging from the local level to the regional scale. Some of these salmon conservation entities include the Puget Sound Shared Strategy, the Governor's Salmon Recovery Office, and the Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Salmon

Recovery Council. Monitoring annual trends in chinook population abundance (as well as the health of other aquatic resources) is an essential part of the salmon conservation planning effort, and will help guide restoration. The City of Bellevue has monitored the spawning effort of anadromous salmonids in the Kelsey Creek watershed since 2000. This report documents spawning activity that was observed in the Kelsey Creek watershed in 2008, and compares these observations with those recorded in previous years.

WRIA 8, the most highly urbanized watershed in the Puget Sound ESU, is inhabited by two of the 22 distinct populations of chinook salmon: the Cedar River and the Sammamish River chinook (Ruckleshaus et al. 2006). The chinook population determinations are based on a variety of parameters, including genetics, run timing, and morphology. Chinook salmon in WRIA 8 are primarily produced in three watersheds: the Cedar River, the Big Bear/Cottage Lake system, and Issaquah Creek. Some production also occurs in smaller Lake Washington tributaries such as the Kelsey Creek system (WDFW/PSIT 2004). Two hatcheries, one at Portage Bay operated by the University of Washington and the other on Issaquah Creek operated by the WDFW, also release salmon within WRIA 8. A direct tributary to Lake Washington, Kelsey Creek is categorized as a Tier 2 satellite area, and is most closely associated with the Sammamish/North Lake Washington population.

Located almost entirely within the City of Bellevue, the Kelsey Creek watershed has historically provided spawning and rearing habitat for anadromous salmonids like chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon, as well as migratory cutthroat trout (*O. clarki*). From its headwaters in the Phantom Lake and Larsen Lake wetlands, Kelsey Creek flows northward to Bel-Red Road before bending southward, where it is joined by a series of small tributaries before discharging to Mercer Slough and ultimately into Lake Washington. Although not as large as some other Lake Washington tributaries, the Kelsey Creek watershed encompasses approximately 10,870 acres, contains more than 19 miles of streams, and is an important component of the greater WRIA 8 watershed.

With impervious surfaces exceeding 40 percent of the watershed area, aquatic habitat conditions have been significantly impacted by development (Scott et al. 1986; Moscrip and Montgomery 1997). Six "factors of decline" identified for the Kelsey Creek watershed include: 1) fish access and passage barriers, 2) increased sedimentation/altered sediment transport processes, 3) poor water quality (increased temperature, other), 4) loss of channel complexity and connectivity, 5) altered hydrology and flow, and 6) degradation of riparian condition (Kerwin 2001).

Similar to previous years, occasional surveys were conducted in portions of the Coal Creek watershed located in the City of Bellevue's jurisdiction to investigate potential salmon utilization. The headwaters of Coal Creek are located at an elevation of 1,400 feet above sea level on Cougar Mountain and flows approximately 7 miles to the northwest, emptying into Lake Washington at Newport Shores. Periodic surveys were conducted during the 2008 chinook and coho spawning season to record salmonid utilization. This follows the completion of restoration work at the mouth of Coal Creek to improve adult salmon passage. Coal Creek was

surveyed from the east end of the culvert passing under I-405 near 119th Avenue SE, upstream along Coal Creek Parkway SE to the culvert that passes under Coal Creek Parkway. Additional survey observations were made periodically in and above the instream sediment pond located at the parking lot for the Coal Creek Park Trail System.

Management objectives for the Lake Washington chinook management unit include an annual escapement of 1,200 chinook to the Cedar River index reach. Although an interim escapement goal of 350 chinook to the Bear Creek/Cottage Creek index area of the North Lake Washington population (Kelsey Creek is a sub area within the North Lake population) is currently in use, the Cedar River escapement goal (1,200 fish) is thought to provide adequate protection for the North Lake Washington population. With a mean (1998 – 2004) escapement of 723, returns to the Cedar River index area indicate that the Cedar River chinook population is currently depressed. Periodic spawner surveys and adult escapement estimates in other Lake Washington stream systems like Kelsey Creek will help quantify annual production and better define the distribution of natural spawning. Reliable documentation of adult escapement in Lake Washington tributaries will also help guide conservation efforts, develop recovery objectives, and enhance the ability to make well-informed management decisions.

Chinook salmon typically enter Mercer Slough near the beginning of September and proceed to spawning areas further upstream in the Kelsey Creek watershed where spawning continues into early November. Sockeye salmon typically begin migrating upstream in Kelsey Creek in early September, and live fish are observed on the spawning grounds until late October or early November. Coho salmon typically start entering Kelsey Creek in October and run through December (Washington Trout 2001; Taylor Associates 2002; The Watershed Company 2003-2007). Migratory cutthroat trout typically begin their upstream movement in January, but they have been known to be in the system as early as November. Their spawning typically continues through the early spring. Resident and migratory (steelhead) rainbow trout have also been observed in Kelsey Creek tributaries (Paulsen, pers. comm., 27 February 2003; Washington Trout 2001).

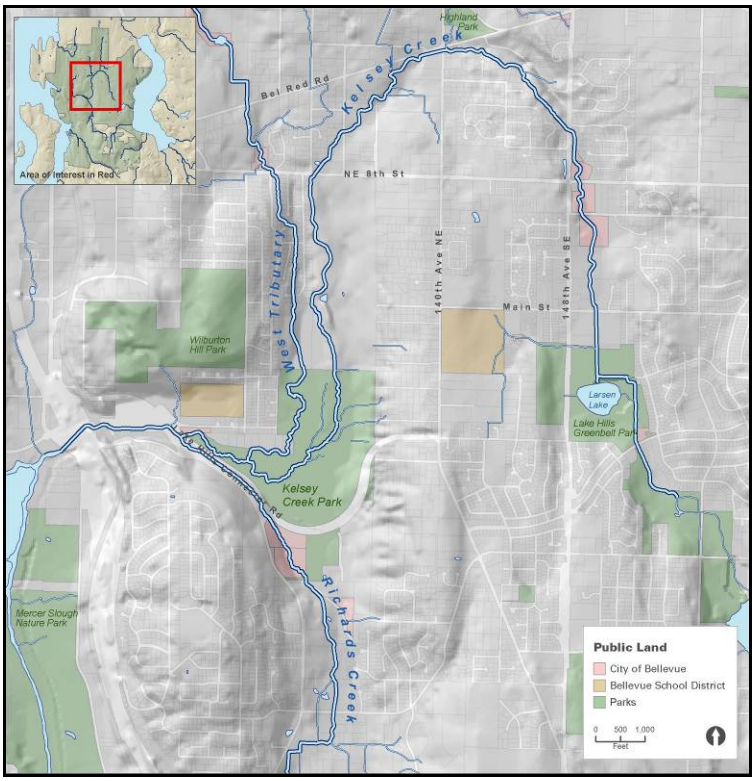


Figure 1. Primary streams (Kelsey Creek, West Tributary and Richards Creek) where annual spawner surveys are conducted in the Kelsey Creek basin.

In the fall and early winter of 2008, The Watershed Company worked cooperatively with City of Bellevue staff to perform spawner surveys of the mainstem of Kelsey Creek and two of its primary tributaries, the West Tributary and Richards Creek (Figure 1). As part of this work, occasional surveys were conducted in the Coal Creek watershed. This report documents the sixth consecutive year of weekly observations in both the West Tributary and Kelsey Creek. Prior to 2003, survey efforts in the West Tributary and Richards Creek were less intense, and these tributaries were only surveyed sporadically using spot checks. These ongoing salmon spawner surveys will provide the City with accurate data regarding the abundance, timing, and distribution of anadromous salmonid activity within Kelsey Creek and the West Tributary.

3. METHODS

3.1 Survey Protocol

The Kelsey Creek mainstem and two of its larger tributaries, the West Tributary and Richards Creek, were surveyed by foot on a weekly and biweekly basis respectively throughout the fall of 2008 to quantify the number of anadromous salmonids that use these streams for spawning. Additional spot surveys of Coal Creek were included to investigate the utility of this drainage for salmon spawning activity. Weekly surveys were scheduled to span the duration of the chinook, coho, and sockeye runs, the dates of which are based on observations from previous

years. Maps, survey protocol, and reach descriptions for each of the streams are provided below.

During each stream survey, all observations of salmonids, including chinook, coho, and sockeye salmon, and cutthroat trout, are recorded (Appendices B, C, and D). Where possible, the species, sex, origin (presence or absence of the adipose fin), and spawning condition (pre-spawn mortality or successful spawner) of each fish are identified. All live fish observed during each weekly survey are recorded, with the result that live spawners persisting on the spawning grounds for more than a week may be recorded more than once. Length measurements (total, fork, post-orbital hypural [POH], and body depth) and scale samples were collected from all chinook and coho carcasses that were encountered (scale samples are not collected from sockeye carcasses). Tissue samples (fin clips) were not collected from any fish in 2007 or 2008. To prevent redundant observations, the lower jaw from each carcass was removed using pruning shears after all relevant data was recorded.

3.2 Redd Counts

During each weekly survey, new redds are enumerated by species and their location marked with flagging, and referenced using a GPS. Flagging the redd locations ensures that old, but still visible, redds are not counted twice. Redds were defined as either "active" or "practice." Active redds generally had a well-defined pit and tailspill with substrate that was bright as a result of fresh cleaning. Active redds are often attended by one to several adult fish. Digs with less definition or poor construction were considered practice digs and not recorded unless completed at a later date. If fish were not present near a redd, combinations of redd characteristics including diameter, substrate size, and position within the stream were used to estimate which salmon species constructed the redd. The size of each redd was measured and recorded for future use. Consistency among redd counts was maximized by utilizing the same surveyor during the majority of weekly surveys.

3.3 Escapement Estimates

Due to a patchwork of private land ownership, regular surveys are not conducted over the entire Kelsey Creek watershed and cumulative redd counts for the full range of available spawning habitat are not available. Therefore, the surveyed portions of Kelsey Creek, the West Tributary, and Richards Creek serve as index reaches for the Kelsey Creek watershed. Similarly, surveys on Coal Creek are not all inclusive of available spawning habitat and also represent an index reach. Other potential spawning sites outside the Kelsey System index area include the upper West Tributary, Goff Creek, and Valley Creek, whereas other potential portions of Coal Creek include those sections downstream of I-405 and reaches above the in-stream sediment pond above Coal Creek Parkway. Although some chinook, sockeye, and coho spawning likely occurs in these outlying areas, most of the spawning effort (>75%) is thought to occur within the surveyed index reaches.

There are a variety of techniques for estimating spawning escapement (Hilborn et al. 1999; Hahn et al. 2003), and three escapement estimates are provided in this report. Escapement

estimates for the index area were generated using methods described in *Puget Sound Chinook Salmon (Oncorhynchus tshawytscha) Escapement Estimates and Methods – 1991* (Smith and Castle 1994), and these methods are consistent with those used by the WDFW to estimate escapement for other WRIA 8 index areas. The three escapement estimates are provided for comparison purposes only. The first method is based on cumulative redd counts, the second method is based on area under the curve (AUC) using live counts, and the third method is a simple peak spawner count that is a simple relative abundance estimate useful for tracking the population dynamics over time (Holt and Cox 2008).

The redd-based escapement estimate uses a cumulative redd count. In the Kelsey Creek system index area, weekly surveys throughout the spawning period enabled the enumeration of all new redds during the spawning season. Total redds were calculated as the number of new redds constructed in the survey area during the survey period. The total number of redds is then multiplied by 2.5 adults/redd (Orrell 1976) to estimate the total escapement for the index area.

The AUC escapement estimate is based on live counts of adult fish observed over the course of the spawning season (Ames 1984). These counts are used to calculate the total number of fish days (F) for the season using the equation:

$$F_{t+1} = [(C_t + C_{t+1})/2] \bullet (J_{t+1} - J_t)$$

where:
F = Fish days,
C = Live count for each survey,
J = Julian Day of each survey, and
t = First survey of the spawning period.

Fish days are then used to determine the AUC escapement using the equation:

$$AUC = \sum(F_t \ldots F_{t+n})/V$$

where:
AUC = Area Under the Curve,
F = Fish days,
t = First survey of the spawning period,
n = Total number of surveys conducted, and
V = Number of days a fish can be counted.
*V is assumed to be 10 days for chinook in Kelsey Creek, as well as other regularly surveyed streams in WRIA 8 (Berge et al. 2006).
**$\sum(F_t \ldots F_{t+n})$ is a summation of Fish days for each survey over the entire survey period.

AUC escapement estimates are highly dependent on reliable estimates of fish stream residence time (*V*), also referred to as stream life (Lady and Skalski 1998). We relied on a borrowed

constant estimate of stream life due to the lack of a system specific estimate. It should be noted that the use of a constant stream life can lead to serious bias in salmon escapement estimates (Shardlow 2004). The stream life span of a spawning salmon varies markedly by species, body size, stream system, and time (Shardlow 2004). More recent approaches using AUC have utilized statistical approaches to incorporate the uncertainty associated with stream life, observer error, and arrival timing into escapement estimates (Holt and Cox 2008).

The peak spawner count estimate was used to compliment the AUC and redd based salmon escapement estimates. While the AUC and redd based estimates attempt to estimate the total salmon escapement for the season, the peak spawner count provides a simple and less bias way of tracking the relative population dynamics of salmon spawners within the system across years. Peak count estimates have outperformed a variety of more complicated monitoring approaches for detecting changes in relative salmon escapement trends (Holt and Cox 2008). The peak count uses the highest count value observed during the spawning season as an index metric of escapement (Bevan 1961). The peak count approach relies on the ability of the stream survey timing and design to capture the peak salmon abundance in the system.

4. STUDY AREA AND REACH DESCRIPTIONS

Foot surveys are conducted in three major streams in the Kelsey Creek system index area: 1) the Kelsey Creek mainstem (eight survey reaches), 2) the West Tributary (four survey reaches), and 3) Richards Creek (five survey reaches – surveyed every other week). Additional surveys were conducted on Coal Creek (one survey reach – surveyed episodically) in an effort to identify the presence of salmon spawning activity. Maps of the four streams and descriptions of their respective survey reaches are included in this section.

4.1 Kelsey Creek

The index area in the Kelsey Creek mainstem (WRIA 8, Stream 0259) consists of eight consecutive survey reaches, beginning at the downstream end with Reach A (RM 3.0) and continuing upstream from Reach 1 through Reach 7 ending at RM 5.8 (Figure 2). Spawning effort in these survey reaches has been monitored from 2003 to 2008. Reach A was added to the 2003 survey (and enlarged in 2006) due to the presence of improved spawning habitat (spawning gravel transported into the reach). Endpoints for Reaches 1 through 7 were established by the Washington Department of Fish and Wildlife (WDFW) during 1999 chinook spawner surveys. Weekly foot surveys generally begin with Reach A (in Kelsey Creek Park) and extend through Reach 7 near the Bellevue Christian Reformed Church on 148th Avenue NE. The 2008 Kelsey Creek surveys began on September 2 and were performed over a 17-week time period ending on December 23.

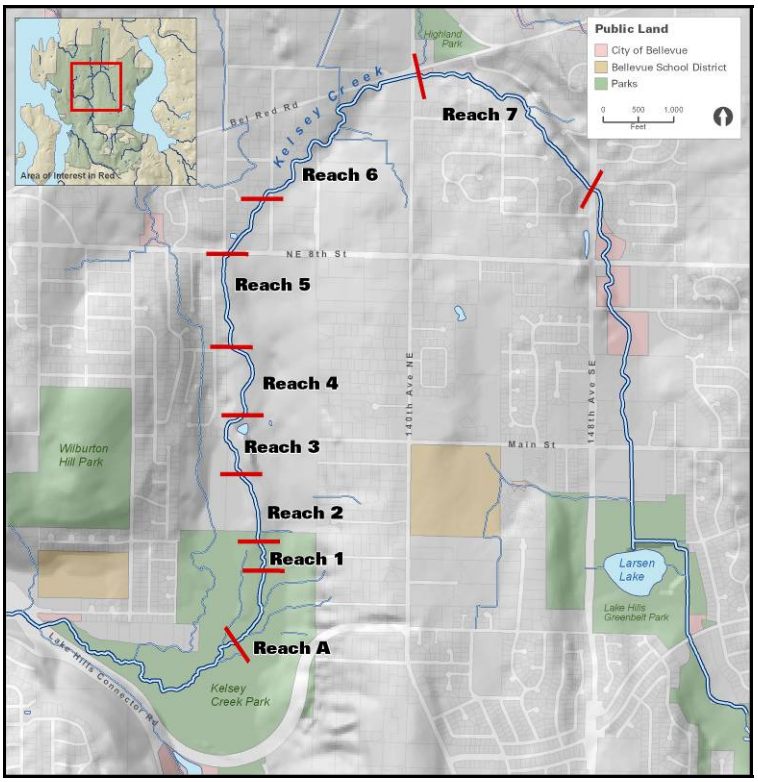


Figure 2. Survey reaches for Kelsey Creek mainstem.

Reach A begins near the southeast corner of the back pastures of Kelsey Farm (RM 3.0), and extends upstream to a wide bend in Kelsey Creek adjacent to the nearby trail, approximately halfway through the park property (RM 3.2). From this point, Reach 1 then extends up to the footbridge crossing Kelsey Creek near the northern park boundary (RM 3.4). Reach 2 continues from this footbridge upstream into the Glendale Golf Course to the third footbridge in the golf course (RM 3.6). Reach 3 then extends from the third footbridge upstream to the first concrete weir located by the golf course pumphouse on the east bank (RM 3.8). From the pumphouse, Reach 4 extends upstream past several concrete weirs to a high footbridge with large rock armoring the east bank (RM 4.0). Reach 5 then extends upstream to the culvert outfall under NE 8th Street at the north property line of the golf course (RM 4.3). Due to private property access issues, there is a two-block gap between Reaches 5 and 6. Reach 6 begins approximately 150 feet downstream of the 134th Avenue NE bridge at the property boundary fence (RM 4.4) and extends upstream to the confluence with Valley Creek, just upstream of 140th Avenue NE (RM 5.1). Due to property access issues in 2008, the survey in reach 6 was commenced at the 140th Avenue NE Bridge. Access was restricted on a small portion (approximately 400 feet) of Reach 6 that is located immediately upstream from 14th Avenue NE and borders private property (parcel number 2725059140). This small stretch of the creek was not surveyed. From the confluence with Valley Creek, Reach 7 extends upstream to the culvert outfall under 148th Avenue NE (RM 5.8).

4.2 West Tributary

The index area for the West Tributary (WRIA 8, Stream 0264) consists of four consecutive survey reaches, extending from the confluence with Kelsey Creek's mainstem (RM 0.0) upstream to the north end of the Glendale Golf Course (RM 0.9) (Figure 3). The 2008 West Tributary surveys began on September 4, and were conducted over a seventeen-week period ending on December 23.

Reach 1 of the West Tributary extends upstream from the Kelsey Creek confluence (RM 0.00) to the first footbridge at the south end of Kelsey Creek Park (RM 0.27). Reach 2 continues upstream to the second footbridge, adjacent to the playground in Kelsey Creek Park (RM 0.45). From the playground, Reach 3 extends around the oxbow and upstream to the park's north property line adjacent to the Glendale Golf Course (RM 0.65). Reach 4 extends from the property line upstream to the north end of the Glendale Golf Course (RM 0.92). These survey reaches have remained the same since 2003. During previous years (2001 and 2002), however, only Reaches 2 through 4 were surveyed (although they were labeled as Reaches 1-3). The survey conducted in 2000 extended from the south end of Kelsey Creek Park upstream to NE 8th Street.

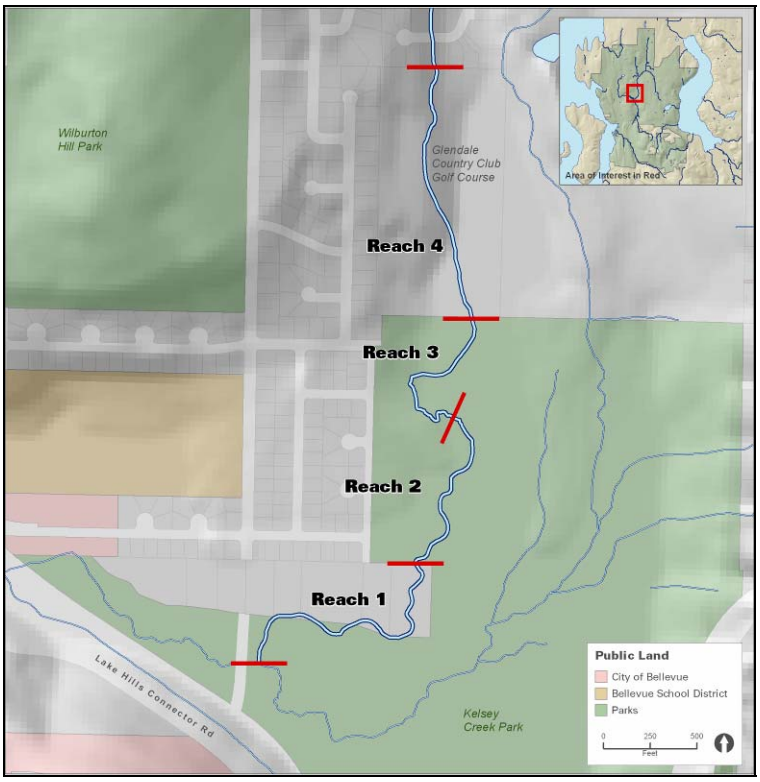


Figure 3. Survey reaches for the West Tributary.

4.3 Richards Creek

Spawner surveys in Richards Creek (WRIA 8, Stream 0261) were conducted bi-weekly (every other week) in 2008. Surveys during the 2006 and 2007 season did not extend past the

confluence reach due to a passage barrier in the Beaver Pond Reach area. However, the primary dam at the downstream end of the Beaver Pond Reach was removed prior to the 2008 spawning season and the removal of this barrier has improved salmon passage through this reach instigating the resumption of surveys in the better spawning habitats located in Reaches 1 thru 4. Surveys of the Richards Creek began on September 18 and extended over a 13-week period ending on December 10. Surveys were initiated in the Confluence Reach which extends along lower Richards Creek from the Kelsey Creek confluence upstream approximately 0.25 mile to the culvert below Richards Road. An initial assessment of the Beaver Pond Reach during the first survey indicated that it was impractical to include this reach in following surveys. Future surveys excluded the Beaver Pond Reach and resumed the survey at the beginning of Reach 1 located at the culvert in Bannerwood Park (RM 0.5). Reach 1 began at the Bannerwood Park culvert and extended upstream to the next culvert crossing (RM 0.9). Reach 2 then extends upstream to the confluence with East Creek. From the confluence with East Creek, Reach 3 extends upstream along East Creek to the culvert at Kamber Road. Reach 4 extends from Kamber Road to the confluence with Sunset Creek.

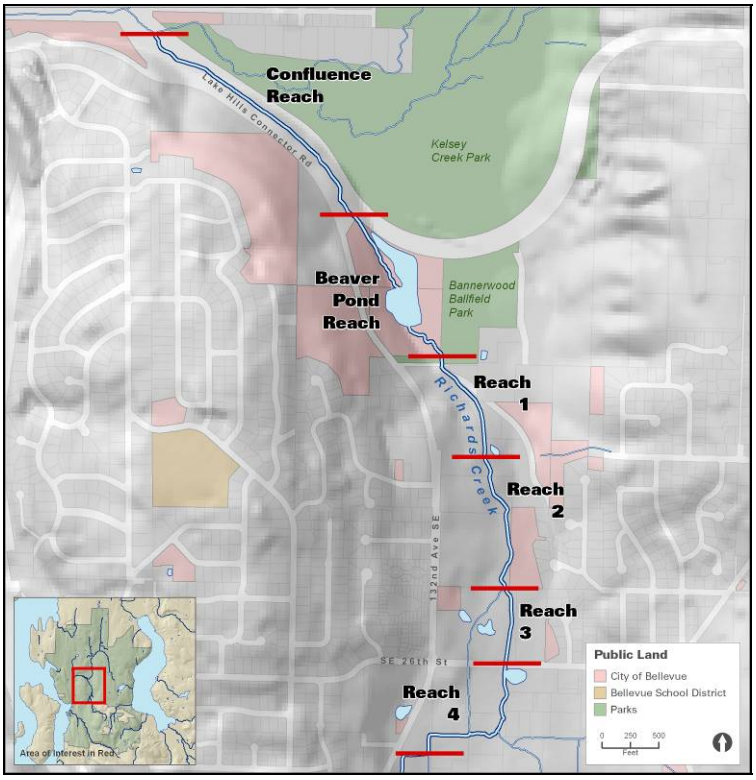


Figure 4. Survey reaches for Richards Creek.

4.4 Lower Kelsey Beaver Dam

Observations by City of Bellevue employees in early September of 2008 identified the construction of a new beaver dam on the mainstem of Kelsey Creek roughly 100 yards below the confluence of the West Tributary with Kelsey Creek, in an area dominate by thick patches of *Spiraea douglasii* (Figure 3). Early chinook returns to the Kelsey mainstem and West Tributary

suggested that salmon were able to pass any potential obstructions downstream. However, in early October, City of Bellevue staff discovered that the beaver dam was acting as a significant passage barrier. On October 10th, a survey was conducted and an initial estimate conservatively confirmed the presence of at least fifteen chinook carcasses in various stages of predation and decomposition around the barrier. It is likely that a significantly larger number of chinook were unable to pass this barrier, perished or migrated out of the system. From this date forward, West Tributary surveys included an assessment of this beaver dam to identify changes in fish passage, additional carcasses or stranded spawners.

4.5 Coal Creek

Recent restoration at the mouth of Coal Creek to improve salmon passage provided the impetus for renewed interest in salmon activity in Coal Creek. A 2006 survey (during the strong chinook run) did not result in any observations of salmon usage at that time (The Watershed Company 2006). However, surveys were not conducted later in the fall when coho would likely be using Coal Creek. Similarly, electrofishing work conducted in association with the instream silt ponds over the last five years has encountered a large amount of wild produced juvenile coho suggesting that adult coho may use Coal Creek as a spawning stream or that juvenile coho migrate into the system to rear. It is also possible that unmarked juvenile coho encountered during electrofishing where released in Coal Creek as part of the salmon in the classroom program. Spawner surveys were initiated in Coal Creek to investigate salmon spawning usage in the fall of 2008. A total of four surveys were conducted beginning at the culvert flowing under I-405 (RM 0.7) and extending upstream to where Coal Creek flows through the culvert at Coal Creek Parkway (RM 2.2; Figure 5). One survey was conducted in early October to correspond with the general timing of the chinook run in the Lake Washington basin and three surveys were conducted in December corresponding with the observed coho salmon run timing in Kelsey Creek. The initial coho survey in December included the mainstem of Coal Creek above Coal Creek Parkway up to the location of the first newly installed footbridge over Coal Creek.

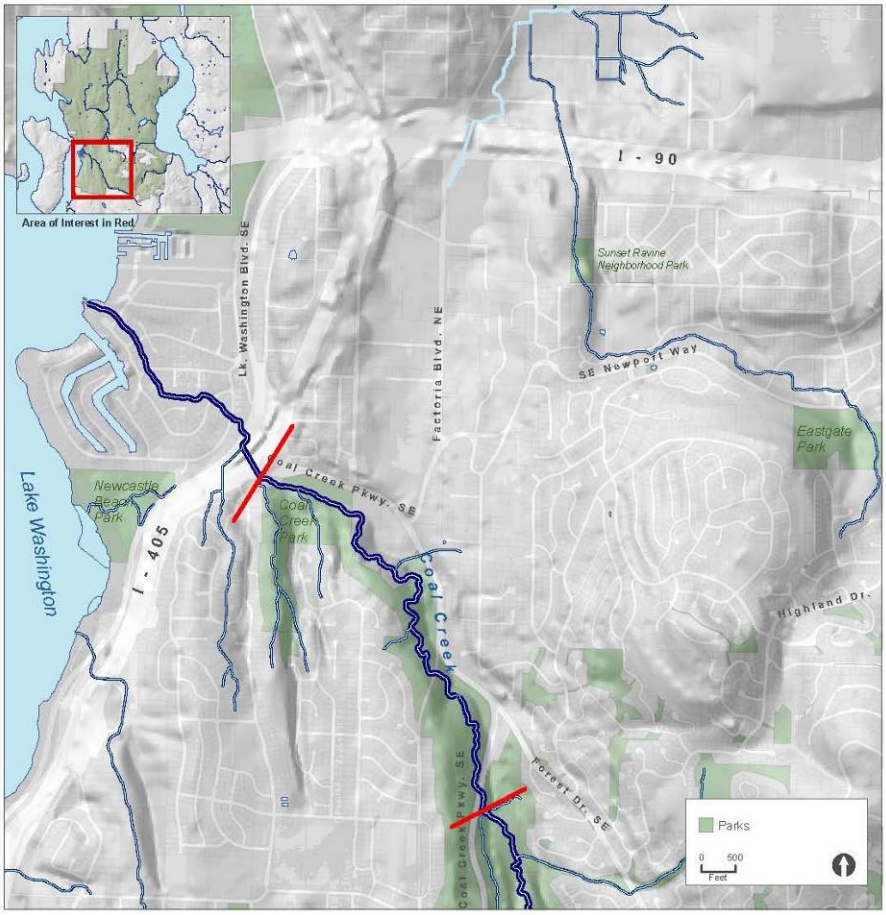


Figure 5. Coal Creek index reach used in 2006 and 2008.

5. RESULTS

The Kelsey Creek mainstem had a relatively weak chinook spawning escapement in 2008 (escapement ~20 fish). Similarly few chinook were observed in either the West Tributary or Richards Creek and the chinook run throughout the Lake Washington basin was relatively low (personal communications, Steve Foley, WDFW Mill Creek). Compared to the previous two spawning seasons, the size of the 2008 chinook run was quite depressed and the sockeye run produced only one carcass in the survey area, a significant reduction from previous years. However coho numbers continued to improve and were up slightly in 2008 compared to 2006 and 2007, but remain low from a historical perspective (Scott et al. 1986). City of Bellevue staff worked cooperatively with biologists from The Watershed Company to complete 17 weekly foot surveys of Kelsey Creek, 17 weekly surveys of the West Tributary, 7 surveys of Richards Creek, and 4 surveys of Coal Creek that extended throughout the 2008 spawning season (Tables 7, 8, and 11). The weekly survey effort began in the week of September 2, 2008 and extended to the week of December 23, 2008.

Length statistics in 2008 include measurements made on fish from all three streams in the Kelsey Creek system index area (Kelsey Creek, West Tributary, and Richards Creek) and the

Coal Creek index area. The majority of carcasses encountered during surveys in 2008 were chinook salmon. Only one sockeye, one coho and two cutthroat trout carcasses recovered were measurable (Table 1). Mean fork length for male chinook returning to the overall index area was 81.7 centimeters (46.0 min., 104.0 max.), total length averaged 84.8 centimeters (47.0 min., 108.0max.), and POH averaged 64.9 centimeters (38.0 min., 86.0 max.; Figure 6). Length measurements for male chinook were based on a sample size of 12 measurable carcasses. Mean fork length for female chinook in the overall index area was 84.2 centimeters (77.5 min., 92.5 max.), total length averaged 86.9 centimeters (82.0 min., 97.0 max.), and POH averaged 67.7 centimeters (62.0 min., 73.0 max.). Length measurements for female chinook were based on a sample size of 15 measurable carcasses. The average body size of chinook salmon carcasses recovered during 2008 in the Kelsey Creek system were not significantly different from chinook carcasses recovered during the past two survey seasons (Table 2, Figure 7).

No measurable sockeye salmon were observed in 2008 and only one predated male carcass was found in the entire Kelsey Creek system.

Coho observations were up from the previous four years, but remain relatively low compared to historic levels. It is possible that some of the increase in coho numbers during a year of declines for other salmon species is related to the egg incubation project initiated in Kelsey and Valley Creeks three years ago. Despite the increased observation of spawning coho in the Kelsey Creek system, only one coho carcasses was observed (Richards Creek). However we were unable to measure the carcass. Anecdotally, the body size of observed spawning coho appeared to be smaller than typical coho spawners in the system, which may have contributed to our inability to find coho carcasses. The one measurable male coho carcass encountered in Coal Creek was moderately sized with a total length of 66.0 cm, fork length of 63.5 cm and a POH of 49.0 cm.

Table 1. Length statistics for salmonid carcasses collected during 2008 spawner surveys.

2008 Length Statistics	*n*	Mean	Minimum	Maximum	95% CI
Chinook (Kelsey Creek)					
Total Length (TL, cm)	27	86.0	47.0	108.0	6.2
Fork Length (FL, cm)	27	83.1	46.0	104.0	6.0
Post Orbital Length (POH, cm)	27	66.4	38.0	86.0	4.7
Body Depth (cm)	27	16.9	7.6	21.0	1.4
Coho (Coal Creek)					
Total Length (TL, cm)	1	66.0			
Fork Length (FL, cm)	1	63.5			
Post Orbital Length (POH, cm)	1	49.0			
Body Depth (cm)	1	15.0			
Cutthroat trout (Kelsey Creek)					
Total Length (TL, cm)	1	24.0			
Fork Length (FL, cm)	1	23.0			
Post Orbital Length (POH, cm)	1	19.0			
Body Depth (cm)	1	4.5			
Cutthroat trout (Coal Creek)					
Total Length (TL, cm)	1	53.0			
Fork Length (FL, cm)	1	52.0			
Post Orbital Length (POH, cm)	1	42.0			
Body Depth (cm)	1	11.0			

Table 2. Body length (cm) comparison of chinook carcasses from the Kelsey Creek system index area recorded in 2006 – 2008.

Kelsey Chinook Length Statistics	*n*	Total Length (cm)	95% CI	Fork Length (cm)	95% CI	POH (cm)	95% CI
2006 Chinook				(cm)			
Female	**102**	**85.7**	**1.5**	**83.7**	**1.5**	**68.9**	**1.2**
Male	**111**	**83.3**	**2.8**	**80.9**	**2.7**	**64.1**	**2**
2007 Chinook							
Female	**67**	**83.7**	**2.2**	**81.5**	**2.1**	**68.1**	**1.8**
Male	**67**	**82.1**	**2.2**	**79.9**	**2.1**	**63.3**	**1.6**
2007 Chinook							
Female	**15**	**86.9**	**2.3**	**84.2**	**2.4**	**67.7**	**1.8**
Male	**12**	**84.8**	**2.2**	**81.7**	**14.3**	**64.9**	**11.4**

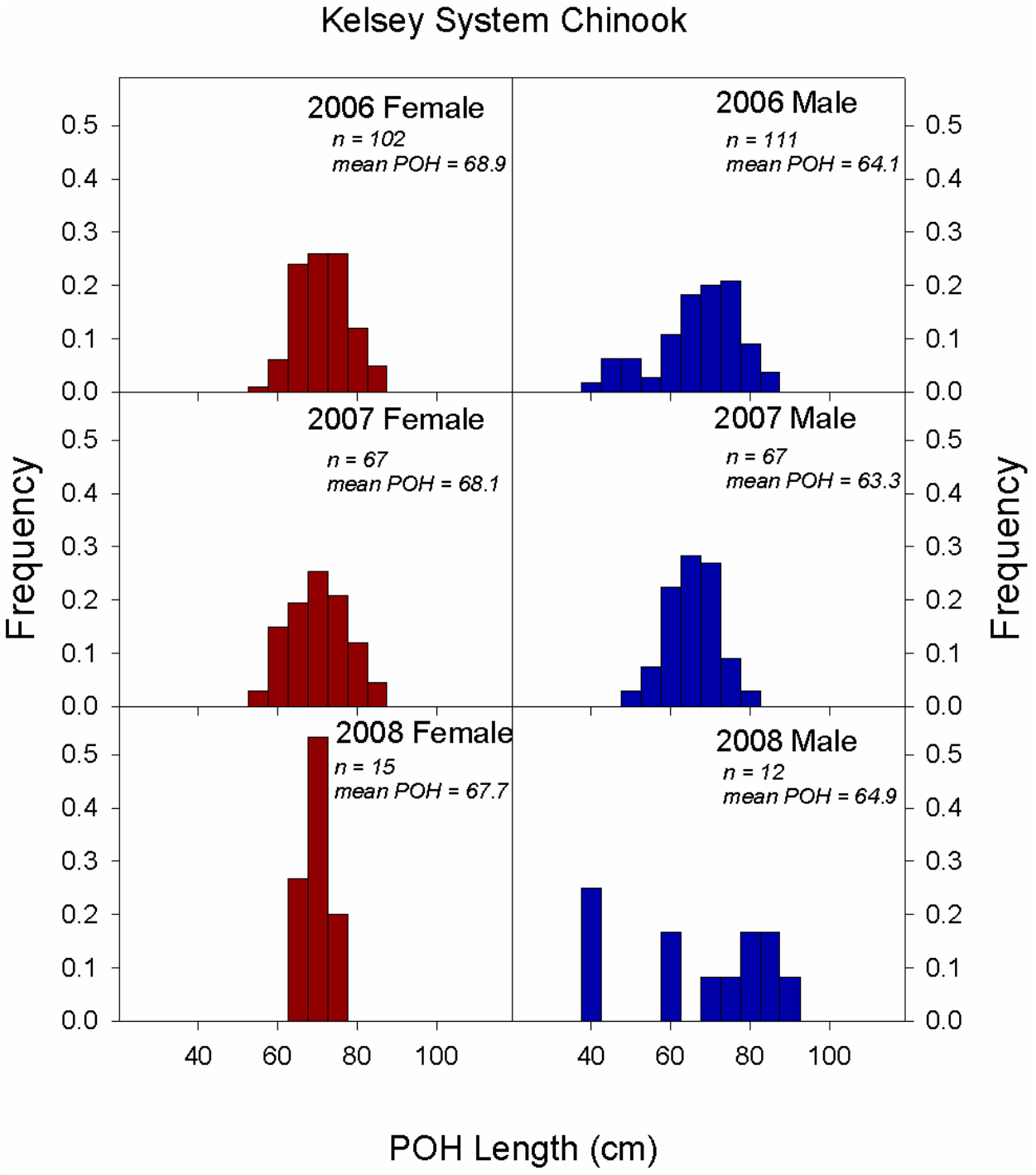


Figure 6. POH length frequency distribution for male and female chinook salmon carcasses from the Kelsey Creek system index area in 2006-2008.

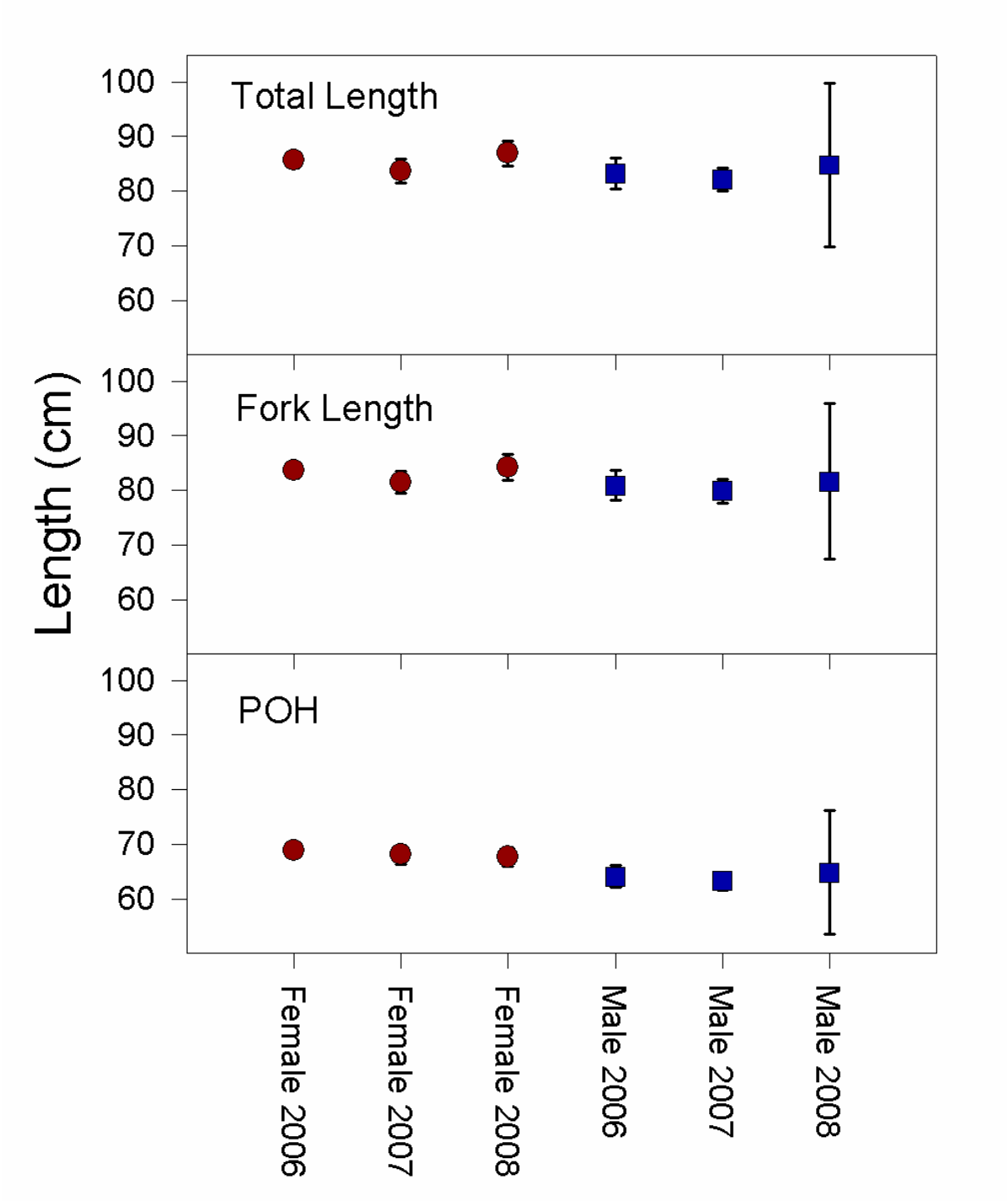


Figure 7. Length measurements (cm) of male and female chinook carcasses from the Kelsey Creek system recovered between 2006 and 2008.

5.1 Kelsey Creek

Compared with the previous two years, very few chinook spawned in the Kelsey Creek mainstem in 2008 with a nearly undetectable sockeye run. Slightly more coho salmon were

observed in 2008 than in 2006 or 2007, but coho spawner numbers remain low in Kelsey Creek (Table 3). Table 4, organized by species and reach, briefly summarizes the counts of live adults, carcasses and redds observed over the course of the 2008 spawning season.

Table 3. Salmon redd-based escapement estimate and the observed peak counts for the Kelsey Creek mainstem survey reaches from 2000-2008.

	Chinook Escapement		Coho Escapement		Sockeye Escapement	
Year	Redd-Based	Peak Count	Redd-Based	Peak Count	Redd-Based	Peak Count
2000	25	4	40	7	113	42
2001	10	4	5	4	38	15
2002	10	5	0	0	38	9
2003	0	0	15	5	0	1
2004	0	0	0	0	5	3
2005	10	3	0	0	5	2
2006	180	43	3	1	488	124
2007	193	73	25	1	20	15
2008	20	7	25	3	0	0

Table 4. A summary of total returns for Kelsey Creek in 2008.

Kelsey	Chinook			Coho			Sockeye		
Reach	Spawner	Carcass	Redd	Spawner	Carcass	Redd	Spawner	Carcass	Redd
A	11	2	5	0	0	0	0	1	0
1	0	0	0	0	0	0	0	0	0
2	2	0	0	0	0	1	0	0	0
3	1	0	0	1	0	1	0	0	0
4	1	1	1	3	0	2	0	0	0
5	1	0	0	0	0	0	0	0	0
6	3	2	2	3	0	5	0	0	0
7	0	1	0	0	0	1	0	0	0
Total	**19**	**6**	**8**	**7**	**0**	**10**	**0**	**1**	**0**

Chinook Salmon

Nineteen (19) live chinook salmon and six (6) chinook carcasses were observed in the Kelsey Creek mainstem during the 2008 spawner surveys (Table 4, Figure 8). A total of 8 chinook redds were constructed within the survey area, and spawning was observed in six of the eight survey reaches (Figure 8). Chinook escapement to the Kelsey Creek mainstem index area in 2008 (Table 5, Figure 9) is estimated at 20 fish (redd-based) or 13 fish (Live Count AUC). The peak count of spawning chinook was recorded at seven fish on September 29 (Figure 10), a week sooner than the peak observation during 2007 and two weeks prior to peak observations during the 2006 survey. Peak counts of chinook salmon in the Kelsey Creek mainstem declined from those observed during the previous three years to a level more common during 2000-2002 (Figure 10).

Table 5. Chinook spawning escapement estimates for the Kelsey Creek mainstem.

			Chinook Escapement		
Year	Carcasses	Redds	Live Count AUC	Redd-Based	Peak Count
2006	193	72	107	180	43
2007	159	77	149	193	73
2008	7	8	13	20	7

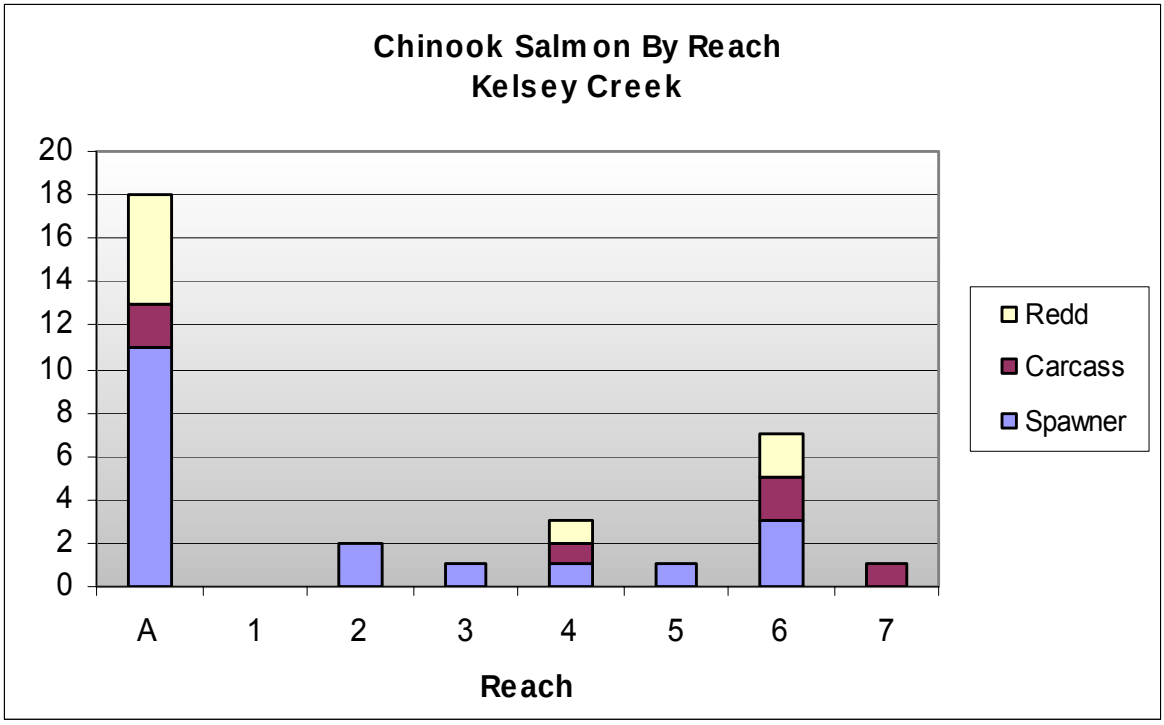


Figure 8. Chinook salmon spawner, carcass, and redd counts from each reach of Kelsey Creek during the 2008 spawner surveys.

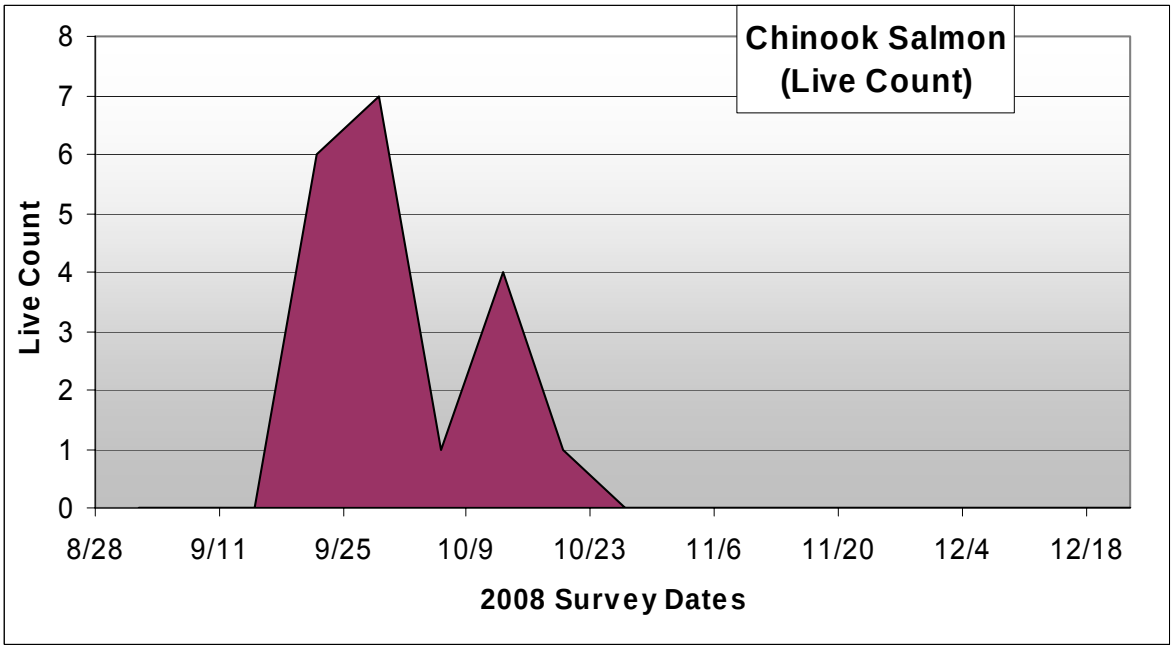


Figure 9. Live count for chinook salmon in the Kelsey Creek mainstem in 2008.

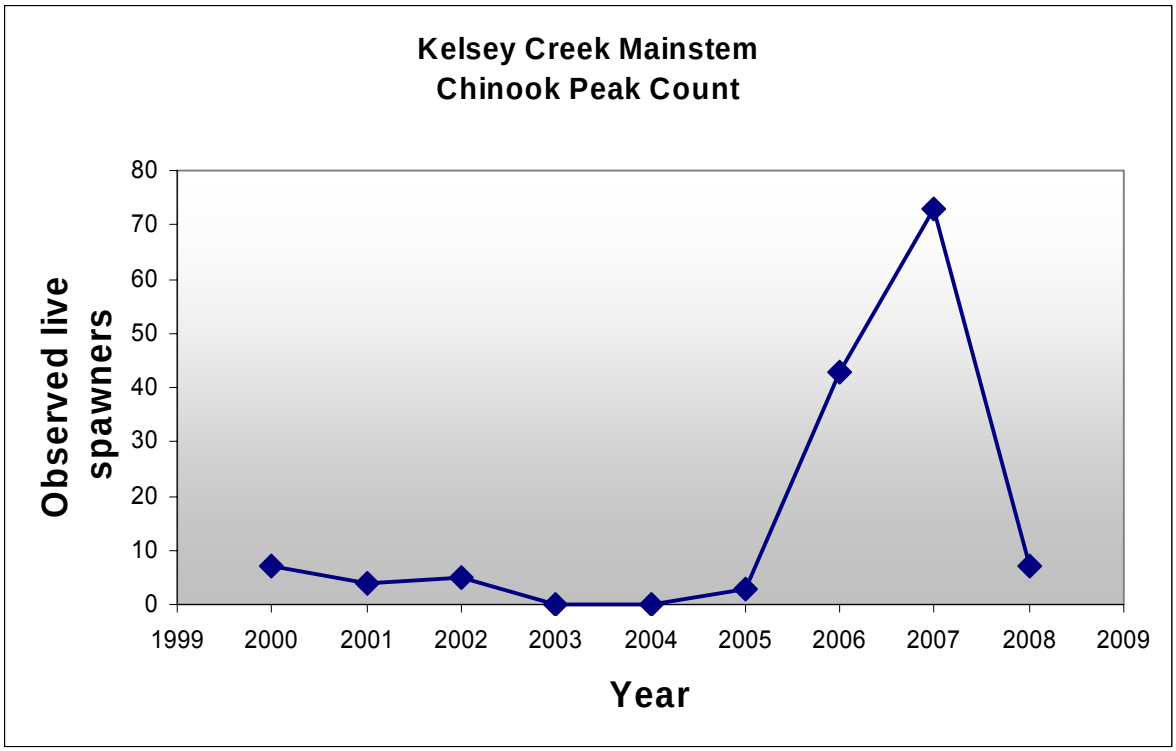


Figure 10. Peak count of chinook salmon escapement to the Kelsey Creek mainstem survey reaches from 2000-2008 (Note: the survey area was expanded in 2003 to account for new spawning gravel recruitment in the lower survey area).

Based on the presence or absence of adipose fins on carcasses in the Kelsey Creek index area, 4 (57%) of the Kelsey Creek chinook (carcasses) were hatchery-origin fish (clipped), 2 (29%) were wild (unclipped), and the remaining 1 (14%) was unknown (Table 6). Five of the seven Kelsey Creek chinook carcasses in 2008 were female (71 %) with one male (14%) and one unidentified (14%). Chinook salmon were first observed in the Kelsey Creek mainstem on September 22, live adults were last observed on the spawning grounds during the week of October 20, and carcasses were last recovered during the survey on November 17 (a duration of approximately 9 weeks, Table 7). Although the 2008 chinook run occurred within the same time frame as the previous six years of runs, the peak of the run was earlier and less protracted (Figure 11). However, the abnormally long period of dry weather during September and October of 2008 contributed to an increase in passage barriers and likely influenced the run timing and abundance of chinook. The majority of chinook spawning activity in Kelsey Creek occurred in Reach A, downstream of the beaver dam that acted as a passage barrier during low flow conditions. Similarly, the beaver dam on Kelsey Creek located below the confluence with the west tributary was a significant passage barrier under the low flow conditions prevalent in 2008 and resulted in a known direct mortality of 22 adult chinook salmon. More chinook salmon died as a result of passage barriers in 2008 than were observed alive in Kelsey Creek.

Table 6. Origin and gender of chinook salmon (carcasses) in the Kelsey mainstem.

		Gender			Origin		
Year	***n***	Female	Male	Unid.	Marked	Unmarked	Unid.
2000	15	47%	53%	0%	---	---	---
2001	8	63%	38%	0%	---	---	---
2002	11	45%	55%	0%	---	---	---
2003	1	100%	0%	0%	---	---	---
2004	0	---	---	---	---	---	---
2005	32	53%	31%	16%	50%	19%	31%
2006	193	42%	54%	3%	83%	8%	8%
2007	148	47%	49%	4%	77%	14%	9%
2008	7	71%	14%	14%	57%	29%	14%

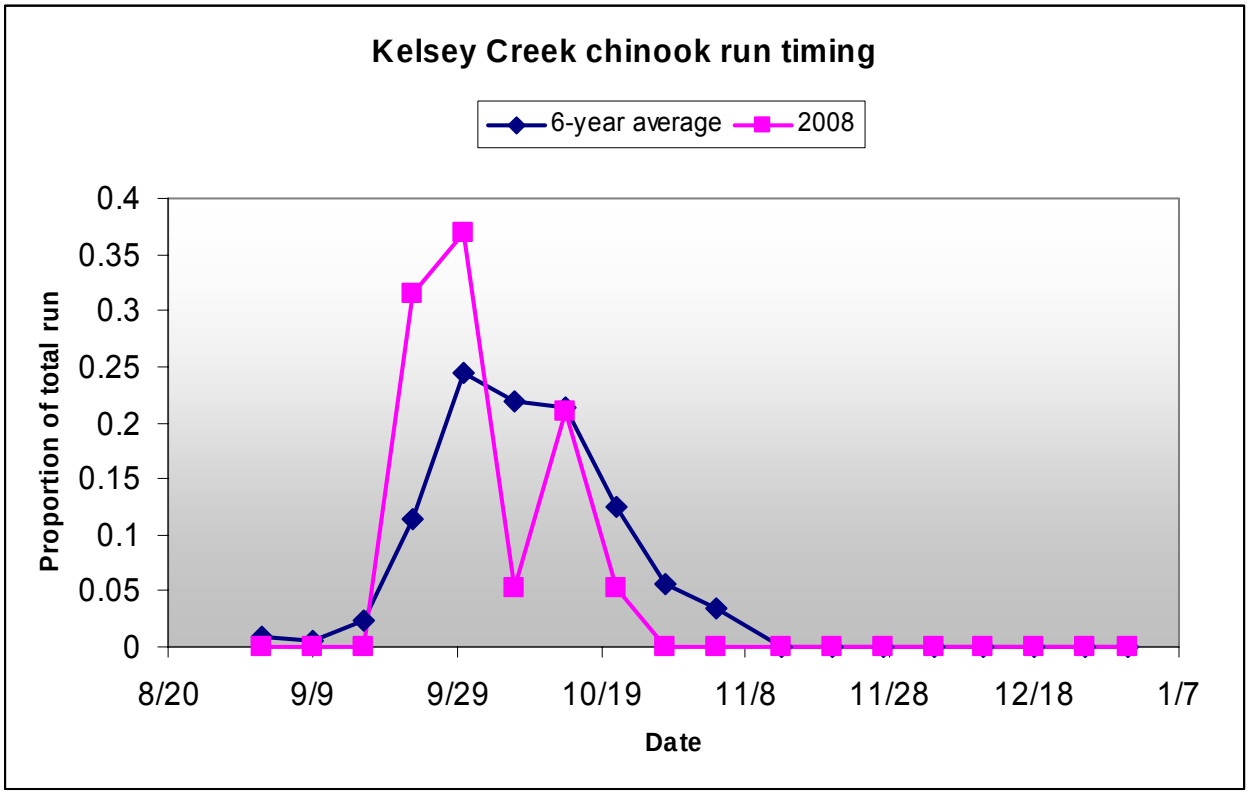


Figure 11. The proportional chinook run timing for Kelsey Creek during the 2008 survey year and the six year average.

Table 7. Annual duration of the Kelsey Creek spawner survey (2000 to 2008) denoting spawner, carcass, and redd observations by survey week.

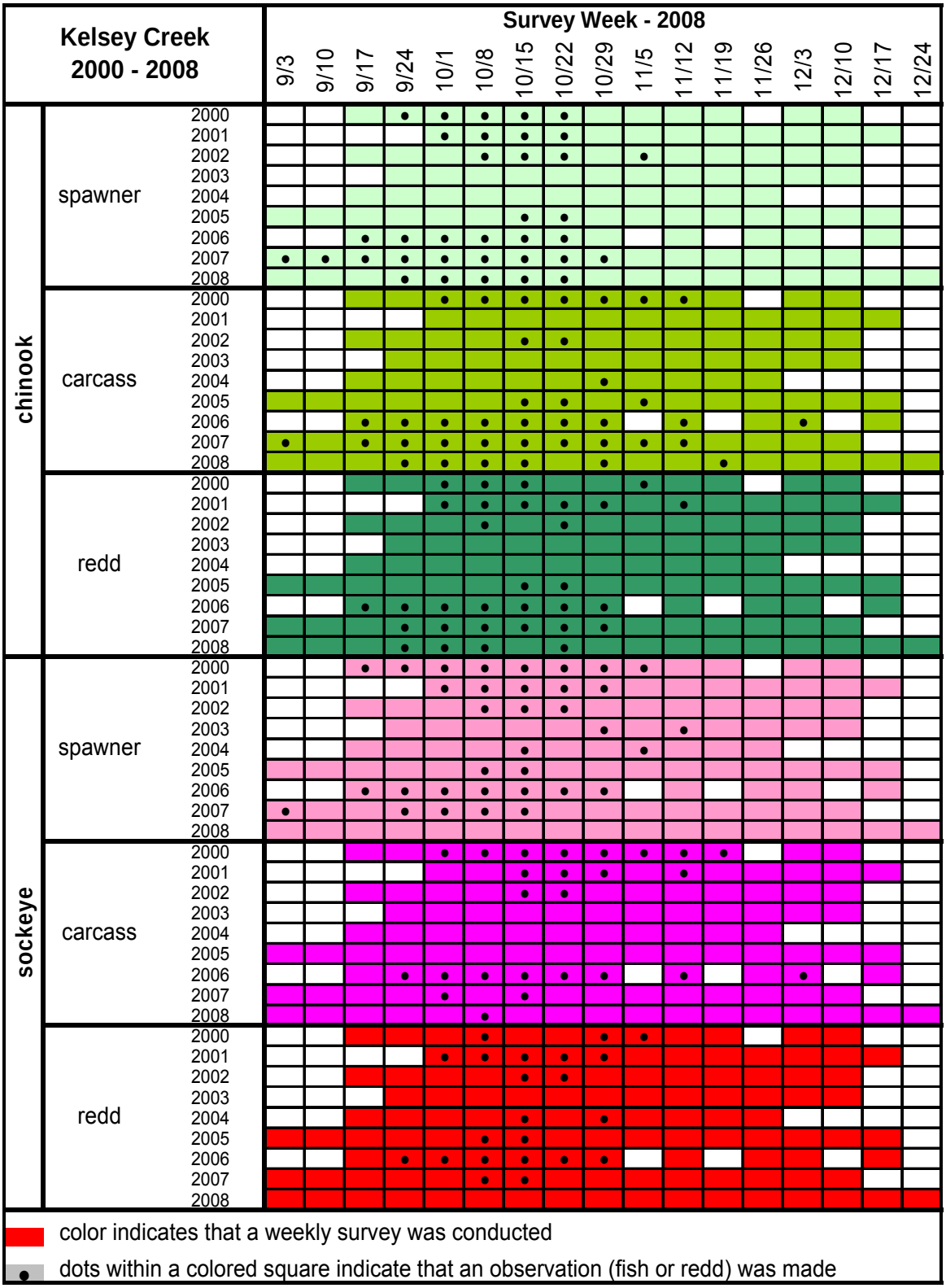
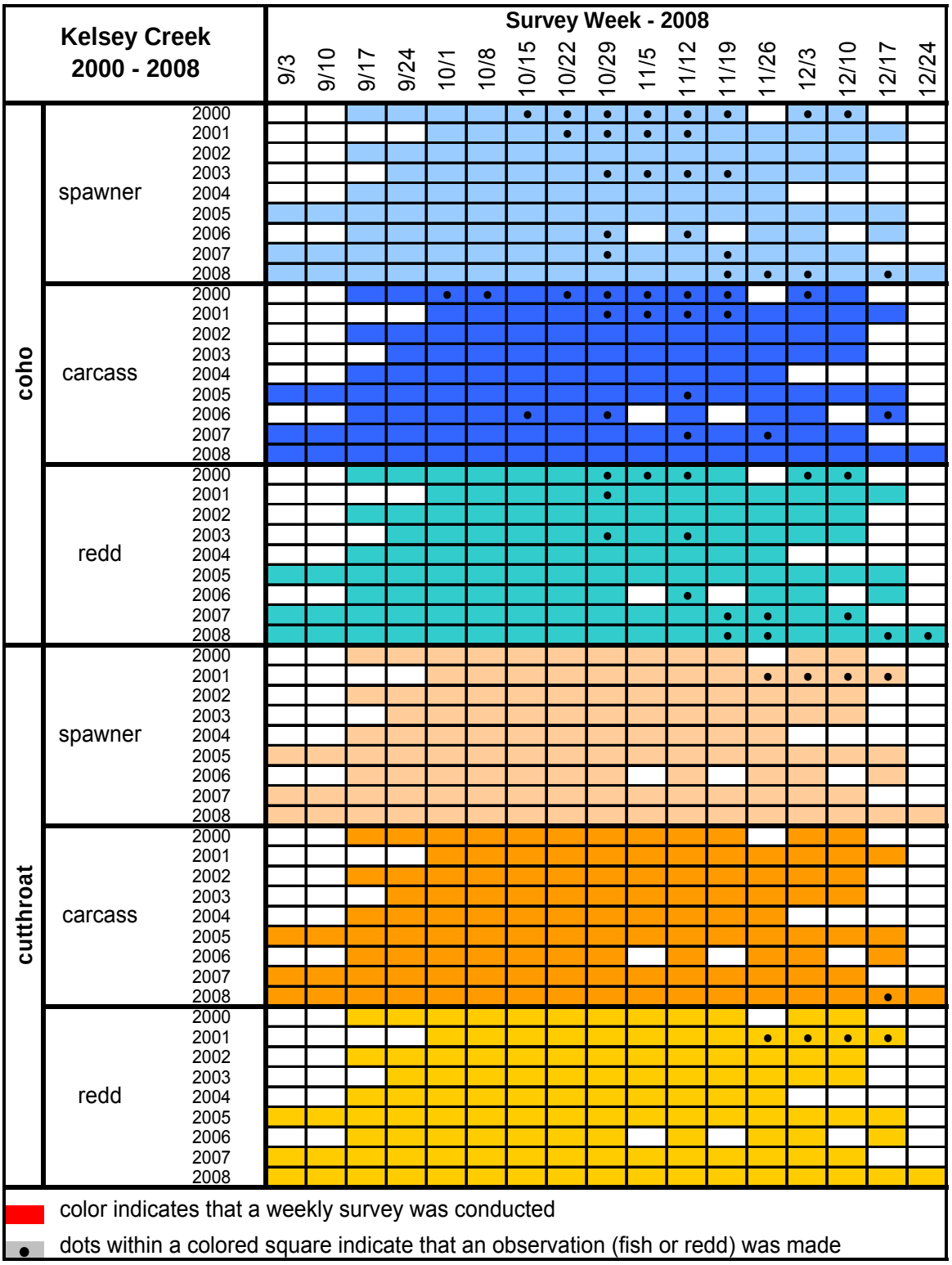


Table 7. Continued.



Sockeye Salmon

Only one partial sockeye carcass was observed in Kelsey Creek in 2008 (Figure 12). The sockeye salmon run throughout the Lake Washington basin was significantly depressed compared to previous years. An estimated 33,629 sockeye passing the Ballard Locks in 2008, far below the pre-season forecast of 105,000 estimated from the 2003 & 2004 fry production estimates (http://wdfw.wa.gov/fish/sockeye/counts.htm).

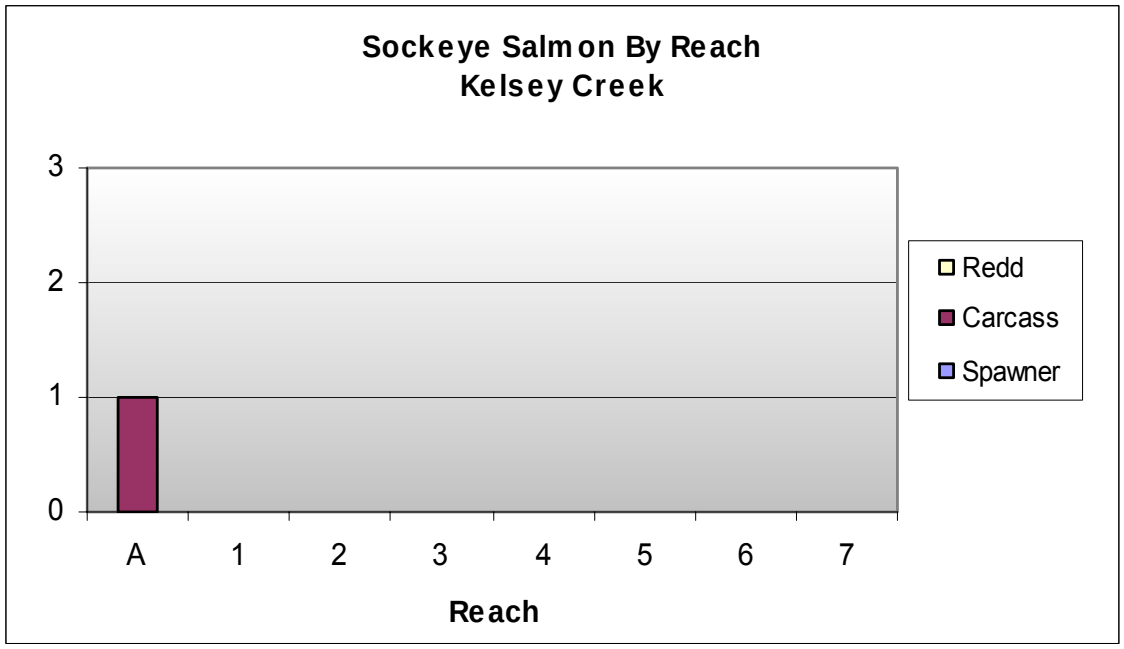


Figure 12. Sockeye salmon spawners, carcasses, and redds observed in Kelsey Creek during the 2008 spawner surveys.

Coho Salmon

Seven live coho spawners and ten coho redds were observed in the 2008 Kelsey Creek spawner surveys (Table 4, Figure 13). The two Coho escapement estimates to the Kelsey Creek system index area are 5 fish for the AUC estimate and 30 fish using the redd-based approach. The general increase in Kelsey Creek coho, despite declines in other salmon species, suggests that the egg box supplementation pond located in the upper

reaches of Kelsey Creek may be making a positive contribution to coho returns.

No coho carcasses were recovered to determine sex or hatchery vs. wild origin. Coho salmon were first observed in Kelsey Creek on November 17, and live adults were last observed on the spawning grounds on December 15 (a duration of approximately 5 weeks, Table 7). A coho redd was observed during the final survey on Kelsey Creek on December 23rd.

The long dry period from September lasting through the first week in November and resuming the following week until early December resulted in an increase in salmon passage barriers. The drought induced passage constraints likely delayed and reduced the coho run in Kelsey Creek during 2008. However, the same low water conditions that inhibited salmon access also contributed to excellent survey and viewing conditions and likely decreased the possibility of observation error during the surveys. Despite the relatively poor flow conditions during much of the coho run the majority of spawning activity was observed in the upper reaches of Kelsey Creek where spawning conditions are thought to be more advantageous for egg and fry survival.

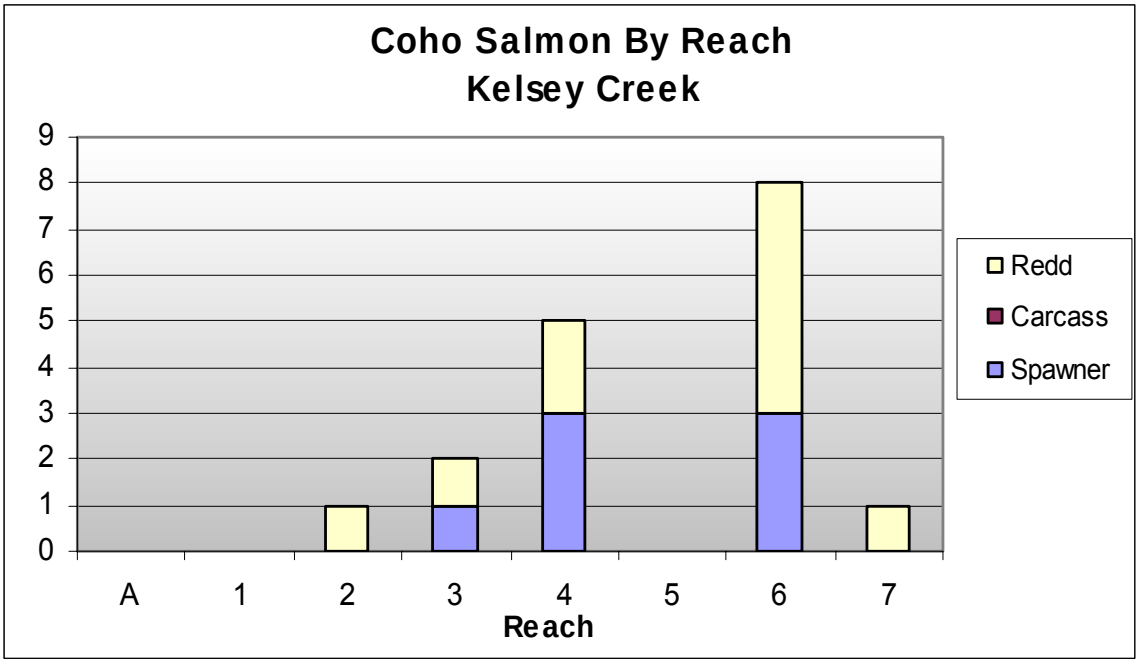


Figure 13. Coho salmon spawners, carcasses, and redds observed in Kelsey Creek during the 2008 spawner surveys.

Cutthroat Trout

A sexually mature male cutthroat trout carcass was observed in Kelsey Creek during the 2008 surveys. The male cutthroat trout carcass was found in Reach 4 on December 15th with fully developed gonads, expired prior to spawning. The cutthroat had a fork length of 23 centimeters and POH length of 19 centimeters. No additional observations of cutthroat staging to spawn or redd activity were encountered in 2008. Cutthroat trout in the Lake Washington Basin

predominantly spawn in February and March (Beauchamp et al. 1992) with mature cutthroat staging in natal streams beginning in January. Mature adfluvial cutthroat trout were also observed during the 2001 surveys in Kelsey Creek (Table 7), however this should be viewed as a rare event based on our current understanding of the movement and life history characteristics of adfluvial cutthroat trout in Lake Washington (Nowak 2000).

Spawning Trend Data

The extended period of low flows resulted in Reach A receiving the heaviest chinook spawning activity in 2008, followed by Reaches 4 and 6 (Figure 14). No chinook redds were observed in Reaches 1, 2, 3, or 7 in 2008. The spatial distribution of 2008 spawning activity in the Kelsey Creek mainstem is depicted in reach-specific aerial photos in Appendix A, and run timing is summarized in Table 7 and Figure 11.

Last year (2007) Reach 7 was heavily utilized by chinook for spawning, while lower reaches, such as Reach A, received little spawning activity (Figure 14, Appendix A). In contrast, Reach A received the most spawning activity in 2008, with no redds observed in Reach 7. The likely reason for annual differences in redd positioning in Kelsey appears to be related to flow conditions and spawner access. Similar to 2006, when low stream flows during the chinook spawning period prompted more fish to build redds lower in the system, while relatively higher stream flows (there were a number of rain events in the fall of 2007 when the chinook were migrating) provided chinook easier access to upper reaches of the Creek in 2007.

The past three years (2005, 2006, 2007) demonstrate that chinook appear to prefer Reaches 4, 5, and 6 for spawning when access is possible. Few redds are ever observed in Reaches 1, 2, or 3 and this is likely due to the limited amount of vegetative cover in reaches 2 and 3, and a general lack of suitable water velocities and pool habitat in Reach 1. A general decline or replacement of native vegetative cover adjacent to Kelsey Creek appears to be the continuing trend in the watershed over the time period of these surveys. Similarly, the concrete grade control weirs that are dispersed throughout this area of Kelsey Creek may affect spawning distribution in Reaches 4 and 5. One of the taller weirs in (lower) Reach 5 appeared to partially block upstream access for some chinook in 2006 and 2007, resulting in a relatively heavy concentration of redds built immediately downstream from the problem weir. However, this was not the case in 2008 primarily due to the limited number of chinook that were able to access Kelsey Creek above the beaver dam in Reach A. Without the partial barrier created by this beaver dam, more fish may have continued upstream and built redds in various reaches higher in the system. Prior to 2006, many chinook migrated up the West Tributary (presumably due to passage barriers in the lower mainstem of Kelsey Creek), and few redds were observed in the mainstem. With the construction of a new beaver dam along lower Kelsey Creek (downstream of the confluence with the West Tributary), this partial migration barrier will likely reduce chinook activity to both Creeks during dry falls in the future. Although Reaches 4, 5, and 6 were often used for spawning prior to 2006, a clear pattern of redd distribution is difficult to discern due to the relatively low overall redd counts characteristic of the Kelsey Creek system (Figure 14).

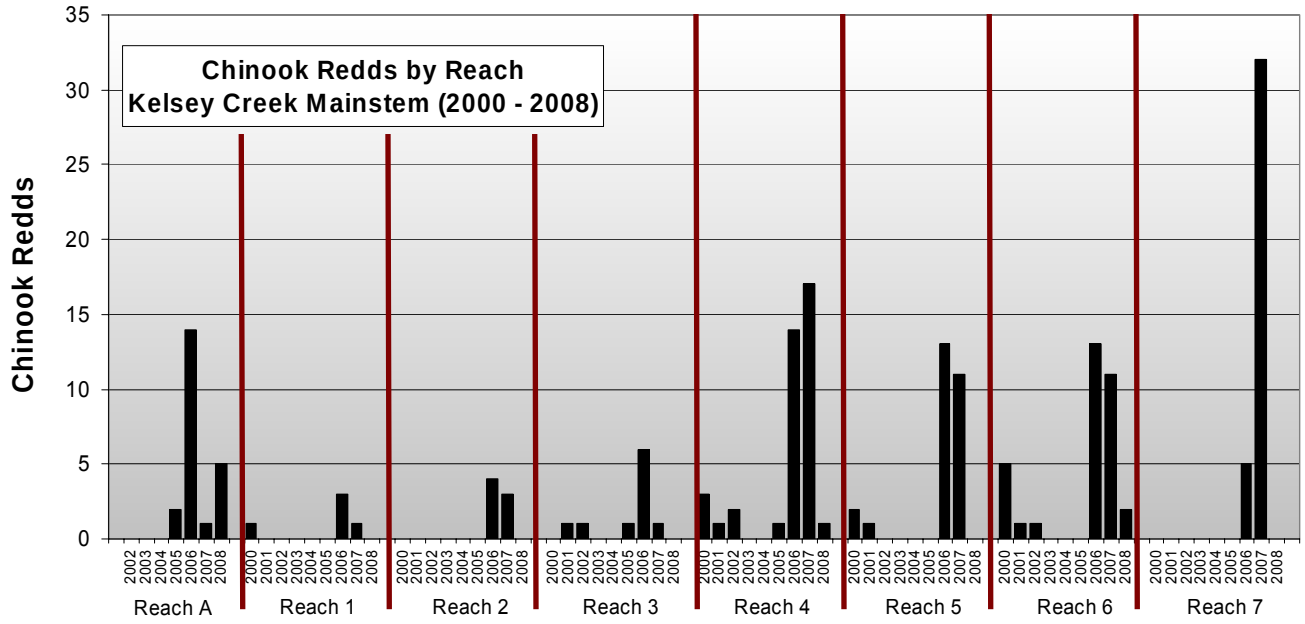


Figure 14. Chinook redds per reach in Kelsey Creek, 2000 to 2008.

Over the last nine years, salmon abundance and species composition in Kelsey Creek has demonstrated wide annual fluctuations (Figure 15). While some of the variability in salmon abundances observed in the Kelsey Creek system appears to result from internal physical changes, the vast majority likely results from external fluctuations in Lake Washington salmon population dynamics. However, relative increases over the last three years in salmon escapement to the Kelsey Creek system illustrate that when salmon are available in the broader Lake Washington basin, an increasing proportion are using Kelsey Creek for spawning.

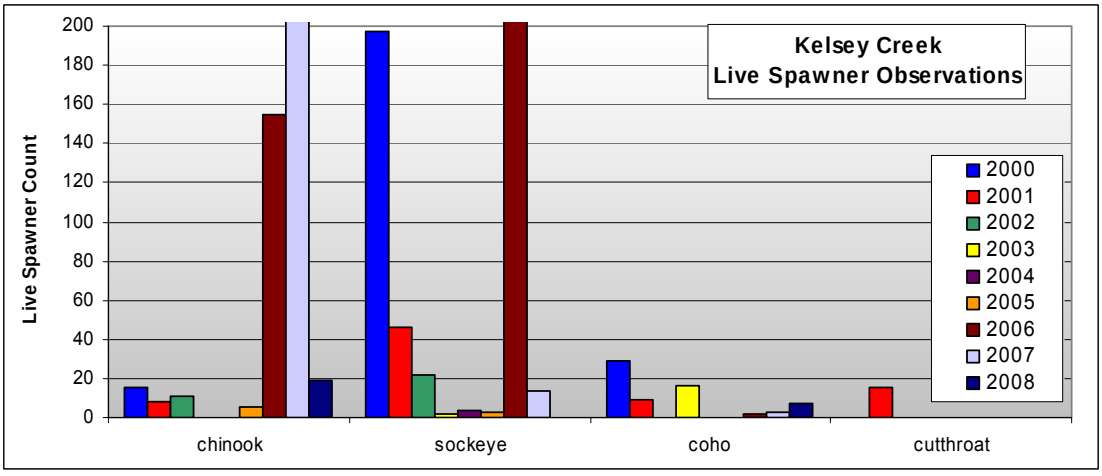


Figure 15. Total number of live spawner observations per species per year in Kelsey Creek from the year 2000 to 2008. The live sockeye count in 2006 totaled 388 and the chinook count in 2007 was 220.

5.2 West Tributary

Despite the general decrease in fish observation in the Kelsey Creek system in 2008, proportionally more fish were observed in the West Tributary this year than during the past two years (Table 8). Four live chinook and one coho were observed in the Reaches 3 and 4, and sixteen total chinook carcasses were observed throughout the survey reaches. However, no chinook redds were constructed in the survey area and some of the chinook using this stream likely migrated upstream beyond the index reaches to spawn. Two coho redds were constructed in Reach 4 in mid-December. Similar to the other surveyed streams, no sockeye were observed. There was no evidence of any major fish passage issues in the West Tributary in 2008. However, the new beaver dam below the confluence with the Kelsey Creek mainstem likely influenced the chinook escapement to the West Tributary as well. Completion of the restoration efforts in Reaches 2 and 3 and the installation of the in-stream sediment pond likely increased the public opportunity to observe salmon and may have contributed to the relative increase in salmon observations during surveys in 2008. Multiple park users commented regarding observations of salmon either passing through the newly constructed channel or staging in the sediment pond above the last bridge in the park. The availability of a deep water pond suitable for holding salmon in the West Tributary appears to have allowed fish to remain in the system more readily during the day and should result in future increases in public salmon observation opportunities.

Table 8. Total returns for the West Tributary in 2008.

W Trib	Chinook			Coho			Sockeye		
Reach	Spawner	Carcass	Redd	Spawner	Carcass	Redd	Spawner	Carcass	Redd
1	0	4	0	0	0	0	0	0	0
2	0	1	0	0	0	0	0	0	0
3	3	3	0	1	0	0	0	0	0
4	1	8	0	0	0	2	0	0	0
Total	**4**	**16**	**0**	**1**	**0**	**2**	**0**	**0**	**0**

Chinook Salmon

Four live chinook salmon and sixteen carcasses were observed in the West Tributary during the 2008 spawner surveys (Table 8, Figure 16). Two redds were observed in Reach 4. Based on the presence or absence of adipose fins, twelve (~75%) of the sixteen West Tributary chinook (carcasses) were hatchery origin fish (clipped), three (~19%) were wild (unclipped), and one unknown (6%; too badly decomposed to determine). Eight of the sixteen West Tributary chinook carcasses were male, and eight were female (Table 9). Chinook body length data was combined with measurements from Kelsey Creek and Richards Creek carcasses. Average length statistics are presented in Figures 5 and 6 above. The first chinook carcass was observed in the West Tributary on September 23rd and carcasses and live spawners were observed in the

survey area until the week of November 3rd, a time frame of approximately 7 weeks (Table 10). Some carcasses may have washed into the upper survey area from upstream locations.

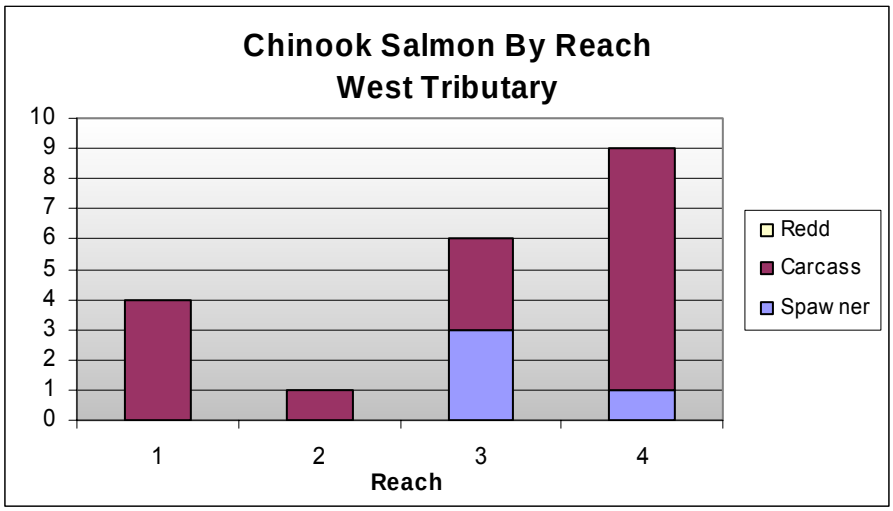


Figure 16. Chinook salmon carcasses, live spawners, and redds observed in the four reaches of West Tributary during the 2008 spawning season.

Sockeye Salmon

No sockeye salmon or sockeye redds were observed in the West Tributary survey area in 2008. This marks the second straight year that no sockeye have been observed in the West Tributary. A significant return of sockeye were last observed in the West Tributary during the 2006 spawning season, when 19 live spawners, 33 carcasses, and 8 redds were recorded.

Coho Salmon

One live coho spawner and two coho redds was observed during the 2008 West Tributary surveys, a decline from the previous year (Table 10, Figure 17). The single coho salmon and two redds observed in the West Tributary were both observed during the week of December 15 (Table 10).

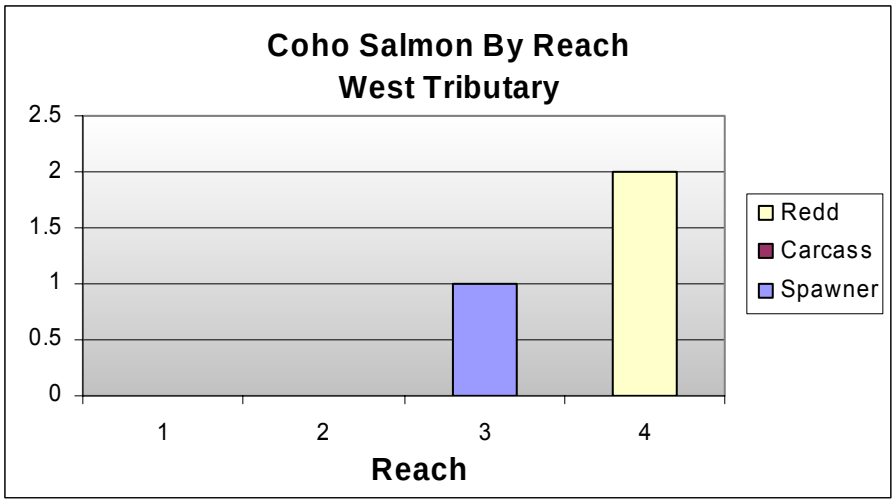


Figure 17. Coho salmon carcasses, live spawners, and redds observed in the four reaches of West Tributary during the 2008 spawning season.

Cutthroat Trout

No presumably mature cutthroat trout were observed in the West Tributary in 2008.

Table 9. Relative abundance of male and female returning salmonids observed in the West Tributary (2003-2008). Total observed only includes those fish for which a positive gender determination was possible. Survey data for the West Tributary is incomplete prior to 2003.

Species	Year	Total Obs.	Male	Female
Chinook	2003	6	33%	67%
	2004	81	30%	70%
	2005	40	43%	58%
	2006	59	49%	51%
	2007	7	33%	67%
	2008	16	50%	50%
Sockeye	2003	0	NA	NA
	2004	10	30%	70%
	2005	0	NA	NA
	2006	37	35%	65%
	2007	0	NA	NA
	2008	0	NA	NA
Coho	2003	2	50%	50%
	2004	0	NA	NA
	2005	2	0%	100%
	2006	1	0%	100%
	2007	3	33%	67%
	2008	0	NA	NA

Table 10. Annual duration of the West Tributary spawner survey (2000 to 2008) denoting spawner, carcass, and redd observations by date.

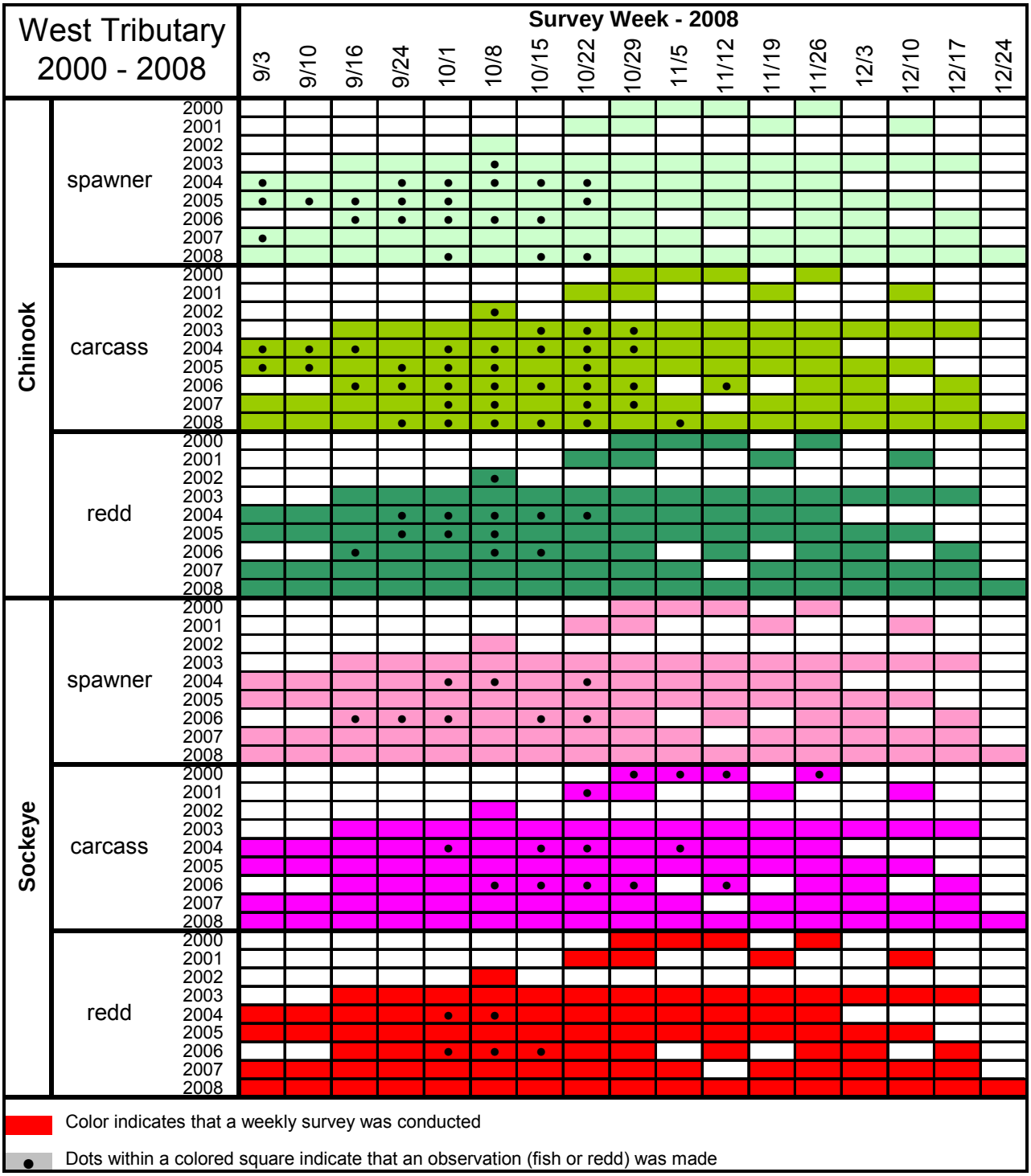
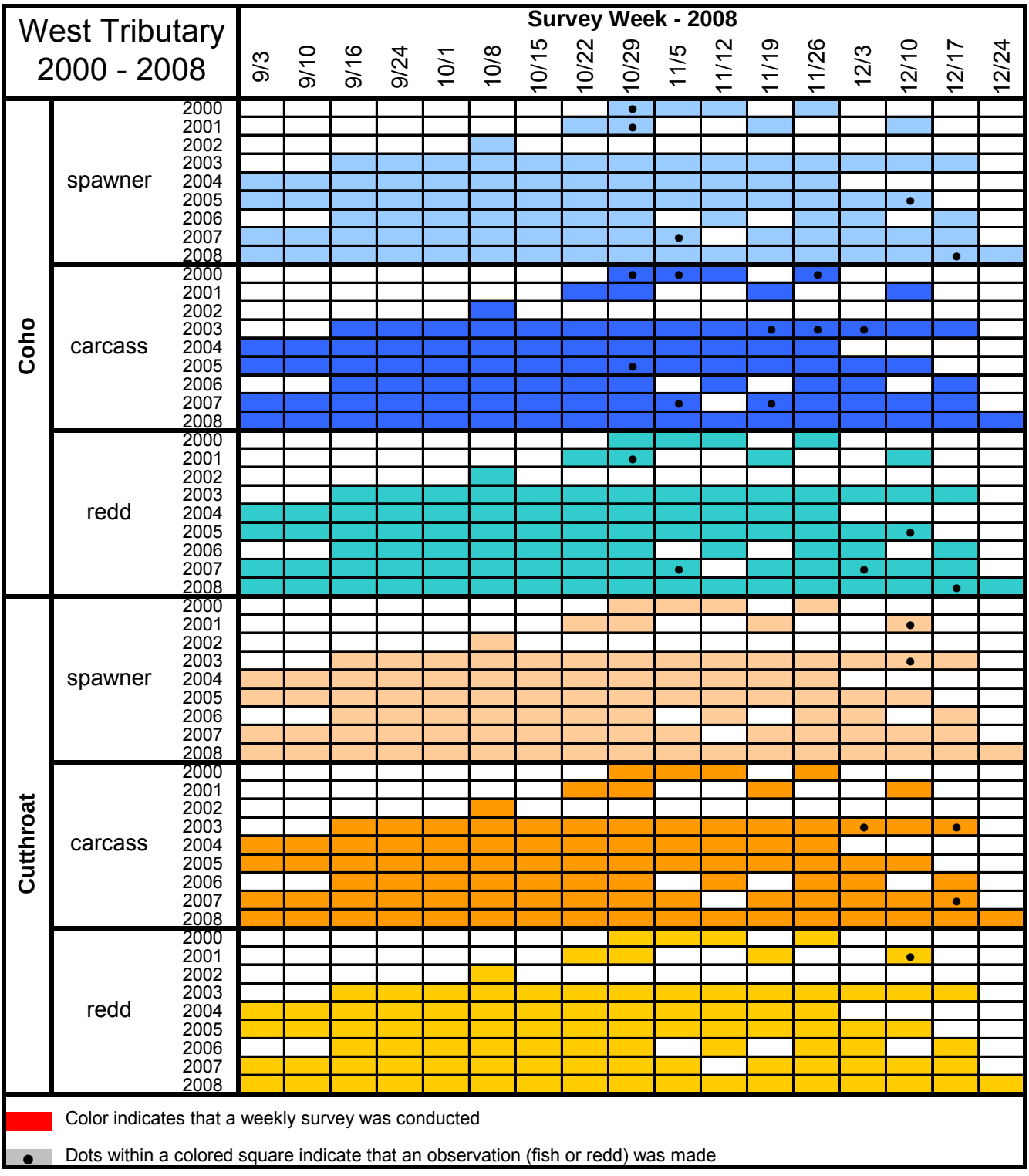


Table 10. Continued.



Spawning Trend Data

The timing of live spawners, carcasses, and redds observed in the West Tributary is summarized by species and date in Table 7 for each survey year. Although the 2000 through 2002 spawner surveys consisted of "spot checks" that occurred between one and four times per year, surveys from 2003 to 2008 were consistently conducted on a weekly basis in the West Tributary. A comparison of the number of live spawners returning to the West Tributary, by species per year, is shown in Figure 18.

No chinook redds were observed in the West Tributary survey area in either 2007 or 2008. Previous observation of chinook spawning in the West Tributary suggest they typically use Reaches 3 or 4 for spawning. Chinook redds have never been observed in Reaches 1 or 2. Recent restoration of the stream channel in Reaches 2 and 3 may provide future opportunity for chinook spawning. It appears that some fish migrate through the West Tributary survey reaches to spawn upstream as illustrated by the 2007 WDFW survey of Goff Creek (The Watershed Company 2008). In Reaches 3 and 4 of the survey area, a total of nine chinook redds were observed in 2005 and a total of six chinook redds in 2006. Prior to 2006, spawning distribution in the West Tributary was affected by a partial fish barrier in the lower Kelsey Creek mainstem that caused many chinook to migrate up the West Tributary (rather than the Kelsey Creek mainstem) to spawn. In 2006, the migration barrier on the Kelsey Creek mainstem was removed, and much of the spawning effort subsequently shifted from the West Tributary over to the Kelsey Creek mainstem. Construction of a new beaver dam that acted as a migration barrier in 2008, downstream of the confluence with the Kelsey Creek mainstem, likely produced the observed increase in chinook activity in Richards Creek or may have resulted in migration out of the Kelsey Creek system to spawning streams in the broader Lake Washington basin without passage barriers (e.g. Cedar River).

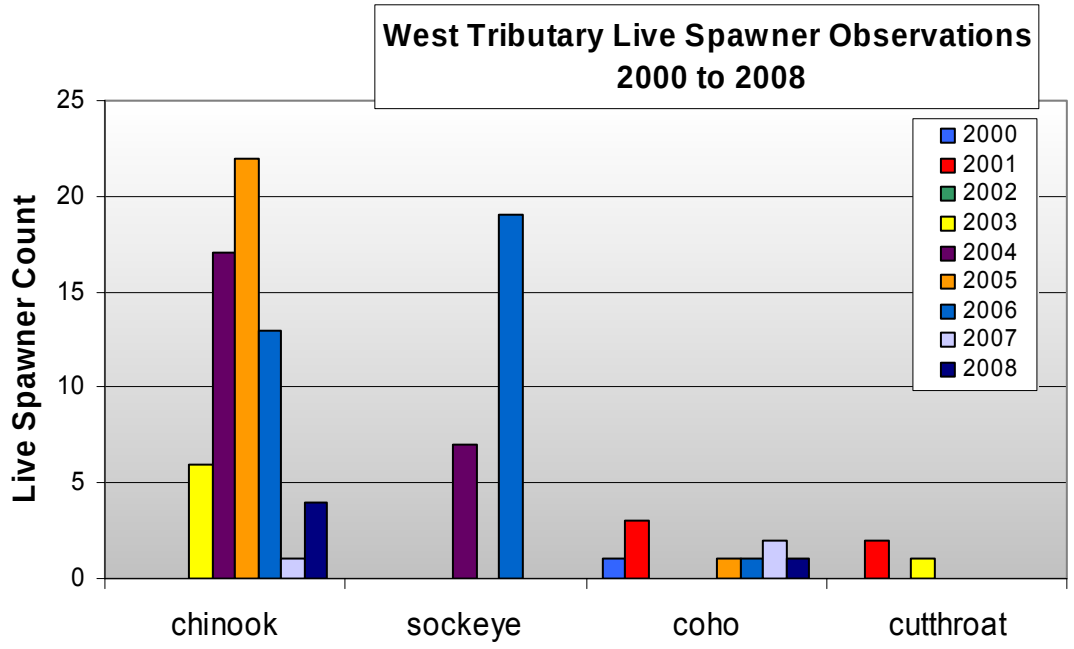


Figure 18. Live spawner observations in the West Tributary from 2000-2008.

5.3 Richards Creek

The Confluence Reach of Richards Creek was surveyed bi-weekly in 2008, and some portion or all of the upper four reaches were surveyed dependent on the flow conditions, passage barriers, and fish presence lower in the system. A leveling device was installed in the largest beaver dam in the Confluence Reach assisting salmon passage. However, an additional dam located slightly downstream combined with low flows inhibited chinook passage to the rest of Richards Creek for part of the season. The majority of chinook salmon carcasses observed in Richards Creek were found at or below this intermittent barrier. However, a few chinook were able to pass the barrier. The beaver dam at the downstream end of the Beaver Pond Reach (that was believed to be the primary migration barrier in previous years) was effectively removed, increasing the possibility for salmon to access upper reaches of Richards Creek. Despite low flow and passage challenges throughout most of the year, one coho carcass was found in Reach 1 above barriers in the Confluence and Beaver Pond Reaches, illustrating that efforts to improve salmon passage were somewhat successful. Given poor flow conditions and low system-wide salmon escapement, it is unclear how successful the 2008 barrier removals were for salmon passage. Continued barrier removal efforts combined with advantageous flow and salmon abundance would likely result in a return of salmon to the upper reaches of Richards Creek.

Seven live chinook spawners, seven chinook carcasses, and two chinook redds were encountered in the Confluence Reach in 2008 (Table 11). One coho carcass was encountered in Reach 1. This is the first coho observed in Richards Creek and the first salmon observed above the Beaver Pond Reach since 2004 (Table 10). Spawning habitat is limited in the Confluence Reach due to low gradient and deposition of fine sediments. It primarily serves as a migration corridor for fish trying to access upper areas of the Creek.

Table 11. Total returns for Richards Creek in 2008.

Richards	Chinook			Coho			Sockeye		
Reach	Spawner	Carcass	Redd	Spawner	Carcass	Redd	Spawner	Carcass	Redd
Confl.	7	7	2	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0
Total	**7**	**7**	**2**	**0**	**1**	**0**	**0**	**0**	**0**

Table 12. Survey timing frequency and observations of species presence in Richards Creek during fall spot surveys from 2000 to 2008.

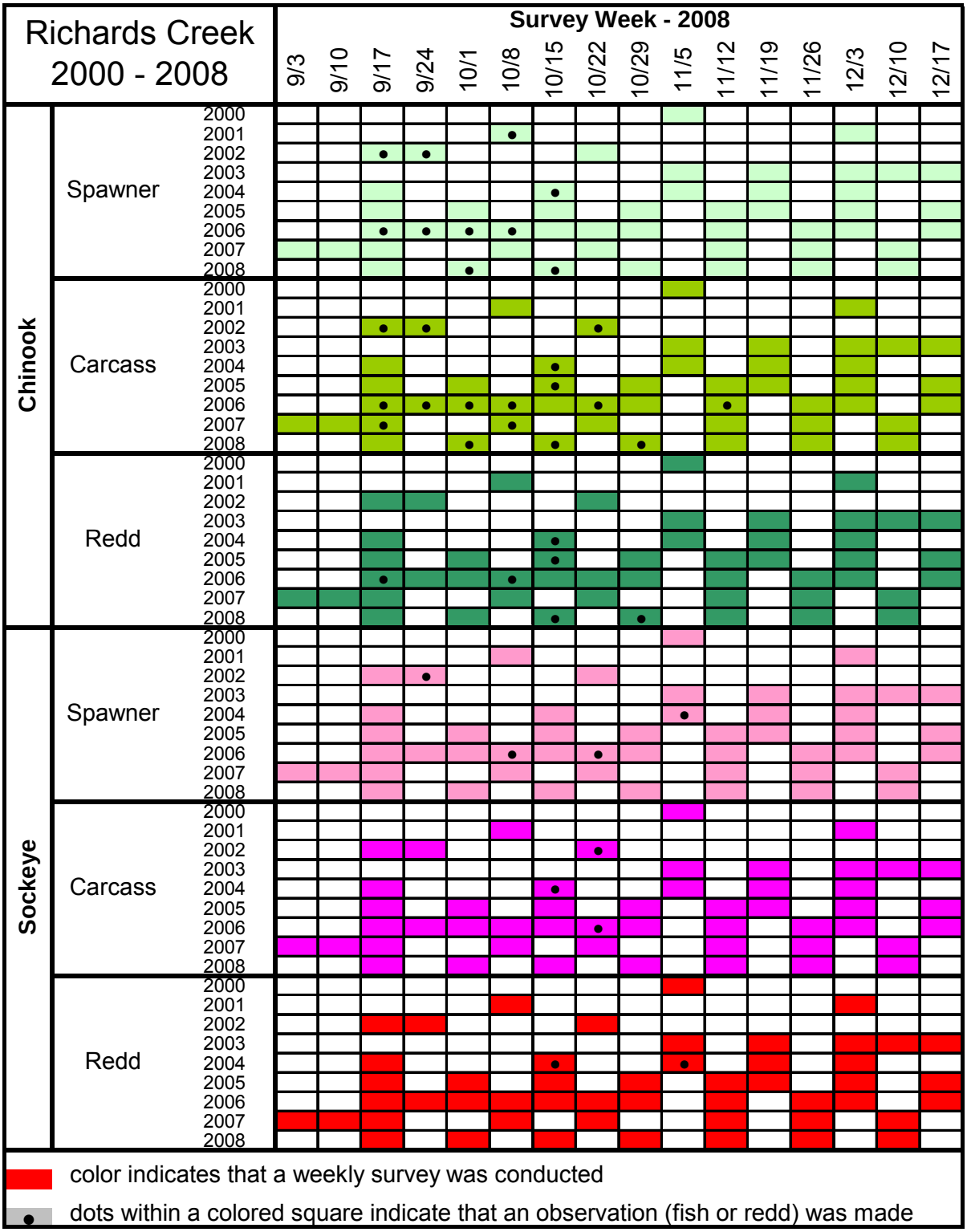
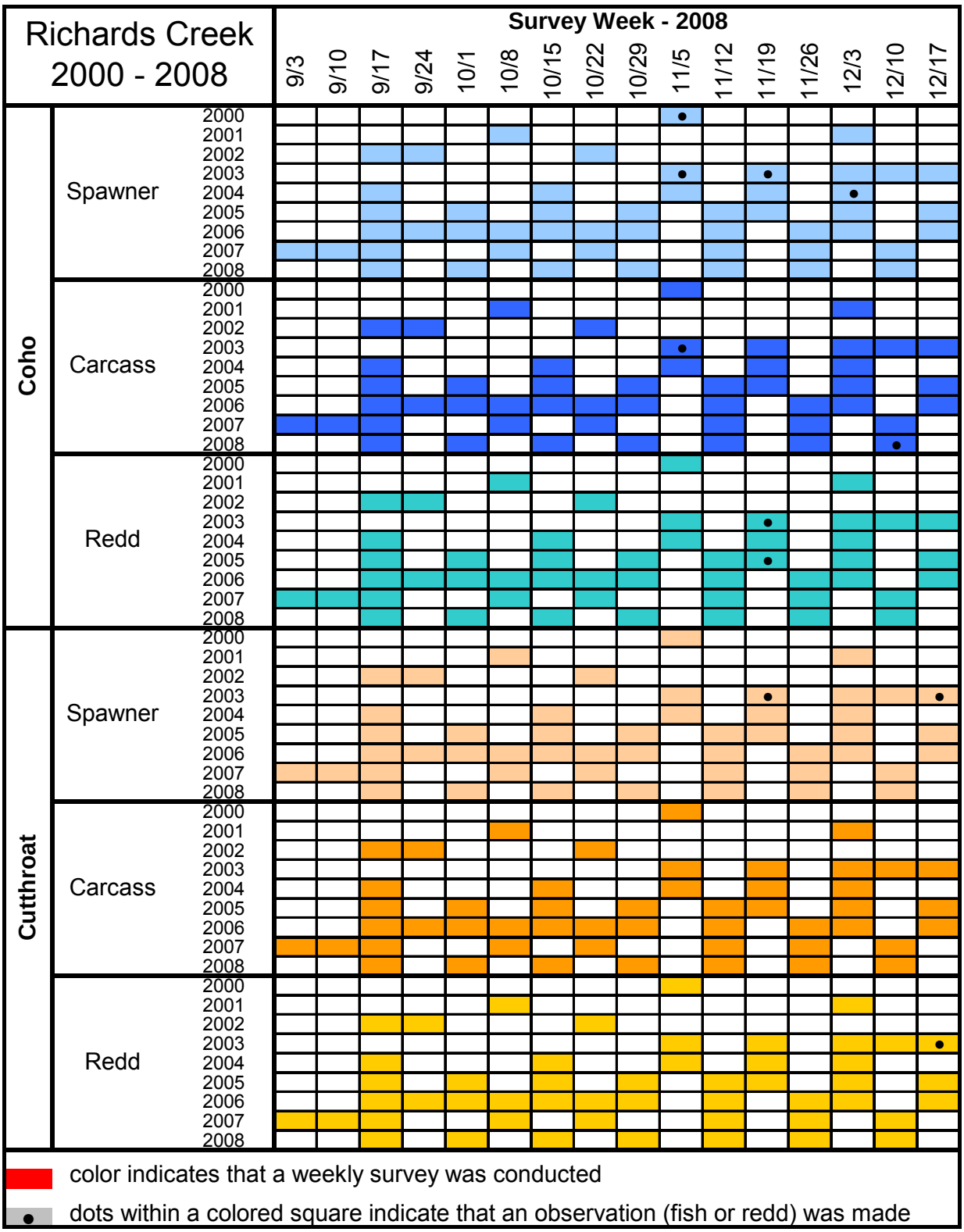


Table 12. Continued.



Chinook Salmon

Fourteen chinook salmon were observed in Richards Creek during the 2008 spawner surveys, seven were live spawners and seven were carcasses (see Table 11, Figure 19). All chinook were observed in the Confluence Reach. The dry conditions and resulting low flows throughout the chinook spawning season appear to be the major cause of poor migration within Richards Creek during 2008. Past removal of impassable beaver dams was not sufficient under the current weather conditions to allow chinook passage to the upper reaches of Richards Creek. Two redds were observed in the poor substrate of the Confluence Reach due to the inability of chinook to pass a new beaver dam. Based on the presence or absence of adipose fins, three (43%) of the Richards Creek chinook (carcasses) were hatchery fish (clipped), two (29%) were wild fish (unclipped), and the origin of the two (29%) remaining chinook was unknown (predated). Three (43%) of these chinook were male and three (43%) were female with one (14%) unknown sexed fish. Chinook body length data was combined with measurements from Kelsey Creek and the West Tributary, and average length statistics are presented in Figures 5 and 6 above. A live chinook spawner and three chinook carcasses were first found in Richards Creek on October 1, and the last carcasses was observed in the week of October 24 (a duration of approximately 5 weeks, see Table 12).

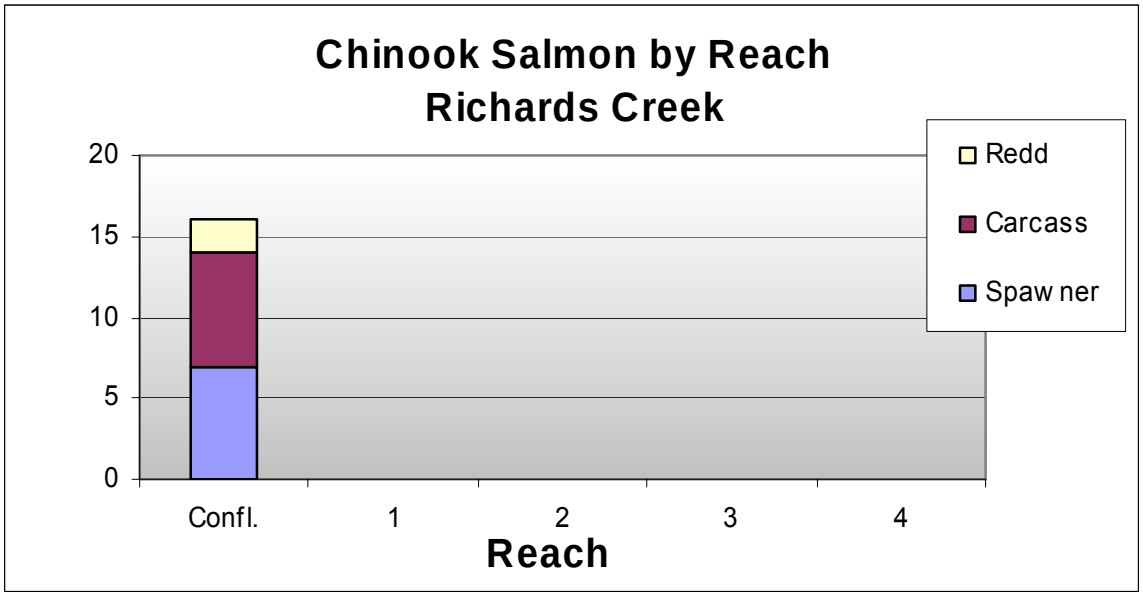


Figure 19. Chinook salmon observations in Richards Creek, 2008.

Sockeye Salmon

No sockeye salmon carcasses, live spawners, or redds were observed in Richards Creek in 2008.

Coho Salmon

One coho salmon carcasses was observed in Reach 1 of Richards Creek on December 10th (Figure 20). No live spawners, or redds were observed in Richards Creek in 2008.

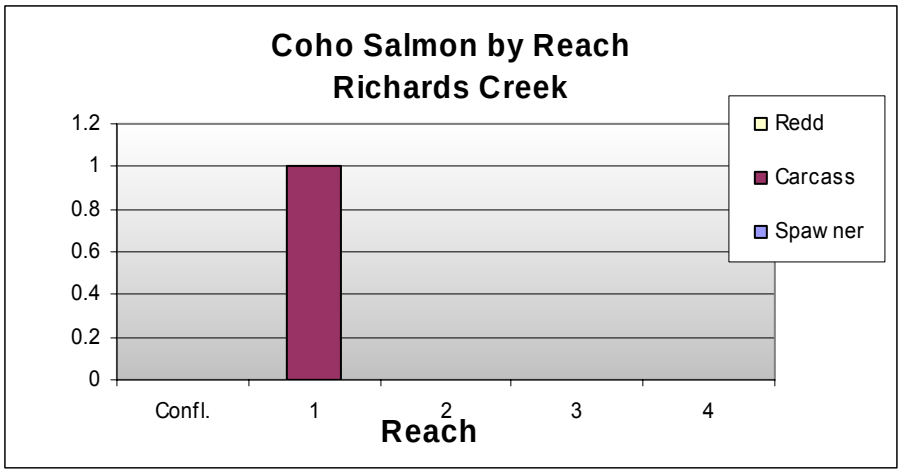


Figure 20. Coho salmon observations in Richards Creek, 2008.

Cutthroat Trout

No cutthroat trout carcasses, live spawners, or redds were observed in Richards Creek in 2008.

5.4 Lower Kelsey Beaver Dam

On October 10th, a conservative estimate of fifteen chinook were found in various states of decay during the initial survey of the beaver dam. One live hatchery female chinook was stranded in the *Spiraea sp.* and passed upstream of the barrier by a City of Bellevue employee. Carcasses were only counted if a whole jaw was discernable, therefore many of the more predated or decomposed chinook were not included in the count. Five (33%) of the carcasses were male, five (33%) female, and five (33%) of unknown sex. Five (33%) of the carcasses were hatchery fish while the remaining ten (66%) were of unknown origin. On the following survey (October 14th), a male chinook spawner was observed passing the dam, but no additional carcasses were found. The beaver dam was surveyed an additional eight times. No additional live spawners or carcasses of any salmon species were encountered.

5.5 Coal Creek

Three coho carcasses, six coho redds, and an adfluvial cutthroat trout (pre-spawn mortality) were observed during surveys on Coal Creek in 2008. Two (67%) of the coho carcasses were hatchery fish (fin clipped) and one (33%) was of unknown origin. All of the coho carcasses were observed downstream of Coal Creek Parkway. Six coho redds were encountered, GPS coordinates were acquired, and a map of redd distributions was produced (Appendix A). The first coho carcass and redds were observed on December 3, and the final three redds were observed on the last survey conducted on December 19, along with one pre-spawn cutthroat trout carcass. However, it is possible more salmon activity occurred in Coal Creek following our survey and went undetected.

5.6 Scale Samples and Genetic Samples

As in past years, scale samples were collected from all chinook and coho carcasses and submitted to the WDFW for analysis. Scale samples were collected from a total of 27 chinook salmon carcasses, 3 coho salmon carcasses, and 1 cutthroat trout carcass in 2008 (Appendix C). Each sample included at least six scales per fish and documentation of fork length, POH length, and sex. The cutthroat trout scales and relevant biological data were provided to Dr. David Beauchamp at the University of Washington for inclusion with his ongoing cutthroat trout scale data. Genetic tissue samples were not collected in 2007 or 2008, but have been taken in previous years.

6. DISCUSSION

6.1 Spawning Escapement and Redd Distribution

In 2008, spawning escapement (redd-based) for the Kelsey Creek mainstem was estimated at 20 chinook, 0 sockeye, and 25 coho. An alternative estimate generated using a live-count AUC indicates that escapement was 13 for chinook, 0 for sockeye, and 5 for coho. As mentioned previously, these escapement estimates are based on regularly surveyed index reaches in Kelsey Creek and have not been expanded to the entire Kelsey Creek watershed. Additionally, it is important to note that both of these escapement measures rely heavily on parameters estimated from previous research on larger salmon populations that often reside in larger and/or less urbanized systems. Substantial variation in salmon life history traits exist between salmon populations and many variations in life history patterns can be attributed to system specific differences associated with stock residency (Quinn 2005). Using borrowed parameters can potentially induce substantial bias into escapement estimates. Two estimates are provided for comparison purposes, and the procedure for calculating escapement is consistent with the methodology used by the WDFW in other WRIA 8 survey areas. However, due to the relative unique nature of the chinook population in Kelsey Creek, we added a simpler, less biased peak spawner count estimate useful for tracking chinook population dynamics through time (Figure 10). Redd counts and spawning escapement estimates for index reaches in the Cedar River, Bear Creek (two of the larger WRIA 8 basins with wild chinook production), and Kelsey Creek are provided in Table 13 for general run-size comparison.

Table 13. Escapement estimates and redd counts from index areas within other primary chinook production basins in WRIA 8 (Steve Foley pers. comm.).

Basin		2005	2006	2007	2008
Cedar River	*AUC Escapement*	518	1066	1730	788
	Redds	339	587	899	599
Bear Creek	*AUC Escapement*	320	328	276	237
	Redds	122	NA	89	132
Kelsey Creek	*AUC Escapement*	19	107	149	13
	Redds	14	72	77	20

Survey conditions were excellent in 2008, and chinook redd counts are thought to be relatively accurate. Extended periods of drought and infrequent high-water events throughout the entire spawning season, while not beneficial to salmon migrations, give us confidence that survey efficiency was high and observation errors were minimal in 2008. Most spawning occurred in the lower Kelsey Creek mainstem in 2008, with five (63%) of the eight chinook redds constructed in Reach A. The fall of 2008 was relatively dry, and the lack of rain events that occurred during the spawning season negatively impacted migration conditions, resulting in poor salmon access, survival, and redd spatial distribution. In the relatively wet 2007, salmon were able to access the entire Kelsey Creek mainstem and spawning activity was heavily concentrated in Reach 7 and in upper Reach 4 and lower Reach 5, downstream from a high grade-control weir that may have acted as a partial fish migration barrier. The apparent shift in redd distribution between the wet 2007 and dry 2008 spawning seasons illustrates one of the key challenges for the future success of salmon populations in the urbanized Kelsey Creek system. Under the current conditions, spawning during dry years results in a reduced migration potential and sub-optimal redd placement in the relatively unstable gravels currently prevalent in the lower reaches of Kelsey Creek, whereas a relatively wet spawning season allows salmon greater access to the more stable gravels found in the upper reaches of Kelsey Creek. Of the 5 redds constructed in Reach A in 2008, all were scoured out or sediment covered prior to the end of the survey season. It is highly unlikely that any chinook eggs survived to hatch from redds constructed in Reach A during 2008. Thus, 63% of the spawning activity during the entire 2008 chinook run was likely lost due to scour and sedimentation activity in lower Kelsey Creek. Spawning activity was limited in the West Tributary in 2008 with only two coho redds observed in Reach 4. However, redd construction in the survey reaches of the West Tributary does not frequently occur (see previous spawner survey reports 2000-2007) and the majority of redd construction in the system likely occurs above the survey reaches. Continued fish passage difficulties from low flows and intermittent barriers in Richards Creek prevented fish from spawning in the upper reaches and resulted in two redds being constructed in the poor quality substrates available in the Confluence Reach.

For the first time, a mature cutthroat trout carcass was observed during a salmon spawner survey on Kelsey Creek in 2008. Actively spawning adfluvial cutthroat trout were observed in 2001 in the mainstem of Kelsey Creek during the surveys, but no cutthroat carcasses have been

reported over the last nine years. However, given the body size of the cutthroat carcass (23cm fork length), it is likely a stream resident fish that may have expired unrelated to the stresses associated with spawning activity. Similarly, a fully mature female cutthroat carcass was observed during the final Coal Creek survey. While the Coal Creek cutthroat was a pre-spawn mortality with no apparent fin wear, the presence of a fully ripe female cutthroat in Coal Creek may have resulted in the misidentification of unattended redds in the system. Redds that were unattended in the Kelsey Creek system and Coal Creek during November and December were generally attributed to coho, but could, in some instances, have been constructed by cutthroat trout. Traditionally the salmon surveys have concluded prior to the start of the typical spawning period for cutthroat trout. Cutthroat trout have typically been observed spawning in streams around February and March (Beauchamp et al. 1992; Mazur and Beauchamp 2006), and were only previously observed in a 2001 survey beginning in late November.

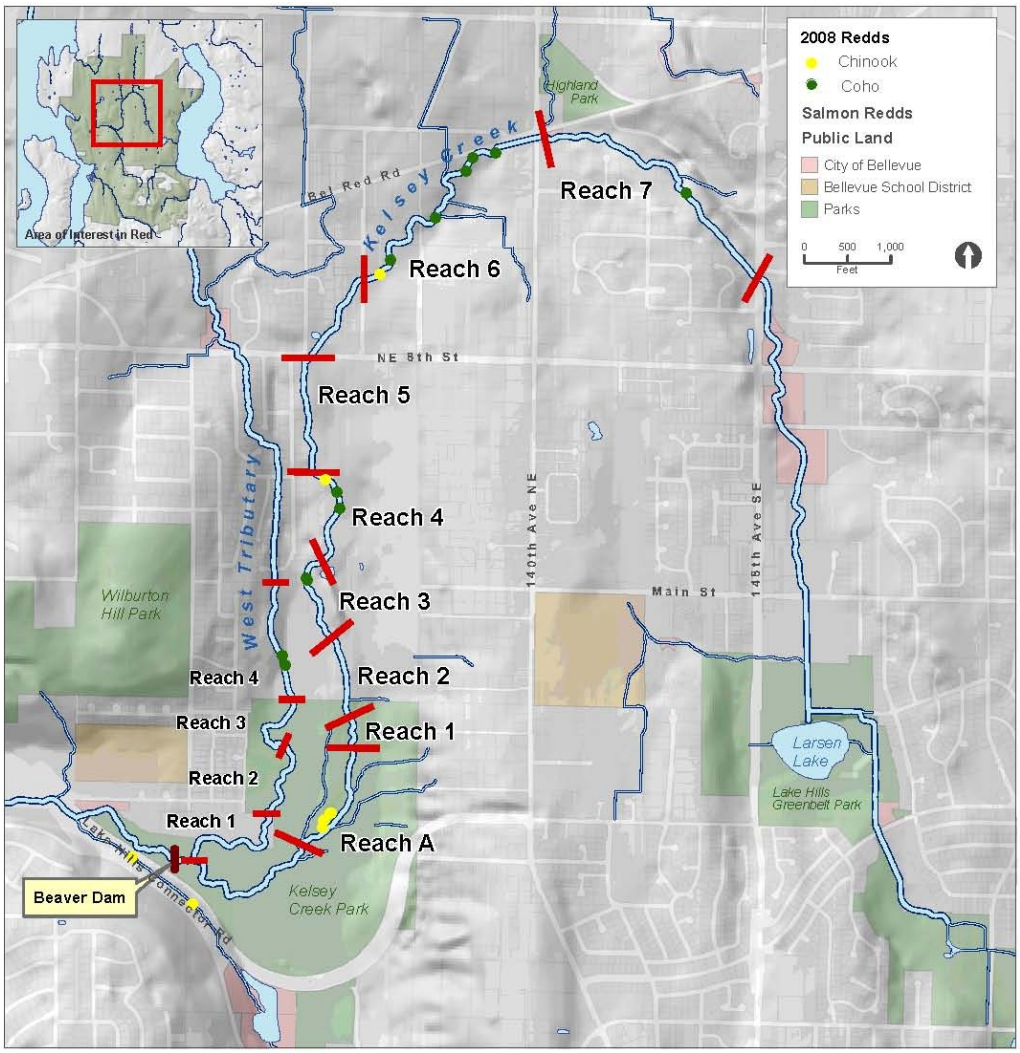


Figure 21. 2008 redd distribution in the Kelsey Creek index area.

6.2 Access to Spawning Areas

Previous fish passage issues along lower Kelsey Creek were addressed in 2006 with the installation of a pond leveling device. Not surprisingly, an additional beaver dam was constructed in lower Kelsey Creek below the pond leveling device prior to the 2008 spawning season. The use of a pond leveling device was effective in 2006 and 2007, allowing fish to negotiate beaver dam areas formerly impassable at lower flows. However, the construction of a new beaver dam below the previously installed leveler, combined with the long periods of dry weather, resulted in poor salmon access to both the Kelsey Creek mainstem and the West Tributary throughout the 2008 spawning season. This partial migration barrier to the Kelsey Creek system resulted in the untimely death of an estimated twenty-two known chinook salmon, a number larger than the total escapement estimate for the year. In less urbanized systems, adult salmon passage around natural barriers such as beaver dams often occurs during high flow events either via jumping over the dam or traversing through a high flow side channel. This particular beaver dam developed a high flow side channel that effectively funneled salmon around the dam into an undefined backwater pooling area adjacent to the dam. The backwater area was dominated by dense patches of *Spiraea douglasii* and non-native reed canary grass, where adult salmon were apparently unable to navigate back to the main channel and many became stranded or were targeted by predators. Marked improvement in passage around the dam occurred after a few select obstructions in the side channel (created by dense *Spiraea douglasii* patches) were removed, effectively providing salmon upstream passage beyond the barrier.

Additional partial passage barriers challenged chinook that were fortunate enough to navigate upstream to the survey reaches in the Kelsey Creek mainstem. An intermittent passage barrier was created by another beaver dam located in Reach A. Five (63%) of the eight chinook redds observed in Kelsey Creek were therefore constructed in unstable gravels characteristic of Reach A. All five of these redds were either scoured out or silted over shortly after being built. However, a few chinook and coho were able to access the upper reaches of Kelsey Creek, constructing redds in the more stable gravels when higher stream flows allowed access upstream of these barriers.

No migration barriers were observed on the West Tributary in 2008. However, beavers are currently active in the area from the mouth upstream through Reach 2. Beaver check dams in this area have created partial migration barriers in the past, and could easily do so again.

Fish passage was a concern in Richards Creek during the beginning of the chinook spawning season (September and October), due to the low flows and an impassable beaver dam. Fish passage was blocked at a new beaver dam, downstream from the old beaver dam and pond leveling device. This dam was assumed to be a migration barrier until high flows allowed upstream passage through scoured high flow side channels along the creek's left and right banks.

Similar to the 2005 through 2007 spawning seasons, access to the upper reaches of Richards Creek were largely inaccessible in 2008 due to poor flow conditions and presence of beaver dams that acted as intermittent passage barriers. Fish passage was presumed to be blocked in the Beaver Pond Reach throughout the chinook spawning season, but may have improved later in the season with increased stream flow. One coho carcass was found at the beginning of Reach 1 late in the 2008 spawning season, proving that with adequate flow, barriers may be intermittently passable.

6.3 Redd life

Redd life refers to the period of time a redd is readily visible, and is typically estimated at 21 days for streams in Washington State (Orrell 1976; Hahn 2003). However, Kelsey Creek is an urban stream with accentuated peak flows and mobile substrates (Scott et al. 1986; Moscrip and Montgomery 1997) that effectively decrease the average redd life in this basin. Redds in the Kelsey Creek system are sometimes visible for up to 21 days, but a single rain event that raises discharge (as measured at the stream gauge in Mercer Slough) over 100 cubic feet per second (cfs) will often obscure any redds that have been constructed. Also, redds that are located higher in the watershed (Reach 6) were typically visible longer than redds that were situated lower in the watershed (Reaches A and 1). This is likely due to the fact that less stormwater is discharged to the upper reaches of the Kelsey Creek mainstem, and peak flows are not magnified to the same extent. Based on qualitative observations (not rigorously documented), a rough estimate for average redd life in the Kelsey Creek system is 14 days. However, redd life in the Kelsey Creek mainstem likely varies from reach to reach, with slightly higher redd life in the upper reaches and lower redd life in downstream reaches. A shorter redd life due to mobile substrates in Kelsey Creek is consistent with observations from previous survey teams as well (Taylor and Associates 2002).

6.4 Discharge

Water flows were frequently low and remained low for extended periods during the salmon spawning season in September and October of 2008 (Figure 22). The relatively low water levels challenged salmon migration and in-stream holding conditions. In 2008, a series of moderate to heavy rain events did occur towards the end of the typical chinook spawning period and just prior to the commencement of the coho migration. However, few fish were present to take advantage of the favorable discharge conditions. Fall freshets typically enhance salmon migration and access to spawning habitats throughout their known distribution (Quinn 2005) and as illustrated by the 2007 and 2008 surveys, when salmon utilization of the upper reaches of the Kelsey Creek mainstem appeared to depend heavily on appropriate flows during migration (The Watershed Company 2007, Figure 23). Spawning and rearing conditions are currently thought to be more favorable in the upper reaches due to stable substrates and less flashy stream flows. Substrates are relatively stable and gravel scour (and presumably egg mortality) is likely lower in Reach 7, where many of the redds were constructed in 2007 in contrast to the high scour losses observed in Reach A during 2008. The relatively moderate flow event on November 4th, 2008 of 188 cfs at the gage in Mercer Slough, was enough to scour all of the redds

in Reach A not stabilized by large woody debris (LWD). Similarly, two redds located upstream of LWD were covered in three inches of sediment following the collapse of a beaver dam (in Reach A) during the subsequent high flow event of 300 cfs on November 7th. Given the current lack of stable substrates anchored by LWD in the lower reaches and the urban hydrograph typical of Kelsey Creek (during and after the salmon run), it is hard to imagine any future successful redds being constructed in Reach A.

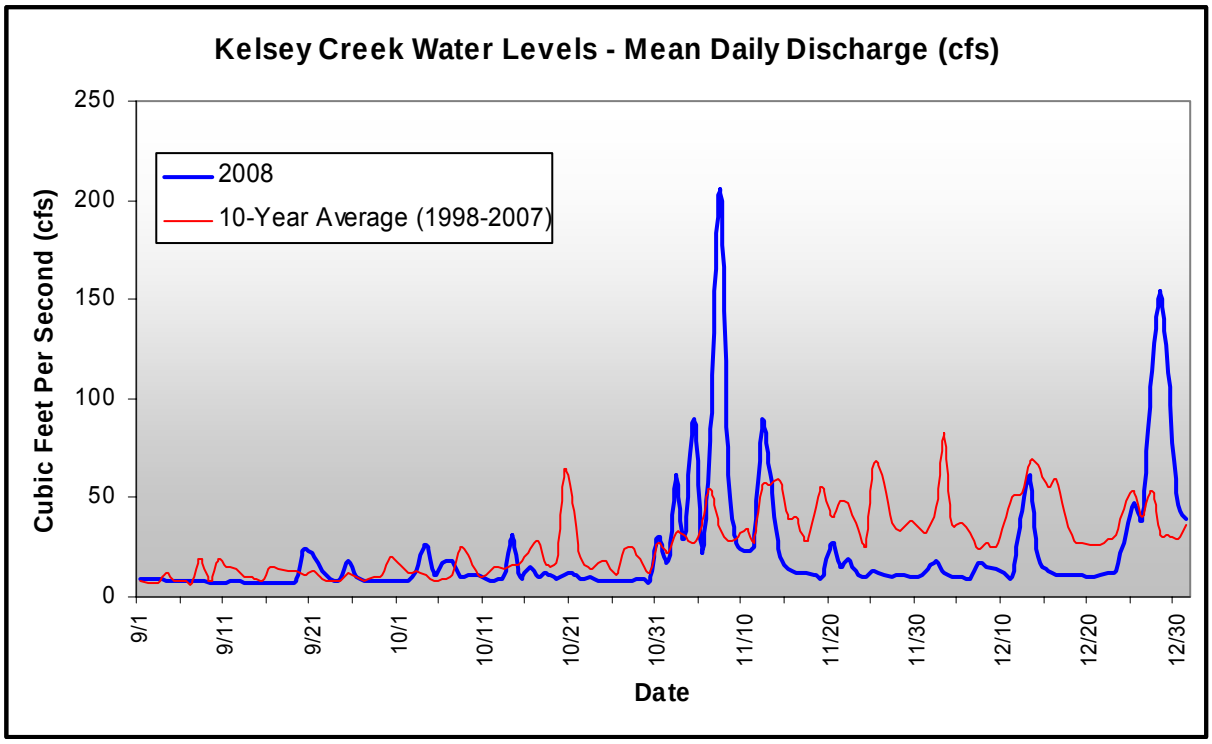


Figure 22. Mean daily discharge in the Kelsey Creek basin from September through December, 2008 and 10-year average discharge (1998-2007), measured at the USGS stream flow gauge in Mercer Slough (USGS Gauge #12120000).

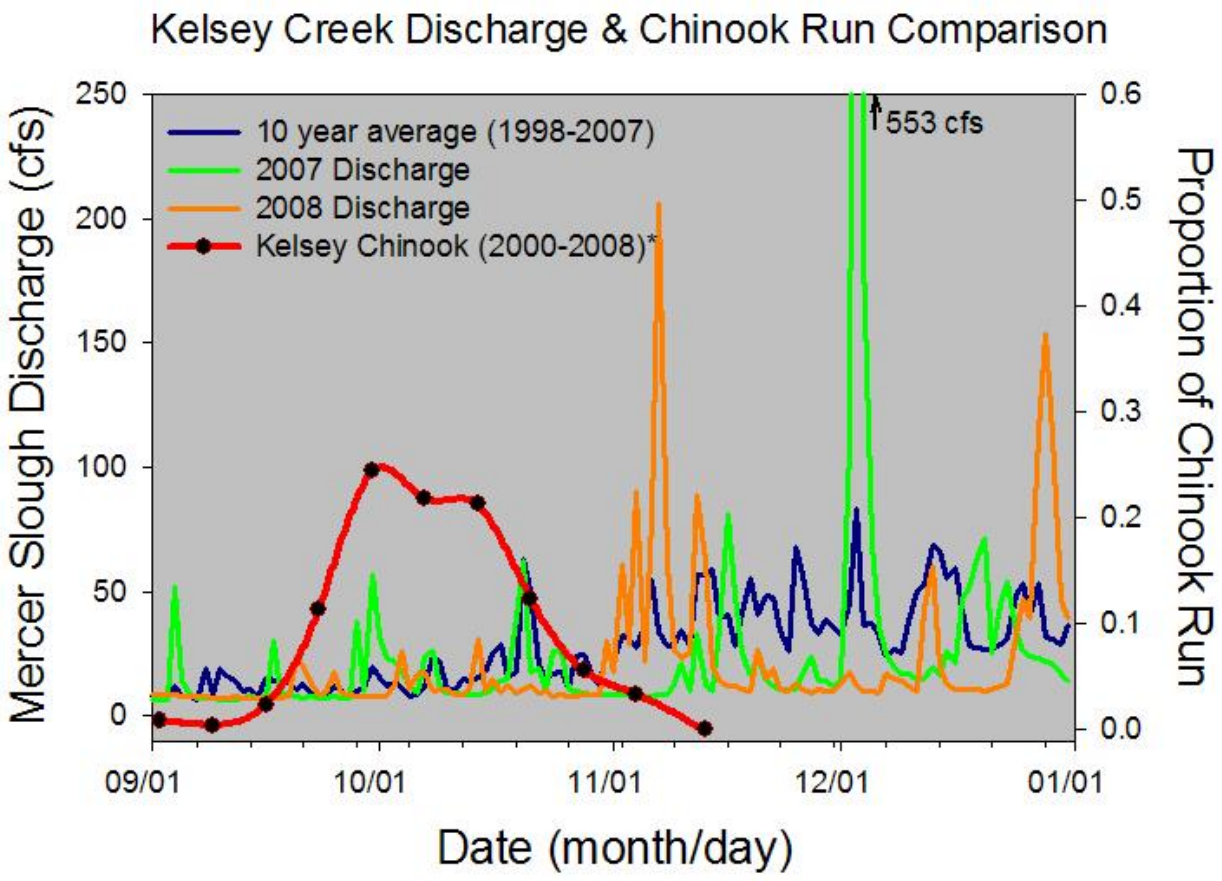


Figure 23. Comparison depicting the temporal discharge patterns in Kelsey Creek (represented by gauge measurements in Mercer Slough) during 2007, 2008, the10-year average, and the proportional run time of chinook salmon to Kelsey Creek over the last nine years. * No data used from 2003 and 2004.

6.5 Fish Origin

Similar to last year, a large percentage (65%) of the chinook observed in 2008 were hatchery-origin (clipped) fish, while 21 percent (21%) were presumed wild origin (unclipped); the origin of the remaining 14 percent (14%) was undetermined. The high percentage of hatchery fish in the 2008 run indicates that chinook production in the Kelsey Creek system is still limited by some factor or combination of factors. Although the Kelsey Creek spawner surveys effectively monitor the annual spawning effort of adult salmonids, estimates of egg-to-juvenile survivorship and overall juvenile salmonid production from the system are currently unknown.

Three (3) coded wire tags (CWTs) were recovered from chinook carcasses during the 2008 spawning season throughout the Kelsey Creek system. These CWTs were collected in the snouts of chinook recovered in the West Tributary (9/23/08), Richards Creek (10/1/08) and Kelsey Creek (10/6/08). All three carcasses had an adipose fin clip. Snouts were collected in the field, frozen and delivered to the WDFW for CWT extraction (Appendix C).

6.6 Pre-Spawn Mortality

Each year in Kelsey Creek, as in other urban streams, a number of female (and male) chinook experience pre-spawn mortality, or die before they have a chance to deposit their eggs. Females that die before they deposit their eggs typically have 100 percent egg retention, with eggs still in skeins that are relatively tight. Female pre-spawn mortality can be monitored by inspecting the body cavity of each carcass to assess egg retention, but male pre-spawn mortality is difficult to determine in the field, and is not tracked in these surveys.

In 2008, a total of 16 female chinook carcasses were recorded in the Kelsey Creek system index area (including the West Tributary and Richards Creek). Of these, 6 percent (6%) experienced pre-spawn mortality (died from unknown factors), 44 percent (44%) were killed by predators (before spawning), 25 percent (25%) spawned successfully, 13 percent (13%) were stranded, and spawning success was unknown in the remaining 13 percent (13%) of the carcasses (Table 14). Some proportion of the carcasses that were attributed to predation could have been eaten postmortem. Similarly, predators may have targeted salmon that were already showing distress due to other factors. The relatively small body size of most known predators in relation to the body size of adult salmon in the Kelsey Creek system and the Lake Washington basin, and the large number of birds and other animals likely to feed on salmon carcasses suggests that some portion of the salmon consumed by wildlife would have likely consisted of recently expired salmon.

Table 14. Chinook pre-spawn mortality in Kelsey Creek.

Year	Pre-Spawn Mortality (Yes, No, Unknown*)	Count	Percent Total
2008	Yes	1 (unknown factors)	6%
		7 (predation-related)	44%
		2 (stranded)	13%
	No	4	25%
	Unknown	2	13%

* indicates that the carcass was either too decomposed or mangled to accurately assess the possible cause of death.

Pre-spawn mortality in salmon is not exclusive to the Kelsey Creek system, and has been recorded in other WRIA 8 spawning areas (Berge et al. 2006, McCarthy et al. 2008). Estimates indicate that pre-spawn mortality for chinook salmon in WRIA 8 streams can range from 0.8% to 23% (Table 15). However, it appears that coho tend to be more susceptible to pre-spawn

mortality given that they have a relatively higher pre-spawn mortality rate (McCarthy et al 2008).

Table 15. Pre-spawn mortality for chinook salmon in other WRIA 8 streams (Berge et al. 2006).

Year	Watershed	Number Chinook Carcasses Sampled	Percent Pre-spawn mortality
2003	Cedar River	134	1.5%
	Bear Creek	95	8%
	Issaquah Creek	71	23%
2004	Cedar River	232	3%
	Bear Creek	69	4%
	Issaquah Creek	Not Sampled	---
2005	Cedar River	122	0.8%
	Bear Creek	138	6.5%
	Issaquah Creek	79	22.7%

6.7 Beaver and Salmon

Beavers have long co-existed with salmon, having a strong ecological relationship. Both salmon and beaver are keystone species, playing a unique role in ecosystem structure and function (Johnson 2001). Beneficial to the environment, beaver dams create pools that forms habitat for aquatic species, controls flooding and erosion, improves water quality by reducing downstream suspended sediment, and raises water tables. Beaver activity increases the amount of in-stream LWD and their droppings may enrich pond productivity. Also a keystone species, salmon act as a food source to a wide variety of predators and scavengers, and act as a nutrient source that drives ecosystem productivity. Both beaver and salmon are critical to the overall health of the Kelsey Creek system.

By ponding water, beaver dams create enhanced rearing and over-wintering habitat that protect juvenile salmon during high flow conditions (Johnson 2001). These ponds are heavily used by juvenile coho and cutthroat trout during the winter (Johnson 2001). Beaver dams may block the upstream return of spawning salmon, but studies indicate that fish can pass over beaver dams during all seasons (Johnson 2001). As seen in the Kelsey Creek system, beaver dams temporarily keep adult salmon in the lower parts of spawning streams, where flow is greater and pools are deeper. Ideally, returning salmon should be able to hold in these lower stream sections until higher stream flows breach the dams, allowing upstream passage. A restoration based solution would enhance these lower stream sections by adding pools, stream cover, and fish holding capacity.

Although beaver activity is generally considered beneficial to the broader environment, beavers also dramatically alter aquatic habitats. Beaver induced habitat alterations can negatively influence portions of the life history of some desired species, such as salmon. Some potentially

negative influences of beaver induced passage barriers for returning salmon include delays in natural migration, altered salmon distribution within the stream, and fish crowding potentially resulting in increased predator access and disease vectoring (Mitchell and Cunjak 2007, Thorstad et al. 2008). Similarly, beaver dams can produce dramatic alterations in fish community abundance and distribution for resident fishes (Schlosser 1995). Dams also slow the flow of water in fast streams, changing the flora and fauna and sometimes creating silting. Beaver ponds may flood low-lying areas, sometimes causing extensive loss of timber. Significant economic impacts can result from the beaver damage to trees, agricultural crops, land, and water control structures.

Much of this report has placed blame on the beaver dam passage barriers, yet this is not entirely the case, and there is no easy solution. The Kelsey Creek beaver population should be maintained and encouraged to thrive in this urban, stormwater driven environment. The fact that beaver ponds slow stormwater, collect fine sediment, and provide salmonid rearing and holding habitat is, ultimately beneficial to the Kelsey Creek system.

In general, the use of pond leveling devices has had moderate success in controlling water levels and maintaining fish passage in existing beaver ponds in the Kelsey Creek Basin. These devices consist of perforated pipe wrapped in hog wire and placed below the surface of the beaver pond. A solid eight-inch diameter pipe is attached to the perforated pipe and inserted through the beaver dam. The beavers have built their dams over the pipe and not attempted to block it. One problem associated with the pond leveling device is the likelihood for it to fill with sediment. This occurs when the beaver pond is too shallow to allow the leveling device to be pinned so that the pipe is at least one foot above the ponds bottom. This is what occurred at the beaver pond leveler previously in place on lower Kelsey Creek, upstream of the West Tributary confluence. Aside from habitat restoration efforts (discussed in more detail in the recommendation section below), the pond leveling device is the best mechanism currently available to ensure fish passage. Dam removal has proven to be only a very short term solution, and is not recommended.

6.8 Physical Habitat Characteristics by Reach

Kelsey Creek

Physical stream habitat conditions in the surveyed portions of the Kelsey Creek mainstem have changed little since 2005. Reaches A and 1 are relatively dynamic and have experienced some flood-driven changes in channel morphology, but other reaches are relatively confined by bank armoring and have little opportunity for lateral migration of the stream channel. Typical stream habitat conditions and photos characterizing individual survey reaches are provided below.

Reach A and Reach 1

Figure 24. Typical habitat in Reach A and Reach 1.

Reach A and Reach 1 are dynamic reaches with wide riparian areas and relatively unconstrained floodplains that promote frequent, small-scale channel changes and adjustments. The stream channel changes from year to year, generally in response to flood events, beaver dams and the formation of small debris jams. The lower end of Reach A was extended approximately one-eighth mile downstream in 2006 because of recent gravel deposition to capture any additional spawning activity that might occur. In 2008, several chinook redds were observed in large gravel bed areas of Reach A. The gravels are relatively mobile, and accumulate over the underlying clay in pool run-outs and in bars behind debris jams. Several small pools have been scoured out around debris jams in Reach A, allowing chinook spawners

to hold in areas with good canopy cover. Relatively good spawning gravels have slowly been migrating into the areas that were previously exposed clay underlain by glacial till.

The riparian corridor through Reaches A and 1 is forested to the east, with a mixture of forest, open space, and pasture to the west. Although a low levee constrains portions of the western bank, the channel contains very little armoring and meanders freely through the east side of Kelsey Creek Park. In both reaches, the stream is well connected to its floodplain, reaching bankfull very quickly during rain events. A fair amount of medium- to small-sized woody debris, much of it live, is present in Reach A, but is less prevalent in Reach 1. Pieces of large wood in the channel are present, but not abundant, and many of the debris dams consist of small- and medium-sized material that accumulates and shifts relatively easy.

A persistent beaver dam, approximately halfway through Reach A, changed very little during the 2008 survey season. Figure 25 shows short-term changes in dam structure and fish passage that occurred as a result of flashy high flow events. Throughout the 2008 spawning season, the beaver dam acted as a challenge for fish passage, provided rearing habitat and habitat complexity to lower Kelsey Creek.

Figure 25. Persistent beaver dam in Reach A (photos taken (left to right/top to bottom): 10/6, 10/20, 10/27, 11/3, 11/10, 11/24, 12/1, 12/8, and 12/23).

Reach 2

Figure 26. Typical habitat in Reach 2 (start- and end-point bridges pictured).

Reach 2 is a relatively short reach with few pools that extends through the downstream portion of the Glendale Golf Course upstream to the third footbridge. Substrate is a mix of small- to medium-sized cobbles and gravels with some fines, and riparian vegetation is predominantly composed of cut grass on both banks, with little overhead cover. Although the substrate generally appears to be good for spawning, few fish build redds in this reach, likely due to a lack of overhead cover. The golf course fairway crosses the stream in two places within Reach 2, and trees or tall shrubs are undesirable (for golfers) in large tracts of this reach.

Reach 3

Figure 27. Habitat in Reach 3 (reach end-point is pictured, right).

Reach 3 extends from the third footbridge in the golf course upstream to the first concrete weir and, other than a few private parcels near the upper end of the reach, flows primarily across land owned by the golf course. The stream flows along the base of a small hill (west of the channel) that is well forested with a conifer/hardwood mix that provides substantial overhead shading for the stream. The east side of the stream, however, is bordered by a golf course fairway and has a very narrow riparian area vegetated with grass and a few shrubs. Many portions of the reach contain suitable spawning substrate, but there is very little large wood in-stream.

Reach 4

Figure 28. Habitat in Reach 4, including photos of the 2005 golf course restoration site.

Similar to Reaches 2 and 3, Reach 4 is bordered by the golf course on both sides. The stream has been channelized and armored (generally with large boulders), and much of the channel is heavily incised. A series of concrete weir structures designed to alleviate down cutting and dissipate energy are spaced throughout the length of Reach 4. This reach has a narrow riparian buffer lining both banks, vegetated with some native shrubs, but largely dominated by Himalayan blackberry and Japanese knotweed. Approximately half the reach, however, is well shaded by a stand of mature Douglas-fir trees.

A section of Reach 4 was restored in 2005 by adding gravel, log structures, and bioengineering to decrease erosion alongside golf course infrastructure, while at the same time improving fish

passage across the weir. These log structures provide some of the only large wood available in this area. The addition of LWD has created habitat complexity (by adding scour pools for fish holding) and the planted riparian vegetation provides some canopy cover. The golf course should be encouraged to plant additional riparian vegetation throughout the restored section of stream to maintain bank stability and ensure that proper densities are maintained to keep out non-natives. Similar projects should be encouraged throughout the golf course and along private properties shorelines along Kelsey Creek.

Reach 5

Figure 29. Habitat in Reach 5.

Reach 5 is bounded on the west by the golf course and by a series of private residences along the east side. Channel morphology in Reach 5 is similar to that of Reach 4 in that the stream is heavily incised with frequent streambank armoring (boulders) and a series of concrete grade-control weirs spaced throughout the reach. Floodplain areas are very small and limited in number. The stream channel is relatively straight with low sinuosity, and concrete weir structures designed for grade control and energy dissipation. These grade control structures may act as partial fish migration barriers.

The narrow riparian buffer along Reach 5 is dominated in many areas by Himalayan blackberry and Japanese knotweed, or by grass lawns with a mix of ornamental shrubs. Many streamside residents actively seek to improve their views across the creek to the golf course, sometimes cutting/trimming larger trees and shrubs along the creek.

Reach 5 is followed by a two-block gap in the survey extending from the culvert beneath NE 8th Street upstream to the start of Reach 6 at the 134th Avenue NE bridge. This is a private parcel with no access.

Reach 6

Figure 30. Typical habitat in Reach 6.

Land use in Reach 6 is primarily residential with some commercial properties toward the upstream end of the reach. The lower half of the reach flows along the power utility corridor and through a residential area. Although the channel is less confined in lower Reach 6, streambanks are still heavily armored (rip-rap). The channel parallels Bel-Red Road along the upper half of the reach, where it is heavily confined by rip-rap banks and metal sheet piling. Down cutting is a concern in these areas with heavy armoring on both sides of the stream.

Riparian buffer width varies, but is typically wide and well shaded along the lower half, and narrow and sparse in the upper half of Reach 6. Invasive species such as English ivy, Japanese knotweed, and Himalayan blackberry are a concern in many areas of the reach. Substrate varies between gravels and angular cobble throughout the reach, but most of the spawning areas are located in the downstream half where the channel is wider and less rip-rap is present. Most of the coho redds observed in the 2008 spawning season were located in Reach 6.

Reach 7

Figure 31. Habitat in Reach 7 (vertical photos are the Reach start- and end-points).

This reach begins at the Valley Creek-Kelsey Creek confluence. Stream flows in Reach 7 are roughly 50 percent of those in the downstream reaches. It is bordered on both sides by residential development that is typically set back to the top of slope. Undercut banks and

erosion can be found in isolated areas throughout the reach. Although streambank armoring is present in isolated areas of Reach 7, it is much less prevalent than in Reaches 5 or 6. The majority of Reach 7 has a wide riparian buffer dominated by conifers, which contributes both large and small woody debris to the channel, creating pools and slowing the transport of sediment. During the 2008 salmon spawning season, only one small coho redd was found in this reach.

West Tributary

Stream habitat in Reach 1, 2 and 4 of the West Tributary has changed little since 2003. In Reach 3, a City of Bellevue stream relocation and enhancement project was completed prior to the 2008 salmon spawning season, with bank stabilization and revegetation continuing into November. This restoration effort greatly changed the condition, function and habitat in Reach 3. The project removed an artificial oxbow channel and Japanese garden to restore the stream to its natural, steeper gradient, and created stream meanders, back water areas (with additional water storage), large woody debris, and gravelly substrates to prevent localized flooding in Kelsey Creek Park, improve salmonid rearing and spawning habitats, and create habitat complexity.

In all, the West Tributary experiences flashy high flows that often reach the extensive floodplain, especially in Reaches 1-3. Physical stream habitat conditions and photos characterizing individual reaches in the West Tributary are cited below.

Reach 1

Figure 32. Habitat in Reach 1 of the West Tributary.

Reach 1 is characterized by a wide riparian buffer with abundant cover provided by willow and alder, a low gradient, sand/silt substrate with little exposed gravel, and few small pools. The reach starts at the confluence with Kelsey Creek, in a broad reed-canarygrass dominated wetland. Upstream, dense riparian vegetation grows into and over the channel, providing abundant overhead shade and small wood that adds complexity to the channel. Very little large woody debris is present throughout this reach. Stream bank can be found washing away in places, although stability varies with flow and rain conditions. Despite generally good riparian conditions in Reach 1, suitable spawning substrates are very limited and fish typically migrate through this reach to access spawning areas further upstream. Access is difficult in this reach, and some portions of are challenging to wade through, as dense riparian vegetation grows throughout portions of the stream channel.

Reach 2

Figure 33. Habitat in Reach 2 of the West Tributary (vertical photo shows flooding of Kelsey Creek Park).

Reach 2 also has a relatively low gradient and flows through the lower end of Kelsey Park. Although narrow in some areas, the riparian zone is vegetated with native shrubs and is generally in good condition. Despite the good riparian area, much of the reach is composed of glide habitat, with few well-defined riffles or pools. Substrate is primarily composed of sand and silt with some small gravel patches. Spawning habitat is highly limited in this area of the stream, with fish typically migrating through to access spawning areas further upstream. A few areas of unstable stream bank were planted with native riparian vegetation during the stream enhancement project, completed in November.

Reach 3

Figure 34. New stream enhancement in Reach 3 of the West Tributary.

The enhancement project addressed the low gradient and sand/silt substrate that previously dominated this reach. Logs were placed in-stream to create habitat complexity, and collect and retain gravelly substrates added as part of the project. The LWD placed in Reach 3 is critical to maintain spawning gravels during the flashy flow events that create high transport rates

throughout the West Tributary. Several high flow events during the 2008 spawning season proved that the enhancement project was maintaining substrate, aiding storm water storage, and preventing large scale flooding of the park.

One very small chinook test redd was observed just downstream of the vehicle bridge and sediment pond, near the end of the reach. Several chinook and coho salmon were seen holding and moving through Reach 3, especially the sediment pond.

Reach 4

Figure 35. Habitat in Reach 4 of the West Tributary.

Reach 4 flows through the Glendale Golf Course, having a slightly higher gradient and a gravel substrate more suitable for salmonid spawning than the lower reaches. Similar to Reach 2 of the Kelsey mainstem, the riparian vegetation in Reach 4 of the West Tributary is predominantly composed of cut grass on both banks, with little overhead cover. Many sections of the grass-lined streambank have sloughed into the stream during high flow events, or have fractured and are slowly falling into the channel. Much of this reach is not shaded, but one section has a

narrow stand of Douglas-fir trees growing along the stream. A few of these trees were removed by golf course staff during the 2008 spawning season, decreasing the canopy. The golf course should be encouraged to plant an understory of riparian vegetation throughout this section. Himalayan blackberry dominates the narrow stream buffer near the end of the reach, upstream to the northern property boundary.

Reach 4 has an abundance of high-quality spawning sized gravels. Two coho redds were found mid-way through the reach, representing the only successful spawning in the surveyed reaches of the West Tributary during the 2008 season.

Richards Creek

Confluence Reach

Figure 36. Typical habitat throughout the Confluence Reach (upper three photos). The lower left photo shows a small debris jam, and the lower right photo shows the beaver pond leveling device in the uppermost dam of the Confluence Reach.

The Confluence Reach flows through a relatively straight channel that is situated between the two lanes of the Lake Hills Connector. The reach extends from the Kelsey Creek confluence upstream to the culvert passing beneath the Richards Road intersection. Although the riparian corridor is relatively narrow, averaging approximately 150 feet in width, it is densely vegetated with alder and willow that overhang the stream channel, often growing through the water and trapping a variety of small woody debris. This is a low-gradient reach without well-defined riffles or pools, and is generally dominated by glide habitat. Gravels and cobbles are extremely rare, with the substrate dominated by sands and silt throughout the reach. This dynamic reach has a relatively unconstrained floodplain that can promote small-scale channel changes and adjustments. Channel changes are generally in response to flood events, beaver dams and the formation of small debris jams.

Two presumably unsuccessful chinook redds were built in the middle section of the Confluence Reach. The reach acts primarily as a migration corridor, with fish passage conditions that should be assessed annually. During the 2008 spawning season, fish passage was blocked at a new beaver dam, downstream from the old beaver dam and pond leveling device. This dam was assumed to be a migration barrier during the first part of the chinook spawning season, until high flows allowed upstream passage through scoured channels along the left and right banks. The pond leveling device allowed fish passage throughout the whole season, collecting only minimal debris on the upstream caging, which was removed by hand during each survey.

Beaver Pond Reach

Figure 37. Habitat towards the downstream portion of the Beaver Pond Reach in Richards Creek.

The area between the Confluence Reach and Reach 1 of the regular Richards Creek survey is a wetland/beaver pond area referred to as the Beaver Pond Reach. Three main beaver dams and a series of smaller, check dams were identified in this area in 2006 and 2007. The upper two dams divert the stream flows out of the regular channel and through a broad reed-canary-grass wetland. The entire area is flooded and densely vegetated, and a single stream channel is difficult to locate. The beaver pond/wetland complex in the Beaver Pond Reach acts as a fish migration barrier at most stream flows. Although fish may have temporary access through this area during flood events, it is likely that few fish successfully bypass the series of barriers that

are present in this reach. The fish passage barriers in this portion of Richards Creek should be assessed along with the quality and amount of habitat available upstream to determine the relative impacts and benefits of creating better chinook and other listed fish access to the upper reaches of this creek at all flows. This reach was not surveyed fully during the 2008 spawning season.

Reach 1

Reach 1 is a well-shaded, densely vegetated (willow), meandering stream channel. It has good floodplain connection and a great supply of small woody debris. Reach 1 has some areas with good spawning gravel/cobble substrates, in addition to the sand/ gravel substrate that dominates. The reach has a good riparian buffer along both stream banks as it passes through the private properties of Bosta Marine, to the reach end at the culvert at SML Insurance. Very little spawning has been recorded in this area, presumably due to the fish passage barriers further downstream.

Reach 2 and 3

Figure 38. Habitat in Reaches 2 and 3 of Richards Creek.

Reaches 2 and 3 extend upstream to the culvert at Kamber Road. This section of Richard's Creek and East Creek has similar vegetative cover and riparian buffer as Reach 1. Reaches 2 and 3 have poor spawning substrate, consisting of almost entirely sand and silt deposits. There are a few large logs in-stream that create habitat complexity, providing pools for numerous cutthroat trout that utilize this reach.

Reach 4

Reach 4 begins at the Kamber Road bridge, and continues upstream through commercial properties to the confluence with Sunset Creek. Riparian vegetation and stream condition varies

greatly from a gravel/cobble channel dominated with a canopy of Himalayan Blackberry; to a well-shaded scrub/shrub, incised, clay/slit lined channel; to a low velocity glide dominated channel that is confined by bank armor (rip-rap) and concrete walls. Habitat comments are limited for this reach, as it was only walked once during the 2008 spawning season.

The following habitat details are from the 2005 Salmon Spawner Survey Report (TWC 2005). Upstream of Kamber Road, in a heavily armored (rip-rap) channel, Reach 4 contains very dense vegetation (ivy, Himalayan Blackberry, and bittersweet nightshade) to the downstream end of the braided sections of East Creek. East Creek's braided channels are incised down to clay and silt, providing no suitable spawning habitat. Further upstream, Reach 4 becomes constricted with high rip-rap armored banks and a narrow riparian buffer. Overall channel conditions are extremely poor, with little if any riparian buffer to the confluence with Sunset Creek.

It is unlikely that any spawning occurs in Reach 4 due to poor and fragmented stream habitat. This reach of Richard's Creek/East Creek could benefit from numerous stream enhancement projects.

Coal Creek

Figure 39. Typical habitat in Coal Creek (between I-405 and Coal Creek Parkway).

The 1.5 mile index reach of Coal Creek, upstream from I-405 to Coal Creek Parkway, generally has a healthy riparian buffer with a primarily deciduous canopy. Large conifers and a dense understory of willow, red alder and various fern species buffer the stream from the nearby Coal Creek Parkway. This riparian vegetation provides good instream cover and shading. Substrate

ranges from pea-sized gravels to large cobble. There are areas suitable for both coho and chinook spawning in addition to juvenile rearing and overwintering habitat.

There are only a few residential properties in the lower third of the Coal Creek index reach, having very little impact on the stream's riparian buffer or instream condition. Coal Creek is a great example of a meandering and dynamic system. Past restoration efforts included the placement and anchoring of LWD instream throughout much of the upper index reach. These log structures are allowing gravel and small wood/debris to accumulate, thereby benefiting salmonids by providing refuge habitat and habitat complexity (Figure 39).

7. RECOMMENDATIONS

Opportunities for salmon and habitat enhancement projects are limited throughout the Kelsey Creek system, due to a combination of private land ownership, utility corridors, and urban infrastructure. Despite these challenges, the need for enhancement and restoration is essential for the spawning and rearing success of salmon. Many of the most basic enhancement projects could involve widening the riparian buffer, removing invasive plants, installing large wood or log structures in the channel, removing armor to soften streambanks, or widening the floodplain/meandering the stream. These types of restoration projects would primarily address three (altered sediment transport processes, loss of channel complexity, and degradation of riparian condition) of the six factors of decline identified earlier.

Physical habitat restoration targeting the stream channel and riparian corridor in the Kelsey Creek mainstem should prioritize areas crossing public lands, or land owned by single large property owners. For example, stream habitat enhancement in Reaches A – 1 should receive a high priority because the land is publicly owned and the riparian area is already in relatively good condition. A great deal of spawning effort occurred in these reaches in 2007 and 2008, and spawning habitat should be protected and enhanced where possible. It is likely that 63% of the 2008 Chinook salmon production was lost due to redd scour and sedimentation in upper sections of Reach A. Stabilization of the stream bed using large woody debris (LWD) in the higher gradient areas of Reach A-1 just east of the Kelsey farm could potentially reduce future losses to scour. Similarly, use of LWD in the lower gradient wetland areas could be used to inhibit spirea encroachment on the channel, beaver access to critical areas, and provide more energy to the channel during high flow events. However, addition of LWD in the wetlands should be done outside of the current channel to avoid creating sediment traps. The power line crossing/utility corridor in Reach 6 is another area that should be considered an enhancement priority. This undeveloped utility corridor parallels a lengthy stretch of Reach 6 that was a popular spawning area in 2006 and 2008. It is relatively protected and would be a good candidate for habitat enhancement.

In addition to habitat enhancement projects on public lands, a number of restoration opportunities also exist in areas where private landowners would be willing partners in salmon recovery. Fish passage over partial migration barriers (such as beaver dams and concrete grade

control weirs) should be assessed annually. Other important factors like poor water quality and altered hydrology are affected by patterns of land use over large upland areas and must be addressed at the watershed scale. The following list contains general recommendations specific to each area surveyed in 2008.

7.1 Kelsey Creek

1. *Fish Passage:* Prior to the start of the spawning season, the lower Kelsey Creek mainstem should be walked (preferably in August, while the window of opportunity for in-stream work is still open, but after the peak of beaver activity in May and June) from the Richards Creek confluence upstream to Kelsey Park, to locate any impassable debris jams, braided channels, or beaver dams that may impede fish passage at low flow. This is also a great time to monitor the condition of reed canarygrass in and adjacent to the channel, and determine appropriate corrective measures.

   Impassable beaver dams in the lower sections of Kelsey Creek, intermittently prevented migration to the mainstem and West Tributary, even causing fish mortality in 2008. The locations on Kelsey Creek should be assessed for fish passage in early 2008 and may be possible candidates for pond leveling devices.

   a. The suitability for installation of a pond leveling device should be assessed at the beaver dam downstream of the Kelsey Creek/West Tributary confluence. If appropriate, this device should be monitored and maintained throughout the salmon spawning season. Alternatively, the creation and maintenance of a side channel, appropriate for salmon passage during high flow events could greatly reduce returning salmon mortalities at this passage barrier.

   b. A second pond leveling device should be considered at the beaver dam just upstream of the Kelsey Creek/West Tributary confluence, at the site of the pond leveling device that was removed in 2008. Late in the 2008 spawning season, beaver activity increased at this location, creating a small low-flow barrier made primarily of small twigs, grass, and mud. The installation of another pond leveling device may only be a temporary solution for this site. The device will require monitoring and maintenance to keep from filling with excessive amounts of silt and sand (as was the case with the previous device).

      An alternative to this may include a greater stream enhancement and riparian revegetation effort along lower Kelsey Creek that could minimize fish passage issues at both beaver dams. Such a project would provide areas for beaver pond habitat in back water sections of stream, while defining and stabilizing the main Kelsey Creek channel. Adding LWD may aid in the retention of gravelly substrates, while shading the stream and creating habitat complexity. There is much need for non-native plant removal followed by native riparian revegetation at proper densities to keep out the invasive species such as reed canarygrass, jewelweed (*Impatiens sp.*, "policeman's helmet") and Himalayan Blackberry that flourish in this lower section of the creek.

c. The third low-flow passage barrier in Kelsey Creek is at the beaver dam complex in Reach A. Beavers actively worked the dam throughout the 2008 spawning season as seen in Figure 25. The beavers also dammed the side channel that passes to the southeast of the Kelsey Park barn. With an intact riparian buffer, this beaver dam complex provides excellent shade and rearing habitat for juvenile salmonids. Minimal work is needed to ensure fish passage at this site, making it ideal for a pond leveling device or maintenance of a high flow side channel. Installation of a pond leveling device at the main beaver dam would most likely alleviate passage concerns. There is easy access for monitoring and maintenance to this site.

Concrete grade control weirs that are dispersed throughout Reaches 4, 5, and 6 hinder fish passage at low stream flows. A fish passage project designed to address these issues is currently being developed by the City of Bellevue (Kit Paulsen pers. comm. 2008). Two of the higher-priority problem areas are listed below.

a. A concrete grade control structure with a high vertical drop in lower Reach 5 was a partial migration barrier for chinook salmon in 2007 (and likely in 2006 as well). Low salmon abundance inhibited detection of passage problems in 2008. Removal of the weir and bioengineering to even the gradient around the structure and reduce the vertical height of this drop is scheduled for 2010.

b. A series of old concrete weirs and rip-rap banks could be removed from the stream channel where it flows through the Olympic Pipeline / utility corridor in the lower portion of Reach 6. Streambank armoring is causing the stream to down-cut in this area, and is slowly exposing small portions of the underground pipeline. Widening the floodplain in this area will decrease the stream's energy during high flow events and slow down-cutting. Log structures, stream channel modifications, and riparian buffer improvements could all be implemented to alleviate down-cutting and improve stream habitat for fish. Construction in the Olympic Pipeline corridor is scheduled for the summer of 2009.

2. *Smolt Production:* Annual smolt production estimates and emigration timing schedules should be obtained for the Kelsey Creek system. Salmonid smolts could be monitored using a standard fence trap or weir structure located at some point in the Kelsey Creek mainstem downstream from the West Tributary and Richards Creek confluence. Annual production estimates based on juvenile emigration studies for the Kelsey basin would complement spawning escapement information and provide a clearer picture of Kelsey Creek's contribution to overall salmon recovery efforts.

3. *Streambed Scour and Sediment Transport:* A sediment transport and gravel scour study should be conducted in the Kelsey Creek mainstem to assess the effects of development, stormwater runoff, and high stream discharge on spawning substrates and sediment transport in this urban stream system. This information could be used to prioritize locations for stream restoration and fish passage efforts.

4. *Augmentation of Large Wood:* Pieces of strategically placed large wood or log structures should be placed throughout Kelsey Creek. Several locations, especially in Reach A, 1, 3, 4 , 6 and 7 are ideal locations for stream enhancement. The addition of log structures in and around the incised mud/clay channel sections would aid in gravelly substrate retention/collection, minimize additional channel incision, aid in stream shading, accumulate small/large wood and debris, and create habitat complexity. Large pieces of wood with intact root wads properly pinned or buried so they would be less likely to float downstream during high flows and block culverts resulting in potential damage to public and private property.

    a. Some larger key logs or structures buried in Reaches A and 1 may help retain/slow gravel substrates that appear to be moving quickly through these reaches. Due to the influx of gravel substrates and the high quality of the riparian corridor, this area of Kelsey Creek is a good candidate for enhancement using pieces of large wood or log structures within the channel. Additional pieces of LWD could be used to supplement areas currently deficient in overhead cover for spawning fish.

    b. In Reach 2, the installation of low-lying log structures, slightly increasing the width of the riparian zone, planting the riparian zone with a variety of low-growing shrub species, and even excavating some small meanders in the channel would vastly improve the stream habitat conditions for fish without impacting golfers' line-of-sight or impairing their access to the course. Implementing these habitat improvements would help convert the reach from a long, straight run into a more complex area with pools, riffles, overhead cover, and suitable spawning gravels.

5. *Riparian Plantings:* Riparian buffers should be widened and vegetation should be enhanced throughout the survey area, especially along areas of Reaches 2, 3, 4 and 6. Non-native invasive species like Himalayan Blackberry and Japanese knotweed should be removed in these areas, and replanted with proper densities of native riparian species.

6. *Reduce Armoring:* Rip-rap armoring and concrete grade control structures in selected stream segments should be removed and bioengineering techniques should be used to address bank erosion and prevent property damage. Rip-rap and other streambank armoring techniques are present throughout the survey reach, but are exceptionally dense in Reaches 4, 5 and 6. Stream channel and riparian area restoration work could be conducted in many areas of Reach 6 without impacting commercial or residential property.

7. *Survey Additional Areas:* Spot surveys should be conducted along Goff Creek and Valley Creek during peak spawning periods to get estimates of fish use in this portion of the watershed.

8. *Water Quality Monitoring:* Water temperature and heavy metal concentrations should be monitored throughout the Kelsey Creek system (including the West Tributary and Richards Creek) to record spatial and temporal fluctuations and assess their effects on salmonids inhabiting the creek. Such data may be useful in answering questions about urban pre-

spawn mortality in chinook and coho salmon. Improvements in the City of Bellevue's stormwater quality may improve spawning success further downstream. It is possible that the same cause(s) for pre-spawn mortality may also be affecting juvenile salmonids throughout the watershed. Investigation into and improvements in water quality may prove beneficial to multiple species and life stages.

9. *Pre-spawn mortality study:* Chinook and coho pre-spawn mortality rates have risen considerably in past years ranging from 39-79% in some basins (for coho in Fauntleroy and Thornton Creeks respectively) (City of Seattle 2007). The City of Bellevue should be encouraged to continue collecting pre-spawn mortality data and potentially additional data and/or biological samples that may contribute to existing research aimed at isolating the cause.

7.2 West Tributary

1. *Augmentation of Large Wood:* Pieces of strategically placed large wood or log structures should be placed throughout Reach 1 and Reach 4. These structures would help add stream meander, increase habitat complexity and retain spawning gravels.

2. *Bioengineering and Riparian Plantings:* Riparian buffers should be widened and riparian vegetation should be enhanced along Reach 4. Rip-rap armoring along selected streambanks in Reach 4 should be removed and bioengineering techniques should be used in these areas to address bank erosion. Installing some low-lying log structures, slightly increasing the width of the riparian zone, removing Himalayan Blackberry, planting the riparian zone with a variety of low-growing native shrub species, and even excavating some small meanders in the channel would vastly improve the stream habitat conditions for fish without impacting golfers' line-of-sight or impairing their access to the course. Implementing these habitat improvements would help increase habitat complexity, while strengthening streambanks and slowing the rate of soil erosion.

3. *Stream side clean up:* Small isolated areas along Reach 1 have been used for trash dumping in the past. Trash continues to move downstream after each high water event. Community or salmon watcher volunteers may be interested in doing a day of stream side clean up. Areas through Reaches 2 and 3 can also be spot checked for unneeded trash that may hinder park aesthetic and restoration success.

7.3 Richards Creek

1. *Fish Passage:* Lower Richards Creek, from the Kelsey Creek confluence up to Bannerwood Park, should be screened for fish migration barriers prior to the spawning period in 2008. These natural fish migration barriers should be monitored, but perhaps not breeched, as they redirect spawning fish into the Kelsey Creek mainstem where better spawning habitat is available.

2. *Augmentation of Large Wood:* Pieces of strategically placed large wood or log structures should be placed throughout the Confluence Reach. This reach has a good riparian buffer with plenty of canopy cover that provides great juvenile rearing and a good migration corridor. The addition of log structures in the stream channel could aid in collecting (the minimal supply of) gravelly substrate, minimize channel incision, accumulate small/large wood and debris, and create habitat complexity. Gravel supplementation would benefit the chinook that attempt to spawn in this reach during times of low flows when upstream passage is not possible (due to beaver dam passage barriers).

7.4 Coal Creek

1. *Survey Additional Areas:* Bi-weekly surveys should be conducted along Coal Creek throughout the chinook and coho salmon runs to get estimates of fish use in this portion of the watershed. Recent stream restoration at the mouth of Coal Creek (to improve migratory conditions, bank stabilization and general habitat improvement upstream of I-405) should be monitored in future years to assess the effectiveness of those activities.

2. *Water Quality Monitoring:* Water temperature and heavy metal concentrations should be monitored throughout the Coal Creek to record spatial and temporal fluctuations and assess their effects on salmonids inhabiting the creek. Such data may be useful in answering questions about urban pre-spawn mortality in chinook and coho salmon.

3. *Riparian Planting*: Plant conifers in the riparian buffer to increase future natural recruitment of LWD and diminish the need for costly restoration efforts designed to hold gravel substrate in place and accumulate additional wood/debris instream.

REFERENCES

Ames, J. 1984. Puget Sound chum salmon escapement estimates using spawner curve methodology. Can. Tech. Rep. fish Aquat. Sci. 1326: 133-148.

Beauchamp D.A., Vecht, S.A., and Thomas, G.L. 1992. Temporal, spatial, and size-related foraging of wild cutthroat trout in Lake Washington. Northwest Science 66, 149-159.

Berge, H.B., M.L. Hammer, and S.R. Foley. 2006. Timing, abundance, and population characteristics of spawning chinook salmon in the Cedar/Sammamish Watershed. Technical report by the King County Department of Natural Resources and Parks and the Washington Department of Fish and Wildlife.

City of Seattle. 2007. State of the Waters Report, Volume 1: Seattle Water courses.

Dunham, J.B., B. Rieman, and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fisheries Management 21:343-352.

Hahn, P.K.J. 2001. Washington State Chinook Salmon Spawning Escapement Assessment in the Stillaguamish and Skagit Rivers 1998. Report to U.S. CTC and U.S. NMFS. WA. Dept. of Fisheries, Olympia, WA.

Hahn, P.K.J., M. C. Mizell, C. Kraemer, and P. Castle. 2003. Assessment of chinook salmon redd life and spawner escapement in the Skagit, Stillaguamish, and Snohomish River systems, 2001. Report to U.S. CTC and U.S. NMFS. WA. Dept. of Fisheries, Olympia, WA.

Hahn, P.K.J. 1998. Stillaguamish River Chinook Salmon Assessment. Hahn Biometric Consulting Report #027A, Wash. Dept. Fish & Wildlife, Olympia, WA 98501-1091. August 28, 1998.

Hilborn, R., B.G. Bue and S. Sharr. 1999. Estimating Spawning Escapements from Periodic Counts: A Comparison of Methods. Can. J. Fish. Aquat. Sci. 56: 888-896.

Holt, K.R., and S.P. Cox. 2008. Evaluation of visual survey methods for monitoring Pacific salmon (*Oncorhynchus* spp.) escapement in relation to conservation guidelines. Can. J. Fish. Aquat. Sci. 65: 212-226.

Johnson, D.H. and T.A. O'Neil (Eds.). 2001. Wildlife-Habitat Relationships in Oregon and Washington. Corvallis: Oregon State University Press.

Kerwin, J. 2001. Salmon and Steelhead Habitat Limiting Factors Report for the Cedar-Sammamish Basin (Water Resource Inventory Area 8). Washington Conservation Commission. Olympia, Wa.

Lady, J.M., and J.R. Skalski. 1998. Estimators of Stream Residence Time on Pacific Salmon (*Oncorhynchus* spp.) Based on Release-recapture Data. Can. J. Fish. Aquat. Sci. 55: 2580-2587.

McCarthy, S.G., J.P. Incardona, and N.L. Scholz. 2008. Coastal Storms, Toxic Runoff, and the Sustainable Conservation of Fish and Fisheries. American Fisheries Society Symposium 64.

Mitchell, S.C. and R.A. Cunjak. 2007. Stream flow, salmon and beaver dams: roles in the structuring of stream fish communities within an anadromous salmon dominated stream. Journal of Animal Ecology, 76: 1062-1074.

Moscrip, A.J. and D.R. Montgomery. 1997. Urbanization, flood frequency, and salmon abundance in Puget Lowland streams. Journal of American Water Resources 33: 1289-1297.

Orrell, R. 1976. Skagit Chinook Race Differentiation Study. Project Completion Report to National Marine Fisheries Service, Project No. 1098-R, Washington Dept. of Fisheries, Olympia, WA.

Puget Sound Technical Recovery Team (PSTRT). 2001. Independent populations of chinook salmon in Puget Sound. Puget Sound TRT Review Draft. 52 p.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. University Press, Seattle. 320 P.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-78, 125 p.

Schlosser I.J. 1995. Dispersal, boundary processes, and trophic-level interactions in streams adjacent to beaver ponds. Ecology, 76(3): 908-925.

Shardlow, T. 2004. Using Time-Lapsed Video to Estimate Survey Life for Area-under-the-Curve Methods of Escapement Estimation. North American Journal of Fisheries Management, 24: 1413-1420.

Smith, C. and P. Castle. 1994. Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*) Escapement Estimates and Methods – 1991. Northwest Fishery Resource Bulletin. Project Report Series No. 1.

Scott, J.B., C.R. Steward, and Q.J. Stober. 1986. Effects of urban development on fish population dynamics in Kelsey Creek, Washington. Transactions of the American Fisheries Society 115:555-567.

Taylor Associates. 2002. Kelsey Creek and Tributaries 2001 Spawner Surveys – Final Report. Prepared for the City of Bellevue, WA. 13p.

The Watershed Company. 2008. Salmon Spawner Survey: Kelsey Creek and Tributaries 2007—Final Report. Prepared for the City of Bellevue, WA. 52p.

The Watershed Company. 2007. Salmon Spawner Survey: Kelsey Creek and Tributaries 2006—Final Report. Prepared for the City of Bellevue, WA. 50p.

The Watershed Company. 2006. Salmon Spawner Survey: Kelsey Creek and Tributaries 2005—Final Report. Prepared for the City of Bellevue, WA. 35p.

The Watershed Company. 2005. Salmon Spawner Survey: Kelsey Creek and Tributaries 2004—Final Report. Prepared for the City of Bellevue, WA. 35p.

The Watershed Company. 2004. Salmon Spawner Survey: Kelsey Creek and Tributaries 2003—Final Report. Prepared for the City of Bellevue, WA. 29p.

The Watershed Company. 2003. Salmon Spawner Survey: Kelsey Creek and Tributaries 2002—Final Report. Prepared for the City of Bellevue, WA. 14p.

Thorstad, E.B., F. Økland, K. Aarestrup, and T.F. Heggberget. 2008. Factors affecting the within-river spawning migration of Atlantic salmon, with emphasis on human impacts. Rev. Fish. Biol. Fisheries, 18:345-371.

U.S. Federal Register Volume 70, No. 123, 28 June 2005, Final rule. Endangered and Threatened Species: Final listing determinations for 16 ESUs of West coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs - *Oncorhynchus tshawytscha*.

U.S. Federal Register Volume 64, No. 56, 24 March 1999, Final rule. Endangered and Threatened Species: Threatened status for three chinook salmon evolutionarily significant units (ESUs) in Washington and Oregon, and Endangered status for on chinook salmon ESU in Washington - *Oncorhynchus tshawytscha*.

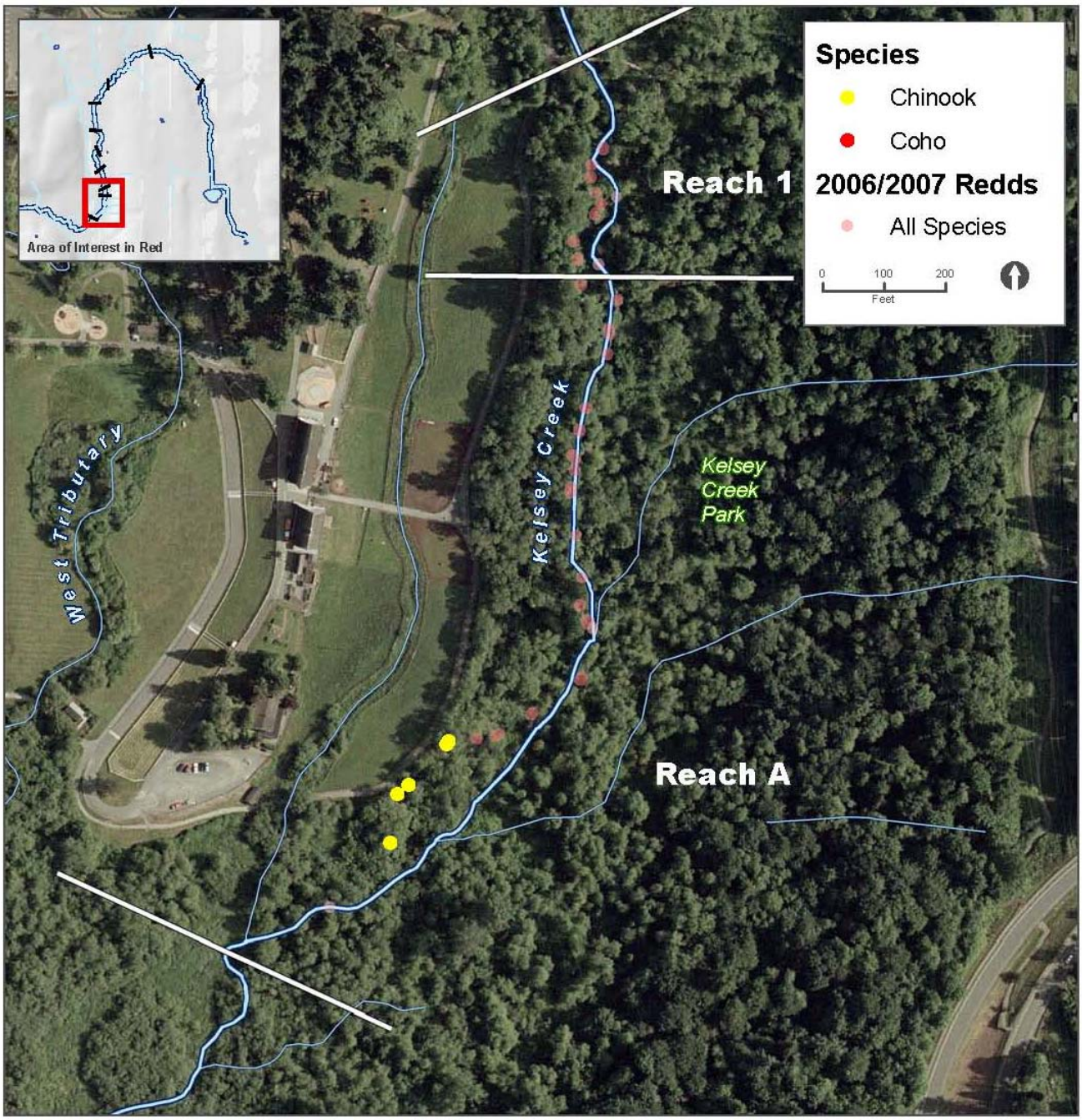
Warheit, K.I. and C.M. Bettles. 2005. Genetic characterization of chinook salmon (*Onchorhynchus tshawytscha*) populations within Watershed Resource Inventory Area 8 (WRIA 8), Washington State. Draft report. Genetics Laboratory, Department of Fish and Wildlife, Olympia, WA.

Washington Department of Fish and Wildlife and Puget Sound Indian Tribes (WDFW/PSIT). 2004. Comprehensive Management Plan for Puget Sound Chinook. Harvest Management Component, Annual Postseason Report 2003-04 Fishing Season.

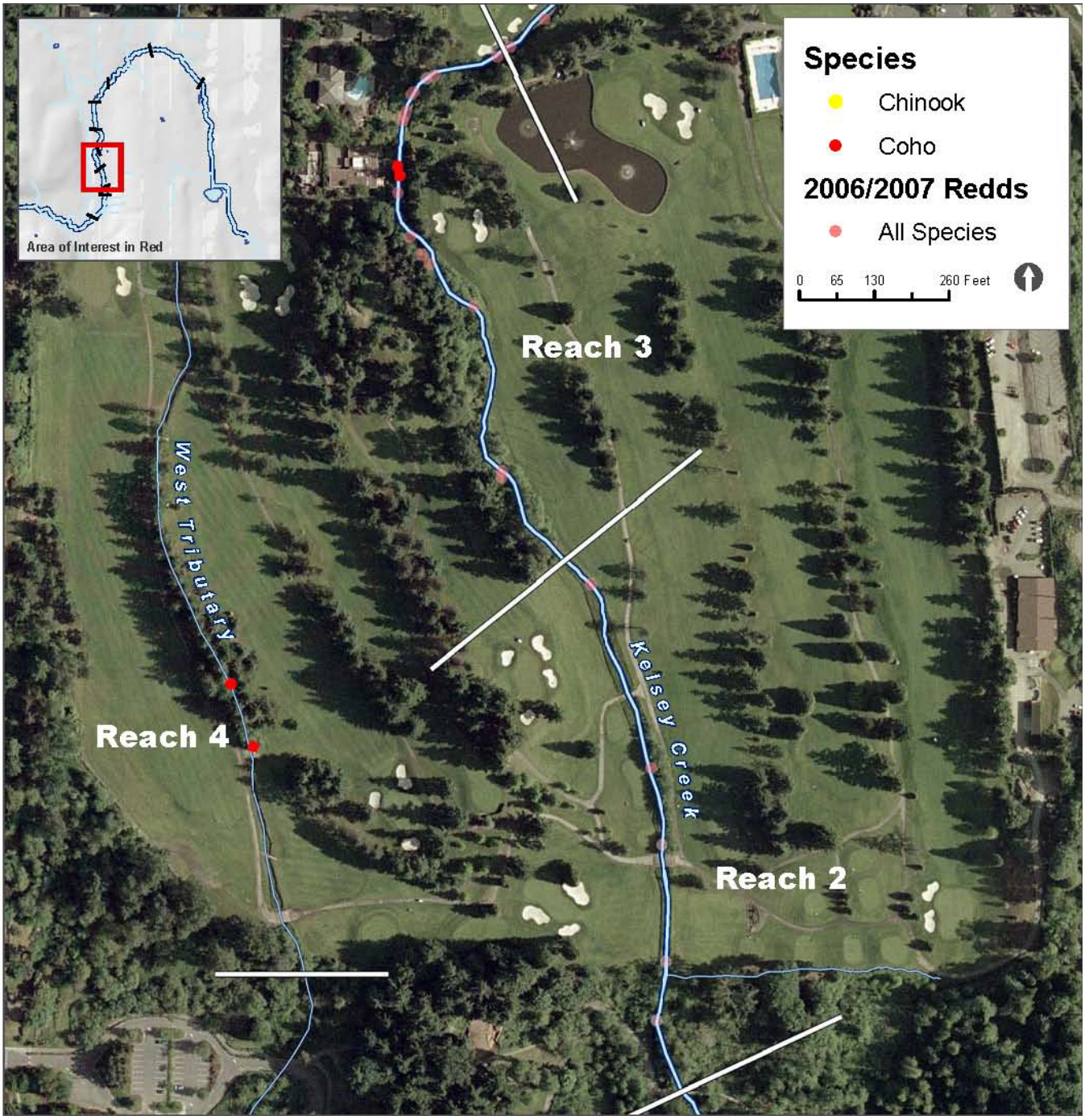
Washington Trout. 2001. Kelsey Creek Salmon Spawning Surveys from September 18, 2000 through December 11, 2000 – Final Report. Prepared for the City of Bellevue, WA. 12p.

WRIA 8 Steering Committee. 2002. Lake Washington/Cedar/Sammamish Watershed (WRIA 8) Near-Term Action Agenda for Salmon Habitat Conservation. Seattle, WA.

Appendix A
Kelsey Creek Redd Distribution Maps

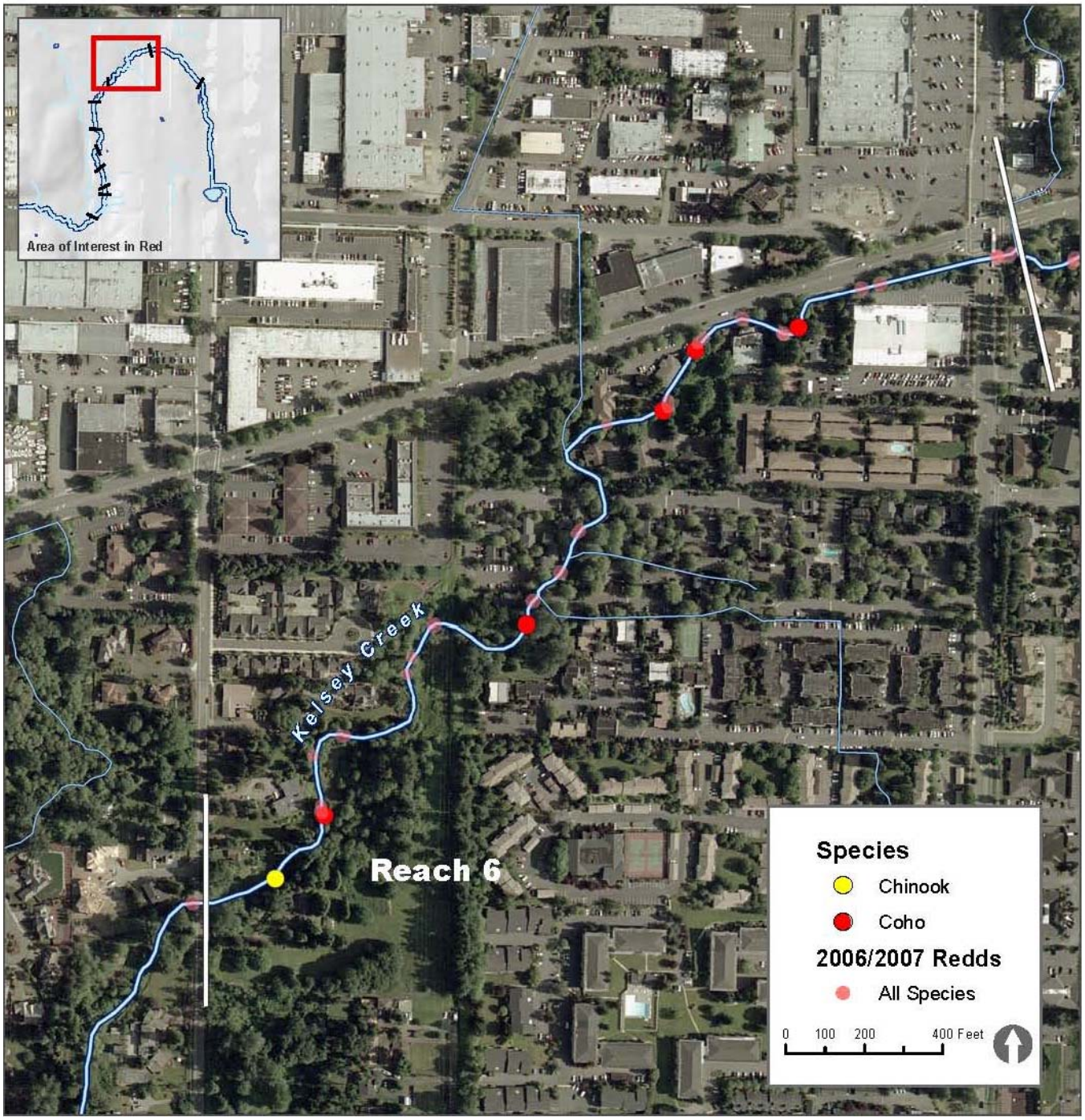


Appendix A-1. Aerial view of Kelsey Creek Reaches A and 1 showing reach breaks, 2008 redd distribution and 2006/2007 redd distribution comparison.



Appendix A-2. Aerial view of Kelsey Creek Reaches 2 and 3 showing reach breaks, 2008 redd distribution and 2006/2007 redd distribution comparison.

Appendix A-3. Aerial view of Kelsey Creek Reaches 4 and 5 showing reach breaks, 2008 redd distribution and 2006/2007 redd distribution comparison.



Appendix A-4. Aerial view of Kelsey Creek Reach 6 showing reach breaks, 2008 redd distribution and 2006/2007 redd distribution comparison.

Appendix A-5. Aerial view of Kelsey Creek Reach 7 showing reach breaks, 2008 redd distribution and 2006/2007 redd distribution comparison.

Appendix B
2008 Spawner Survey Data:

- **Kelsey Creek**
- **West Tributary**
- **Richards Creek**
- **Coal Creek**

Stream	Observation Date	Measurements Made (Y / N)	Species	Reach Number	Spawner(S), Carcass(C)	Sex (M/F/U)	Adipose fin clipped (Y / N / U)	Total length (cm)	Fork length (cm)	POH (cm)	Body Depth (cm)	Cut off lower jaw (Y / N)	Coloration (Ocean, Partial,or Spawner)	% egg retention	Pre-spawn mortality (Y / N / U)	Estimated time since death (days)	Scale samples collected (Y / N)	Genetic sample collected (Y / N)	Genetic sample number	Fish observation comments
Beaver dam	10/10/08	n	chinook		S	F	Y						P							passed above the dam - did not look like she would live long or spawn
Beaver dam	10/14/08	n	chinook		S	M	Y						S							moving upstream through reed-canary grass adjacent to the Spiraea by-passing the beaver dam
Kelsey	9/22/08	n	chinook	A	S	U	Y						O							@ debris jam
Kelsey	9/22/08	n	chinook	A	S	U	Y						O							@ debris jam with other fish, both fish were probably males
Kelsey	9/22/08	n	chinook	2	S	M	Y						O							@ reach break between reaches 1 & 2, first observed at bridge and confirmed about 50 yards upstream
Kelsey	9/22/08	n	chinook	2	S	M	Y						O							@ reach break between reaches 1 & 2, first observed at bridge and confirmed about 50 yards upstream
Kelsey	9/22/08	n	chinook	3	S	U	Y						O							@ the second bend past the high bridge near reach breaks 2-3, holding next to rip-rap boulders
Kelsey	9/22/08	n	chinook	5	S	U	U						O							@ the new bridge holding in the deep water next to the rip-rap east shore.
Kelsey	9/29/08	n	chinook	A	S	M	U						P							near redd & practice redd, large male
Kelsey	9/29/08	n	chinook	A	S	M	Y						O							near redd & practice redd, moderate body sized male
Kelsey	9/29/08	n	chinook	A	S	F	Y						O							near redd & practice redd, small female
Kelsey	9/29/08	n	chinook	A	S	F	N						O							
Kelsey	9/29/08	n	chinook	6	S	F	Y						P							on redd
Kelsey	9/29/08	n	chinook	6	S	F	U						P							test redd under cedar tree
Kelsey	9/29/08	n	chinook	6	S	M	Y						P							test redd under cedar tree
Kelsey	10/06/08	n	chinook	A	S	M	U						S							Located at redd #03 - fairly beat up, looked like he was one of the fish observed the previous week
Kelsey	10/13/08	n	chinook	A	S	M	Y													
Kelsey	10/13/08	n	chinook	A	S	M	U													
Kelsey	10/13/08	n	chinook	A	S	M	U													
Kelsey	10/13/08	n	chinook	A	S	M	Y													
Kelsey	10/20/08	n	chinook	4	S	F	U						P							Vigorous, fresh fish - likely built redd #008, however we did not observe a carcass or male fish in the
Kelsey	11/17/08	n	coho	4	S	F	U						P							on redd #09
Kelsey	11/17/08	n	coho	4	S	U	U						P							upstream of redd #09 in a large pool
Kelsey	11/17/08	n	coho	6	S	U	U						NA							just upstream of no access property in reach 6, under brush
Kelsey	11/24/08	n	coho	4	S	U	U						NA							in large pool upstream of redd #009 - quick tail slap, then it swam downstream
Kelsey	12/2/08	n	coho	3	S	M	U						P							Jack
Kelsey	12/15/08	n	coho	6	S	M	U													on redd #15
Kelsey	12/15/08	n	coho	6	S	F	U													on redd #15
Richards	10/1/08	n	chinook	Conf	S	F	Y						P							
Richards	10/15/08	n	chinook	Conf	S	F	Y						P							on test redd, below the first small beaver dam
Richards	10/15/08	n	chinook	Conf	S	M	Y						S							upstream the barrier beaver dam
Richards	10/15/08	n	chinook	Conf	S	M	Y						S							upstream the barrier beaver dam
Richards	10/15/08	n	chinook	Conf	S	M	Y						S							upstream the barrier beaver dam
Richards	10/15/08	n	chinook	Conf	S	U	U						S							upstream the barrier beaver dam
Richards	10/15/08	n	chinook	Conf	S	M	U						P							upstream of the beaver leveler, just downstream of the culvert at the reach break before the beaver
West Trib	9/30/08	n	chinook	3	S	F	N						P							in sediment pond
West Trib	9/30/08	n	chinook	3	S	M	U						P							in sediment pond
West Trib	10/14/08	n	chinook	4	S	M	Y						S							
West Trib	10/22/08	n	chinook	3	S	M	Y						S							in sediment pond
West Trib	12/15/08	n	coho	3	S	U	U						P							in sediment pond

Appendix C
Carcass Measurements:

- **Kelsey Creek**
- **West Tributary**
- **Richards Creek**
- **Coal Creek**

Stream	Observation Date	Measurements Made (Y / N)	Species	Reach Number	Spawner(S), Carcass(C)	Sex (M/F/U)	Adipose fin clipped (Y / N / U)	Total length (cm)	Fork length (cm)	POH (cm)	Body Depth (cm)	Cut off lower jaw (Y / N)	Coloration (Ocean, Partial,or Spawner)	% egg retention	Pre-spawn mortality (Y / N / U)	Estimated time since death (days)	Scale samples collected (Y / N)	Genetic sample collected (Y / N)	Genetic sample number	Fish observation comments
Beaver dam	10/10/08	n	chinook		C	F	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	M	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	U	U								Y	3				
Beaver dam	10/10/08	n	chinook		C	U	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	M	Y								U	>7				
Beaver dam	10/10/08	n	chinook		C	F	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	F	Y								Y	3				
Beaver dam	10/10/08	n	chinook		C	U	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	U	Y								U	>7				
Beaver dam	10/10/08	n	chinook		C	M	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	U	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	M	Y								U	>7				
Beaver dam	10/10/08	n	chinook		C	M	Y								U	>7				
Beaver dam	10/10/08	n	chinook		C	F	U								U	>7				
Beaver dam	10/10/08	n	chinook		C	F	U								U	>7				
Coal creek	12/3/08	y	coho		C	M	Y	66.0	63.5	49.0	15.0	Y	S	NA	U	5	Y	N	NA	No CWT, full gonads
Coal creek	12/11/08	n	coho		C	F	U	NA	NA	NA	10.0	N	P	0	N	9	Y	N	NA	unable to scan snout, no head or tail
Coal creek	12/11/08	n	coho		C	M	Y	NA	NA	NA	12.0	N	S	NA	U	3	Y	N	NA	unable to scan snout, no head
Coal creek	12/19/08	y	cutthroat		C	F	N	53.0	52.0	42.0	11.0	Y	O	100	Y	0	Y	N	NA	no CWT, pre-spawn mortality, large adfluvial cutthroat
Kelsey	9/29/08	y	chinook	A	C	F	Y	97.0	92.0	73.0	21.0	Y	O	0*	Y	3	Y	N	NA	*eggs were eaten by a predator - considered to be a pre-spawn mortality
Kelsey	9/29/08	n	chinook	7	C	U	U	NA	NA	NA	NA	NA	P	NA	NA	NA	N	N	NA	located 5-10' above confluence/Valley Ck. Just a sack of skin and a few bones present
Kelsey	10/06/08	y	chinook	6	C	F	Y	88.0	85.0	69.0	17.0	Y	S	0	N	3	Y	N	NA	@ redd #04 (scale card 1, cells 1 & 2)
Kelsey	10/06/08	y	chinook	6	C	F	Y	89.5	86.5	71.0	19.0	Y	S	1	N	1	Y	N	NA	CWT present - snout retained (scale card 1, cells 3 and 4) located @ the redd under the Cedar tree #06
Kelsey	10/06/08	n	sockeye	A	C	M	U	NA	NA	NA	NA	NA	P	NA	NA	NA	N	N	NA	Predated sockeye male, head only left, found at the beginning of the survey reach
Kelsey	10/13/08	y	chinook	A	C	F	N	87.0	85.5	67.0	16.0	Y	S	0	N	5	Y	N	NA	snout was mostly eroded, did scan for CWT though, caudal peduncle was beaten up
Kelsey	10/27/08	y	chinook	4	C	F	Y	82.0	81.0	67.5	13.0	Y	S	0	N	4	Y	N	NA	female found at the large redd #08 first observed the previous week. Probably the live fish we observed
Kelsey	11/17/08	y	chinook	6	C	M	N	47.0	46.0	39.4	7.6	Y	S	NA	Y	<1	Y	N	NA	predation - pre-spawn mortality
Kelsey	12/15/08	y	cutthroat	4	C	M	N	24.0	23.0	19.0	4.5	Y	O	NA	Y	2	N	N	NA	37 degrees F, gonads fully developed - pre-spawn mort.
Kelsey	12/15/08	n	cutthroat	5	C	U	U						O	NA	U	1	N	N	NA	
Richards	10/1/08	y	chinook	Conf	C	M	N	95.0	90.0	68.0	18.0	Y	P	NA	NA	4	Y	N	NA	
Richards	10/1/08	y	chinook	Conf	C	M	Y	103.0	99.0	75.0	21.0	Y	P	NA	Y	3	Y	N	NA	CWT present - snout retained (scale card 1, cells 3 and 4)
Richards	10/1/08	n	chinook	Conf	C	U	U	NA	NA	NA	NA	NA	P	NA	NA	NA	N	N	NA	predation - carcass found on the barrier beaver dam (still impassable)
Richards	10/15/08	y	chinook	Conf	C	F	Y	82.5	77.5	62.0	15.5	Y	S	60	Y	2	Y	N	NA	Predated - found on bank adjacent to the pond leveler, eggs were scattered, some wear on caudal
Richards	10/24/08	y	chinook	Conf	C	M	N	103.5	102.0	81.5	20.5	Y	S	NA	Y	2	Y	N	NA	predated, length is best estimate because vertebrate was snapped
Richards	10/24/08	n	chinook	Conf	C	F	NA	NA	NA	NA	NA	Y	NA	NA	NA	1	N	N	NA	predated, no scales taken, only the head was recovered
Richards	10/24/08	y	chinook	Conf	C	F	Y	94.0	92.5	72.0	19.0	Y	S	60	Y	2	Y	N	NA	predated, found on the right bank w/eggs scattered, no tail wear (caudal peduncle looked good)
Richards	12/10/08	n	coho	1	C	F	U	NA	NA	NA	NA	N	P	NA	NA	NA	N	N	NA	carcass lost under bank/debris jam

Stream	Observation Date	Measurements Made (Y / N)	Species	Reach Number	Spawner(S), Carcass(C)	Sex (M/F/U)	Adipose fin clipped (Y / N / U)	Total length (cm)	Fork length (cm)	POH (cm)	Body Depth (cm)	Cut off lower jaw (Y / N)	Coloration (Ocean, Partial,or Spawner)	% egg retention	Pre-spawn mortality (Y / N / U)	Estimated time since death (days)	Scale samples collected (Y / N)	Genetic sample collected (Y / N)	Genetic sample number	Fish observation comments
West Trib	9/23/08	y	chinook	1	C	F	Y	87.0	85.0	69.0	19.0	Y	P	1	Y	5	Y	N	NA	predation
West Trib	9/23/08	y	chinook	1	C	F	Y	86.0	85.0	69.0	16.5	Y	O	0	Y	4	Y	N	NA	predation
West Trib	9/23/08	y	chinook	1	C	F	Y	84.0	82.0	65.0	19.0	Y	P	100	Y	0	Y	N	NA	stranded
West Trib	9/23/08	y	chinook	2	C	F	Y	85.0	82.0	67.0	17.5	Y	P	100	Y	0	Y	N	NA	stranded - CWT present - snout retained (scale card 1, cells 7 and 8)
West Trib	9/23/08	y	chinook	3	C	F	Y	87.0	84.0	67.0	19.0	Y	P	100	Y	0	Y	N	NA	predation
West Trib	9/23/08	y	chinook	4	C	F	Y	88.0	87.0	70.0	19.0	Y	O	100	Y	1	Y	N	NA	predation - @ last 100 yards of golf course
West Trib	9/30/08	y	chinook	4	C	F	Y	82.0	78.0	62.0	15.0	Y	P	0	NA	6	Y	N	NA	predation - @ last 100 yards of golf course
West Trib	9/30/08	y	chinook	4	C	M	N	79.0	76.0	60.0	17.0	Y	S		Y	6	Y	N	NA	milt still present - @ last 100 yards of golf course
West Trib	10/7/08	y	chinook	1	C	F	Y	84.5	80.0	65.0	16.5	Y	S	0*	Y	1	Y	N	NA	*eggs were eaten by a predator - predation
West Trib	10/7/08	y	chinook	4	C	M	N	72.0	70.0	57.0	14.0	Y	S	NA	Y	4	Y	N	NA	milt still present
West Trib	10/7/08	y	chinook	4	C	M	U	98.0	94.0	76.5	16.0	Y	S	NA	NA	7	Y	N	NA	no snout - not scanned for a CWT
West Trib	10/14/08	y	chinook	3	C	M	N	52.5	51.0	39.0	9.5	Y	S	NA	Y	5	Y	N	NA	
West Trib	10/22/08	y	chinook	4	C	M	Y	107.0	101.0	86.0	21.0	Y	S	NA	Y	6	Y	N	NA	all milt still present, partially predated post mortality
West Trib	10/22/08	y	chinook	4	C	M	Y	101.5	98.5	76.0	19.0	Y	S	NA	Y	2	Y	N	NA	all milt still present
West Trib	11/3/08	y	chinook	3	C	M	Y	108.0	104.0	82.0	20.0	Y	S	NA	NA	5	Y	N	NA	carcass was mostly eaten
West Trib	11/3/08	y	chinook	4	C	M	Y	51.0	48.5	38.0	11.0	Y	S	NA	Y	1	Y	N	NA	jack

Appendix D
2008 Redds:

- **Kelsey Creek**
- **West Tributary**
- **Richards Creek**
- **Coal Creek**

Redd Number	Stream	Observation Date	Species	Reach Number	Fish on Redd (Y / N)	M/F/Both	Redd Length (feet)	Redd Width (feet)	Redd pit Depth (feet)	Redd mound Depth (feet)	Redd tailspill Depth (feet)	Redd location description
1	Coal	12/03/08	coho		N		2.50	1.50	0.75	0.20	0.50	tail of small pool under some brush ~ 2/3 way up from trash rack
2	Coal	12/03/08	coho		N		4.75	2.25	0.75	0.25	0.50	redd located mid-channel
3	Coal	12/11/08	coho		N		4.00	2.50	0.50	0.33	0.25	upstream redds 1 and 2 ~200 meters
4	Coal	12/19/08	coho		N		3.75	2.75	0.08	0.42	0.42	3' off left bank, just below redd #03
5	Coal	12/19/08	coho		N		3.50	2.00	0.25	0.08	0.25	1' off right bank, down stream of a small log jam, directly below a down log
6	Coal	12/19/08	coho		N		5.50	3.75	1.50	0.25	0.50	one small test towards the left bank, at the tailspill of a pool in the bend of the creek
1	Kelsey	09/29/08	Chinook	A	N		7.00	4.00	1.25	0.50	1.00	
2	Kelsey	09/29/08	Chinook	A	Y	B	4.00	3.00	4.50	1.00	2.50	
3	Kelsey	09/29/08	Chinook	A	Y	F	11.00	6.00	1.25	0.50	1.25	tailspill on a log
4	Kelsey	09/29/08	Chinook	6	Y	F	9.00	5.50	1.50	0.25	0.50	
5	Kelsey	10/06/08	Chinook	A	N		8.50	3.00	1.50	0.75	1.25	left bank near farm trail, older redd probably built prior to rain on Saturday
6	Kelsey	10/06/08	Chinook	6	N		7.50	5.50	2.00	0.25	1.00	left bank located under the cedar tree - test redd with M&F last week - Carcass of female located near redd
7	Kelsey	10/20/08	Chinook	A	N		5.25	3.75	1.50	0.33	0.17	superimposed on redd # 03 on the upside of the log
8	Kelsey	10/20/08	Chinook	4	N		9.00	8.00	1.00	0.17	0.50	above bridge with pvc conduit ~ 100' below reach break between 4&5. Mid-channel. Female located ~50' upstream
9	Kelsey	11/17/08	coho	4	Y	F	5.00	3.50	NA	NA	NA	upstream of weir. Female was actively building redd, scared upstream upon approach.
10	Kelsey	11/17/08	coho	6	N		5.50	4.00	0.75	0.17	0.33	just downstream of no access property in reach 6, under brush.
11	Kelsey	11/24/08	coho	6	N		4.50	3.50	1.00	0.25	0.50	downstream ~15' from large overhanging cedar and bee nest & redd #006, appears to be about 5-7 days old
12	Kelsey	12/15/08	coho	3	N		3.25	2.75	0.75	0.33	0.50	1 m off right bank in front of the house with the terracotta warrior
13	Kelsey	12/15/08	coho	4	N		3.50	2.75	0.75	0.25	0.33	very small, possibly a test redd, upstream of pool above redd #009
14	Kelsey	12/15/08	coho	6	N		3.00	2.00	0.75	0.42	0.50	very small, possibly a test redd?
15	Kelsey	12/15/08	coho	6	Y	B	4.50	3.50	1.00	0.33	0.50	~20 feet upstream from early world restoration site, along the right bank
16	Kelsey	12/23/08	coho	3	N		4.00	3.75	0.75	0.42	0.33	~3m downstream of redd #12, ~3m of the left bank, in front of the house with the terracotta warrior
17	Kelsey	12/23/08	coho	6	N		4.00	2.50	0.50	0.25	0.42	upstream of the second no access property that is a consulting firm/dentist office???
18	Kelsey	12/23/08	coho	7	N		3.00	1.50	0.50	0.25	0.33	more like a test redd…. 1' off the right bank, midway between the downed bridge and coho rearing ponds
1	Richards	10/15/08	Chinook	Conf	Y	B	3.50	5.00	2.00	1.00	0.75	midstream, ~200' upstream of the barrier beaver dam
2	Richards	10/24/08	Chinook	Conf	N		7.00	3.00	1.25	0.75	0.75	along left bank, pit dug down to clay, very little gravel present
1	West Trib	12/16/08	coho	4	N		4.50	3.75	0.75	0.25	0.25	directly under the 2nd bridge in golf course
2	West Trib	12/16/08	coho	4	N		4.50	4.00	0.67	0.17	0.17	under Douglas Firs, upstream ~200 feet from #01 (2 nests)