Nooksack Salmon Enhancement Association

Salmon Spawning Grounds Surveys 2010

Conducted in Selected WRIA 1 Nooksack River and Independent Drainages

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Table of Contents

	Page
Acknowledgements	1
List of Figures	3
List of Tables	4
1.0 Introduction	5
2.0 Methods	6
2.1 Redd Documentation	7
2.2 Carcass Documentation	7
2.3 Live Counts	8
2.4 Survey Reaches	8
3.0 Results	11
3.1 Survey Conditions and Effort	11
3.2 Results by Species	13
3.2.1 Chinook Salmon (*Oncorhynchus tshawytscha*)	14
3.2.2 Coho Salmon (*Oncorhynchus kisutch*)	15
3.2.3 Chum Salmon (*Oncorhynchus keta*)	16
3.2.4 Unknown Salmonids	16
3.3 Results by Reach	17
3.3.1 Terrell Creek	17
3.3.2 Lower Deer Creek	18
3.3.3 Upper Deer Creek	19
3.3.4 Silver Springs Creek	19
3.3.5 Starry Creek	20
3.3.6 Bertrand Creek	20
3.3.7 Lower Fishtrap Creek	21
3.3.8 Upper Fishtrap Creek	22
3.3.9 Lower Anderson Creek	23
3.3.10 Upper Anderson Creek	24
3.3.11 Smith Creek	25
3.3.12 Lower Macaulay Creek	26

3.3.13 Upper Macaulay Creek 27
3.3.14 Mitchell Creek 27
3.3.15 Tawes Creek 28
3.3.16 Tinling Creek 29
3.3.17 Landingstrip Creek 29
3.3.18 Tributary of Landingstrip Creek 30
3.3.19 Squalicum Creek 31
3.3.20 Padden Creek 31
4.0 Discussion 32
4.1 Data Limitations and Caveats 32
4.2 Notable Fish Sightings 34
4.3 Redd Superimposition 34
4.4 Historical Trends in Redd Counts 35
4.5 Future Work 36
5.0 Past Reports 37

Appendices

Appendix A: Sampled Carcass Results 39
Appendix B: Redd Counts versus Survey Effort 46
Appendix C: Directions to Stream Reach Locations 53

List of Figures

Figure 1. Map of NSEA spawning grounds survey reaches 9
Figure 2. Nooksack River hydrograph 12
Figure 3. Chinook salmon adipose fin clips 14
Figure 4. Map of Chinook salmon redd locations 15
Figure 5. Coho salmon adipose fin clips 16
Figure 6. Redds per species per survey reach 17
Figure 7. Terrell Creek live salmon by date 18
Figure 8. Lower Deer Creek live salmon by date 18
Figure 9. Upper Deer Creek live salmon by date 19
Figure 10. Silver Springs Creek live salmon by date 20

Figure 11. Bertrand Creek live salmon by date 21
Figure 12. Lower Fishtrap Creek live salmon by date 22
Figure 13. Upper Fishtrap Creek live salmon by date 23
Figure 14. Lower Anderson Creek live salmon by date 24
Figure 15. Upper Anderson Creek live salmon by date 25
Figure 16. Smith Creek live salmon by date 26
Figure 17. Lower Macaulay Creek live salmon by date 26
Figure 18. Upper Macaulay Creek live salmon by date 27
Figure 19. Mitchell Creek live salmon by date 28
Figure 20. Tawes Creek live salmon by date 28
Figure 21. Tinling Creek live salmon by date 29
Figure 22. Landingstrip Creek live salmon by date 30
Figure 23. Tributary of Landingstrip Creek live salmon by date 31
Figure 24. Padden Creek live salmon by date 32
Figure 25. Redds per species per year 35
Figure 26. Redds per species per survey effort per year 36

List of Tables

Table 1. Survey reaches and number of surveys completed 10
Table 2. Live, dead, and redd counts per species by reach 13
Table 3. Chinook salmon carcass sample index 39
Table 4. Coho salmon carcass sample index 42
Table 5. Surveys per year by reach 46
Table 6. Chinook salmon redds per year by reach 47
Table 7. Coho salmon redds per year by reach 48
Table 8. Chum salmon redds per year by reach 49
Table 9. Chinook salmon redds per effort by reach 50
Table 10. Coho salmon redds per effort by reach 51
Table 11. Chum salmon redds per effort by reach 52
Table 12. Directions to stream reach locations 53

1.0 Introduction

The Nooksack Salmon Enhancement Association (NSEA) conducted salmon spawning grounds surveys for late-run Chinook salmon (*Oncorhynchus tshawytscha),* coho salmon *(O. kisutch),* and chum salmon *(O. keta)* under the direction of the Washington Department of Fish and Wildlife (WDFW) in selected Nooksack River tributary streams and independent drainages in Whatcom County.

The Nooksack Salmon Enhancement Association conducts surveys to provide information to augment the data that is collected annually by Nooksack River basin fisheries co-managers and to provide year-to-year consistency for comparisons with the past eleven years of NSEA survey efforts. Surveys also provide data for stream reaches where instream and riparian restoration projects are located or planned, as well as provide some insight into Whatcom County Chinook salmon, coho salmon, and chum salmon spawning populations over time. Spawning grounds surveys in the Nooksack River basin are also performed by the following co-managers: WDFW, the Lummi Nation, and the Nooksack Tribe. The City of Bellingham (COB) Environmental Resources Department also conducted spawning grounds surveys on coastal streams within the city limits prior to 2009. Descriptions and locations of all reaches surveyed by NSEA are listed at the end of this report.

Spawning grounds survey sites consisted of 20 reaches in 16 streams in Water Resource Inventory Area 1 (WRIA 1) (Figure 1). WRIA 1 is located primarily in Whatcom County, Washington. Thirteen of these streams are located in Nooksack River sub-basins, with additional surveys conducted on the following independent drainages: Terrell Creek in the Birch Bay watershed and Padden and Squalicum creeks in the Bellingham Bay watershed.

In the Lower Mainstem Nooksack River watershed, NSEA surveyed eight reaches in five streams consisting of two reaches in Fishtrap Creek, one in Bertrand Creek, and four reaches on tributaries in the Tenmile Creek sub-basin; two reaches in Deer Creek, one in Silver Springs Creek, and one in Starry Creek. In the Upper Mainstem Nooksack River watershed, six stream reaches were surveyed consisting of two reaches on Anderson Creek, and four in the Smith Creek sub-basin; one in Smith Creek, two in Macaulay Creek, and one in Mitchell creek. In the South Fork Nooksack River watershed four stream reaches were surveyed consisting of Tinling Creek in the Black Slough sub-basin, Tawes Creek in the Lower South Fork sub-basin, and Landingstrip Creek and an unnamed tributary of Landingstrip creek in the South Acme sub-basin. In independent coastal drainages three reaches were surveyed consisting of one reach on Terrell, Padden, and Squalicum creeks.

Three new reaches were added this year on Anderson and Macaulay creeks and in an unnamed tributary of Landingstrip Creek (Table 1 and Figure 1). The reach on Anderson Creek, located downstream of the previously surveyed reach, was added upon recommendation by WDFW. The reach on Macaulay Creek was added to include a riparian restoration and channel modification project downstream of the previously

surveyed reach. The reach on the unnamed tributary of Landingstrip Creek was added to monitor a newly created channel where the stream had previously been in an underground culvert. The project was completed in summer 2010 at the Catalyst Restoration Site south of Acme. The reach on Landingstrip Creek was also lengthened to include a newly created channel where the stream was previously in an underground culvert.

Four reaches were either removed from spawning grounds surveys or monitored by agencies other than NSEA. Reaches on Schell, Tenmile, and Whatcom Creeks were removed from spawning grounds surveys. The reach on Schell Creek was removed because of consistently low fish counts. The reach on Tenmile Creek was removed because of a lack of spawning habitat, low fish counts, and consistently poor viewing conditions. WDFW monitored Chuckanut Creek this year. Data for Chuckanut Creek can be found by contacting the Nooksack River Stock Assessment Fish Biologist, Natasha Geiger at the WDFW Bellingham Trout Hatchery office, 1700 Silver Beach Rd Bellimgham, WA 98229. The Bellingham Technical College's Fisheries Tech Program monitored chum escapement for Whatcom Creek at the Whatcom Creek Hatchery, and results can be obtained online at:
http://fisheries.btc.ctc.edu/Hatchery/Hatchery%20Information/Hatchery%20Info.htm

The Nooksack Salmon Enhancement Association also began assisting the WDFW in conducting spring season steelhead surveys in Nooksack River tributaries in 2009. The goal of steelhead surveys is to establish escapement estimates for Nooksack steelhead, which became listed as threatened under the Endangered Species Act in 2007.

2.0 Methods

This was the 12th year that NSEA has conducted spawning grounds surveys in Nooksack River tributaries using WDFW survey protocols. Spawning grounds surveys for the 2010 season began on September 15, 2010 and continued through February 8, 2011. Reaches were targeted for survey every 7 to 10 days. Viewing conditions, stream flow, and turbidity determined actual survey periodicity. Survey teams generally consisted of two people. Stream banks were walked when possible, with instream walking being necessary in certain situations. Reaches were surveyed from the lower end (downstream) to the upper end (upstream) of each survey reach to minimize turbidity, which could impede surveyors' vision and/or disturb spawning fish.

Survey data collected in the field included: stream name, surveyors' initials, WRIA basin and stream number, start and finish times, weather conditions, water temperature, live counts by species, dead counts by species, and redd counts by species. The estimated percentage of the survey reach that was visible and the estimated percentage of salmon seen were recorded; given the viewing conditions at the time. Flow conditions were recorded as low, medium, or high. In addition, carcasses for all species were sampled, with descriptions of sampling protocols for each species included in the carcass documentation section.

2.1 Redd Documentation

Redds were counted and recorded only after spawning and redd construction was complete. Redd data recorded in the field included date and species type. A "redd date" was assigned to each completed redd on the day when the redd was first documented. Completed redds were flagged and labeled to avoid trampling or recounting by future surveyors. To determine the species that created the redd, concurrent sightings of identified live and/or dead fish near the redd were used. If no live or dead fish could be found near the redd, the redd was classified as unknown. The locations of Chinook salmon redds were recorded via a global positioning system (GPS), The GPS coordinates were put into a Geographic Information Systems (GIS) shape file.

2.2 Carcass Documentation

Chinook salmon carcasses were sampled for sex, fork length, adipose fin presence or absence, and coded wire tag (CWT) presence or absence. In cases where the carcasses were not severely decomposed, fish scale samples and otoliths were taken from Chinook salmon carcasses. Six scales were taken from each carcass for scale samples.

Chum salmon carcasses were sampled for sex, fork length, and scales. If carcasses were fresh or only moderately decomposed, we collected tissue samples for DNA analysis..

Coho salmon carcasses were sampled for prespawn mortality and CWT presence or absence. Males were classified as unspawned, partially spawned, or spawned by examining the amount of milt present in the testes. To assess spawning success in females, the number of eggs remaining were counted in the abdomen. If the number of eggs appeared to be under 100, the eggs were counted by hand in the field. If the number of eggs appeared to be over 100, the eggs were bagged and later weighed to get a total count. Sex, fork length, gill and eye condition, adipose fin presence or absence, and presence of puncture and/or potentially fatal wounds were conditions also recorded for all coho salmon carcasses sampled for prespawn mortality. To assess gill condition (freshness), gill color (red, pink, grey or unknown) was used, and eye condition was assessed by eye clarity (clear, milky, or unknown). Prespawn mortality data will not be included in this report, but is available on file at the NSEA office. Information on sex, fork length, and adipose presence of coho carcasses is listed in the appendix.

To avoid re-counting and re-sampling, caudal fins were cut off after sampling. When carcasses were inaccessible or severely decomposed, the carcass was only counted, and if possible adipose fin presence or absence was checked and the caudal fin was cut off. After cutting off caudal fins, carcasses were returned to the location where they were found. Completed scale cards, DNA tissue samples, otolith, and CWT samples were given to WDFW for analysis. Results from these samples can be obtained from Nooksack River Stock Assessment Fish Biologist Natasha Geiger at the WDFW Bellingham Trout Hatchery office. If the species of a carcass could not be determined, usually due to excessive decay or animal predation, the carcass was classified as unknown.

2.3 Live Counts

Live fish were counted and identified to species when possible. To minimize over-counting, each fish was recorded only after it had passed downstream of the surveyor, in an attempt to keep live counts accurate in streams where fish spooked easily. A minimum wait time of 7 days was adhered to between surveys to reduce the possibility of recounting the same live fish.

Occasionally, a live adult salmon was encountered that could not be identified, either because the fish spooked or was hiding in an area with reduced visibility, such as in a deep pool or below an undercut bank. In cases where the fish could not be identified, the fish was classified as an unknown salmonid.

Peak index days are the dates when the largest numbers of live fish were seen in individual reaches. These dates are discussed further in the Results by Reach section. Limitations for peak index days include foul weather during the spawning season, which can create turbid water that bars visibility of fish.

2.4 Survey Reaches

Nooksack Salmon Enhancement Association spawning grounds survey reaches were originally chosen based on WDFW survey data. Survey reaches selected had good quality spawning habitat, and/or were located near past or future instream and/or riparian habitat restoration sites. Stream reaches have remained fairly consistent since 1999, except for several reaches that have been dropped or added. Adjustments in certain reaches have been made for the ease of surveying over the years.

Surveys of two of the new reaches added this year on Anderson Creek and an unnamed Landingstrip Creek Tributary began at different times than the other reaches because the reaches were added mid-season. Surveying on the Anderson Creek reach began on October 21st, 2010. Surveying on the Landingstrip Creek Tributary began on November 9th. Previous to November 9th, a portion of the Landingstrip Creek Tributary about 0.2 miles long was included in the survey of Landingstrip Creek, although no adult salmon were seen before the two reaches were separated, so the change did not affect the fish counts.

A list of survey reaches by name (including the WRIA number), the river miles of the reach, and the number of times we surveyed each reach for the 2010-2011 season are shown in Table 1. NSEA 2010 spawning grounds survey summary results are recorded in Table 2. The location in the Nooksack River basin of each NSEA survey reach is shown on the map in Figure 1.

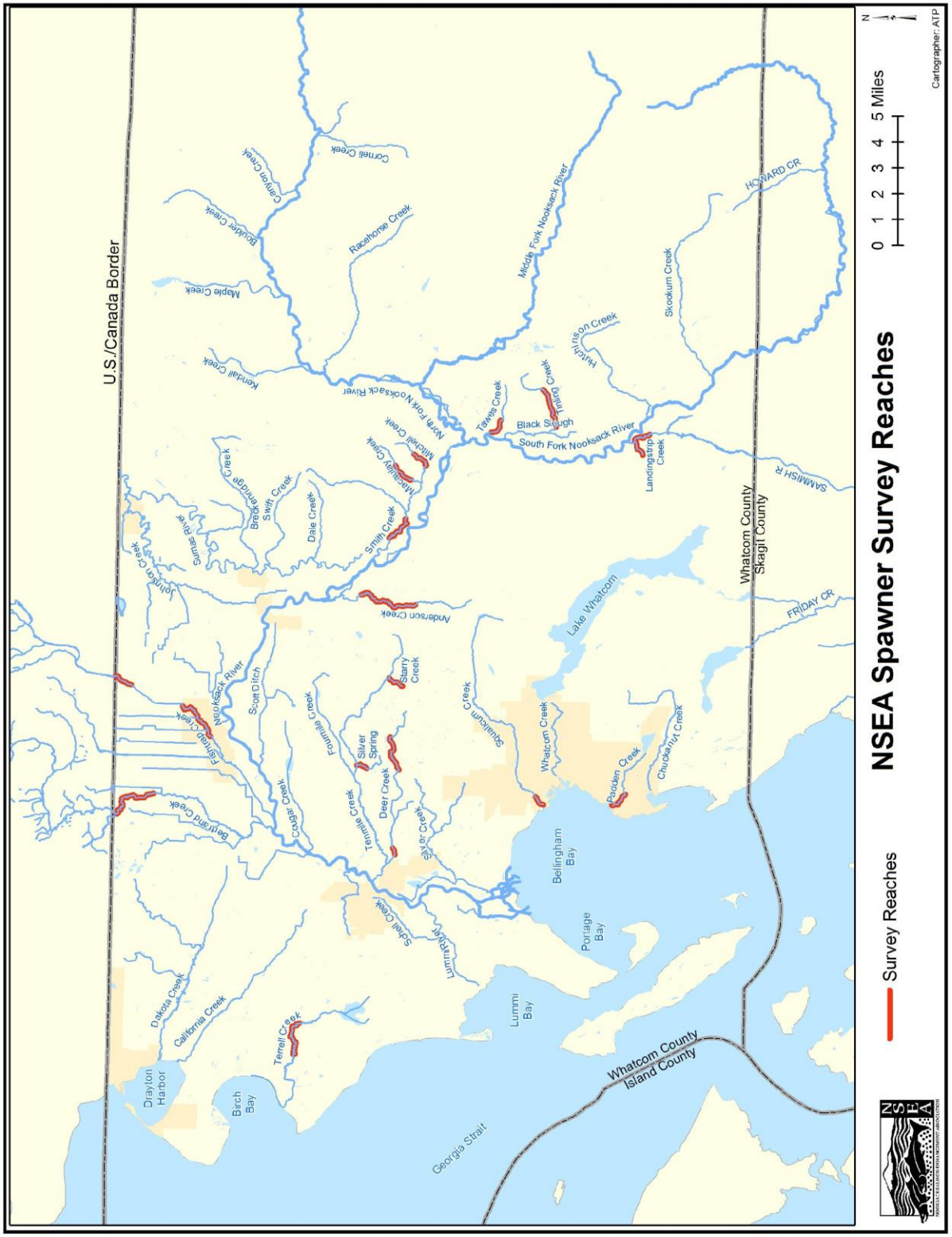

Figure 1. Map of 2010 NSEA spawning grounds survey reaches.

Table 1. WRIA 1 Nooksack River basin and independent stream reach identifiers and the number of spawning grounds surveys completed for each NSEA reach during the 2010 fall spawning season. Survey reaches are ordered by WRIA number, beginning with those streams nearest to the mouth of the Nooksack River and progressing upstream. The tributary of Landingstrip Creek does not have an assigned WRIA number. Padden, Squalicum, and Terrell creeks are all drainages independent of the Nooksack River basin.

Stream Reach Surveyed	**WRIA Number**	**River Mile**	**Surveys Completed**
Terrell Creek	01-0089	4.9 - 5.3	8
Deer Creek, lower	01-0165	0.5 - 0.8	12
Deer Creek, upper	01-0165	3.2 - 3.7	6
Silver Springs Creek	01-0184	0.0 - 0.5	13
Starry Creek	01-0189	0.0 - 0.75	6
Bertrand Creek	01-0201	8.2 - 8.7	10
Fishtrap Creek, lower	01-0210	4.9 - 5.7	10
Fishtrap Creek, upper	01-0210	8.8 - 9.2	13
Anderson Creek, lower	01-0228	1.2 - 2.7	7
Anderson Creek, upper	01-0228	2.7 - 4.0	10
Smith Creek	01-0234	2.5 - 3.5	11
Macaulay Creek, lower	01-0235	0.5 - 1.0	12
Macaulay Creek, upper	01-0235	1.0 - 1.5	13
Mitchell Creek	01-0236	0.3 - 1.0	13
Tawes Creek	01-0247	0.4 - 0.5	9
Tinling Creek	01-0250	2.0 - 2.3	8
Landingstrip Creek	01-0263	0.4 - 1.0	11
Landingstrip Creek Tributary	not assigned	0.0 - 0.4	9
Squalicum Creek	01-0522	0.0 - 0.5	9
Padden Creek	01-0622	0.0 - 0.8	11
Total			**201**

3.0 Results

Presented below, in three parts are the spawning grounds survey results, titled as follows: Survey Conditions and Effort, Results by Species, and Results by Survey Reach. Project archive information is discussed at the end of this section.

3.1 Survey Conditions and Effort

The 2010 spawning season began with a wet September, providing many larger streams with enough water to enable spawning access for the first returning species, Chinook salmon. A relatively dry October followed which made for good surveying conditions. Upper Macaulay, Mitchell, Upper and Lower Anderson, Starry, Lower Deer, Squalicum, and Tinling creeks remained too low to provide spawning access until the end of October or beginning of November (Figure 2).

Throughout the first three weeks of November, periodic rainfall created ample streamflow for spawning access and optimal surveying conditions, although Upper Deer Creek remained too low to provide spawning access until early December. A cold snap during the fourth week of November decreased stream flows and froze many of the reaches. The ice and cold temperatures made surveying dangerous and difficult, and for about a week surveys could only be completed on Mitchell, Macaulay, Landingstrip and Lower Deer creeks.

Heavy rains in early December led to high turbidity and streamflow, causing all of the reaches to be unsurveyable from December 8th to December 16th. During this time the Nooksack River reached a discharge of over 30,000 cubic feet per second at the Ferndale gauge, marking the peak in stream flow for the survey season. The heavy rains subsided during the third week of December, and flow and turbidity decreased enough to allow surveying, except on Anderson, Bertrand and Smith creeks which remained too turbid to survey until the first week of January. Sustained turbid conditions were also present on the lower reach of Fishtrap Creek, and the creek could not be surveyed after December 7th. A second cold snap during the last week of December and the first week of January again caused icy conditions in streams, but did not hinder surveying. However, heavy rains following the icy conditions quickly increased the stream flows, prohibiting surveying again until January 10th.

Because of a second pulse of coho salmon at the end of December and the presence of chum salmon in Bertrand, Fishtrap, and Padden creeks surveys continued through January and into early February. Nearly constant rains fell throughout January, making all streams turbid and discharges high. Surveying during January was sporadic as a result, and fewer surveys were completed during January than other months. Surveys ended February 8th, 2011.

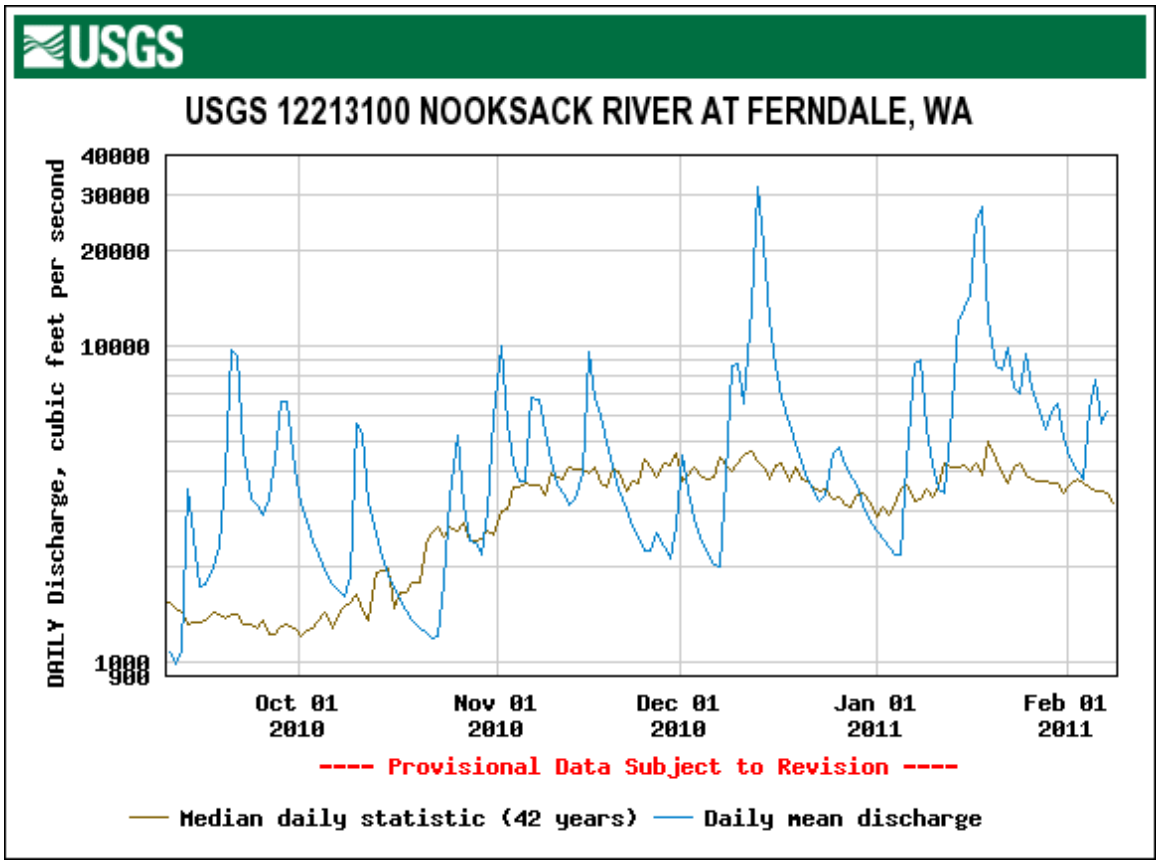

Figure 2. Nooksack River discharge in cubic feet per second from September 15, 2010 to February 8, 2011 as recorded by the Ferndale US Geological Survey Gauging Station. Median daily stream flow based on 42 years of data from this site is also shown. http://waterdata.usgs.gov/nwis/dv/?dd_cd=03_00060_00003&format=img_stats&site_no=12213100&begin_date=20100910&end_date=20110208

3.2 Results by Species

Table 2. Number of live and dead salmon and redds by species observed in each NSEA spawning grounds survey reach in the 2010 fall spawning season.

2010 NSEA Spawning Grounds Survey Summary												
Survey Reach	***Chinook***			***Coho***			***Chum***			***Unknown***		
	Live	Dead	Redds	Live	Dead	Redds	Live	Dead	Redds	Live	Dead	Redds
Terrell	0	0	0	4	4	2	0	0	0	1	0	4
Deer, lower	0	1	0	38	5	22	0	0	0	0	0	8
Deer, upper	0	0	0	3	0	3	0	0	0	0	0	0
Silver Springs	7	1	1	29	10	9	0	0	0	0	1	0
Starry	0	0	0	0	0	0	0	0	0	0	0	0
Bertrand	70	22	24	14	9	6	1	2	1	1	1	13
Fishtrap, lower	74	45	25	34	21	12	1	0	0	5	0	14
Fishtrap, upper	229	115	48	51	16	22	0	0	0	0	1	10
Anderson, lower	0	0	0	35	16	24	0	0	0	0	0	15
Anderson, upper	0	0	0	26	4	18	0	0	0	0	0	18
Smith	8	2	3	88	12	23	0	0	0	1	0	1
Macaulay, lower	6	7	4	9	4	4	0	0	0	0	0	7
Macaulay, upper	0	0	0	19	4	7	0	0	0	0	0	2
Mitchell	5	0	1	39	18	24	0	0	0	0	0	4
Tawes	0	0	0	10	0	1	0	0	0	0	0	0
Tinling	0	0	0	80	18	11	0	0	0	0	0	0
Landingstrip	0	0	0	5	5	3	0	0	0	1	0	2
Tributary of Landingstrip	0	0	0	35	21	12	0	0	0	0	0	0
Squalicum	0	0	0	0	0	0	0	1	0	0	0	1
Padden Creek	8	1	0	1	3	1	7	1	0	1	0	3
Total	**408**	**194**	**106**	**520**	**170**	**204**	**9**	**4**	**1**	**10**	**3**	**102**

3.2.1 Chinook Salmon (*Oncorhynchus tshawytscha*)

Chinook salmon created a total of 106 redds in Silver Springs, Bertrand, Fishtrap, Smith, Mitchell and Macaulay creeks; the first redd documented on September 24th and the last on November 29th. Fishtrap Creek contained 69% of the redds, with twice as many redds in the upper reach as the lower. Bertrand Creek contained 23% of the redds. While live Chinook salmon were seen in Padden Creek, no redds were seen so no successful spawning likely occurred (Table 2, Figure 4 and Figure 6).

One hundred ninety four Chinook salmon carcasses were found, roughly half of the live count. Although found 194 carcasses were found, only 100 were sampled because this number satisfied the quota from the WDFW for scale and otolith collection (Table 2 and Table 5). Approximately five times as many carcasses had clipped adipose fins than intact adipose fins, indicating hatchery raised fish comprised for an overwhelming majority of the fall run Chinook salmon (Figure 3 and Table 3).

Four hundred eight live Chinook salmon were observed in Silver Springs, Bertrand, Fishtrap, Smith, Macaulay, Mitchell and Padden creeks between September 15th and November 12th, with the vast majority in Fishtrap and Bertrand creeks. Upper Fishtrap Creek had the largest run of fall Chinook by live count, followed by Lower Fishtrap Creek then Bertrand Creek (Table 2).

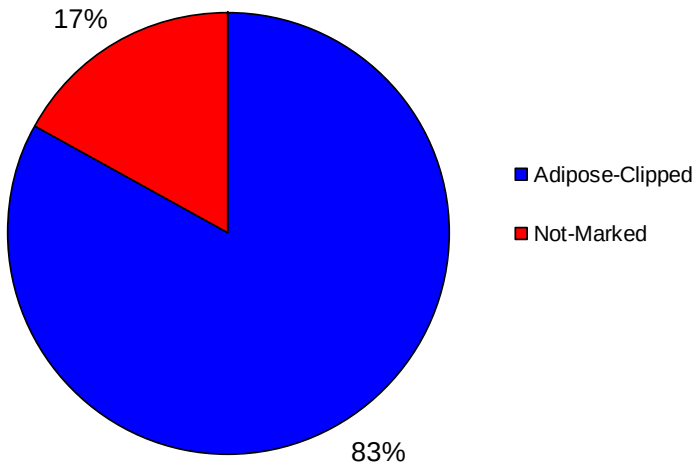

Figure 3. Percentage of Chinook salmon carcasses with adipose fins intact (not-marked) or absent (adipose-clipped) for 2010 NSEA fall spawning grounds surveys.

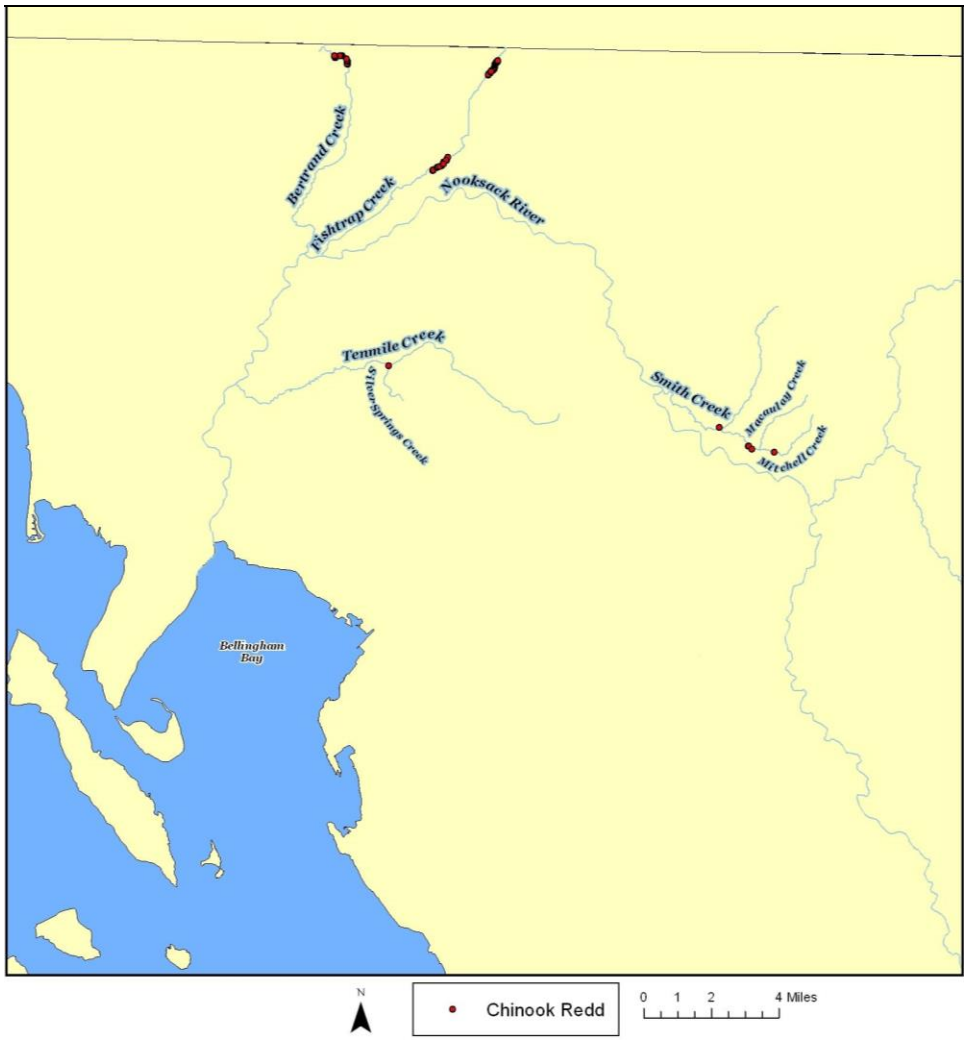

Figure 4. Map of Chinook salmon redds detected during 2010 NSEA fall spawning grounds surveys.

3.2.2 Coho Salmon (*Oncorhynchus kisutch*)

Coho salmon created a total of 204 redds in Terrell, Deer, Silver Springs, Bertrand, Fishtrap, Anderson, Smith, Macaulay, Mitchell, Tawes, and Tinling creeks, as well as Landingstrip Creek and its Tributary, and Padden Creek. Mitchell and Lower Anderson creeks contained the highest number of redds, followed closely by Smith and Upper Fishtrap creeks. Comparing sub-basins, Smith Creek had the most redds and Anderson Creek the second most (Table 2 and Figure 6). With 2.7 river miles surveyed in the Smith Creek sub-basin and 2.8 miles surveyed in the Anderson Creek sub-basin, the two watersheds also have similar survey efforts (Table 1). Forty seven unknown redds in Terrell, Deer, Anderson, and Landingstrip creeks likely belong to coho salmon, because only coho salmon were seen in these streams (Table 2).

One hundred seventy coho salmon carcasses were found and 150 were sampled. Six times as many carcasses had intact adipose fins than clipped or partially clipped adipose fins, indicating a wild origin for most coho salmon (Tables 2, 4 and Figure 5).

Five hundred twenty live coho salmon were observed in Terrell, Deer, Silver Springs, Bertrand, Fishtrap, Anderson, Smith, Macaulay, Mitchell, Tawes, and Tinling creeks, Landingstrip Creek and Tributary, and Padden Creek. Smith Creek contained the largest run of coho by live count for any one reach, and the Smith Creek basin (Smith, Macaulay, and Mitchell creeks) had a combined live count of 155 coho salmon, more than any other Nooksack River tributary sub-basin surveyed. Tinling Creek had the second largest run by live count followed by Upper Fishtrap and Lower Anderson creeks (Table 2).

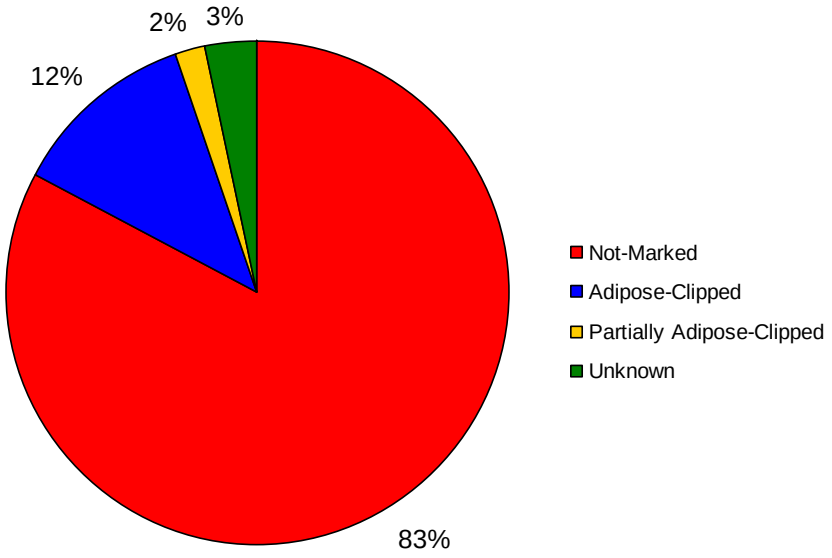

Figure 5. Percentage of coho salmon carcasses with adipose fins intact (not-marked), clipped, partially clipped, or unknown for 2010 NSEA fall spawning grounds surveys. Advanced decay or animal predation made adipose presence unknown.

3.2.3 Chum Salmon (*Oncorhynchus keta*)

Bertrand Creek held the only documented chum salmon redd (Table 2 and Figure 6).

Four chum salmon carcasses were found in Bertrand, Squalicum, and Padden creeks. DNA samples were taken from three carcasses in Bertrand and Squalicum creeks, and a scale sample was taken from one carcass in Bertrand Creek.

Nine live chum salmon were observed in Bertrand, Fishtrap, and Padden creeks. Padden Creek, a drainage outside the Nooksack watershed, had the majority of the chum salmon by live count (Table 2).

3.2.4 Unknown Salmonids

The species creating 102 redds could not be determined. The majority of unknown redds occurred in Bertrand, Fishtrap, and Anderson creeks, all streams prone to sustained high flows and turbid conditions. Surveys after two to four week periods of unsurveyable conditions contributed many of the unknown redds in all three creeks. Only coho salmon

were seen in Anderson Creek, so the unknown redds found in Anderson Creek are likely coho salmon redds (Table 2).

Ten unknown live salmon were seen in Terrell, Bertrand, Fishtrap, Smith, Landingstrip, and Padden creeks. Three unknown carcasses were found in Silver Springs, Bertrand, and Fishtrap creeks (Table 2).

3.3 Results by Survey Reach

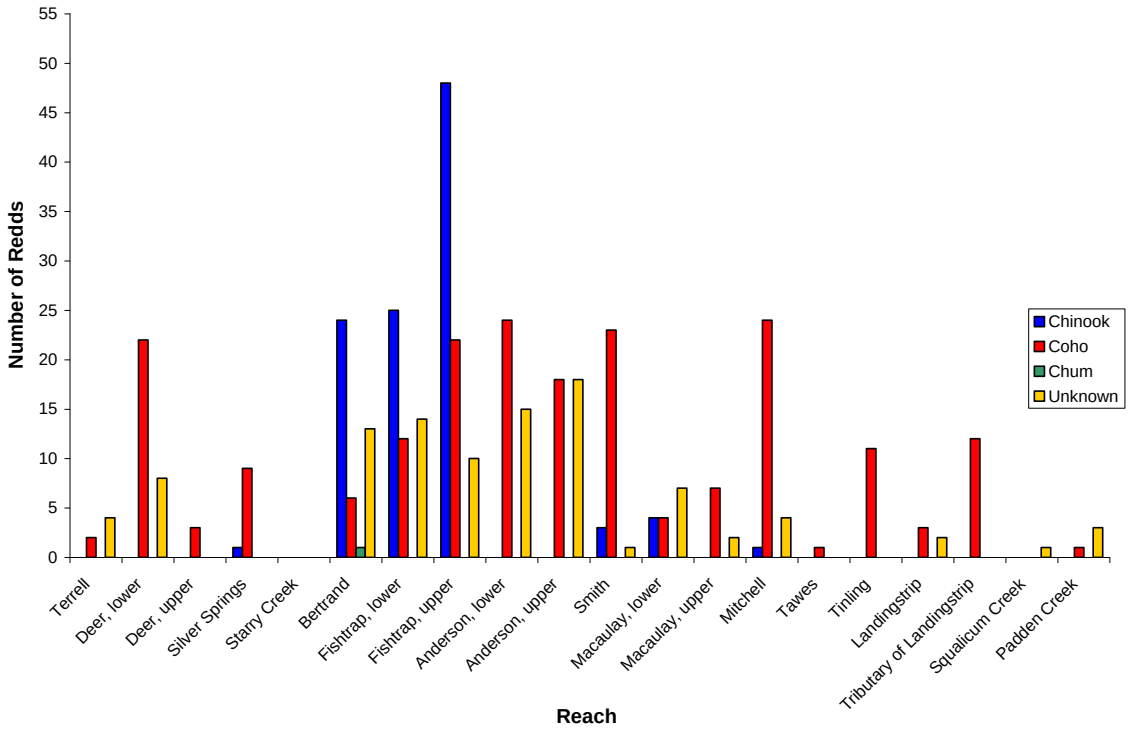

Figure 6. Redd counts by reach and species for 2010 NSEA spawning grounds surveys.

3.3.1 Terrell Creek was surveyed eight times from October 7, 2010 to January 26, 2011. Only coho salmon were seen by our survey crew in Terrell Creek, with sightings of four live fish, four carcasses, and two redds (Table 2 and Figure 6). The run of coho salmon appeared to take place in two waves, the first in early December and the second late December. Two coho salmon redds and a peak index of two coho salmon on December 7th and December 30th were observed (Figure 7). The one unknown live fish and four unknown redds observed likely belong to coho salmon because only coho salmon were seen, both in this reach and on the days when the unknown redds were observed (Table 2).

The habitat of the Terrell Creek survey reach is low-gradient with ample shade, pools and riffles, abundant large woody debris, and mixed-gravely substrate, ranging from boulders to clay. Stream flow is dictated in part by a dam located just downstream of Lake Terrell, the headwaters of Terrell Creek. The stream water is often dark brown and tannic, which reduces visibility.

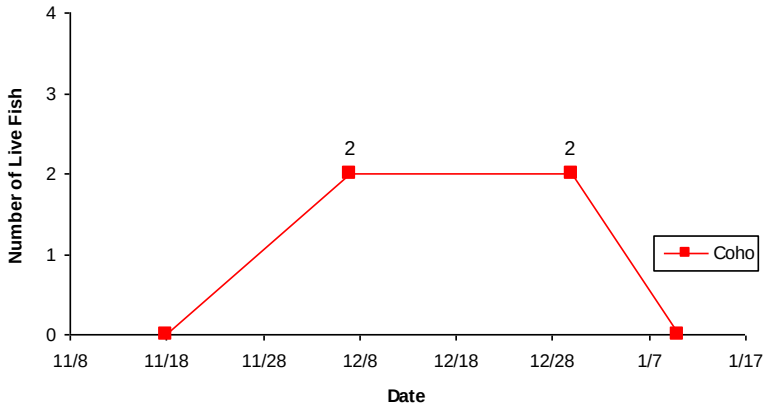

Figure 7. The number of live adult salmon seen by date in Terrell Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.2 Lower Deer Creek was surveyed 12 times from September 30, 2010 to January 11, 2011. Chinook salmon and coho salmon were seen in Lower Deer Creek. A carcass discovered during the first survey was the only evidence of Chinook salmon. Coho salmon spawned in two waves and formed 22 documented redds. The first wave occurred from late October to mid November, with a peak of 11 live coho on November 4th, and the second from late November to early January, with a peak of 16 live coho on December 2nd (Figure 8). The eight unknown redds documented likely belong to coho salmon because the redds were noted on days when only coho salmon were observed (Table 2).

The habitat of the Lower Deer Creek reach consists of a mature riparian zone that provides ample shade, sections of coarse gravel suitable for spawning between areas of sand and fine gravel, alternating pool and riffle sequences, and log jams formed by large woody debris. No beaver dams were present in Lower Deer Creek during the 2010 fall spawning season.

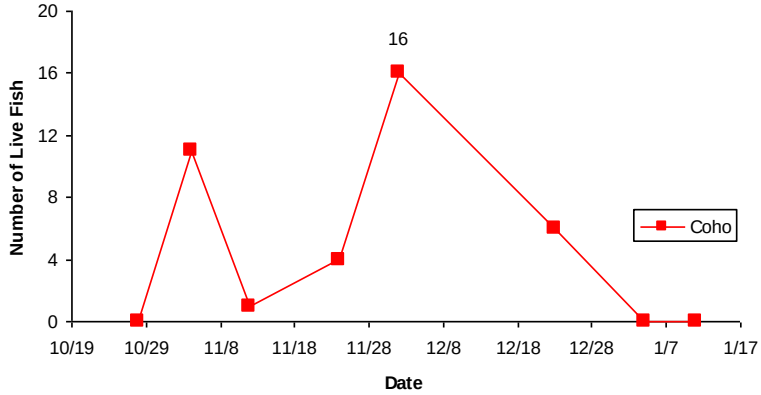

Figure 8. The number of live adult salmon seen by date for Lower Deer Creek, with the peak index labeled, for 2010 NSEA spawning grounds surveys.

3.3.3 Upper Deer Creek was surveyed six times from October 28, 2010 to January 10, 2011. The streamflow of Upper Deer Creek remained too low to provide spawning access until early December. Only coho salmon were seen in Upper Deer Creek, and live coho salmon were only observed on one day, December 17th. With only three documented coho redds, there were fewer coho redds in Upper Deer Creek than Lower Deer Creek, possibly due in part to the lack of stream flow until early December (Figures 6 and 9).

The habitat of the Upper Deer Creek reach is characterized by a mature riparian zone that provides ample shade, although essentially no woody riparian vegetation is present in the upstream end of the reach as the property is an easement for high voltage power lines. There are riffles and runs with mixtures of cobble and coarse gravel, side channels that are wetted during high flows, and deep pools formed by large woody debris jams. The water is clearer and less tannic than the Lower Deer Creek reach.

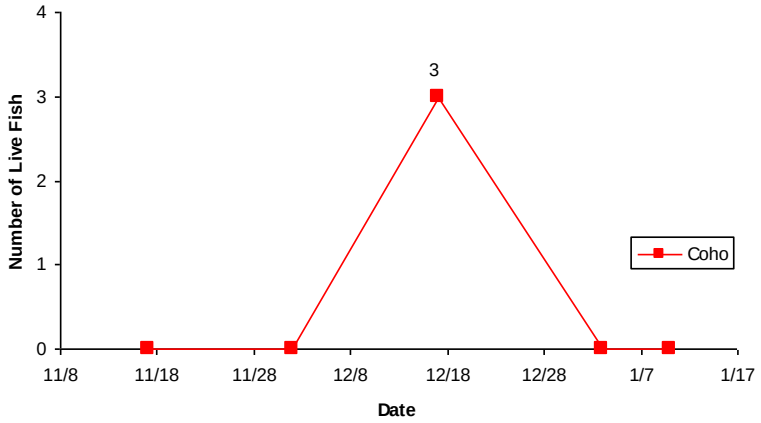

Figure 9. The number of live adult salmon seen by date for Upper Deer Creek, with the peak index labeled, for 2010 NSEA spawning grounds surveys.

3.3.4 Silver Springs Creek was surveyed 13 times from September 30, 2010 to January 11, 2011. Chinook salmon and coho salmon were seen in Silver Springs Creek. Silver Springs Creek was the only survey reach in the Tenmile Creek watershed where Chinook salmon were observed. Chinook salmon spawned from early to late October, had a peak index of five live Chinook salmon on October 14th, and produced one documented redd. The run of coho salmon was larger than the run of Chinook by redd and live fish counts. Coho salmon spawned from early November to mid December, had a peak index of 11 live coho on November 4th, and created nine documented redds (Figures 6 and 10). Most coho salmon redds were found upstream of Hemmi Road, and the Chinook salmon redd was located less than 0.1 miles from the mouth of Silver Springs Creek.

Silver Springs Creek runs entirely through agricultural land in the survey reach. The first quarter mile runs through grazing pastures, and has a dense riparian buffer of young trees, shrubs, and reed canary grass and large woody debris placed during a 1994-1995 restoration project. The middle section, between field road culvert and the Hemmi Road culvert, has a more open riparian zone with more reed canary grass than the lower section and a lack of spawning gravel. The upper portion of the reach has a mature riparian zone

from a previous planting and runs alongside a dairy barn for about 0.1 miles, then through agricultural fields. The substrate of the reach is mostly silt and sand with patches of spawning gravel placed by restoration work generally less than 3 meters long. The stream is fed mostly by groundwater so the water remains clear even after rain events; however, reed canary grass mats reduce the visibility.

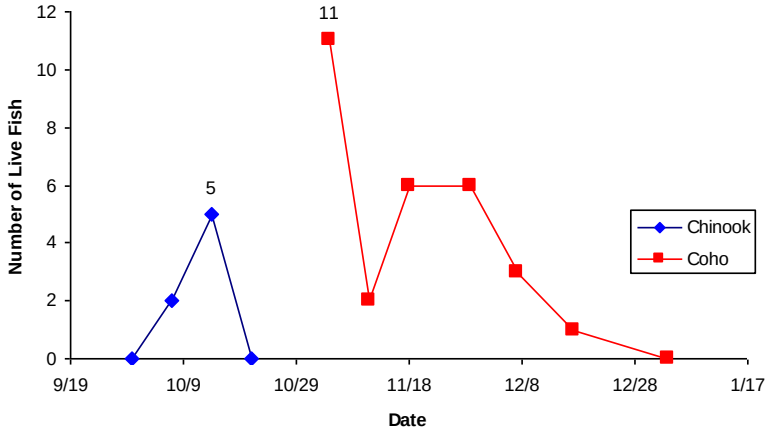

Figure 10. The number of live adult salmon seen by date and species for Silver Springs Creek, with the peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.5 Starry Creek was surveyed six times from October 12, 2010 to January 5, 2011. No fish or redds were seen in Starry Creek.

This reach of Starry Creek has a mature riparian zone that begins at the mouth of the creek as a thin buffer, and then after about 0.1 miles becomes part of a forested ravine with large cedars, dense salmonberry and vine maple. The end of the reach flows through less-dense forested residential areas. The stream has patches of good sized spawning gravel, but in many areas the gravel is not very deep and underlain by clay. The stream channel has complex habitat with large woody debris, deep pools, side channels, and riffles and glides.

3.3.6 Bertrand Creek was surveyed ten times from September 15, 2010 to January 5, 2011. Bertrand Creek is surrounded by agricultural fields and the water is often fast moving, turbid, and tannic in color, making visibility poor. The creek also rises quickly and becomes turbid after rain events, due partially to residential areas in the upper, Canadian side of the watershed. The combination of poor visibility and flashiness after rain events can make surveying difficult and led to a month long period, from mid November to early December, when surveying was not possible.

Chinook salmon, coho salmon, and chum salmon were seen in Bertrand Creek. Bertrand Creek had the third largest Chinook salmon run of any reach by redds and live counts. The largest run of any species by redds and live count in Bertrand Creek was Chinook salmon. Chinook salmon spawned from early October to early November, had a peak index of 23 live Chinook salmon on October 13th, and created 24 observed redds. Coho salmon had the second largest run on Bertrand Creek. Coho salmon spawned from mid October to likely early December, although from December 8th to January 5th surveys were not possible, so the run may have lasted into mid or late December. The coho

salmon had a peak index of eight live fish on November 15th and produced 6 known redds. Bertrand Creek was one of the four reaches chum salmon were documented in and the only reach where a successful chum salmon redd was observed (Table 2 and Figures 6 and 11).

The habitat of the Bertrand Creek reach consists of mature riparian areas providing partial shading in the lower portion and more complete shading in the upper portion. The reach has ample spawning gravel, some of which is not utilized by spawning salmon. The reach has diverse instream habitat with deep pools, some large woody debris, and glides and riffles.

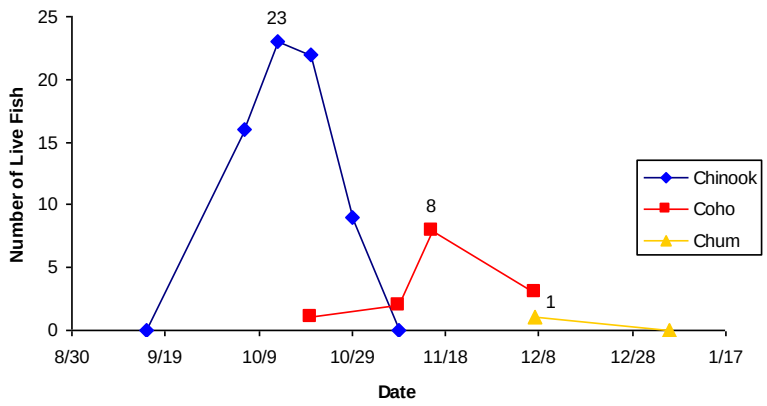

Figure 11. The number of live adult salmon seen by date and species for Bertrand Creek, with the peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.7 Lower Fishtrap Creek was surveyed ten times from September 24th, 2010 to December 7th 2010. After December 7th, water remained too high and turbid for the stream to be surveyed for the rest of the season. More salmon than were counted likely entered the reach after December 7th, so counts for coho salmon and especially chum salmon may be lower than the actual returns.

Surveyors observed Chinook salmon, coho salmon, and chum salmon in Lower Fishtrap Creek. Lower Fishtrap Creek held the second largest run of Chinook salmon for any reach, by redds and live count. Five live Chinook salmon were seen on the first survey, but Chinook salmon likely spawned from late September to mid November with a peak index of 23 live Chinook on October 8th, and created 25 documented redds. Coho salmon had the second largest run by redds and live count. Coho salmon spawned from late October through our last survey on Lower Fishtrap Creek on December 7th, had a peak index of 11 live coho on November 5th and 12th, and created 12 documented redds. Many coho salmon were observed superimposing redds over existing Chinook salmon redds. Lower Fishtrap Creek was one of four reaches chum salmon were observed in. One live chum salmon, no carcasses, and no redds were observed. (Table 2, Figures 6 and 12).

The Lower Fishtrap Creek reach is urban in character and heavy runoff from city streets dramatically increases turbidity and deposits trash into the stream. The reach is well-shaded and contains many areas of spawning gravel. The reach has a diversity of instream habitat with alternating pools and riffles, although due to the urban location the

reach has virtually no off-channel habitat because much of the channel is constrained by riprap placed on the banks.

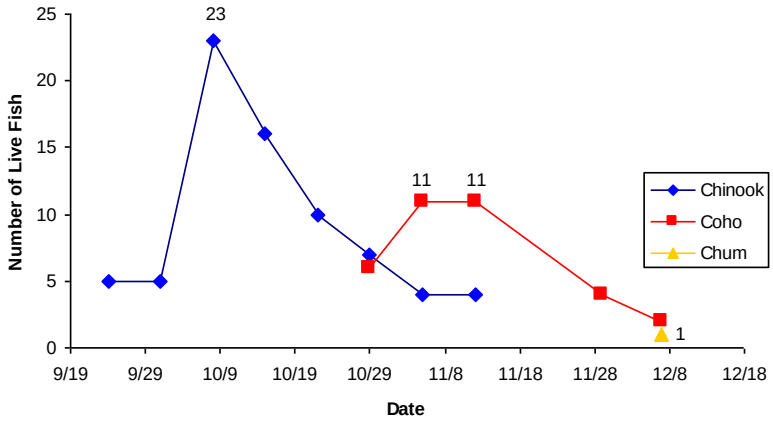

Figure 12. The number of live adult salmon seen by date and species for Lower Fishtrap Creek, with the peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.8 Upper Fishtrap Creek was surveyed 13 times from September 15, 2010 to January 27, 2011. Upper Fishtrap Creek contained Chinook salmon and coho salmon. Upper Fishtrap Creek had the largest run of Chinook salmon by redds and live counts, and one of the largest runs of coho salmon for any reach. The Chinook salmon live count is three times larger than any other reach, and the peak index is greater than the total live count of any other reach. Chinook salmon spawned from late September to mid November with a peak index of 87 live Chinook salmon on October 11th, and produced 48 documented redds. Coho salmon spawned from early October to early January, had a peak index of 20 live coho salmon on November 4th, and created 22 documented redds (Table 2 and Figures 6 and 13).

Many coho salmon were observed superimposing redds over Chinook salmon redds. The redd superimposition was even more prevalent than in Lower Fishtrap Creek, and made redd counting later in the season quite difficult. Because of this, the coho salmon redd count may be an underestimate.

The Upper Fishtrap Creek reach flows through agricultural fields and is channelized. Shading varies along the reach although a buffer is present the entire length; a narrow riparian buffer provides shade in some areas, while other areas are open with new riparian plantings. The channel is a mix of wide, shallow areas with spawning gravel and fast flowing deep areas, and reed canary grass lines the banks.

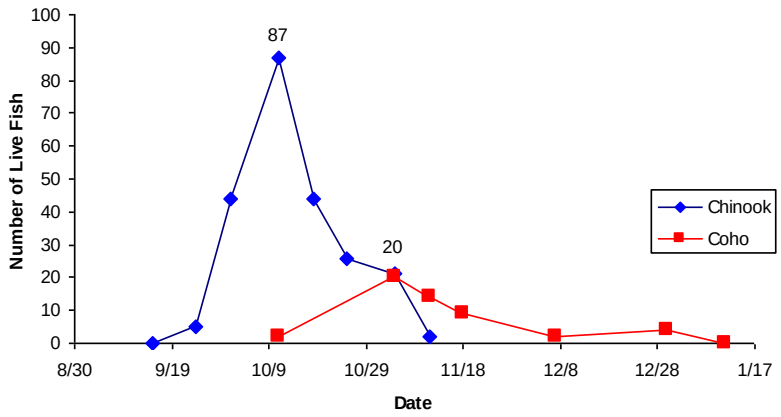

Figure 13. The number of live adult salmon seen by date and species for Upper Fishtrap Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.9 Lower Anderson Creek was surveyed seven times from October 21, 2010 to February 1, 2011. The streamflow on Anderson Creek remained low, possibly too low to allow spawning migration, until early November. The creek also froze over in early January. Surveying on Anderson Creek can be difficult because after rain events the stream flow rises quickly and remains high and turbid for prolonged periods. This led to three to four week periods from November to February when surveying was not possible.

Only coho salmon were seen in Lower Anderson Creek. The reach tied with Mitchell Creek for the largest run of coho by redd count. Coho salmon spawned from early November to likely mid-December with a peak index of 27 live coho on December 6th, and created 24 known redds. The ending date of the coho salmon run is roughly estimated, because after the peak index stream conditions were unsurveyable until January 4th when the reach, partially ice covered, was surveyed and no live fish were seen (Figures 6 and 14). The 15 unknown redds documented likely belong to coho salmon, because no other species of salmon was observed spawning in Anderson Creek this year, and all the unknown redds were noted after the first survey.

The Lower Anderson Creek reach is heavily wooded and shows little sign of human intrusion. There are many large log jams and pools formed by large woody debris, and active recruitment of large woody debris from upstream and upland. The channel is complex with shallow riffles and glides containing spawning gravel, pools, and side channels.

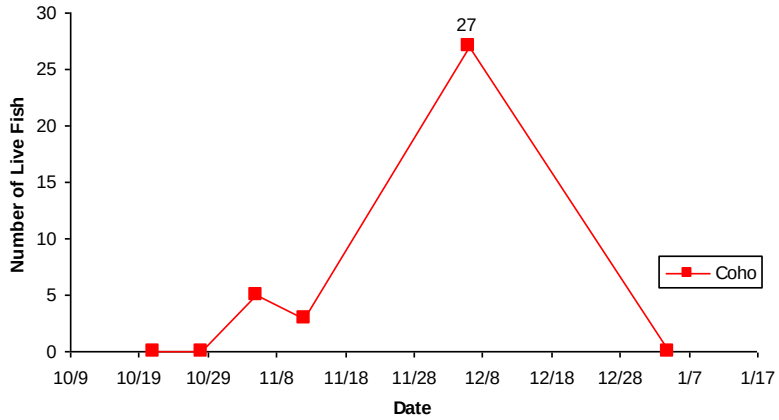

Figure 14. The number of live adult salmon seen by date and species for Lower Anderson Creek, with the peak index labeled, for 2010 NSEA spawning grounds surveys.

3.3.10 Upper Anderson Creek was surveyed ten times from September 23, 2010 to January 4, 2010. The streamflow on Anderson Creek remained low, possibly too low to allow spawning migration, until early November. The creek also froze over in early January. Surveying on Anderson Creek can be difficult because after rain events the stream flow remains high and turbid for prolonged periods. This led to three to four week periods from November to February when stream conditions were unsurveyable.

Only coho salmon were seen Upper Anderson Creek. Fewer redds were observed in Upper Anderson Creek than Lower Anderson Creek. Coho salmon spawned from late October to early January with the peak index of 12 live coho salmon on December 6th, and created 18 known redds. The ending date of the coho salmon run is roughly estimated, because after the peak index stream conditions were unsurveyable until January 4th. Ice partially covered the stream during this survey and no live fish were seen (Figures 6 and 15). The 18 unknown redds likely belong to coho salmon, because no other species of salmon were observed spawning in Anderson Creek this year, and all the unknown redds were noted after the first survey (Table 2).

The Upper Anderson Creek reach has habitat similar to Lower Anderson Creek

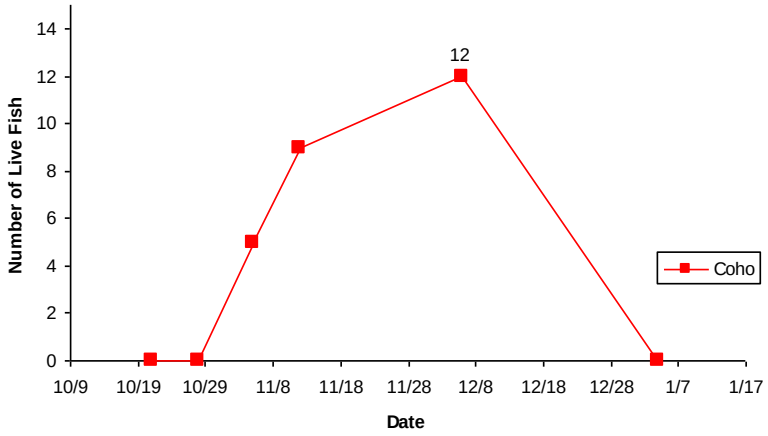

Figure 15. The number of live adult salmon seen by date and species for Upper Anderson Creek, with the peak index labeled, for 2010 NSEA spawning grounds surveys.

3.3.11 Smith Creek was surveyed 11 times from September 22, 2010 to January 28, 2011. Surveying Smith Creek can be difficult because streamflow remains high and turbid after rain events and the water is dark and tannic even during low flows. From late November to early January and mid January to late January, stream conditions made Smith Creek unsurveyable.

We saw Chinook salmon and coho salmon in Smith Creek. Chinook salmon spawned from mid to late September through early November with a peak index of three live Chinook salmon on October 13th, and produced three known redds. However, one live Chinook salmon was seen on the first survey. Smith Creek had the second largest run of coho salmon by redd count and the largest run by live count. Coho salmon spawned from late October to likely mid January with a peak index of 28 live coho salmon on November 12th, and created 23 documented redds. The end timing of the coho salmon run is somewhat unknown because stream conditions were unsurveyable in Smith Creek for most of January (Table 2 and Figures 6 and 16). All of the redds in Smith Creek except one were seen upstream of Finsrud Road.

The Smith Creek reach is partially shaded with mature riparian zones and blackberry lined banks that provide a mixture of shade. The lower section of the reach is a mostly deep, U-shaped channel with a streambed made of primarily sand and silt. The upper section of the reach has a more complex channel containing large woody debris, riffles, glides, and pools, and many areas of coarse spawning gravel.

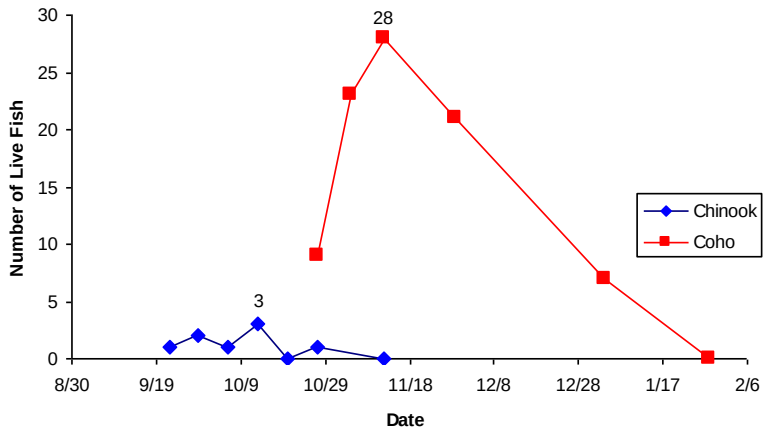

Figure 16. The number of live adult salmon seen by date and species for Smith Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.12 Lower Macaulay Creek was sampled twelve times from September 22, 2010 to December 30, 2010. Chinook salmon and coho salmon were seen in Lower Macaulay Creek. Chinook salmon spawned from late September to mid October with a peak index of four live Chinook salmon on September 29th, and created four known redds. Coho salmon spawned from early October to late December, had a peak index of four live coho salmon on November 4th, and produced four documented redds (Figure 17).

Lower Macaulay Creek runs through an NSEA restoration project. The restoration work was completed in 2009 and 2010 and included riparian planting, channel modification, and large woody debris placement. The upper most portion of the reach is ditched along Highway 542 and has reed canary grass lining the banks, although it was recently replanted with native vegetation.

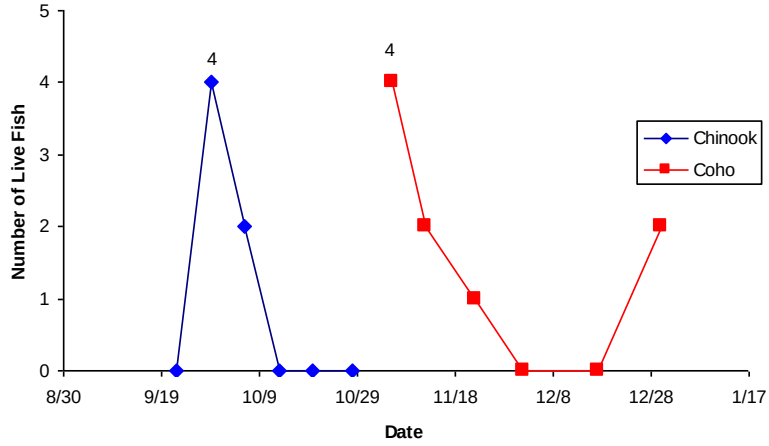

Figure 17. The number of live adult salmon seen by date and species for Lower Macaulay Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.13 Upper Macaulay Creek was surveyed thirteen times from September 22, 2010 to January 10th, 2011. The streamflow remained too low to provide spawning access until early November, which may have restricted Chinook salmon from spawning in this reach as Chinook salmon were seen in Lower Macaulay Creek but not Upper Macaulay Creek and Lower Macaulay had higher streamflow early in the season.

We saw only coho salmon in Upper Macaulay Creek. Coho salmon spawned from early November to late December, had a peak index of eight live coho salmon on December 2nd, and created seven documented redds. There were more coho salmon in Upper Macaulay Creek than Lower Macaulay Creek by redds and live count (Table 2 and Figures 6 and 18).

Upper Macaulay Creek is partially shaded, with the lower portion of the reach surrounded by reed canary grass and the upper portion covered by mature forest. The streambed is wide and shallow, with virtually no woody debris. A past dredging project in the middle of the reach removed spawning gravels, allowing silt to collect downstream and bury spawning gravels. A sediment pond was constructed upstream of the dredging to reduce siltation.

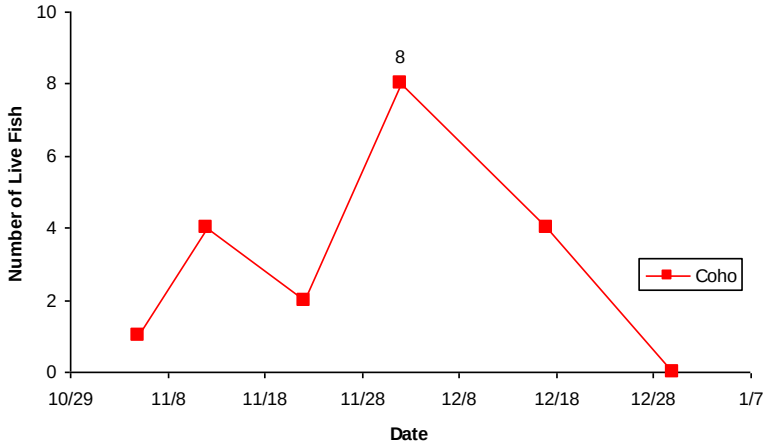

Figure 18. The number of live adult salmon seen by date and species for Upper Macaulay Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.14 Mitchell Creek was surveyed 13 times from September 22, 2010 to January 28, 2011. Throughout January Mitchell Creek remained turbid for long periods following rain events, and we could not survey it for nearly four weeks.

Chinook salmon and coho salmon were observed in Mitchell Creek. Chinook salmon spawned from late September to early November with peak indexes of two live Chinook on October 6th and October 28th, and produced one known redd. The coho salmon run tied Lower Anderson Creek for largest coho run of any reach by redd count. Coho salmon spawned from early November to late December, had a peak index of 11 live coho salmon on December 2nd, and created 24 known redds (Figures 6 and 19). The six unknown redds seen likely belong to coho salmon because they were noted in late November and late December at times when only coho salmon were seen spawning.

Mitchell Creek is well shaded and shallow; containing abundant spawning gravels, some woody debris, and a few small pools. Himalayan blackberry is beginning to overtake native riparian vegetation in the middle of the reach.

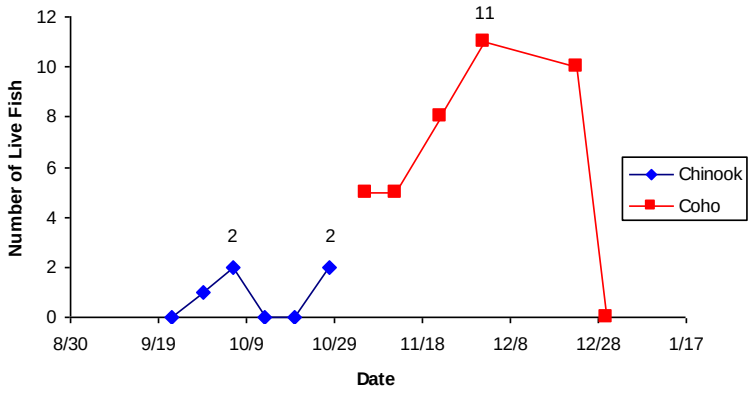

Figure 19. The number of live adult salmon seen by date and species for Mitchell Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.15 Tawes Creek was surveyed nine times from September 29, 2010 to January 10, 2011. Coho salmon were observed in Tawes Creek. Coho salmon spawned from late October to early January with a peak index of five live coho salmon on November 16th, and created one documented redd (Figure 20).

The Tawes Creek Reach has a shallow, well-shaded channel containing abundant spawning gravel.

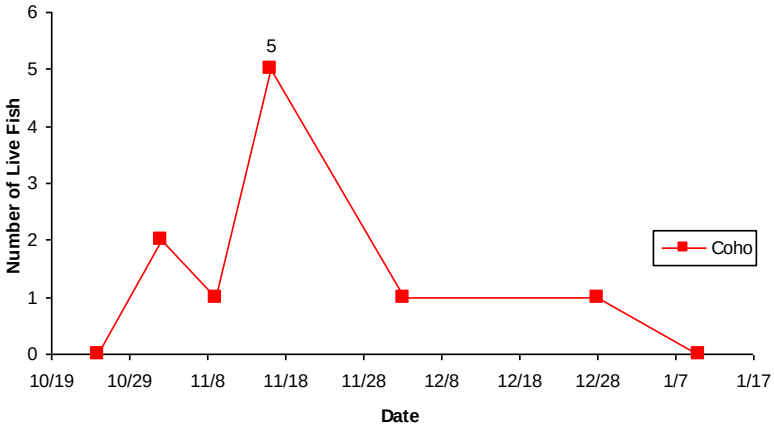

Figure 20. The number of live adult salmon seen by date and species for Tawes Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.16 Tinling Creek was surveyed eight times from September 29, 2010 to January 10, 2011. Until early November Tinling Creek had low or no flow.

Coho salmon were seen in Tinling Creek. The reach had the second largest run of coho salmon for any reach by live count, but had only 11 confirmed redds. The run occurred in two waves. The first wave began in early November and had the peak index of 37 live coho on November 9th. The second wave followed a heavy rain event in mid December and had a peak of 29 live coho on December 18th (Table 2 and Figure 21). The heavy rain event also generated a pulse of alluvium, which was deposited downstream of the Clipper Road culvert and covered the old channel as well as any coho redds formed during the first wave of the coho run.

The Tinling Creek survey reach is well shaded and diverse in character with a high width-to-depth ratio. The substrate is primarily boulders and cobble, but with several areas of spawning gravel. Below the culvert on Clipper Road the channel becomes an alluvial fan, separating into multiple channels as it flows through a forested wetland. Above the culvert, the stream forms a deep and narrow channel that is diked on one side. The reach has been enhanced with riparian plantings and the placement of large woody debris structures.

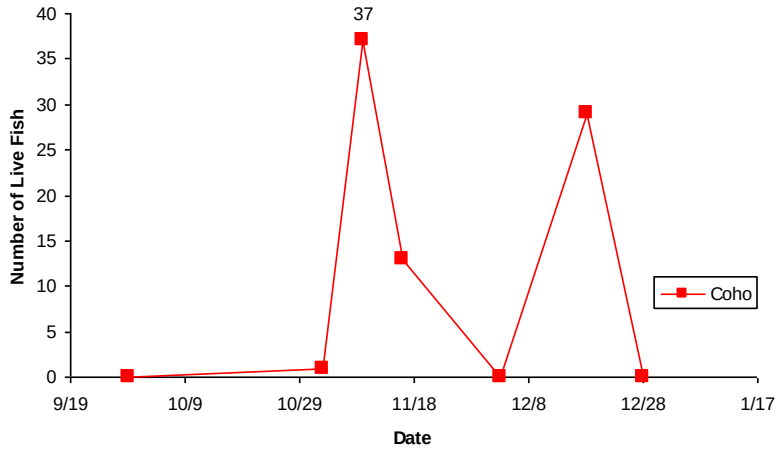

Figure 21. The number of live adult salmon seen by date and species for Tinling Creek, with the peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.17 Landingstrip Creek was surveyed 11 times from September 29, 2010 to January 28, 2011. Visibility was generally fair to poor due to reed canary grass mats in the stream channel and high turbidity.

Coho salmon were seen in Landingstrip Creek. The run produced three documented coho salmon redds and occurred from early November to mid January, with a peak index of three live coho on December 3rd. The two unknown redds likely also belong to coho salmon since no other species of salmon were observed spawning in Landingstrip Creek (Table 2 and Figure 22). Most redds were located in the newly restored channel upstream of Rothenbuhler Road.

The Landingstrip Creek reach has two distinct portions. The portion of the reach downstream of Rothenbuhler Road is a slow moving channel covered in reed canary grassy and has some shading from a mature riparian zone on one bank and a riparian restoration project on the other bank. Upstream of Rothenbuhler Road the stream runs through land recently cleared of a poplar plantation that is now owned by the Whatcom Land Trust. This property is an NSEA restoration project. The channel was enhanced in 2010 with spawning gravel, channel modification and woody debris placement, and riparian planting has commenced.

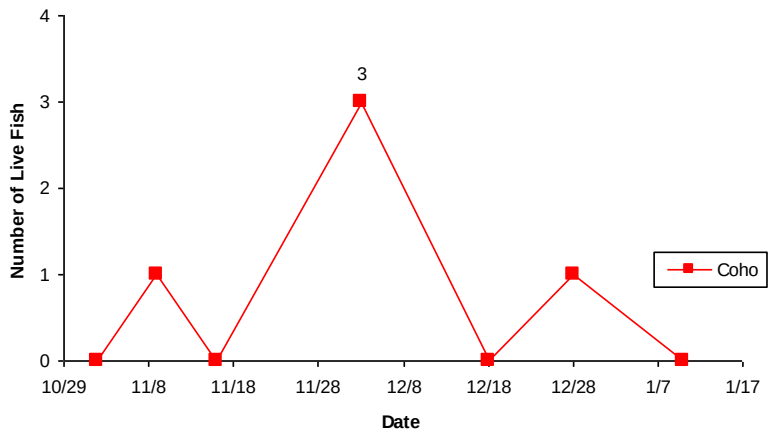

Figure 22. The number of live adult salmon seen by date and species for Landingstrip Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.18 Tributary of Landingstrip Creek was surveyed nine times from November 9, 2010 to February 8, 2011. Coho salmon were seen in the tributary of Landingstrip Creek. As surveys began in November, a zero count was not achieved, but the run likely occurred from early November to early February, with a peak index of 11 live coho salmon on December 18th. Most coho salmon had spawned by mid January but a live coho was seen on January 28th. The majority of the 12 documented redds were noted upstream of Rothenbuhler Road in the newly created stream channel. The run was larger in the tributary than in Landingstrip Creek by redds and live count (Table 2 and Figures 6 and 23).

The tributary of Landingstrip Creek has two distinct portions. The lower section, downstream of Rothenbuhler Road, is an older NSEA restoration project that entailed riparian planting and woody debris placement. The stream banks and channel are lined with reed canary grass, and the grass mats are so dense that in first 0.1 miles of the survey the stream channel is hardly visible. The upper section, upstream of Rothenbuhler Road, is a newly created channel that was removed from an underground culvert in 2010. Along with creating the new channel, restoration work included woody debris and spawning gravel placement, and riparian planting which has commenced.

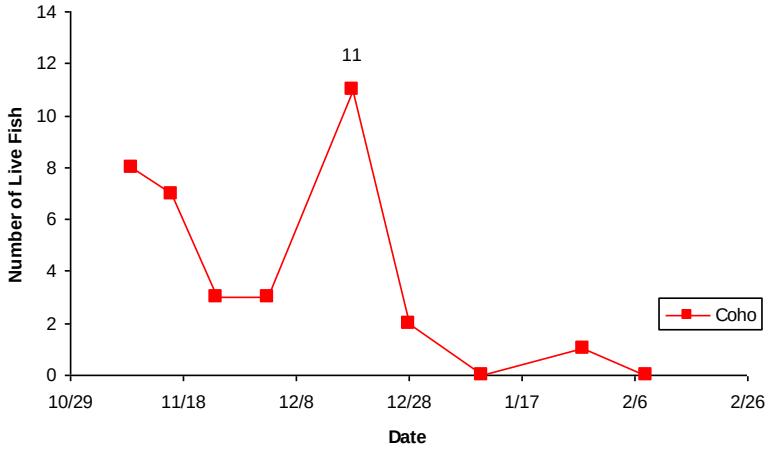

Figure 23. The number of live adult salmon seen by date and species for the tributary of Landingstrip Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.3.19 Squalicum Creek was surveyed nine times from September 15, 2010 to January 4, 2011. No live salmon and two unknown redds were seen, and one chum salmon carcass was sampled for DNA (Table 2 and Figure 6).

The Squalicum Creek reach is well shaded, but in close proximity to Squalicum Way, a major road connecting northern Bellingham to the waterfront. The reach has a diverse array of substrate, although much of it is heavily embedded. A large portion of the Squalicum Creek watershed is urbanized, so streamflow and turbidity rise quickly after rain events.

3.3.20 Padden Creek was surveyed 11 times from September 15, 2010 to January 26, 2011. Chinook salmon, coho salmon, and chum salmon were seen. Coho salmon were the only species for which a redd was documented, so no successful spawning of Chinook salmon or chum salmon was observed, although three unknown redds were documented. Chinook salmon spawned from early October to late October, and had a peak index of 4 live Chinook salmon on October 12th. Coho salmon spawned from late October to early December; the beginning timing based on a carcass recovery not a live fish sighting. Chum salmon likely spawned from early December to early January, with a peak index 5 live chum on December 2nd.

On November 11th we noticed the stream water had an unnatural green coloration. The origin and composition of the green substance is unknown.

The Padden Creek reach is mostly shaded, meandering alongside interurban trails for the entire reach. The reach has a good diversity of habitat, including riffles and deep pools, and several sections of spawning gravel (mostly in the upper half of the reach), although the reach also contains three fish ladders. The mouth of the creek is brackish and tidally influenced.

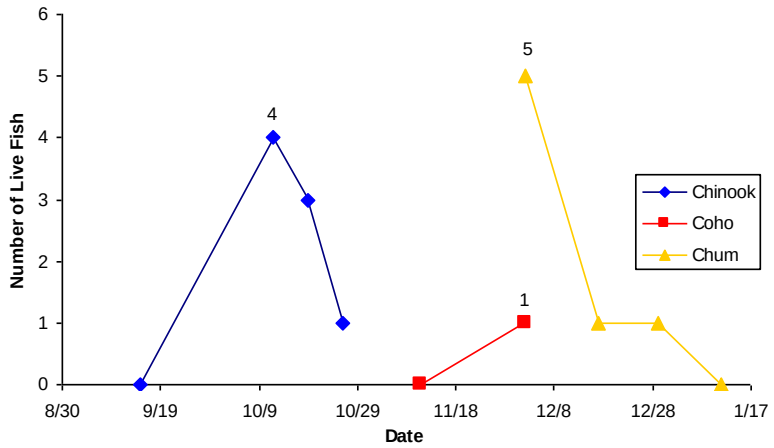

Figure 24. The number of live adult salmon seen by date and species for Padden Creek, with peak indexes labeled, for 2010 NSEA spawning grounds surveys.

3.4 Project Archives

The 2010 NSEA spawning grounds survey project field notes are archived in paper and electronic files at the NSEA office. Scale cards are archived at WDFW offices in Olympia. Results from scale cards are available from the Nooksack River Stock Assessment Fish Biologist Natasha Geiger at the WDFW Bellingham Trout Hatchery office. Data spreadsheets and the report for this survey season can be accessed at the NSEA office in Bellingham. Past spawning grounds survey reports are on file at the NSEA office and are also available at the NSEA website: www.n-sea.org

4.0 Discussion

4.1 Data Limitations and Caveats

The discussion section of this report is necessarily limited. One can only bring attention to observed trends over time rather than hypothesize about the causes of the trends. Salmon species have complex life cycles that span broad temporal and spatial ranges. Therefore, there are many environmental and anthropogenic factors that can exert influence on any given salmon population at any time. Commercial and recreational fishing, urbanization, land use, fish passage barriers, and ocean conditions in the North Pacific can all have detrimental effects on depressed salmon populations. With these variables in mind, a causal effect between any particular activity and an increase or decrease in returning salmon cannot be assumed for any given year.

NSEA spawning grounds surveys have consistently covered many of the same reaches since 1999. The data collected are one source of information about the numbers of Chinook salmon, coho salmon, and chum salmon spawning within the Nooksack River basin and other WRIA 1 watersheds over a number of years. While these surveys alone are not extensive enough to show trends in overall populations, they do allow us to investigate the roles that specific streams play in salmonid life histories by examining

yearly data from the survey reaches. This data can also be used by Nooksack River basin co-managers in combination with other spawning grounds survey results to estimate basin-wide return trends.

In addition to limitations with the size and scope of our surveys, certain methodological constraints should be considered when interpreting spawning grounds survey data. The frequency of surveys and the likelihood of seeing salmon that are present in the streams are dependent upon viewing conditions, stream accessibility, and timing. Late fall and early winter commonly receive large amounts of precipitation in the Pacific Northwest. The severity and timing of these rain and snowfall events can have significant impacts on migrating salmon and the likelihood that surveyors see them. Whereas heavy rains often draw spawning salmon upstream, they also can inhibit human access to these streams; potentially leaving many fish and redds uncounted. Carcasses are often washed downstream and redds can be scoured out or filled in with sediment beyond recognition. Surveys will have slightly different timing and frequency each year (based on rainfall patterns), which will affect fish and redd counts from year to year.

Using the number of live fish observed as a population indicator presents an obstacle as miscounts and recounts are more likely with live fish than with carcasses or redds. Using carcasses as an indicator of populations could also lead to inaccurate estimates of returning salmon. For example, streams located in more rural or forested settings, such as Macaulay, Mitchell, and Anderson creeks, typically have low numbers of carcasses recovered in relation to live fish sightings. This is likely due to the prevalence of wildlife in these areas that scavenge salmon carcasses for food and drag carcasses far from streams. In addition to scavenging, high flows can wash carcasses downstream and out of the survey reach.

In contrast to live and dead fish, redds may remain visible for a longer time period and give us an estimate of the number of spawning fish - if it is assumed that for every redd counted a minimum of two spawning adults returned to the stream. This conservative number gives us an estimate of effective spawners as opposed to escapement estimates, which show us how many individuals were able to make it back to their spawning grounds. Additionally, several salmon have been found dead during each survey season before ever spawning for various reasons. If the goal is to assess the number of effective spawners in a population, then using redds as a marker is more important than counts of live or dead fish. However, redds can be tricky to identify no matter how knowledgeable and experienced the surveyors are.

In an effort to compensate for limited access during some years, trends in both raw data redd counts and redds per survey effort (the average number of redd counts per survey) can be examined. One limitation to using survey effort, however, is that eventually all observable redds will have been counted and completion of more surveys only lessens the weight of each redd. Therefore, we can look at both trends; one that is based solely on the number of redds seen and one that is based on the amount of effort that went into seeing each redd.

Data limitations and caveats aside, there are several topics worth discussing further. First discussed will be phenomena from 2010 - notable fish sightings and redd superimposition. Second, considering the limitations of each method of estimating salmon populations, redd counts seem to offer the most accurate estimate of spawning success, and as with past NSEA spawning grounds survey reports, redd counts will be used to compare this year's data to past surveys. Lastly discussed will be recommendations for future spawning grounds surveys.

4.2 Notable Fish Sightings

Salmon were seen spawning in several streams where NSEA has recently completed restoration projects or has historically devoted many restoration efforts. In Terrell Creek, where NSEA has completed multiple riparian plantings and where a fish barrier culvert on Blaine Road was replaced in 2007, several live coho salmon and at least two coho redds were seen. In Macaulay Creek, Chinook salmon and coho salmon were seen spawning in the newly created channel that NSEA completed work on in 2009. In Landingstrip Creek and its tributary, coho salmon wasted no time in utilizing the channels newly created in 2010 for spawning, which is especially note worthy since the channel on the tributary of Landingstrip Creek had been in an underground culvert for over 50 years. In all, seeing salmon using newly restored and accessible habitat is promising and validating for NSEA's restoration work.

Salmon were also observed in two reaches where they have not been seen in recent years. In Bertrand Creek, the first known chum salmon redd since 2005 was recorded. In Lower Fishtrap Creek, the first live chum salmon sighting during spawning grounds surveys since 2007 occurred. The chum salmon sightings in Bertrand and Fishtrap creeks are a hopeful and encouraging sign.

4.3 Redd Superimposition

On Upper and Lower Fishtrap Creek coho salmon were seen superimposing redds on top of Chinook salmon redds. The redd superimposition signals that the large runs of fall Chinook salmon likely used up most of the available spawning habitat in the reaches, forcing coho salmon to superimpose their redds over Chinook salmon redds or dig redds in less optimal spawning habitat, usually with finer substrates. Forcing coho salmon to superimpose their redds or use less optimal spawning habitat adds another pressure to coho stocks, and also to the Chinook salmon whose redds got dug up by the coho salmon.

4.4 Historical Trends in Redd Counts

The total number of redds for Chinook salmon and coho salmon in 2010 show a general increase from levels in 2004 to 2009, but not for chum salmon. The number of Chinook salmon and coho salmon redds this year are higher than the 12 year average, but the number of chum salmon redds is lower. This year marked the largest number of coho salmon redds ever recorded during NSEA spawning grounds surveys and the second largest number of Chinook salmon redds (Figure 25). However, more surveys were completed this year than any other year, so examining the trends in the number of redds per survey effort offers a more complete picture.

When comparing the number of redds to previous years using the number of redds per survey effort, the number of Chinook salmon and coho salmon redds are less impressive, but still positive. The number of coho salmon redds per survey effort this year shows the highest numbers since 2006, but is lower than the 12 year average. The number of Chinook salmon redds per survey effort this year is the highest since 2005, and is similar to the 12 year average. The number of chum salmon redds per survey effort is similar to the low levels seen since 2004 with the exception of the higher numbers in 2006, and is lower than the 12 year average (Figure 26).

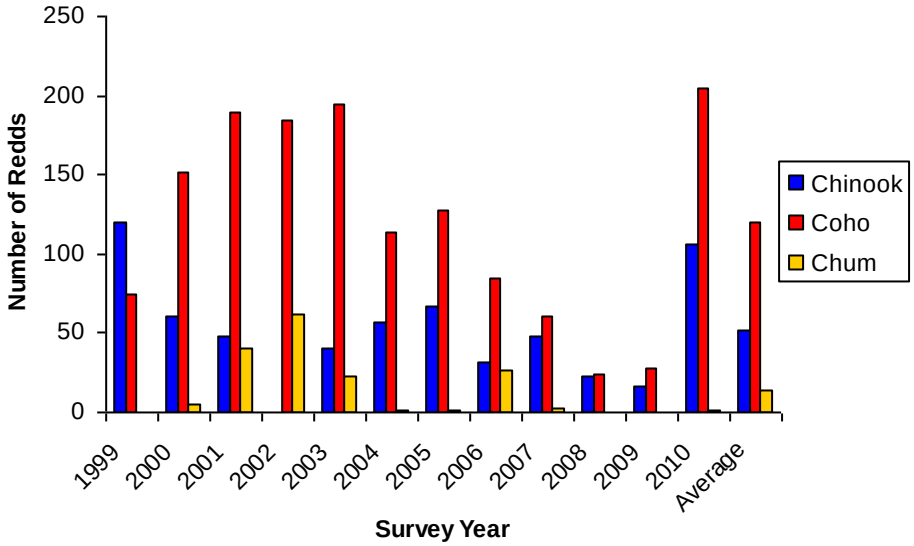

Figure 25. The number of redds documented per species for each survey season during NSEA spawning grounds surveys, along with the 12 year average number of redds for each species. Unknown redds are not shown.

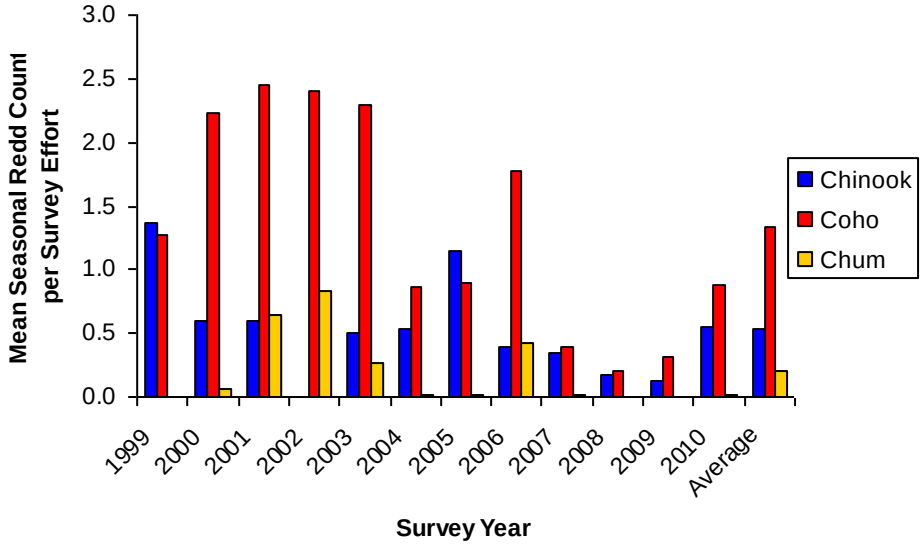

Figure 26. The number of redds documented per survey effort by species for each NSEA spawning grounds survey season along with the 12 year average number of redds per survey effort for each species. Unknown redds are not shown.

4.5 Future Work

Spawning grounds surveys should continue in the same survey reaches each year so longer-term assessment of WRIA 1 salmon spawning populations can continue. Surveys should continue to follow current WDFW protocols. The following list provides suggestions and guidance about spawning grounds survey methodology:

1. Continue to collect additional valuable data on stream water temperatures, prespawn mortality of coho, and sex, fork length, and adipose fin presence for all carcasses, regardless of whether or not the WDFW protocols call for it. Collecting this extra data is relatively easy and does not cost extra money. This list of extra data is not exhaustive and should expand to meet future needs as long as it does not add significant time or money requirements to the surveys.

2. Continue to GPS and map the locations of Chinook salmon redds, to monitor the possible colonization of fall Chinook salmon into lowland tributaries of the Nooksack River.

3. Continue to assist WDFW in conducting steelhead trout spawning grounds surveys so that WRIA 1 fisheries co-managers can have an accurate idea of steelhead escapement in the Nooksack River system.

4. In odd years start surveys earlier to capture the pink salmon run.

5. Consider adding reaches to get a better idea of chum salmon spawning populations.

6. Consider dropping or modifying the reach on Starry Creek as no live fish, carcasses, or redds have ever been recorded in the reach during NSEA spawning grounds surveys.

7. If new reaches are added, try to incorporate NSEA fish barrier removal and/or stream restoration projects, so NSEA can bolster the effectiveness monitoring of restoration efforts.

5.0 Past Reports

Survey reports on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington:

Moore, S. NSEA Salmon Spawner Survey 1999. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Moore, S. Nooksack Enhancement Association Salmon Spawner Survey 2000. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Timmer, D. Salmon Spawner Survey 2001 Yearly Report. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Krancus, L. Nooksack Salmon Enhancement Association Spawner Survey 2002. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Hovezak, M. Lower Nooksack River Basin 2003 Salmon Spawner Survey. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Roberts, M. Lower Nooksack River Basin 2004 Salmon Spawner Survey. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Roberts, M. Nooksack Salmon Enhancement Association 2005 Salmon Spawner Survey. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Brecha, C. Nooksack Salmon Enhancement Association 2006 Salmon Spawning Grounds Survey Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Van Leaven, K. Salmon Spawning Grounds Survey 2007. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Lundgren, N. Nooksack Salmon Enhancement Association 2008 Salmon Spawning Grounds Survey. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Hines, E. Nooksack Salmon Enhancement Association 2009 Salmon Spawning Grounds Survey. Report on file, Nooksack Salmon Enhancement Association, 2445 East Bakerview Road, Bellingham, Washington.

Appendix A. 2010 NSEA Spawning Grounds Survey Sampled Carcass Results

Sampled carcass information for Chinook salmon is shown in Table 3 and coho salmon in Table 4.

Table 3. Sampled Chinook salmon carcass locations, sampling dates, sexes (M=male, F=female, J=jack), fork lengths (FKL), and adipose fin presence (NM=adipose present, AC=adipose clipped) for 2010 NSEA spawning grounds surveys.

Chinook Sample Index n=100					
Stream Name	**WRIA**	**Date**	**Sex**	**FKL (cm)**	**Adipose (NM,AC)**
Lower Deer	01-0165	9/30/2010	M	70	AC
Silver Springs	01-0184	10/7/2010	F	79	AC
Bertrand	01-0201	10/6/2010	M	81	AC
Bertrand	01-0201	10/13/2010	M	99	AC
Bertrand	01-0201	10/13/2010	M	76	AC
Bertrand	01-0201	10/13/2010	M	75	AC
Bertrand	01-0201	10/20/2010	F	69	AC
Bertrand	01-0201	10/20/2010	M	68	NM
Bertrand	01-0201	10/20/2010	F	83	AC
Bertrand	01-0201	10/20/2010	M	74	AC
Bertrand	01-0201	10/20/2010	M	84	AC
Bertrand	01-0201	10/20/2010	F	76	AC
Bertrand	01-0201	10/20/2010	F	74	AC
Bertrand	01-0201	10/29/2010	F	76	AC
Bertrand	01-0201	10/29/2010	F	82	AC
Bertrand	01-0201	10/29/2010	M	71	NM
Bertrand	01-0201	10/29/2010	M	81	AC
Bertrand	01-0201	10/29/2010	F	76	AC
Bertrand	01-0201	10/29/2010	F	75	AC
Bertrand	01-0201	10/29/2010	F	77	NM
Bertrand	01-0201	11/8/2010	J	52	NM
Bertrand	01-0201	11/8/2010	F	61	NM
Upper Fishtrap	01-0210	10/1/2010	F	96	AC
Upper Fishtrap	01-0210	10/1/2010	F	85	AC
Lower Fishtrap	01-0210	10/8/2010	M	77	AC
Lower Fishtrap	01-0210	10/8/2010	M	64	AC
Lower Fishtrap	01-0210	10/8/2010	M	65	AC
Upper Fishtrap	01-0210	10/11/2010	J	53	NM
Upper Fishtrap	01-0210	10/11/2010	F	69	AC

Upper Fishtrap	01-0210	10/11/2010	F	83	NM
Upper Fishtrap	01-0210	10/11/2010	M	69	AC
Upper Fishtrap	01-0210	10/11/2010	F	69	AC
Upper Fishtrap	01-0210	10/11/2010	M	85	AC
Upper Fishtrap	01-0210	10/11/2010	M	95	AC
Upper Fishtrap	01-0210	10/11/2010	F	83	AC
Upper Fishtrap	01-0210	10/11/2010	M	78	AC
Upper Fishtrap	01-0210	10/11/2010	M	77	AC
Upper Fishtrap	01-0210	10/11/2010	F	81	AC
Upper Fishtrap	01-0210	10/11/2010	F	71	AC
Upper Fishtrap	01-0210	10/11/2010	F	92	AC
Upper Fishtrap	01-0210	10/11/2010	M	71	AC
Upper Fishtrap	01-0210	10/11/2010	M	79	AC
Upper Fishtrap	01-0210	10/11/2010	F	95	AC
Upper Fishtrap	01-0210	10/11/2010	M	84	AC
Lower Fishtrap	01-0210	10/15/2010	M	89	AC
Lower Fishtrap	01-0210	10/15/2010	M	79	AC
Lower Fishtrap	01-0210	10/15/2010	M	66	AC
Lower Fishtrap	01-0210	10/15/2010	M	88	AC
Lower Fishtrap	01-0210	10/15/2010	F	73	AC
Upper Fishtrap	01-0210	10/18/2010	M	80	NM
Upper Fishtrap	01-0210	10/18/2010	M	91	AC
Upper Fishtrap	01-0210	10/18/2010	M	87	AC
Upper Fishtrap	01-0210	10/18/2010	M	89	AC
Upper Fishtrap	01-0210	10/18/2010	M	78	AC
Upper Fishtrap	01-0210	10/18/2010	M	81	AC
Upper Fishtrap	01-0210	10/18/2010	F	75	AC
Upper Fishtrap	01-0210	10/18/2010	M	61	AC
Upper Fishtrap	01-0210	10/18/2010	F	86	AC
Upper Fishtrap	01-0210	10/18/2010	M	68	AC
Upper Fishtrap	01-0210	10/18/2010	F	92	AC
Upper Fishtrap	01-0210	10/18/2010	M	77	AC
Upper Fishtrap	01-0210	10/18/2010	M	95	AC
Upper Fishtrap	01-0210	10/18/2010	F	85	NM
Upper Fishtrap	01-0210	10/18/2010	M	92	AC
Upper Fishtrap	01-0210	10/18/2010	F	88	AC
Upper Fishtrap	01-0210	10/18/2010	M	86	AC
Upper Fishtrap	01-0210	10/18/2010	M	91	AC
Upper Fishtrap	01-0210	10/18/2010	M	81	AC
Upper Fishtrap	01-0210	10/18/2010	F	73	AC
Upper Fishtrap	01-0210	10/18/2010	F	81	AC
Upper Fishtrap	01-0210	10/18/2010	F	74	NM

Upper Fishtrap	01-0210	10/18/2010	M	89	AC
Upper Fishtrap	01-0210	10/18/2010	F	67	AC
Upper Fishtrap	01-0210	10/18/2010	M	71	AC
Upper Fishtrap	01-0210	10/18/2010	J	47	NM
Upper Fishtrap	01-0210	10/18/2010	M	84	NM
Upper Fishtrap	01-0210	10/18/2010	M	70	AC
Upper Fishtrap	01-0210	10/18/2010	F	78	AC
Upper Fishtrap	01-0210	10/18/2010	M	72	AC
Lower Fishtrap	01-0210	10/22/2010	F	82	AC
Lower Fishtrap	01-0210	10/22/2010	F	79	AC
Lower Fishtrap	01-0210	10/22/2010	M	96	AC
Upper Fishtrap	01-0210	10/25/2010	F	70	AC
Upper Fishtrap	01-0210	10/25/2010	M	92	AC
Upper Fishtrap	01-0210	10/25/2010	J	47	NM
Upper Fishtrap	01-0210	10/25/2010	F	78	NM
Upper Fishtrap	01-0210	10/25/2010	F	76	AC
Lower Fishtrap	01-0210	10/29/2010	F	72	AC
Lower Fishtrap	01-0210	10/29/2010	F	89	AC
Upper Fishtrap	01-0210	11/4/2010	F	66	AC
Upper Fishtrap	01-0210	11/4/2010	F	72	AC
Upper Fishtrap	01-0210	11/4/2010	M	87	AC
Upper Fishtrap	01-0210	11/4/2010	F	75	AC
Lower Fishtrap	01-0210	11/5/2010	J	55	NM
Upper Fishtrap	01-0210	11/11/2010	F	71	AC
Upper Fishtrap	01-0210	11/11/2010	F	74	AC
Upper Fishtrap	01-0210	11/11/2010	F	66	AC
Smith	01-0234	10/13/2010	F	70	NM
Lower Macaulay	01-0235	10/6/2010	M	64	NM
Padden	01-0622	10/19/2010	M	82	AC

Table 4. Sampled coho salmon carcass locations, sampling dates, sexes (M=male and F=female), fork lengths (FKL), and adipose fin presence (NM=adipose present, AC=adipose clipped, PAC=partially adipose clipped, and UNK=unknown) for 2010 NSEA spawning grounds surveys.

Coho Sample Index					
Stream Name	**WRIA**	**Date**	**Sex**	**FKL (cm)**	**Adipose (NM,AC, PAC,UNK)**
Terrell	01-0089	12/30/2010	M	58	NM
Terrell	01-0089	12/30/2010	F	71	NM
Lower Deer	01-0165	11/12/2010	UNK	56	NM
Lower Deer	01-0165	12/2/2010	F	63	NM
Lower Deer	01-0165	12/23/2010	M	80	NM
Lower Deer	01-0165	1/4/2011	F	64	NM
Lower Deer	01-0165	1/4/2011	F	58	NM
Silver Springs	01-0184	11/18/2010	F	67	UNK
Silver Springs	01-0184	11/18/2010	F	55	PAC
Silver Springs	01-0184	12/7/2010	M	74	NM
Silver Springs	01-0184	12/7/2010	F	65	NM
Silver Springs	01-0184	12/7/2010	M	59	NM
Silver Springs	01-0184	1/3/2011	F	60	NM
Silver Springs	01-0184	12/17/2010	F	56	NM
Silver Springs	01-0184	11/29/2010	F	68	NM
Silver Springs	01-0184	11/29/2010	F	60	NM
Silver Springs	01-0184	11/29/2010	F	67	NM
Bertrand	01-0201	11/8/2010	F	58	NM
Bertrand	01-0201	11/8/2010	M	51	NM
Bertrand	01-0201	11/8/2010	M	62	NM
Bertrand	01-0201	11/15/2010	F	55	NM
Bertrand	01-0201	11/15/2010	F	58	NM
Bertrand	01-0201	11/15/2010	F	48	NM
Bertrand	01-0201	11/15/2010	F	60	NM
Bertrand	01-0201	12/3/2010	F	63	NM
Lower Fishtrap	01-0210	11/5/2010	M	61	NM
Lower Fishtrap	01-0210	12/7/2010	M	75	NM
Lower Fishtrap	01-0210	12/7/2010	M	60	NM
Lower Fishtrap	01-0210	12/7/2010	M	78	NM
Lower Fishtrap	01-0210	12/7/2010	M	70	NM
Lower Fishtrap	01-0210	11/29/2010	M	58	NM
Lower Fishtrap	01-0210	11/29/2010	M	80	NM
Lower Fishtrap	01-0210	11/29/2010	M	74	NM

Upper Fishtrap	01-0210	11/18/2010	F	59	NM
Upper Fishtrap	01-0210	11/18/2010	M	49	NM
Upper Fishtrap	01-0210	11/18/2010	F	55	NM
Lower Fishtrap	01-0210	11/12/2010	F	60	NM
Lower Fishtrap	01-0210	11/12/2010	M	78	NM
Lower Fishtrap	01-0210	11/12/2010	M	57	NM
Lower Fishtrap	01-0210	11/12/2010	F	62	NM
Lower Fishtrap	01-0210	11/12/2010	M	57	NM
Lower Fishtrap	01-0210	11/12/2010	F	63	NM
Upper Fishtrap	01-0210	11/11/2010	M	46	NM
Upper Fishtrap	01-0210	11/11/2010	M	74	NM
Upper Fishtrap	01-0210	11/11/2010	M	63	NM
Upper Fishtrap	01-0210	11/11/2010	M	74	NM
Upper Fishtrap	01-0210	11/11/2010	F	66	NM
Lower Fishtrap	01-0210	10/29/2010	M	64	NM
Lower Anderson	01-0228	1/4/2010	M	48	NM
Lower Anderson	01-0228	1/4/2010	F	61	NM
Lower Anderson	01-0228	11/12/2010	M	53	NM
Upper Anderson	01-0228	11/12/2010	M	44	NM
Upper Anderson	01-0228	11/12/2010	F	71	AC
Upper Anderson	01-0228	11/12/2010	M	73	NM
Lower Anderson	01-0228	12/6/2010	M	72	NM
Lower Anderson	01-0228	12/6/2010	F	63	NM
Lower Anderson	01-0228	12/6/2010	M	74	NM
Lower Anderson	01-0228	12/6/2010	M	63	NM
Lower Anderson	01-0228	12/6/2010	M	74	NM
Lower Anderson	01-0228	12/6/2010	M	77	NM
Upper Anderson	01-0228	12/6/2010	M	51	NM
Smith	01-0234	1/3/2011	M	73	AC
Smith	01-0234	1/3/2011	F	61	NM
Smith	01-0234	1/3/2011	M	60	NM
Smith	01-0234	1/3/2011	M	UNK	NM
Smith	01-0234	1/3/2011	M	66	AC
Smith	01-0234	11/12/2010	M	49	NM
Smith	01-0234	11/12/2010	M	75	NM
Smith	01-0234	11/29/2010	M	71	NM
Smith	01-0234	11/29/2010	F	61	NM
Smith	01-0234	11/29/2010	F	63	NM
Smith	01-0234	11/29/2010	F	70	AC
Upper Macaulay	01-0235	12/30/2010	M	60	AC
Lower Macaulay	01-0235	12/2/2010	F	60	AC
Lower Macaulay	01-0235	12/2/2010	M	52	NM

Lower Macaulay	01-0235	12/2/2010	F	71	AC
Upper Macaulay	01-0235	12/2/2010	F	UNK	NM
Lower Macaulay	01-0235	11/22/2010	M	48	NM
Upper Macaulay	01-0235	11/22/2010	F	64	NM
Upper Macaulay	01-0235	11/22/2010	F	62	NM
Mitchell	01-0236	12/30/2010	F	57	NM
Mitchell	01-0236	12/30/2010	M	58	NM
Mitchell	01-0236	12/30/2010	M	58	NM
Mitchell	01-0236	12/2/2010	M	80	AC
Mitchell	01-0236	12/2/2010	F	64	NM
Mitchell	01-0236	12/23/2010	F	62	NM
Mitchell	01-0236	12/23/2010	M	80	NM
Mitchell	01-0236	11/22/2010	M	48	NM
Mitchell	01-0236	11/22/2010	M	54	NM
Mitchell	01-0236	11/22/2010	M	78	AC
Mitchell	01-0236	11/22/2010	F	70	NM
Mitchell	01-0236	11/12/2010	M	48	NM
Tinling	01-0250	11/9/2010	UNK	UNK	NM
Tinling	01-0250	12/28/2010	F	48	NM
Tinling	01-0250	12/28/2010	M	54	NM
Tinling	01-0250	12/28/2010	F	63	PAC
Tinling	01-0250	12/28/2010	M	64	NM
Tinling	01-0250	12/18/2010	F	60	NM
Tinling	01-0250	11/16/2010	M	54	NM
Tinling	01-0250	11/16/2010	F	65	NM
Tinling	01-0250	11/16/2010	F	70	NM
Tinling	01-0250	11/16/2010	M	52	NM
Tinling	01-0250	11/16/2010	F	66	NM
Tinling	01-0250	11/16/2010	F	61	NM
Landingstrip	01-0263	12/28/2010	F	62	NM
Landingstrip	01-0263	12/28/2010	M	UNK	NM
Landingstrip	01-0263	12/3/2010	F	59	NM
Landingstrip Tributary	not assigned	12/28/2010	M	50	NM
Landingstrip Tributary	not assigned	12/28/2010	M	65	NM
Landingstrip Tributary	not assigned	12/28/2010	M	72	NM
Landingstrip Tributary	not assigned	12/28/2010	F	67	NM
Landingstrip Tributary	not assigned	12/28/2010	M	49	NM
Landingstrip Tributary	not assigned	12/18/2010	F	64	AC
Landingstrip Tributary	not assigned	12/18/2010	F	62	NM
Landingstrip Tributary	not assigned	12/18/2010	M	78	NM
Landingstrip Tributary	not assigned	12/18/2010	F	66	AC
Landingstrip Tributary	not assigned	11/24/2010	F	68	NM

Landingstrip Tributary	not assigned	11/24/2010	M	73	NM
Landingstrip Tributary	not assigned	11/24/2010	F	62	NM
Landingstrip Tributary	not assigned	11/16/2010	F	74	PAC
Landingstrip Tributary	not assigned	11/16/2010	F	63	AC
Landingstrip Tributary	not assigned	12/3/2010	F	63	AC
Landingstrip Tributary	not assigned	12/3/2010	M	57	NM
Padden	01-0622	11/11/2010	F	66	NM
Padden	01-0622	11/2/2010	F	66	AC

Carcasses only sampled for adipose presence:

Adipose	**Number**
NM	17
AC	4
UNK	4

Appendix B. Redd Counts Versus Survey Effort

The following data analysis estimates the number of redds per survey effort for NSEA spawning grounds survey reaches. Table 5 lists how many surveys were done each year for each reach. Tables 6, 7, and 8 list how many redds were seen each year in each reach for each species. Tables 9, 10, and 11 list the number of redds per survey effort and was calculated by dividing the number of redds seen by the number of surveys completed each year.

Table 5. The number of surveys per reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Number of Surveys per year												All Years	Percent of total
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
Anderson, Upper	10	9	8	8	6	11	10	4	9	5	5	10	95	8.1%
Bertrand	12	9	6	8	8	6	8	2	6	4	6	10	85	7.2%
Deer, lower	2	1	5	8	8	12	10	5	12	8	7	12	90	7.7%
Deer, upper	3	7	5	5	8	12	5	5	7	7	8	6	78	6.6%
Fishtrap, lower	4	7	7	7	5	7	1	5	10	6	6	10	75	6.4%
Fishtrap, upper	8	7	7	6	7	12	10	4	10	8	10	13	102	8.7%
Landingstrip	ns	ns	ns	ns	ns	ns	3	2	ns	5	8	11	29	2.5%
Macaulay, Upper	8	7	7	3	5	13	14	3	10	9	9	13	101	8.6%
Mitchell	7	7	7	6	5	8	13	2	9	9	11	13	97	8.3%
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	7	11	18	1.5%
Silver Springs	5	5	6	5	9	14	14	4	13	13	11	13	112	9.5%
Smith	9	9	7	3	5	11	12	1	8	4	1	11	81	6.9%
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	7	9	16	1.4%
Starry	ns	3	ns	3	7	ns	ns	ns	ns	ns	6	6	25	2.1%
Tawes	ns	ns	ns	ns	ns	ns	3	3	1	7	7	9	30	2.6%
Terrell	ns	ns	ns	ns	5	9	9	6	9	7	7	8	60	5.1%
Tinling	3	5	6	4	5	11	15	4	7	6	6	8	80	6.8%
Totals	**71**	**76**	**71**	**66**	**83**	**126**	**127**	**50**	**111**	**98**	**122**	**173**	**1174**	**100.0%**

Table 6. The number of Chinook salmon redds per reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Chinook Salmon Redds by Reach by Year												All Years	Percent of total
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
Anderson, Upper	6	0	0	0	6	1	0	0	0	0	0	0	13	2.1%
Bertrand	46	25	11	0	7	5	0	0	6	0	1	24	125	20.4%
Deer, lower	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Deer, upper	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Fishtrap, lower	17	9	18	0	8	29	13	32	13	2	7	25	173	28.2%
Fishtrap, upper	41	24	17	0	2	16	53	0	27	21	7	48	256	41.8%
Landingstrip	ns	ns	ns	ns	ns	ns	0	0	ns	0	0	4	0	0.0%
Macaulay, Upper	1	0	0	0	11	1	0	0	0	0	1	0	14	2.3%
Mitchell	3	0	0	0	4	1	0	0	0	0	0	1	9	1.5%
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	0	0	0.0%
Silver Springs	0	0	0	0	1	0	0	0	0	0	0	1	2	0.3%
Smith	6	3	1	0	1	4	1	0	2	0	0	3	21	3.4%
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	0	0	0.0%
Starry	ns	0	ns	0	0	ns	ns	ns	ns	ns	0	0	0	0.0%
Tawes	ns	ns	ns	ns	ns	ns	ns	0	0	0	0	0	0	0.0%
Terrell	ns	ns	ns	ns	0	0	0	0	0	0	0	0	0	0.0%
Tinling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Totals	**120**	**61**	**47**	**0**	**40**	**57**	**67**	**32**	**48**	**23**	**16**	**106**	**613**	**100.0%**

Table 7. The number of coho salmon redds per reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Coho Salmon Redds by Reach by Year												All Years	Percent of total
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
Anderson, Upper	3	13	34	53	18	5	9	7	0	1	4	18	165	12.0%
Bertrand	1	21	11	6	20	0	15	0	0	0	0	6	80	5.8%
Deer, lower	2	10	12	26	18	16	6	25	16	5	0	22	158	11.5%
Deer, upper	5	25	30	12	11	17	8	0	0	2	0	3	113	8.2%
Fishtrap, lower	0	1	0	16	37	10	0	0	4	0	0	12	80	5.8%
Fishtrap, upper	0	5	5	5	9	13	12	0	6	8	2	22	87	6.3%
Landingstrip	ns	ns	ns	ns	ns	ns	3	0	ns	0	0	3	3	0.2%
Macaulay, Upper	18	21	23	3	12	6	15	18	3	1	8	7	135	9.8%
Mitchell	23	26	35	10	27	20	21	28	9	2	12	24	237	17.3%
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	1	1	0.1%
Silver Springs	8	9	16	22	21	11	7	4	13	2	0	9	122	8.9%
Smith	5	20	23	7	6	3	11	0	4	1	2	23	105	7.7%
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0	0	0	0.0%
Starry	ns	0	ns	0	0	ns	ns	ns	ns	ns	0	0	0	0.0%
Tawes	ns	ns	ns	ns	ns	ns	ns	0	0	0	0	1	1	0.1%
Terrell	ns	ns	ns	ns	0	1	1	0	0	1	0	2	5	0.4%
Tinling	10	0	0	18	14	5	12	3	5	1	0	11	79	5.8%
Totals	**75**	**151**	**189**	**178**	**193**	**107**	**120**	**85**	**60**	**24**	**28**	**164**	**1371**	**100.0%**

Table 8. The number of chum salmon redds per reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey, unk = unknown number of redds. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Chum Salmon Redds by Reach by Year												All Years	Percent of total
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
Anderson, Upper	0	0	0	2	0	0	0	0	0	0	0	0	2	1.4%
Bertrand	0	1	10	7	8	0	1	0	0	0	0	1	28	19.9%
Deer, lower	0	0	14	0	1	0	0	0	0	0	0	0	15	10.6%
Deer, upper	0	0	8	0	0	1	0	0	0	0	0	0	9	6.4%
Fishtrap, lower	0	0	0	6	11	0	0	1	2	0	0	0	20	14.2%
Fishtrap, upper	0	0	1	12	2	0	0	26	0	0	0	0	41	29.1%
Landingstrip	ns	ns	ns	ns	ns	ns	0	0	ns	0	0	0	0	0.0%
Macaulay, Upper	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Mitchell	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	unk	0	0	0.0%
Silver Springs	0	4	6	15	1	0	0	0	0	0	0	0	26	18.4%
Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	unk	0	0	0.0%
Starry	ns	0	ns	0	0	ns	ns	ns	ns	ns	0	0	0	0.0%
Tawes	ns	ns	ns	ns	ns	ns	ns	0	0	0	0	0	0	0.0%
Terrell	ns	ns	ns	ns	0	0	0	0	0	0	0	0	0	0.0%
Tinling	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%
Totals	**0**	**5**	**39**	**42**	**23**	**1**	**1**	**27**	**2**	**0**	**0**	**0**	**141**	100.0%

Table 9. The number of Chinook salmon redds per survey effort for each reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Ratio of Chinook Redds Per Survey Effort												Ratio Mean
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Anderson, Upper	0.60	0.00	0.00	0.00	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Bertrand	3.83	2.78	1.83	0.00	0.88	0.83	0.00	0.00	1.00	0.00	0.17	2.40	1.14
Deer, lower	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Deer, upper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fishtrap, lower	4.25	1.29	2.57	0.00	1.60	4.14	13.00	6.40	1.30	0.33	1.17	2.50	3.21
Fishtrap, upper	5.13	3.43	2.43	0.00	0.29	1.33	5.30	0.00	2.70	2.63	0.70	3.69	2.30
Landingstrip	ns	ns	ns	ns	ns	ns	0.00	0.00	ns	0.00	0.00	0.36	0.07
Macaulay, Upper	0.13	0.00	0.00	0.00	2.20	0.08	0.00	0.00	0.00	0.00	0.11	0.00	0.21
Mitchell	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.02
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.00	0.00	0.00
Silver Springs	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.02
Smith	0.67	0.33	0.14	0.00	0.20	0.36	0.08	0.00	0.25	0.00	0.00	0.27	0.19
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.00	0.00	0.00
Starry	ns	0	ns	0	0	ns	ns	ns	ns	ns	0.00	0.00	0.00
Tawes	ns	ns	ns	ns	ns	ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Terrell	ns	ns	ns	ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tinling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	**1.33**	**0.65**	**0.63**	**0.00**	**0.50**	**0.57**	**1.31**	**0.46**	**0.40**	**0.21**	**0.13**	**0.55**	**0.43**

Table 10. The number of coho salmon redds per survey effort for each reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Ratio of Coho Redds Per Survey Effort												Ratio Mean
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Anderson, Upper	0.30	1.44	4.25	6.63	3.00	0.45	0.90	1.75	0.00	0.20	0.80	1.80	1.79
Bertrand	0.08	2.33	1.83	0.75	2.50	0.00	1.88	0.00	0.00	0.00	0.00	0.60	0.83
Deer, lower	1.00	10.00	2.40	3.25	2.25	1.33	0.60	5.00	1.33	0.63	0.00	1.83	2.47
Deer, upper	1.67	3.57	6.00	2.40	1.38	1.42	1.60	0.00	0.00	0.29	0.00	0.50	1.57
Fishtrap, lower	0.00	0.14	0.00	2.29	7.40	1.43	0.00	0.00	0.40	0.00	0.00	1.20	1.07
Fishtrap, upper	0.00	0.71	0.71	0.83	1.29	1.08	1.20	0.00	0.60	1.00	0.20	1.69	0.78
Landingstrip	ns	ns	ns	ns	ns	ns	1.00	0.00	ns	0.00	0.00	0.27	0.25
Macaulay, Upper	2.25	3.00	3.29	1.00	2.40	0.46	1.07	6.00	0.30	0.11	0.89	0.54	1.78
Mitchell	3.29	3.71	5.00	1.67	5.40	2.50	1.62	14.00	1.00	0.22	1.09	1.85	3.45
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.00	0.09	0.05
Silver Springs	1.60	1.80	2.67	4.40	2.33	0.79	0.50	1.00	1.00	0.15	0.00	0.69	1.41
Smith	0.56	2.22	3.29	2.33	1.20	0.27	0.92	0.00	0.50	0.25	2.00	2.09	1.30
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	0.00	0.00	0.00
Starry	ns	0.00	ns	0.00	0.00	ns	ns	ns	ns	ns	0.00	0.00	0.00
Tawes	ns	ns	ns	ns	ns	ns	ns	0.00	0.00	0.00	0.00	0.11	0.02
Terrell	ns	ns	ns	ns	0.00	0.11	0.11	0.00	0.00	0.14	0.00	0.25	0.08
Tinling	3.33	0.00	0.00	4.50	2.80	0.45	0.80	0.75	0.71	0.17	0.00	1.38	1.24
Average	**1.28**	**2.41**	**2.68**	**2.50**	**2.46**	**0.86**	**0.94**	**2.04**	**0.45**	**0.23**	**0.29**	**0.88**	**1.06**

Table 11. The number of chum salmon redds per survey effort for each reach for each year of NSEA spawning grounds surveys. Lower Anderson Creek, Lower Macaulay Creek, and Tributary of Landingstrip Creek are not listed because they were added in 2010. ns = no survey, unk = unknown number of redds. From 2002 to 2009 the City of Bellingham monitored Padden and Squalicum creeks.

Reach Name	Ratio of Chum Redds Per Survey Effort												Ratio Mean
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	
Anderson, Upper	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Bertrand	0.00	0.11	1.67	0.88	1.00	0.00	0.13	0.00	0.00	0.00	0.00	0.10	0.32
Deer, lower	0.00	0.00	2.80	0.00	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24
Deer, upper	0.00	0.00	1.60	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Fishtrap, lower	0.00	0.00	0.00	0.86	2.20	0.00	0.00	0.20	0.20	0.00	0.00	0.00	0.29
Fishtrap, upper	0.00	0.00	0.14	2.00	0.29	0.00	0.00	6.50	0.00	0.00	0.00	0.00	0.74
Landingstrip	ns	ns	ns	ns	ns	ns	0.00	0.00	ns	0.00	0.00	0.00	0.00
Macaulay, Upper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mitchell	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Padden	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	unk	0.00	0.00
Silver Springs	0.00	0.80	1.00	3.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41
Smith	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Squalicum	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	unk	0.00	0.00
Starry	ns	0.00	ns	0.00	0.00	ns	ns	ns	ns	ns	0.00	0.00	0.00
Tawes	ns	ns	ns	ns	ns	ns	ns	0.00	0.00	0.00	0.00	0.00	0.00
Terrell	ns	ns	ns	ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tinling	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average	**0.00**	**0.08**	**0.66**	**0.58**	**0.29**	**0.01**	**0.01**	**0.48**	**0.02**	**0.00**	**0.00**	**0.01**	**2.12**

Appendix C. Directions to Spawning Grounds Survey Reach Locations

Table 13. Directions to stream reach locations where surveys were conducted in 2010. RM indicates River Mile. Reaches are listed in order by WRIA numbers so that creeks listed next to one another should be in relatively close in proximity. Landowner contact information is available at the NSEA office.

2010 Spawning Grounds Survey Reach Locations and Directions		
Terrell	RM 4.9-5.3	Drive west on Grandview Road to Blaine Road. Turn right onto Blaine Road and take the first left to the gated parking area. Find a small hunter's path that follows the edge of the trees that surround the creek. Walk next to the trees for about 0.25 miles until you see an opening down to the stream (it should be marked with pink flagging). Start your survey here. Walk upstream through the culvert unless water levels are too high to make it through safely. Should this be the case, find your way up the bank, cross the street, and scramble back down to the creek upstream of the culvert. Continue past the culvert upstream for 0.4 miles. There are pink flags marking the end of the reach near a small fork in the creek. Walk up the left bank and take the hunter's path back to the parking area.
Deer, lower	RM 0.5-1.1	Take Northwest Avenue to Axton Road. Turn left on Axton Road, then take the next left onto Judy Way. Drive down Judy Way past the private driveway sign and cross the bridge over the creek. Park in the pullout on the right side of the driveway immediately past the bridge. Continue on foot along the right fork in road and follow the old grass road/trail on the right through the woods with the creek on your right. Walk downstream about 0.25 miles until you see pink flagging marking the start point. There is a path here that leads to the creek. At this point you can view a house on the other side of the creek from the main trail. If you reach the hill, you have gone too far. Enter the creek here and survey upstream to an old fallen wooden bridge, then stop. Beyond this point, the creek becomes narrow and deep with lots of invasive plants and little shaded vegetation. Turn around here and walk back downstream until reaching the bridge where your vehicle is parked. Call the landowner before each survey.
Deer, upper	RM 3.2-3.7	Drive north (from NSEA) on the Guide Meridian. Turn left on Smith Road and drive west until Manthey Road, which is directly across from the North Bellingham Golf Course. Turn right on Manthey Road and park off the road on the right near the barn (5390 Manthey Road) that is halfway down the road. Go through the fence where possible. Walk ENE through fields for 0.25 miles and then pass through another fence. Walk on the left side of this field near the trees until you come to a small stand of alders where you will see an entrance to the creek (and pink flagging). Survey from here upstream to where the creek crosses under the power lines. Exit creek on the right bank and walk back through the fields to your vehicle.

Silver Springs, lower	RM 0.0-0.5	Drive north (from NSEA) on Hannegan Road. Then turn left on Hemmi Road. Park on the north side of the road near the dairy farm where the creek crosses under Hemmi Road. Walk through the farm north downstream to the confluence with Tenmile Creek. Start your survey here and follow the stream back to Hemmi Road. Cross the street and survey the stream until it goes under the barn. Walk around the barn and join the stream where it exits the barn. Walk up the creek until you reach a barbed wire fence. Contact the landowner before surveying.
Starry Creek	RM 0.0-0.75	Drive north on Hannegan Road from NSEA and turn right onto Axton Road. Take Axton Road until it dead ends and turn left into the Shuksan Golf Course. Park in the golf course parking lot. The reach begins at the confluence with Tenmile Creek, down the large hill and east from the parking lot. Survey upstream until the creek reaches Starry Road. Call the Shuksan Golf Course before each survey at 360-398-8888 ext. 7.
Bertrand	RM 8.2-8.7	Drive north on the Guide Meridian to H Street. Turn left and drive west to the bridge over the creek. Park vehicle in the pullout near the bridge. Begin survey under bridge and walk upstream. You will pass under an old bridge about halfway through the survey. There are pink and green flags marking the exit point, which is about .25 miles past the large logjam and clay slide area. Walk up the right bank, over the barbed wire fence, through the field to the gravel driveway, and out to H St. If you miss the exit flags, you can walk to the border and turn around. Leave a note on your vehicle for Border Patrol.
Fishtrap, lower	RM 4.9-5.7	Drive to Lynden on Hannegan Road. Take a left on Main Street and then a right on Depot Road. Park at Lynden City Park on your right. The reach begins 100 meters downstream of the Depot Road bridge and continues all the way to Bender Road. Follow paved path through the park back to vehicle.
Fishtrap, upper	RM 8.8-9.2	Drive north on Northwood Road (east of Lynden) 0.8 miles past Pangborn Road. Take a left at the gravel road immediately south of the house at 9621 Northwood Road. Drive down the gravel road to where it crosses Fishtrap Creek. Park near the stream and survey upstream to where the creek flows under an impenetrable thicket of blackberries. Leave a note on your vehicle for Border Patrol.
Anderson, Lower	RM 1.2-2.7	This reach is done in conjunction with Upper Anderson, and requires two vehicles due to the length. From NSEA, drive north on Hannegan and turn left on Kelly Road. Drive east on Kelly Road about 4.7 miles until the Anderson Creek bridge, and park one vehicle here. In the second vehicle, continue east on Kelly Road and take a left onto Sand Road. Take Sand Road for 2.5 miles then turn left onto Goshen Road. Drive down Goshen Road for 0.44 miles and take a left onto Salakanum Way. Park off the road past the Anderson Creek bridge and survey upstream until the E. Smith Road bridge.
Anderson, Upper	RM 2.7-4.0	This reach is from E. Smith Road through to Kelly Road. Walk upstream from the E Smith Road bridge to the bridge on Kelly Road.

Smith	RM 2.5-3.5	Drive east on the Mt. Baker Highway (SR 542) and pass through Nugent's Corner. Park one vehicle in gravel area next to the bridge where Smith Creek passes underneath SR 542 for the second time (upstream). Park the second vehicle in the driveway of the first house east of the Smith Creek bridge, or walk the highway to the bridge. If parking a second vehicle, park off on the right side of the driveway and contact the landowner beforehand. Walk upstream to the bridge with the train tracks where vehicle is parked.
Macaulay, Lower	RM 0.5-1.0	Going east on Mt. Baker Highway (SR 542), turn left on Macaulay Road (between Nugent's Corner and Deming). Turn right just after the bridge over the creek onto a dead-end gravel road. Park here. Walk through the fields west of Macaulay Road, staying close to Macaulay Creek and walking downstream until you reach a small bridge, which is the starting point. Survey upstream from the small bridge until the end of the reach where the creek makes a sharp turn away from SR 542, and begins flowing in a dredged channel perpendicular to the highway.
Macaulay, Upper	RM 1.0-1.5	Start this survey at the endpoint of Lower Macaulay, where the creek makes a sharp turn away from SR 542 and begins flowing in a dredged channel perpendicular to the highway. Survey upstream until you reach a barbed wire fence running across the stream.
Mitchell	RM .3-1.0	Going east on the Mt. Baker Highway (SR 542), turn left on Scarlett Road (a private driveway with a sign advertising One Heron Pond Pottery Studio). Follow the driveway past the first house and workshop and turn around in the driveway by the second house. Park on the corner just before the creek facing Mt. Baker Highway. Start the survey here and walk upstream to the third bridge. You will know it is the correct bridge because it is wooden and as you climb out and look to the left you will see a "Private Forest" sign on the closest tree. Walk towards the highway on Mitchell Road, then along the highway back to your vehicle.
Tinling	RM 2.0-2.25	Take Strand Road off of SR 9 to Clipper Road. Park just past the creek in the driveway at the red house on the right. Follow Tinling Creek downstream on a rough trail/road for about 0.25 miles, until it reaches a swampy area marked with pink and green flagging. Survey upstream to Clipper Road then cross the road and continue upstream until you reach a small stream flowing into Tinling Creek on the right hand side. Turn around here and walk back to Clipper Road. Contact the Landowner at the beginning of the season.
Tawes	RM 0.4-0.5	This stream is located just off of SR 9 South. The turn-off is at the large U curve just before Van Zandt. Park on the far right of the driveway at pink house on the west side of the road. Make sure to ask permission from the landowner first. Walk past the old outbuildings behind the house until you reach the stream. Survey about 0.1 miles of Tawes Creek, ending at SR 9.

Tributary of Landingstrip	RM 0.0-0.4	Head south on SR 9 and go through Acme. Take a left onto Rothenbuhler Road. Park just before the creek in the pullout by an apple tree. First, survey upstream of the Rothenbuhler Road culvert until you reach a second culvert, just upstream of the railroad bridge. Next, walk back down to the Rothenbuhler culvert and survey downstream until you reach the confluence with Landingstrip Creek, which is the end of the survey.
Landingstrip	RM 0.4-1.0	Typically this reach is surveyed in conjuction with the tributary of Landingstrip Creek. After finishing the tributary survey, begin surveying Landingstrip Creek starting at the confluence with the tributary. The survey ends at the bridge upstream of Rothenbuhler road.
Squalicum	RM 0.0-0.5	Heading south on Meridian Street (from NSEA), turn right onto Squalicum Way. Head down Squalicum Way until intersection with West Street, and about 0.25 miles beyond will be a small turnout on the left side of the road (the creek crosses underneath the road here). Park in this turnout and continue walking down road. The reach begins at the second overpass (most downstream) and winds all the way back up to the culvert where vehicle is parked.
Padden	RM 0.0-0.8	Head down Harris Avenue towards the Fairhaven bus and ferry terminals. Just after 8th Street Padden Creek passes under the road. Park on the left-hand side of the street on the gravel. This reach begins directly upstream of the road. Note that the mouth of this creek is tidally influenced and harbor seals have been known to swim through here - be cautious! The creek may, at times, seem high at the mouth, but it may become lower further upstream. Walk through the first fish ladder, but get out and walk around the next two; crossing over the interurban trail each time. Reach ends at the fish ladder in Fairhaven Park. Get out on right side and take interurban trail back to vehicle.