Salmon Spawning Grounds Surveys 2012

Conducted in Selected WRIA 1 Nooksack River and Independent Drainages.
ACKNOWLEDGEMENTS

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1.0 INTRODUCTION

The Nooksack Salmon Enhancement Association (NSEA) conducted salmon spawning grounds surveys for Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and chum salmon (*O. keta*) under the direction of the Department of Fish and Wildlife in select Nooksack River basin tributaries and independent drainages. Data collected supplements salmonid population information that is collected annually by Nooksack basin fisheries co-managers. NSEA has conducted spawning grounds surveys for fourteen years, and this extensive historical data set allows for monitoring long-term trends at the stream reaches surveyed.

In 2012, Bellingham Technical College (BTC) increased their involvement in conducting NSEA spawning grounds surveys. Previously, second year students from BTC’s Fisheries and Aquaculture program surveyed Whatcom, Squalicum, and Padden Creeks. This year, approximately forty first and second year students participated, surveying ten creeks: Anderson, Bertrand, Deer, Fishtrap, Padden, Silver Springs, Smith, Squalicum, Terrell, and Whatcom Creeks. NSEA staff and interns surveyed Macaulay, Mitchell, Tawes, Landingstrip and its tributary, and Tinling Creek.

NSEA surveys began October 4, 2012 and ended March 6, 2013. Each stream reach was surveyed every 7-10 days, weather permitting, until the salmon were finished spawning. Qualitative and quantitative parameters were recorded each survey, including: temperature, pH, stream flow, water clarity/visibility, weather observations and air temperature. The number of live, dead (carcasses) and redds were recorded, and species was indicated when possible.

NSEA surveys 21 designated reaches in 16 streams, located in the Water Resource Inventory Area 1 (WRIA 1). Maps and descriptions of all NSEA designated reaches can be found in Figure 1 and Appendix A. Directions to Spawning Grounds Survey Reach Locations. These streams are in several regions throughout the county, including: the Nooksack River upper main stem, lower main stem, and south fork, as well as Whatcom County independent drainages (Figure 2). Co-managers of the Nooksack Basin that also collect spawning ground survey data include the Lummi Nation, the Nooksack Tribe, and the Washington Department of Fish and Wildlife.

In 2012, NSEA partnered with Lummi Natural Resources (LNR) to expand their coho surveys. Additional creeks surveyed include: Black Slough in the South Fork region, Tenmile Creek in the lower main stem region, and a reach at the mouth of Landingstrip Creek. NSEA’s survey reach on Tawes creek was extended an additional .1 miles from
the previous ending point at the request of LNR. Survey data for the additional LNR reaches is included in Appendix G. Coho Data Collected for Lummi Natural Resources.

2.0 METHODS

Spawning grounds survey protocol was developed to meet WDFW reporting requirements (Appendix C. WDFW Survey Protocol). At least two of the surveyors recorded information during each survey. At the conclusion of each survey, the two records were compared to reduce error. Surveyors wore polarized sunglasses to increase stream visibility. Each reach was surveyed every seven to ten days, weather permitting. Stream visibility and surveyor availability determined when the reaches were surveyed within the seven to ten day period. Quantitative and qualitative measurements were taken, some at the beginning and some at the end of each survey. Measurements taken include: temperature, pH, time in, time out, live count, redd count, carcass count, carcass scale card information, weather, visibility, and flow. All measurements, except those for the scale cards, were recorded and entered into an NSEA spreadsheet following the survey. Surveys continued until no new redds, carcasses or live fish were seen for two consecutive weeks.

2.1 QUANTITATIVE MEASUREMENTS

Water temperature and pH were measured and recorded at the entry point of each reach. Temperature was measured with a field thermometer. The pH was measured using semi-quantitative Hach® water quality pH test strips. The time of entry and exit was also recorded. From the entry point to the exit point a team of two or more surveyed the reach from the best viewpoint possible, either in the stream or on the bank. Extreme care was taken to avoid habitat disturbance by walking on the outmost edges of the stream when possible. If the creek was too deep or turbid at points, the survey was done from the stream banks. Surveyors began downstream and surveyed upstream to the exit point in order to avoid creating turbidity.

2.1.1 LIVE COUNTS

Each live fish sighting was recorded and the species was identified when possible. A minimum wait time of 7 days was adhered to between surveys to reduce the possibility of recounting the same live fish. Also, a hand held counting device was used if large quantities of live fish were found to reduce counting error. At times when circumstances did not allow identification to a species, due to the fish swimming into a deep pool or under woody debris, the fish was documented as an “unknown” species.
2.1.2 REDD COUNTS

Each redd sighting was also recorded and identified by fish species when possible. Surveyors tagged each redd by placing labeled flagging tape on a near-by branch or rock to avoid being walked on or recounted during future surveys. The flagging tape label included the following information: surveyor initials, date of the sighting, organization conducting the survey, and species. Redds were only counted when both an upstream depression and a downstream mound of clean, non-compacted substrate were present. When reds were found confirmation was sought from the other surveyors, in order to minimize subjectivity. The species that created the redd was also recorded, if possible. Redds were only identified to species when a fish was on or near the redd. If no fish were observed, the redd was recorded as being made by an “unknown” species.

2.1.3 CARCASS DOCUMENTATION

Each carcass was recorded and examined for sex, fork length, adipose fin presence or absence, coded wire tag, and the number of eggs remaining if it was a female. Surveyors extracted the otoliths from Chinook salmon carcasses and placed them in a vial with ethanol preservative to be submitted to the Washington Department of Fish and Wildlife (WDFW). All measurements taken were recorded on a separate numbered scale card which was submitted to WDFW. Additionally, the carcass count, species, and otolith vial numbers were recorded in the surveyor’s data notebooks.

Carcass examinations were completed in several steps. First, the scale card was completed with the stream name, WRIA number and sub-basin code, date, sampler’s initials, fork length, species, sex, adipose fin presence or absence (Appendix D. Scale Card Instructions and Appendix E. WDFW Scale Card Example). If the adipose fin was absent, the carcass was checked for a coded wire tag (CWT) with a CWT detector wand by placing it near and in the carcass mouth. The device emitted an audible beep when a CWT was present. To confirm the sex the carcass was dissected from the vent to pelvic fins. Evidence of eggs or milt verified sex. Next, three scales from each side of the fish were extracted and placed onto the scale card. The scales were always taken from above the lateral line and posterior of the dorsal fin using forceps. Extreme care was taken in order to not flip the scales upside down when transferring to the scale card so that they could be examined in the WDFW lab.

Information on spawning success and gill and eye conditions was also recorded. If male, then spawn status was determined by the amount of milt present. If female, then the spawn status was determine by the number of eggs present. The remaining eggs were counted and the number recorded in the data notebooks. The carcass was
determined to be spawned, pre-spawned or partially spawned depending on how many eggs were deposited before death. Gill condition was noted as red, pink, grey or unknown (if absent). Eye condition was noted as clear, cloudy or unknown. Gill and eye condition can be used as a time of death estimate.

Finally, the caudal (tail) fin was cut off after all information was gathered to avoid re-counting and re-sampling. If a carcass was too decomposed to sample, it was recorded in the data notebook and the species identified if possible. If the carcass was severely decomposed, only the presence or absence of the adipose fin was noted and then the caudal fin was removed. After the caudal fin was removed the carcass was returned to the location where it was found. Completed scale cards, Chinook otolith samples, and CWT head 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.

2.2 QUALITATIVE MEASUREMENTS

At the start of each survey the weather was recorded and the air temperature was estimated. Weather was recorded as sunny, overcast, raining, windy or a combination of thereof. Rain was further described as light, moderate/drizzle, heavy, or other equivalent language.

After the survey was complete, the surveyors estimated visibility and flow of the entire reach based on the pre-determined WDFW code. Flow was estimated by speed and volume of water in the stream and was relative to each creek. Visibility was estimated by turbidity of the stream (water clarity) as well as the amount of the stream bed that was visible throughout the survey reach. If there were dark pools, large woody debris, or other obstructions, the visibility would be recorded as lower.

2.3 SURVEY REACHES

Survey reaches were originally selected based on the available WDFW data. For logistical reasons, the streams were also selected based on their accessibility. Also, streams were selected based on their proximity to past or future NSEA stream restoration sites. The data collected on spawning grounds surveys helps measure the effectiveness of NSEA habitat restoration projects completed on those streams.

In 2012 surveys were conducted every seven to ten days from October 4, 2012 to March 6, 2013, with various numbers of surveys depending on the spawning window at each individual reach. Reaches were surveyed until no new redds, carcasses, or live fish were seen for two consecutive surveys.
Figure 1. Map of NSEA spawning grounds survey reaches.
Figure 2. Map of NSEA spawning grounds survey watersheds.
Table 1. WRIA number, river miles and the number of surveys completed for each reach surveyed during 2012 NSEA spawning grounds surveys. Padden, Squalicum, Terrell, and Whatcom creeks are all Whatcom County drainages independent of the Nooksack River basin.

<table>
<thead>
<tr>
<th>Stream Surveyed</th>
<th>WRIA Number</th>
<th>River Miles</th>
<th>Surveyed By</th>
<th>Survey Window</th>
<th>Number of Surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anderson Creek, lower</td>
<td>01-0228</td>
<td>1.2 – 2.7</td>
<td>BTC</td>
<td>10/8/12 - 1/15/13</td>
<td>10</td>
</tr>
<tr>
<td>Anderson Creek, upper</td>
<td>01-0228</td>
<td>2.7 – 4.0</td>
<td>BTC</td>
<td>10/8/12 - 1/15/13</td>
<td>14</td>
</tr>
<tr>
<td>Macaulay Creek, lower</td>
<td>01-0235</td>
<td>0.5 – 1.0</td>
<td>NSEA</td>
<td>10/8/12 - 1/16/13</td>
<td>16</td>
</tr>
<tr>
<td>Macaulay Creek, upper</td>
<td>01-0235</td>
<td>1.0 – 1.5</td>
<td>NSEA</td>
<td>10/8/12 - 1/23/13</td>
<td>16</td>
</tr>
<tr>
<td>Mitchell Creek</td>
<td>01-0236</td>
<td>0.3 – 1.0</td>
<td>NSEA</td>
<td>10/8/12 - 1/23/13</td>
<td>21</td>
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<tr>
<td>Smith Creek</td>
<td>01-0234</td>
<td>2.5 – 3.5</td>
<td>BTC</td>
<td>10/8/12 - 1/14/13</td>
<td>14</td>
</tr>
<tr>
<td>Bertrand Creek</td>
<td>01-0201</td>
<td>8.2 – 8.7</td>
<td>BTC</td>
<td>10/4/12 - 1/4/13</td>
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<tr>
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<td>0.5 – 0.8</td>
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<td>10/19/12 - 1/15/13</td>
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<td>10/4/12 - 1/16/13</td>
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<td>Fishtrap Creek, upper</td>
<td>01-0210</td>
<td>8.8 – 9.2</td>
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<td>10/4/12 - 1/16/13</td>
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<td>Silver Springs Creek</td>
<td>01-0184</td>
<td>0.0 – 0.5</td>
<td>BTC</td>
<td>10/19/12 - 1/4/13</td>
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<td>Tawes Creek</td>
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<td>0.4 – 0.5</td>
<td>NSEA</td>
<td>10/15/13 - 1/3/13</td>
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</tr>
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<td>Tinling Creek</td>
<td>01-0250</td>
<td>2.0 – 2.3</td>
<td>NSEA</td>
<td>10/8/12 - 1/3/13</td>
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</tr>
<tr>
<td>Landingstrip Creek</td>
<td>01-0263</td>
<td>0.4 – 1.0</td>
<td>NSEA</td>
<td>10/8/12 - 3/6/13</td>
<td>24</td>
</tr>
<tr>
<td>Landingstrip Tributary</td>
<td>01-0263</td>
<td>0.0 – 0.4</td>
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<td>10/8/12 - 3/6/13</td>
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</tr>
<tr>
<td>Terrell Creek</td>
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<td>BTC</td>
<td>10/4/13 - 1/15/13</td>
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<td>Padden Creek</td>
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<td>0.0 – 0.5</td>
<td>BTC</td>
<td>10/4/12 - 1/3/13</td>
<td>13</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>308</strong></td>
</tr>
</tbody>
</table>
The following section details the results of the 2012 NSEA spawning grounds surveys in three sections, including: Survey Conditions and Effort, Results by Species, and Results by Survey Reach.

3.1 SURVEY CONDITIONS AND EFFORT

The 2012 spawning season began late, with rains not starting until mid-October, shortening the Chinook spawning window. From August 30th to October 12th, there was no measurable rainfall in Bellingham, totaling 44 consecutive days without precipitation. This delayed the fall spawning season, which normally begins in September for Chinook. Many of the South Fork Nooksack tributaries were completely dry until the end of October when there was enough rain to allow fish migration upstream.

![Figure 3. Nooksack River discharge in cubic feet per second from October 1, 2012, to March 31, 2013. Data recorded by the Ferndale US Geological Survey Gauging Station and can be obtained at http://waterdata.usgs.gov/usa/nwis/uv?site_no=12213100.](image)

The fall/winter coho spawning season also extended into March in Landingstrip Creek, which is later than the typical end of the season in January. In total, 308 spawning...
grounds surveys were conducted (see Table 1), almost doubling last year’s 165 surveys. See Table 1 for more information on reach locations and the number of surveys conducted on each reach.

3.2 RESULTS BY SPECIES

Table 2. Number of live and dead salmon and redds by species by reach observed on NSEA spawning grounds surveys in the fall 2012 season.

<table>
<thead>
<tr>
<th>Survey Reach</th>
<th>Chinook</th>
<th>Coho</th>
<th>Chum</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Live</td>
<td>Dead</td>
<td>Redds</td>
<td>Live</td>
</tr>
<tr>
<td><strong>Upper Mainstem (Deming, WA area) Nooksack Tributaries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>Anderson, lower</td>
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<td>Anderson, upper</td>
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<td>1</td>
</tr>
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<td>Mitchell</td>
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<td>51</td>
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<td>Smith</td>
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Figure 4. The total number of live salmon, dead salmon, and redds and the percentage of each species observed during fall 2012 Nooksack Salmon Enhancement Association spawning grounds surveys.
3.2.1 CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*)

Nine percent of all the live salmon counted during the fall 2012 spawning grounds surveys were Chinook. Eight percent of all the salmon carcasses surveyed during fall 2012 were Chinook carcasses. Seven percent of all the salmon redds identified were Chinook redds (Figure 4).

Forty two live Chinook salmon were surveyed during fall 2012. Thirty four of the live Chinook were found in Whatcom Creek’s upper and lower reaches. Seven of the forty-two live Chinook salmon were found in Bertrand Creek. One live Chinook was observed in Mitchell creek (Table 2).

There was a 65% decrease in Chinook salmon redds from 2011 to 2012. There was a 85% decrease in Chinook salmon redds from 2010 to 2012. Of the last 13 years of fall spawning grounds surveys, 2002 was the only year where less than 15 Chinook salmon redds were observed (Figure 5).
There were no Chinook carcasses observed in the upper main stem region of the Nooksack River or in the South Fork tributaries on NSEA spawning grounds surveys.

### 3.2.2 COHO SALMON (*Oncorhynchus kisutch*)

Eighty two percent of live salmon counted during fall 2012 spawning grounds surveys were identified as coho. Eighty eight percent of salmon carcasses counted were coho carcasses. Sixty one percent of salmon redds identified were coho redds (Figure 4).

Three hundred seventy four live coho salmon were surveyed during fall 2012. Twenty eight percent of the live coho counted were found in Terrell Creek. Seventeen percent of the live coho were counted in Lower Deer Creek. Mitchell Creek (14%), Smith Creek (12%) and Upper Deer Creek (12%) also had large numbers of live coho counted (Table 2).
The number of Coho redds counted during 2012 was over double that of 2011. The fall 2012 season ranked 6th for the most Coho redds identified from the past 13 years. A downward trend is seen for Coho redds identified from fall 2005 to 2009, but in 2010 and 2012 there was a noticeable increase in the number of Coho redds counted when compared to 2006 to 2008 and 2011 (Figure 6).

3.2.3 CHUM SALMON (*ONCORHYNCHUS KETA*)

Four percent of live salmon counted during fall 2012 spawning grounds surveys were identified as Chum. One percent of salmon carcasses counted were chum carcasses. One percent of salmon redds identified were Chum redds (Figure 4).

Sixteen live Chum salmon were counted during fall 2012. All live chums observed were seen at Padden Creek. The only Chum carcass was found at Squalicum Creek. All three Chum redds identified were at Padden Creek (Table 2).

![Annual Chum Redd Totals](figure7.png)

*Figure 7. Total Chum redds observed during Fall Spawning Grounds Surveys from 1999 to 2012.*

The number of Chum redds observed during fall 2012 was less than half that of 2011. The number of Chum redds surveyed per year on NSEA reaches shows a general downward trend since 2006 (Figure 7).

There were no chum carcasses observed in the Upper Main Stem, Lower Main Stem, or South Fork reaches of the Nooksack River.
3.2.4 UNKNOWN SALMONIDS

In 2012, sixty five redds were documented during NSEA surveys as being created by an unknown species. Twenty seven of these unknown redds were observed in Mitchell Creek and eleven were recorded in Landingstrip Creek and its tributary. These redds were most likely coho redds since they are primarily coho streams and the redds were observed during the usual coho spawning window. To avoid errors, NSEA records a redd as unknown unless a live fish or carcass is seen on or near the redd. In many cases, redds are observed without accompanying fish, and are therefore identified as an unknown species. See Table 2 for a complete listing of where unknown species redds were seen.

3.3 REACH RESULTS AND HABITAT DESCRIPTIONS

Figure 8. Total redd counts by reach and species observed during 2012 NSEA spawning grounds surveys.
3.3.1 BERTRAND CREEK

Bertrand Creek runs through agricultural fields and the water is often high, fast moving, turbid, and tannic which affects overall visibility and ability to complete surveys. The upper portion of Bertrand Creek reach consists of some mature riparian areas providing shade. The reach has diverse instream habitat with deep pools, some large woody debris, and glides and riffles.

Figure 9. Live and dead salmon species and redds observed at Bertrand Creek during Fall 2012 NSEA Spawning Grounds Surveys.
3.3.2 LANDINGSTRIP CREEK

Landingstrip Creek is located on land recently cleared of a poplar plantation and owned by Whatcom Land Trust. NSEA has been actively involved in restoration on the site. Beginning in 2010, the channel was enhanced and modified with spawning gravel, large woody debris placement, and riparian planting. Restoration work was still being conducted in the 2012 season, though primarily on the tributary.

Figure 10. Live and dead salmon species and redds observed at Landingstrip Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.3 LANDINGSTRIP TRIBUTARY

Landingstrip Tributary is a new channel removed from an underground culvert in 2009. Extensive restoration is still occurring including LWD placement, spawning gravel placement, and riparian planting. Surveying conditions were excellent overall with only one day in the season deemed too turbid to survey.

![Graph showing salmon species and redds observed at Landingstrip Tributary during NSEA Fall 2012 Spawning Grounds Surveys.](image)

Figure 11. Live and dead salmon species and redds observed at Landingstrip Tributary during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.4 LOWER ANDERSON CREEK

The Lower Anderson Creek reach is heavily wooded and shows little sign of human impact. 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 12. Live and dead salmon species and redds observed at Lower Anderson Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.5 UPPER ANDERSON CREEK

Upper Anderson Creek runs through both agricultural zones and forested areas. Throughout the reach mature riparian vegetation offers ideal environments for salmonids. Off-channel habitat varies from residential to agricultural to forested stretches.

Figure 13. Live and dead salmon species and redds observed at Upper Anderson Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.6 LOWER DEER CREEK

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.

Figure 14. Live and dead salmon species and redds observed at Lower Deer Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.7 UPPER DEER CREEK

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 15. Live and dead salmon species and redds observed at Upper Deer Creek during NSEA Fall 2012 Spawning Grounds Surveys.](image-url)
The Lower Fishtrap Creek reach is urban in character and heavy runoff from city streets dramatically increases turbidity and deposits trash into the stream. However, portions of the reach are well-shaded and contain 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 16. Live and salmon species and redds observed at Lower Fishtrap Creek during Fall 2012 Spawning Grounds Surveys.
3.3.9 UPPER FISHTRAP CREEK

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 17. Live and dead salmon species and reds observed at Upper Fishtrap Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.10 LOWER MACAULAY CREEK

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. The water is slightly tannic with heavy silt flows various times throughout the spawning season.

Figure 18. Live and dead salmon species and redds observed at Lower Macaulay Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.11 UPPER MACAULAY CREEK

Upper Macaulay Creek is comprised of two distinct portions separated by a large sediment pond in the center. The lower portion of the reach is wide with minimal shade, no LWD installments, few resting pools, and fine to medium gravel suitable for spawning. The upper portion of the reach runs through a heavily wooded area with large gravel and boulders not conducive to spawning. Flow is generally low, even following heavy rain events and visibility is high.

![Graph showing salmon species and redds observed at Lower Macaulay Creek during NSEA Fall 2012 Spawning Grounds Surveys.](image)

**Figure 19.** Live and dead salmon species and redds observed at Lower Macaulay Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.12 LOWER WHATCOM CREEK

The primary land uses within the Whatcom Creek watershed include residential, commercial, industrial, and forestry. There are three parks along Whatcom Creek, the largest being Whatcom Falls Park and Maritime Heritage Park, as well as two hatcheries and a water treatment plant. Whatcom Creek provides almost four miles of accessible spawning habitat downstream of Lake Whatcom.

Figure 20. Live and dead salmon species and redds observed at Lower Whatcom Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.13 UPPER WHATCOM CREEK

The habitat at Upper Whatcom Creek is similar to that of the Lower Whatcom Creek reach.

Figure 21. Live and dead salmon species and redds observed at Upper Whatcom Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.14 MITCHELL CREEK

Mitchell Creek is well-shaded and shallow. Some small pools provide resting areas, large woody debris is present, and spawning gravel is abundant. Riparian vegetation is mature in some areas, but the creek also borders the backyards of several properties with few trees.

Figure 22. Live and dead salmon species and redds observed at Mitchell Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.15 PADDEN CREEK

Padden Creek meanders along the interurban trail and is well shaded. While the reach contains three fish ladders, in-stream habitat remains advantageous to spawning with shaded pools, riffles, and spawning gravel throughout. The mouth of the creek is brackish and tidally influenced.

Figure 23. Live and dead salmon species and redds observed at Padden Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.16 SILVER SPRINGS CREEK

Silver Springs Creek runs entirely through agricultural land. The first quarter mile runs through grazing pastures, and has a dense riparian buffer of young trees, shrubs, reed canary grass and large woody debris placed during a 1994-1995 restoration project. The middle section 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 24. Live and dead salmon species and redds observed at Silver Springs Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.17 SMITH CREEK

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 mostly a 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 abundant coarse spawning gravel.

Figure 25. Live and dead salmon species and redds observed at Smith Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.18 SQUALICUM CREEK

Squalicum Creek is urban in nature and consists of a mixture of native and invasive plant species within the riparian zone. On the south side of the creek, a large buffer zone helps to minimize the effects of urban runoff. Substrate and stream consist of sand, pebbles, and cobbles with alternating pool and riffle sequences. Much of the channel has been modified by extensive beaver activity.

Figure 26. Live and dead salmon species and redds observed at Squalicum Creek during NSEA Fall 2012 Spawning Grounds Surveys.
3.3.19 TAWES CREEK

Tawes Creek has a shallow, well-shaded channel containing sand, pebbles, and abundant spawning gravel. The reach was expanded in the 2012 season, at the request of Lummi Natural Resources, to include approximately 0.1 river miles past Highway 9 where conditions were advantageous to spawning.

![Graph showing salmon observations at Tawes Creek](image)

*Figure 27. Live and dead salmon species and redds observed at Tawes Creek during NSEA Fall 2012 Spawning Grounds Surveys.*
3.3.20 TERRELL CREEK

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. The stream water is often dark brown and tannic, which reduces visibility.

3.3.21 TINLING CREEK

The Tinling Creek survey reach is well shaded and wide with shallow flows. The substrate is primarily boulders and cobble, but there are several areas of spawning gravel. NSEA finished a restoration project summer 2012, after a landslide had washed out the creek. The project entailed channel modification, large woody debris placements, and riparian plantings. Downstream of the survey reach, a culvert was also removed and replaced with a bridge to enable fish passage.

No live fish, carcasses, or redds were seen or observed throughout the survey season. Since 2012 marked the completion of an NSEA restoration project and culvert removal on Tinling Creek, fish runs will hopefully begin to return in the coming years.

Figure 28. Live and dead salmon species and redds observed at Terrell Creek during NSEA Fall 2012 Spawning Grounds Surveys.
4.0 DISCUSSION

The discussion section of this report details data limitations and caveats, notable fish sightings, and historical trends in redd counts.

4.1 DATA LIMITATIONS AND CAVEATS

The discussion section of this report is necessarily limited. Only the trends over time at specific NSEA survey reaches can be analyzed, rather than making basin-wide conclusions. Salmon species have complex life cycles that span broad temporal and spatial ranges. Therefore, there are many environmental and anthropogenic factors that can influence 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 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 prevent 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 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.

### 4.2 NOTABLE FISH SIGHTINGS

One of the reasons NSEA conducts spawning grounds surveys is to measure the effectiveness of our restoration projects in improving salmon habitat. In 2012, several creeks where NSEA has completed restoration projects had notable fish sightings compared to previous years. The number of live Coho seen at Deer Creek in the lower survey reach was the highest in the history of NSEA spawning grounds surveys (Figure 4).

Another creek with notable fish counts in 2012 was Mitchell Creek, with the highest number of Coho observed in ten years. It should be noted that surveys were not conducted in 2011 due to issues with accessing the creek. In 2012, new relationships were built with landowners who lived along the creek, making the creek accessible for surveys again (Table 2).
Figure 29. The total number of live Coho observed annually on NSEA spawning grounds surveys since 1999.

Figure 30. The total number of live Coho observed annually on NSEA spawning ground surveys since 1999.
4.3 HISTORICAL TRENDS IN REDD COUNTS

The total number of coho reds observed during NSEA spawning grounds surveys in 2012 were higher than the 13 year average, but Chinook and chum salmon reds were lower than the 13 year average. Chinook and coho redd counts from 2010 to 2012 have been in general higher than they were from 2006 to 2009, but they still have not been consistently increasing. The chum redd counts from 2010 to 2012 are higher than 2007 to 2009, but also are not consistently increasing (Figure 31).

Figure 31. The total number of reds observed per species each year during NSEA spawning grounds surveys, including the 13 year average for each species. Unknown species redds are not shown.
4.4 FUTURE WORK

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

1. Continue to collect survey data on stream temperature, pH, sex, fork length, and adipose fin presence for all carcasses.

2. Continue to assist WDFW in conducting steelhead trout spawning grounds surveys so that WRIA 1 fisheries co-managers have a more comprehensive picture of steelhead escapement in the Nooksack River basin.

3. In odd years, start surveys earlier to capture the as much of the pink salmon run as possible.

4. Further investigate future restoration projects at stream reaches that need invasive removal, large woody debris placement, or channel modification to improve spawning habitat. Specific streams that were noted as needing improvement in 2012 were Smith Creek (extensive Himalayan blackberry infestation along banks) and Macaulay Creek (needs further channel reconstruction and invasive removal).

5. Add a new reach on the newly reconstructed tributary to Landingstrip Creek. In 2012, NSEA completed a restoration project on another tributary to Landingstrip that flows into the tributary that NSEA currently surveys, and a reach should be added to assess the effectiveness of this project in improving spawning habitat.

6. Assist Lummi Natural Resources with additional coho surveys again, if there is a need and staff availability allows for it.

7. Continue to partner with Bellingham Technical College’s Fisheries & Aquaculture program to facilitate further community involvement and provide valuable survey experience for students.


APPENDIX A. DIRECTIONS TO SPAWNING GROUNDS SURVEY REACH LOCATIONS

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.

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<th>2012 Spawning Grounds Survey Reach Locations and Directions</th>
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</thead>
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<tr>
<td><strong>Deer, upper</strong></td>
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<tr>
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<tr>
<td>Location</td>
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</tr>
<tr>
<td>Bertrand</td>
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<td>Fishtrap, lower</td>
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<td>Fishtrap, upper</td>
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<td>Smith</td>
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<td>Macaulay, Lower</td>
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<tr>
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<tr>
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<tr>
<td>Macaulay, Upper</td>
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<td>Mitchell</td>
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<td>Tributary of Landingstrip</td>
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<tr>
<td>Location</td>
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</tr>
<tr>
<td>Squalicum</td>
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<tr>
<td>Padden</td>
</tr>
<tr>
<td>Whatcom, Lower</td>
</tr>
<tr>
<td>Whatcom, Upper</td>
</tr>
</tbody>
</table>
Recommended Materials and Equipment for Spawner Surveys

Sampling Kit (each surveyor):

- polarized sunglasses
- knife
- pencils and sharpies
- measuring tape
- pH strips
- scissors for tissue samples
- hand pruners
- otolith and/or DNA sample vials
- thermometers
- Rite in the Rain notebook binder
- scale cards
- survey flagging
- head bags and labels
- tweezers
- forceps
- fish counter devise

Additional equipment:

- fish pughs
- chest waders and felt-soled boots
- survey vest
- extra socks
- extra pants
- rubber gloves
- map of area being surveyed
- camera
- watch or cell phone for time
- CWT wand
APPENDIX C. WDFW SURVEY PROTOCOL

WDFW Protocol for Surveying Chinook, Chum and Coho in the Nooksack River Basin

The primary objective is otolith and scale recovery from all Chinook and coded wire tag recovery from chinook. The run has a Double Index Tag (D.I.T.) Groups (both clipped and non-clipped tag-bearing fish). ALL ACCESSIBLE CHINOOK CARCASSES SHOULD BE WANDED.

Secondary objective: Collect DNA samples from all CHUM Salmon (depending on freshness of carcass) and scales.

Surveyors should, in each stream reach:

- Count all live fish (including chinook, coho, sockeye, pink & chum salmon).
- Count all visible completed chinook and coho redds. Flag completed Chinook Redds with tape.
- Count all chinook AND other species carcasses.
- Count all chinook carcasses previously sampled (tailcuts).
- WAND ALL ACCESSIBLE CHINOOK CARCASSES.
- CUT TAILS OFF ANY SAMPLED FISH (SCALES AND/OR WANDED OR OTOLITHS) recover and attach freshwater labels to all tag-bearing heads.
- Maintain a tally of non-adipose clipped versus adipose clipped chinook carcasses that are checked.
- COLLECT OTOLITHS and SCALES FROM ALL CHINOOK
- COLLECT DNA TISSUE SAMPLES and SCALES FROM ALL CHUM

Record at end of survey for each reach:

Data For Chinook
  Total live chinook.
  Total dead chinook
  Total pre-sampled carcasses
  D.I.T. and Hatchery versus Wild discrimination

Number of adipose clipped/No CWT checked- Marked/No Beep- MNB
Number of non-adipose clipped/No CWT checked- Unmarked/No Beep- UMNB
Number of adipose clipped w/CWT collected- Marked Beep- MB
Number of non-adipose clipped w/CWT collected-UnMarked Beep- UNB

Data For Chinook Redds
  Total visible chinook redds, new and old

Data for Other Salmon Species
  Total number of live coho, pink, sockeye and chum.
  Total number of dead coho, pink, sockeye and chum.
  Total redds, if any, associated with each species.
INSTRUCTIONS FOR SCALE SAMPLING SALMON SPAWNERS AND HOW TO FILL OUT THE SCALE CARD

The standard salmon scale card (scale card form WDFW 548) should be used for routine scale sampling of chinook, chum, coho, and sockeye in the Puget Sound and coastal escapements. Scales from genetically sampled fish should be mounted on the Genetics Scale Card (see genetics sampling protocols). Please refer to the “GENERAL PROCEDURE FOR SCALE SAMPLING SALMON SPAWNERS” for the best method for collecting and mounting scales. The minimum number of scales per fish to be mounted are: chinook and sockeye – 3, chum – 2, and coho (hatchery/wild) – 6. The coho scales should be mounted within two scale spaces (maximum 10 fish per card).

FILLING OUT THE SCALE CARD:

Use a number 2 pencil and write legibly as the data on the chinook and chum cards are entered directly from the card. Coding for the various fields on the card follows.

STREAM/HATCHERY/BUYER: Stream or hatchery name. THIS IS OPTIONAL.

WEEK field: 2-digit WDFW statistical week number

YEAR field: last 2 numbers in the year

MONTH field: 2-digit month number

DAY field: 2-digit number

AREA field: 2-digit WRIA number (01, 02, …..24)

SUB-A field: 4-digit numeric stream code

GEAR field: one single number circled; the only allowable escapement gear codes are:

1 = hatchery rack
2 = broodstock (any method other than at a hatchery rack)
3 = spawning ground survey
4 = stream trap (fish released)

SP. field: 2 digit field indicating race first and species second. RACE CODE IS OPTIONAL.
Race codes: 1 = spring  2 = fall
3 = winter  4 = summer
Species codes: 1 = chinook  2 = chum
4 = coho
5 = sockeye

**TYPE field:** 3-digit number. The first digit indicates the Sample Type, the second digit indicates Sampler Type, and the third digit indicates Fish Condition Type.

Sample Type codes:
1 = “random” sampling
2 = non-CWT fish only
4 = surplused fish (gear code 1 only)
7 = “select” sampling

Code 1 would be used primarily with gear codes 2, 3, 4; and with gear code 1 where the fish have not been electronically sampled for CWTs prior to scale sampling. Code 2 would be used primarily with gear code 1 for scale sampling fish that are not CWTed (i.e., sampling fish where the age is not known). Code 7 would be used rarely (e.g., fecundity samples at a hatchery rack).

Sampler Type codes:
1 = WDFW or co-op samplers
2 = tribal samplers

Fish Condition Type codes:
2 = carcasses
4 = fish released live

**R.M. field:** 6-digit number used primarily for spawning ground surveys, indicating the river mile of the upper end (“U”) of the survey and the lower end (“L”) of the survey. Each end of the survey should coded to the nearest tenth of a mile and contain 3 digits (e.g., U: 09.6, L: 00.0). Single locations (spot checks) or stream trap location should be coded in the “L” space. There is no need code this field for hatchery rack sampling.

**SAMPLER field:** 2-digit alpha code of the sampler’s initial or sampler’s alpha-numeric code (tribal sampled).

**CARD field:** 2-digit number indicating that day’s card number

**INDIVIDUAL FISH DATA:**

**FKL column:** 2 or 3-digit number; fork length to the nearest centimeter

**SEX column:** single digit number; 1 = male, 2 = female

**AGE column:** LEAVE BLANK!

**MARK column:** write an “AC” for an adipose fin-clipped fish, or” NM” for non-clipped OTHERWISE LEAVE BLANK!

**LABEL column:** this column is used primarily to record snout label numbers for CWTed fish, but can be used for any other data (e.g., otolith sample number, other fin clips, or female egg retention). DATA IN THIS COLUMN ARE NOT ENTERED INTO THE PUGET SOUND “BIOLOGICAL DATABASE” AT THIS TIME.
### APPENDIX E. WDFW SCALE CARD EXAMPLE

<table>
<thead>
<tr>
<th>Stream/Hatchery/Buyer</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

- **6 Scales:** Fork length cm
- **Sex:** 1 = M, 2 = F
- **NM or AC:** Leave blank (lab age)
- **CWT, HBL:** OR WNT (wanted notag)
  OR NW
- **DNA Val # or NO DNA**
  OR OTO Val # or NO OTO
- **Rm (location of carcass approx.)**

**ON BACK**

- DNA:
  - eye:
  - gill:
  - Rigor:
  - Clear:
  - Red:
  - Pink:
  - White:
  - cloudy:
  - NO

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2012 NSEA Spawning Grounds Survey Report

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NSEA spawning grounds survey interns, Kaitlin Schanken (left) and Abbey Curtin (right) sample scales from a coho salmon at the tributary to Landingstrip Creek.

Spawning grounds surveyor, Kaitlin Schanken, displaying a coho salmon carcass at the tributary to Landingstrip Creek.
Kaitlin Schanken, Katie Rohrer, and Abbey Curtin (left to right), conducting a spawner survey on Macaulay Creek.

Coho salmon carcass at Deer Creek.
Live coho salmon at Landingstrip Creek.

Spawner survey intern, Brooke Bannerman, surveying Tinling Creek.
Coho salmon redd at Landingstrip Creek.

View of a coho redd from above (looking downstream). When identifying redds, surveyors look for a clean mound of gravel downstream of a depression.
APPENDIX G. COHO DATA COLLECTED FOR LUMMI NATURAL RESOURCES

In 2012, NSEA collected additional coho data for Lummi Natural Resources (LNR). Survey reaches were added at Black Slough (RM 2.2-2.4), Landingstrip (RM 0.1-0.2), and Tenmile (RM 8.6-9.4) Creeks. NSEA’s reach at Tawes Creek was extended an additional .1 miles upstream.

The abstract for the LNR coho project is described below:

2012 Nooksack Basin Coho Assessment

This project proposed by the Lummi Natural Resources Department (LNR) is a Nooksack basin wide assessment of Coho spawning habitat to examine the extent at which Coho stray from the Skookum Hatchery as well as to generate a wild Coho escapement for the entire Nooksack basin. The project will combine spawning ground survey efforts from LNR, Washington Department of Fish and Wildlife (WDFW), Nooksack Salmon Enhancement Association (NSEA), and the Nooksack Natural Resources Department (NNR). This project will supplement surveys that have been performed in the Nooksack basin for decades and will expand to areas not previously surveyed. Upon completion of the field work, LNR will analyze the data to assess whether or not it is possible to generate an escapement estimate for wild Coho. This will be done by comparing spawning ground data to harvest sampling hatchery/wild proportions data and hatchery returns to see if we were able to account for the number of wild Coho that should be present in the basin. The project should also identify all stocks of Coho present in the basin.

Table 4. NSEA 2012 Coho data collected for Lummi Natural Resources.

<table>
<thead>
<tr>
<th>Survey Reach</th>
<th>Coho</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Live</td>
<td>Dead</td>
</tr>
<tr>
<td>Tawes</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>Black Slough</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Landingstrip (Mouth)</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Tenmile</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>4</td>
</tr>
</tbody>
</table>