# Juvenile Salmon and Nearshore Fish Use in Cornet Bay, Deception Pass State Park in Response to Beach Restoration, 2009-2016

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# INTRODUCTION

This report summarizes the results of beach seine fish sampling conducted for the Cornet Bay nearshore habitat restoration project, from 2009 (pre-restoration) through 2016 (post-restoration), including comparisons with natural reference sites outside of the restoration area. The Cornet Bay Day Use Area of Deception Pass State Park in Island County, Washington underwent several phases of nearshore habitat restoration from 2012 through 2015. The project, initiated in 2009 by the Island County Marine Resources Committee (IC MRC) and conducted in collaboration with Washington State Parks and the Northwest Straits Marine Conservation Foundation and the Island County Sound Water Stewards (formerly Island County Beach Watchers), includes the restoration of approximately 1.24 acres of modified shoreline to natural habitat conditions.

Shoreline modifications and fill imported on-site in the 1970s converted the upper intertidal shoreline into a flat upland bench planted with grass. The area selected for restoration contains four boat launch ramps, a T-shaped public pier used for mooring boats and fishing, and a Washington State Parks' Marine Crew maintenance pier.

Monitoring questions addressed in this report are:

1. How does local environment vary by year, season, and spatial strata within the Cornet Bay Restoration Project?
2. What fish species are present within the restored area?
3. How does juvenile Chinook, chum and pink salmon density vary by year and site within the Cornet Bay Restoration Project?
4. How does density in the Cornet Bay Restoration Project compare with nearby natural pocket estuaries and outmigration populations?
5. Can variation in juvenile Chinook, chum and pink salmon outmigration timing be attributed to other environmental factors such as temperature or precipitation changes?
6. What relationship do environmental parameters and outmigration timing have in regards to fish size?

# SITE AND PROJECT DESCRIPTION

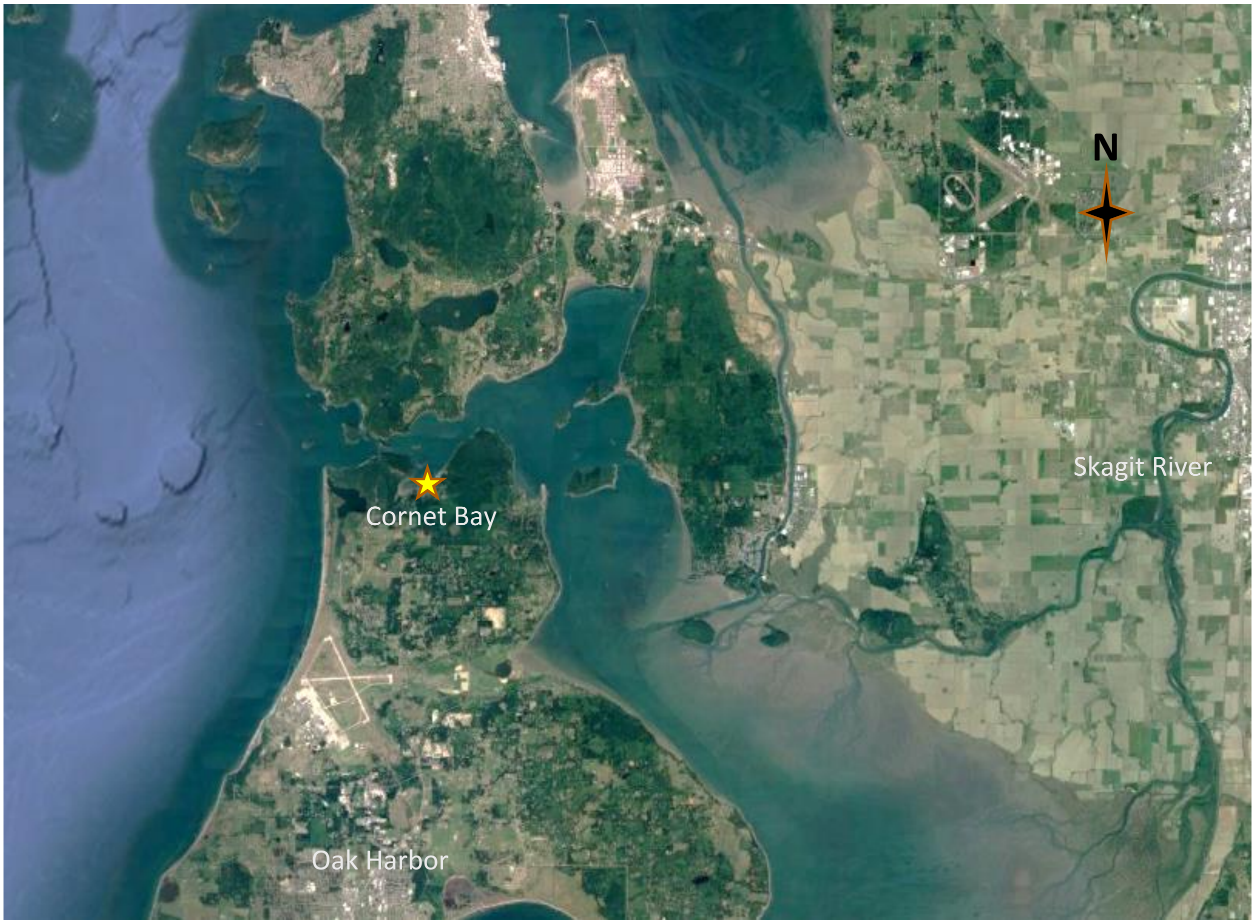



*Figure 1 - Map of Area*

Cornet Bay is located in the northern top of the Whidbey Basin between the Skagit River and Deception Pass (*Figure 1*).

The bay provides a low energy environment similar to a pocket estuary, which are an important habitat for Chinook juvenile salmon as they outmigrate from natal rivers (Beamer et al. 2003, Beamer et al. 2006). The bay is within Washington State Park's Deception Pass Park and is highly used by visitors year round. The Park is used as a day-use picnic area and for beach combing, smelting, boat launching and hiking. The infrastructure included boat ramp launches, piers, parking lot, restroom facilities, picnic tables and a creosote timber bulkhead that separated the parking lot and picnic area from the beach.

As a result of the vertical bulkhead, the intertidal portion of the beach had become coarse grained and flat. There was an approximately three foot drop down to the beach from the picnic area. The picnic area consisted of picnic tables and grass that was frequented by geese. Washington State Parks, the IC MRC and the Water Resource Inventory Area (WRIA) 6 Island Lead Entity developed a restoration project to remove the bulkhead and restore the natural grade of the beach. The intention was to improve accessibility to the beach for visitors as well as restore intertidal habitat that would be suited for forage fish spawning and salmonid rearing. The eelgrass beds and shellfish habitat deeper in the bay would be supported by the restoration of natural beach forming processes.

The restoration was completed in two phases. The first restoration was completed in 2012 in the highest use areas. This phase included the removal 65.1 tons (approximately 750 linear feet) of creosote bulkhead and 79.8 tons of contaminated fill, re-grading of the topography to natural slope conditions, the placement of 1,200 tons of beach spawning gravel in the intertidal zone. Native emergent and upland shoreline buffer vegetation was installed in approximately 0.5 acres of the project site.

The second phase of restoration was completed in 2015 at the southwestern extent of the beach (approximately 570 linear feet) and included removing 30 creosote wood fence posts, lawn and associated fill. The beach was regraded and nourished with approximately 1180 cubic yards of gravel of appropriate grain size for forage fish spawning.

In support of the restoration project conducted by the Northwest Straits Foundation, the IC MRC and Island County Sound Stewards conducted a monitoring project with the goal of characterizing the use of the site by fish before and after the restoration project.

The monitoring project consisted of annual fish sampling and public outreach and education at one of the most used boat launch sites in the state parks system. Fish sampling conducted annually since 2009, in the four years prior to the 2012 partial restoration, helped to characterize fish population and use at the project site. Sampling conducted from 2013 through 2015 represented the first three years of post-restoration monitoring at the site, but also included some sites still unrestored. Final site restoration was completed in 2015, and surveys conducted in 2016 were within restored and natural sites only.

Additional information regarding the Cornet Bay restoration project and annual reports documenting the results of fish sampling in years 2009 – 2015 are available on the Island County Marine Resources Committee website: (http://www.islandcountymrc.org/Projects/Marine-Habitats/Cornet-Bay-Restoration.aspx). The template for this report is based on prior report formats and data.

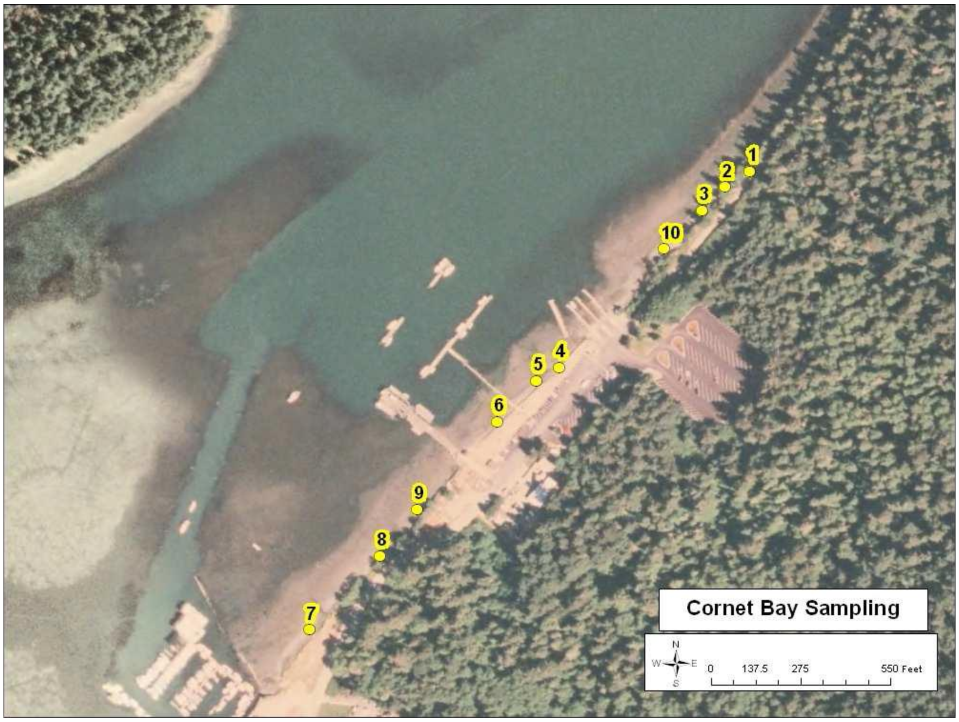



*Figure 2: Seining Site Map*

There were 10 sites (9 in 2009) that were sampled each sampling day. All sites remained in the same location on the beach from 2009-2016. Site locations are highlighted in the map above (Figure 2).

- 2009 – 3 control sites (#1-3) & 6 pre-restoration sites (#4-9)
- 2010-2012 – 4 control sites (#1-3 & 10) and 6 pre-restoration sites (#4-9)
- 2013-2015 – 4 control sites (#1-3 & 10), 4 post-restoration sites (#4-6 & 9) and 2 pre-restoration sites (#7 & 8)
- 2016 – 4 control sites (#1-3 & 10), 4 sites at 3 year old restoration (#4-6 & 9), 1 site in front of Fall 2015 restoration (#7) and one site in front of area not restored (#8).

*Table 1: Summary of Beach Seine effort (number of sets) at Cornet Bay by strata, month, and Year.*

| Year | Months sampled | # Pre-restoration sites sampled | # Post-restoration sites sampled | # Control sites sampled | Total # of seine sets |
|---|---|---|---|---|---|
| 2009 | March-June | 6 | N/A | 3 | 65 |
| 2010 | February-June | 6 | N/A | 4 | 99 |
| 2011 | February-June | 6 | N/A | 4 | 80 |
| 2012 | March-June | 6 | N/A | 4 | 60 |
| 2013 | February-June | 2 | 4 | 4 | 90 |
| 2014 | February-June | 2 | 4 | 4 | 90 |
| 2015 | February-June | 2 | 4 | 4 | 79 |
| 2016 | January-June | 1 | 5 | 4 | 100 |

Photo courtesy of Northwest Straits Foundation

*Figure 3: Sites 4 and 5 Pre-restoration*


Photo courtesy of Northwest Straits Foundation

*Figure 4: Sites 4 and 5 Post-restoration*


*Figure 5: Small lagoon adjacent to Site 9 Pre-restoration.*


*Figure 6: Site 9 Post-restoration*

# METHODS

The use of beach seining techniques to understand juvenile salmon utilization of coastal lagoon habitats and adjacent beach sites started in Island County in 2002 with research focused on Chinook juvenile salmon at sites in Skagit Bay (Beamer et al. 2003). Since then a number of studies have utilized this technique to assess nearshore fish use throughout Island County.

Small beach seine methodology uses an 80-foot (24.4 m) by 6-foot (1.8 m) by 1/8-inch (0.3 cm) mesh knotless nylon net. Average beach seine set area is 96 square meters (Skagit System Cooperative, 2003). The small beach seines were used to sample fish in shallow intertidal areas at ten locations along the shoreline of the Cornet Bay Day Use Area. Established in 2009, the sampling locations include four sites (1-3 and 10) along the natural shoreline east of the boat ramps and six sites (4-9) to the west, where creosote armoring along the modified shoreline was targeted for removal during restoration Figure 2The selected seine areas are typically less than four feet deep (1.2 m).

Based on their outmigration patterns from natal freshwater rivers, juvenile salmon are expected to use the project's nearshore area from mid-February to mid-June. Sampling during this period is generally scheduled to occur during +9 to +5 feet (MLLW) tides every two weeks.

One beach seine set was made at each of the 10 sites per sampling day. Recorded data for each beach seine set included the time of net deployment, estimate of the percent of the net used, and the maximum depth of the net (measured with a meter stick at the location furthest from the beach where the net was set). A YSI meter was used to measure water quality parameters, including water temperature, salinity, and dissolved oxygen (DO) levels at each sample site at the time the seine is set. Water temperature and salinity measurements are taken on the bottom and on the surface of the water column at the maximum depth (*full length*) and then again at the estimated halfway point back to shore (*half length*). Dissolved oxygen levels are measured during the bottom parameter readings at the net edge farthest from shore.

Fish catch are identified and counted by species. The first 20 fish of each species are measured by fork length in millimeters at each of the ten sites. If the species of a particular fish is in question, it is placed in a Photarium and a photograph is taken for verification later. All fish are released at site of capture.

*Figure 7: Beach Seining*

*Figure 8: Water Quality Parameter Measuring*

Figure 8: Water Quality Parameter Measuring

# Results and Discussion

Analyses were modeled after the Crescent Harbor Marsh monitoring summary by Beamer et al. (2016) so as to be comparable and allow for broader regional inferences when and where appropriate at a later time.

## Water quality

An Analysis of Variance (ANOVA) methodology was used to determine factor influences on three variables: 1) temperature, 2) salinity, and 3) dissolved oxygen (DO). Factors include year and site on each variable. Overall, the water quality parameters did not show statistical differences based on site or year to year and do not appear to be an influence on fish presence/ absence or abundance. Table 2 summarizes the water quality parameter data over the course of the study.

*Table 2: Descriptive statistics for salinity, temperature, and dissolved oxygen.*

| | Temperature (c) | Salinity (ppt) | Dissolved Oxygen (ppm) |
|---|---|---|---|
| **N of cases** | 636 | 636 | 635 |
| **Minimum** | 6.00 | 20.45 | 5.01 |
| **Maximum** | 12.15 | 32.20 | 10.80 |
| **Range** | 6.15 | 11.75 | 5.79 |
| **Median** | 9.35 | 28.18 | 7.71 |
| **Mean** | 9.27 | 27.62 | 7.71 |
| **Std. Error** | 0.05 | 0.08 | 0.03 |
| **Standard Dev** | 1.23 | 2.11 | 0.75 |

### Temperature

No statistical difference was found between sites or years for temperature (Table 3). 2015 had slightly warmer water temperatures compared to other years (one degree Celsius warmer than 2009-2013), but not to a degree to be considered statistically significant (Table 4). Beamer et al found that 2013 had the warmest temperatures during the Crescent Harbor study (Beamer et al 2016). Both Crescent and Cornet are in the Whidbey Basin and influenced by the Skagit River.

The water temperature at site 4 (west of boat ramp), when measured at half depth, was slightly different from the other sites but not to a degree to be considered statistically significant (

Table 5). When measured at the surface, the water temperature at site 4 was not different from other sites. Perhaps this reflects water column mixing differences due to the boat ramp proximity. Due to sampling on an ebb tide, the current was flowing from the west to the east, into the boat ramp from the end of the lagoon.

Restoration did not appear to have a significant effect on water temperature but this is to be expected considering vegetation has not matured enough to provide shade to the intertidal area (Figure 9).

Water temperatures did not exceed the 15 C level thought to be stressful to juvenile salmon (Fresh 2006) at any time during the study.

Boxplots for temperature across months by year are included in Figure 10.

*Table 3: ANOVA significance results for water half depth surface temperature at Cornet Bay. P-values significant at 0.05.*

| Variable Type | Variable | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|---|
| Factors | Site | 9 | 0.4 | 0.05 | 0.124 | 0.999 |
| | Year | 1 | 96.1 | 96.09 | 255.333 | < 2e-16 |
| | Month | 3 | 552.1 | 184.05 | 489.039 | < 2e-16 |
| Interactions | Site*Year | 9 | 1.2 | 0.13 | 0.349 | 0.958 |
| | Site*month | 27 | 0.8 | 0.03 | 0.082 | 1 |

*Table 4: Pairwise results for water half depth surface temperature by year at Cornet Bay using Tukey's Honesty Pairwise Significance Difference Test. P-values are significant at the 0.05 level.*

| Year(i) | Year(j) | Difference | p-Value | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | lwr | upr |
| 2010 | 2009 | 0.8420513 | 0.585314 | -0.54154 | 2.225644 |
| 2011 | 2009 | 0.02201925 | 1 | -1.35369 | 1.397728 |
| 2012 | 2009 | 0.19246415 | 0.99993 | -1.28894 | 1.673864 |
| 2013 | 2009 | 0.10299146 | 0.999998 | -1.23802 | 1.444002 |
| 2014 | 2009 | 0.99526358 | 0.322339 | -0.3489 | 2.339429 |
| 2015 | 2009 | 1.29230769 | 0.087079 | -0.09128 | 2.6759 |
| 2016 | 2009 | 0.9895927 | 0.342763 | -0.36786 | 2.347042 |
| 2011 | 2010 | -0.82003205 | 0.549701 | -2.13096 | 0.490901 |
| 2012 | 2010 | -0.64958715 | 0.861845 | -2.07104 | 0.771861 |
| 2013 | 2010 | -0.73905984 | 0.645007 | -2.01353 | 0.535412 |
| 2014 | 2010 | 0.15321228 | 0.999959 | -1.12458 | 1.431004 |
| 2015 | 2010 | 0.45025639 | 0.968464 | -0.86895 | 1.76946 |
| 2016 | 2010 | 0.1475414 | 0.999971 | -1.14422 | 1.4393 |
| 2012 | 2011 | 0.1704449 | 0.999958 | -1.24333 | 1.584221 |

| | | | | | |
|---|---|---|---|---|---|
| 2013 | 2011 | 0.0809722 | 1 | -1.18494 | 1.346881 |
| 2014 | 2011 | 0.97324433 | 0.277809 | -0.29601 | 2.242495 |
| 2015 | 2011 | 1.27028844 | 0.065317 | -0.04064 | 2.581221 |
| 2016 | 2011 | 0.96757345 | 0.299004 | -0.31574 | 2.250884 |
| 2013 | 2012 | -0.0894727 | 0.999999 | -1.46951 | 1.290562 |
| 2014 | 2012 | 0.80279942 | 0.6439 | -0.5803 | 2.185901 |
| 2015 | 2012 | 1.09984354 | 0.266682 | -0.3216 | 2.521292 |
| 2016 | 2012 | 0.79712854 | 0.663149 | -0.59889 | 2.193143 |
| 2014 | 2013 | 0.89227212 | 0.350986 | -0.33928 | 2.123829 |
| 2015 | 2013 | 1.18931623 | 0.087666 | -0.08516 | 2.463788 |
| 2016 | 2013 | 0.88660124 | 0.375206 | -0.35944 | 2.132643 |
| 2015 | 2014 | 0.29704411 | 0.996791 | -0.98075 | 1.574836 |
| 2016 | 2014 | -0.00567088 | 1 | -1.25511 | 1.243766 |
| 2016 | 2015 | -0.30271499 | 0.996625 | -1.59447 | 0.989043 |

*Table 5: Pairwise results for water half depth surface temperature by Site at Cornet Bay using Tukey's Honesty Pairwise Significance Difference Test. P-values are significant at the 0.05 level.*

| Strata(i) | Strata(j) | Difference (degrees C) | p-Value | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | lwr | upr |
| Site 10 | Site 1 | 0.092 | 1.000 | 1.471 | 1.655 |
| Site 2 | Site 1 | 0.013 | 1.000 | 1.537 | 1.564 |
| Site 3 | Site 1 | 0.029 | 1.000 | 1.528 | 1.585 |
| Site 4 | Site 1 | 1.075 | 0.456 | 0.475 | 2.626 |
| Site 5 | Site 1 | 0.072 | 1.000 | 1.478 | 1.622 |
| Site 6 | Site 1 | 0.074 | 1.000 | 1.471 | 1.618 |
| Site 7 | Site 1 | 0.116 | 1.000 | 1.447 | 1.680 |
| Site 8 | Site 1 | 0.025 | 1.000 | 1.531 | 1.582 |
| Site 9 | Site 1 | 0.055 | 1.000 | 1.501 | 1.612 |
| Site 2 | Site 10 | 0.079 | 1.000 | 1.642 | 1.484 |
| Site 3 | Site 10 | 0.063 | 1.000 | 1.633 | 1.506 |
| Site 4 | Site 10 | 0.983 | *0.601* | 0.580 | 2.546 |
| Site 5 | Site 10 | 0.020 | 1.000 | 1.583 | 1.543 |
| Site 6 | Site 10 | 0.018 | 1.000 | 1.575 | 1.539 |
| Site 7 | Site 10 | 0.025 | 1.000 | 1.551 | 1.600 |
| Site 8 | Site 10 | 0.067 | 1.000 | 1.636 | 1.503 |
| Site 9 | Site 10 | 0.037 | 1.000 | 1.606 | 1.533 |
| Site 3 | Site 2 | 0.015 | 1.000 | 1.541 | 1.572 |
| Site 4 | Site 2 | *1.062* | *0.475* | 0.488 | 2.612 |
| Site 5 | Site 2 | 0.059 | 1.000 | 1.492 | 1.609 |
| Site 6 | Site 2 | 0.060 | 1.000 | 1.484 | 1.605 |
| Site 7 | Site 2 | 0.103 | 1.000 | 1.460 | 1.666 |
| Site 8 | Site 2 | 0.012 | 1.000 | 1.545 | 1.569 |
| Site 9 | Site 2 | 0.042 | 1.000 | 1.515 | 1.599 |
| Site 4 | Site 3 | 1.047 | *0.503* | 0.510 | 2.603 |
| Site 5 | Site 3 | 0.043 | 1.000 | 1.513 | 1.600 |
| Site 6 | Site 3 | 0.045 | 1.000 | 1.506 | 1.596 |
| Site 7 | Site 3 | 0.088 | 1.000 | 1.481 | 1.657 |
| Site 8 | Site 3 | 0.003 | 1.000 | 1.566 | 1.560 |
| Site 9 | Site 3 | 0.027 | 1.000 | 1.536 | 1.590 |
| Site 5 | Site 4 | 1.003 | *0.560* | 2.554 | 0.547 |
| Site 6 | Site 4 | 1.002 | *0.557* | 2.546 | 0.543 |
| Site 7 | Site 4 | 0.959 | *0.636* | 2.522 | 0.604 |
| Site 8 | Site 4 | 1.050 | *0.499* | 2.606 | 0.507 |
| Site 9 | Site 4 | 1.020 | *0.542* | 2.576 | 0.537 |
| Site 6 | Site 5 | 0.001 | 1.000 | 1.543 | 1.546 |
| Site 7 | Site 5 | 0.044 | 1.000 | 1.519 | 1.607 |
| Site 8 | Site 5 | 0.047 | 1.000 | 1.603 | 1.510 |
| Site 9 | Site 5 | 0.017 | 1.000 | 1.573 | 1.540 |
| Site 7 | Site 6 | 0.043 | 1.000 | 1.514 | 1.600 |
| Site 8 | Site 6 | 0.048 | 1.000 | 1.599 | 1.502 |
| Site 9 | Site 6 | 0.018 | 1.000 | 1.569 | 1.532 |
| Site 8 | Site 7 | 0.091 | 1.000 | 1.660 | 1.478 |
| Site 9 | Site 7 | 0.061 | 1.000 | 1.630 | 1.508 |
| Site 9 | Site 8 | 0.030 | 1.000 | 1.533 | 1.593 |

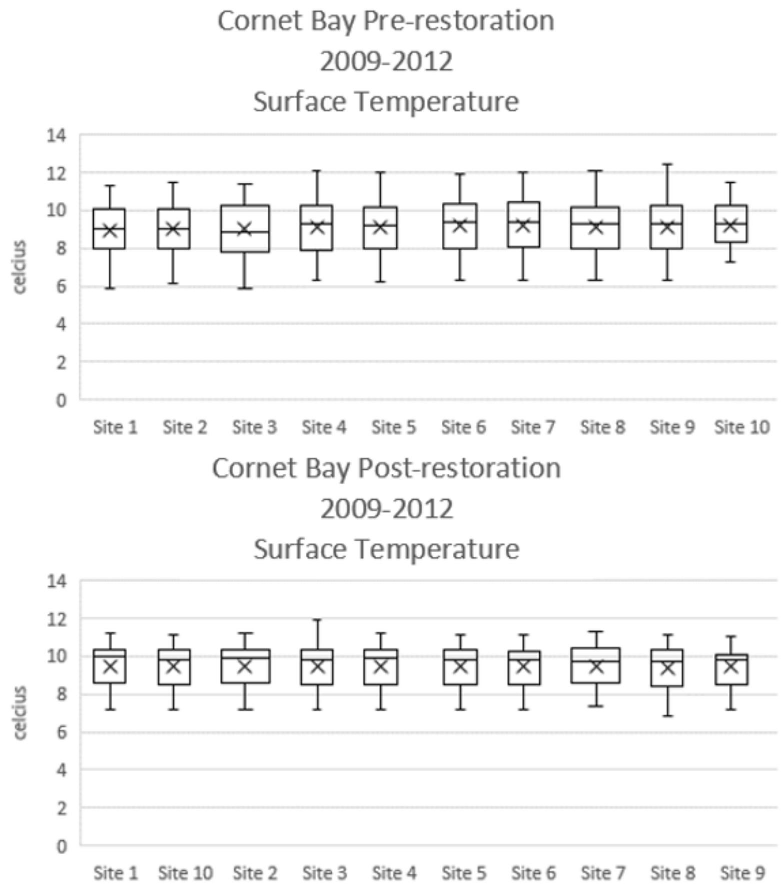



*Figure 9: Boxplot of water surface temperature at Cornet Bay. Boxes shows 25th and 75th percentiles. Whiskers show 5th and 95th percentiles. The "X" represents the mean marker. Circles (if present) represent outliers.*

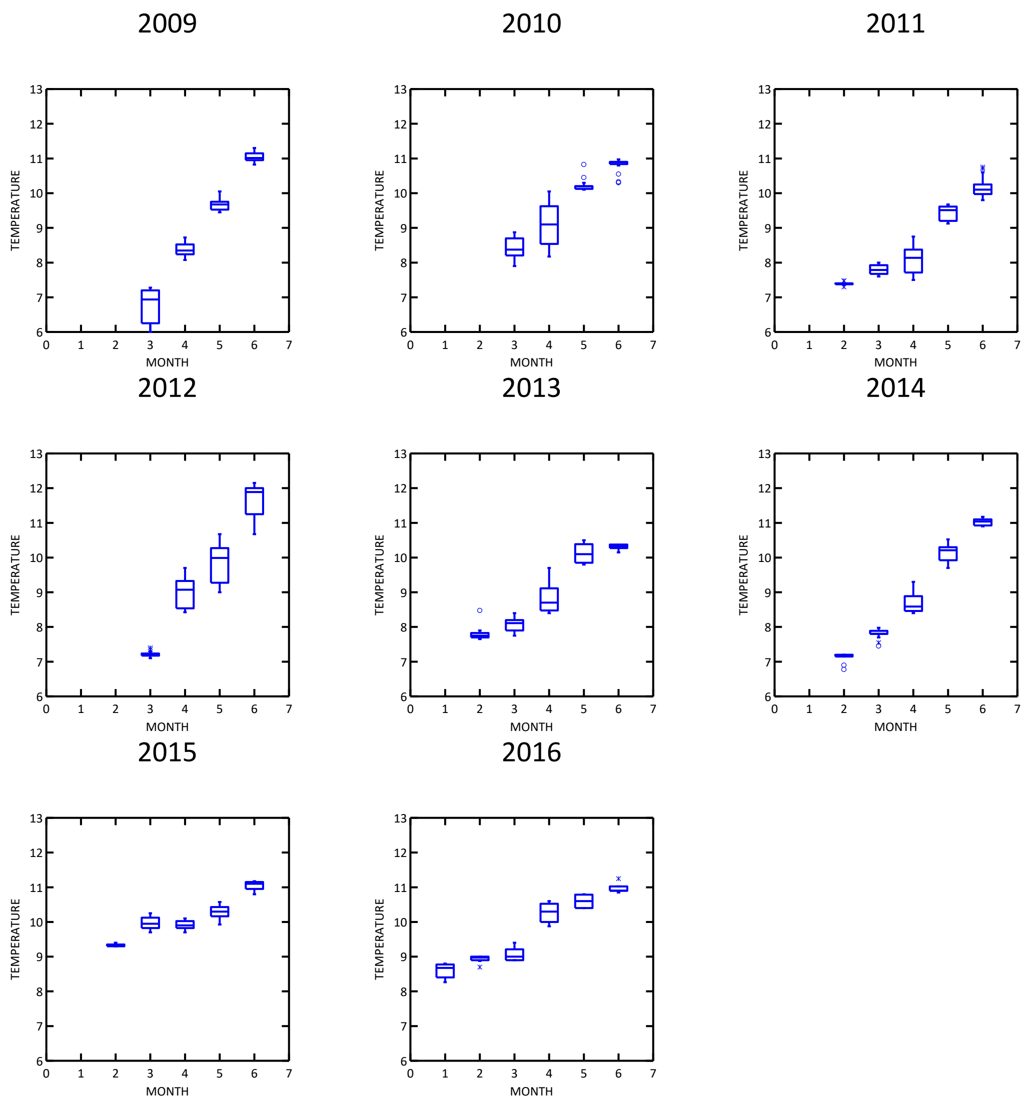



*Figure 10: Temperature box plots across months by year.*

## Salinity

The mean for salinity was 27 ppt but varied depending on month and year.
The salinity mean dropped over the sampling season in 2009, varied in 2011-2013 but increased through the sampling season between Feb and June in 2010 and 2014-2016 (Figure 11 and Figure 12).

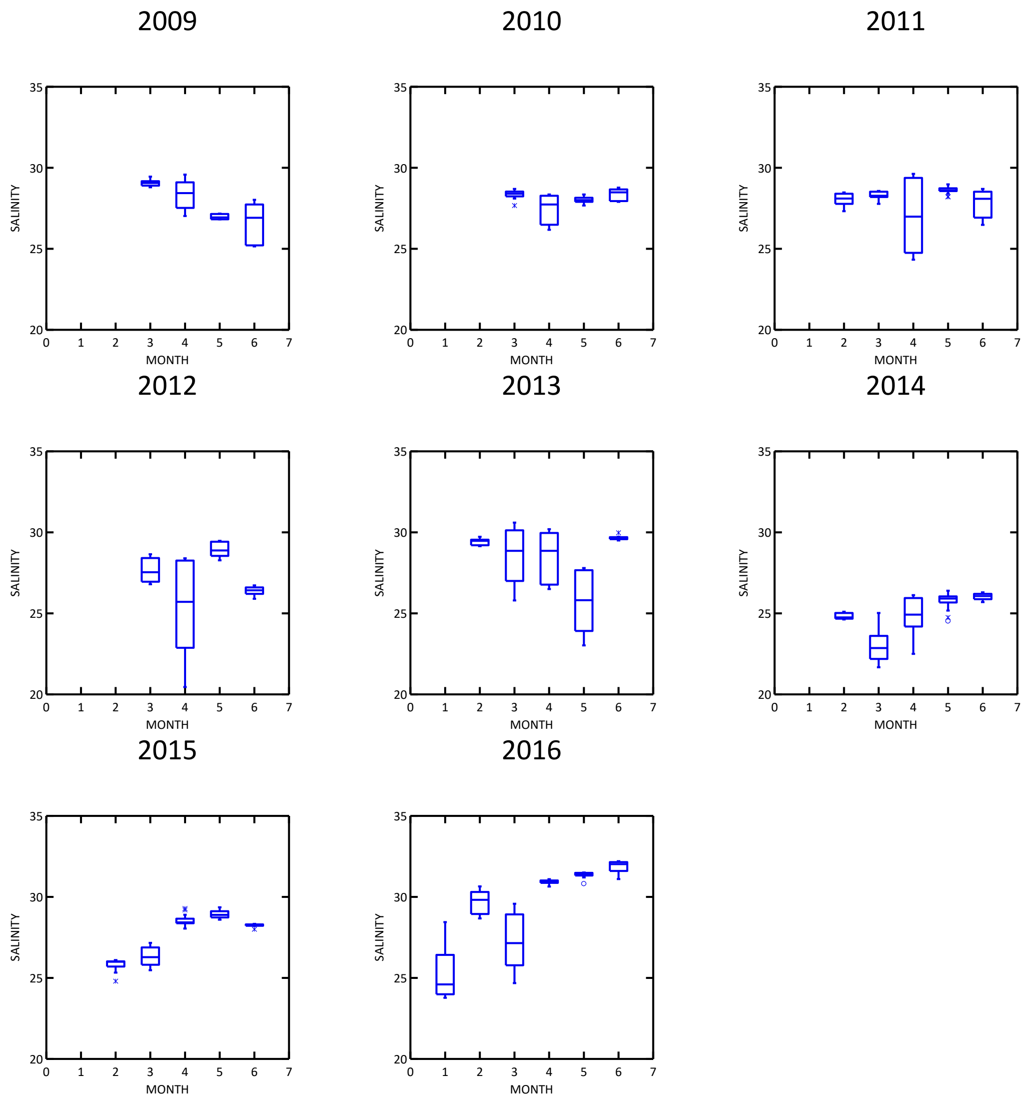



*Figure 11: Boxplot of dissolved oxygen as Cornet Bay. Boxes shows 25th and 75th percentiles. Whiskers show 5th and 95th percentiles. The "X" represents the mean marker. Circles (if present) represent outliers.*

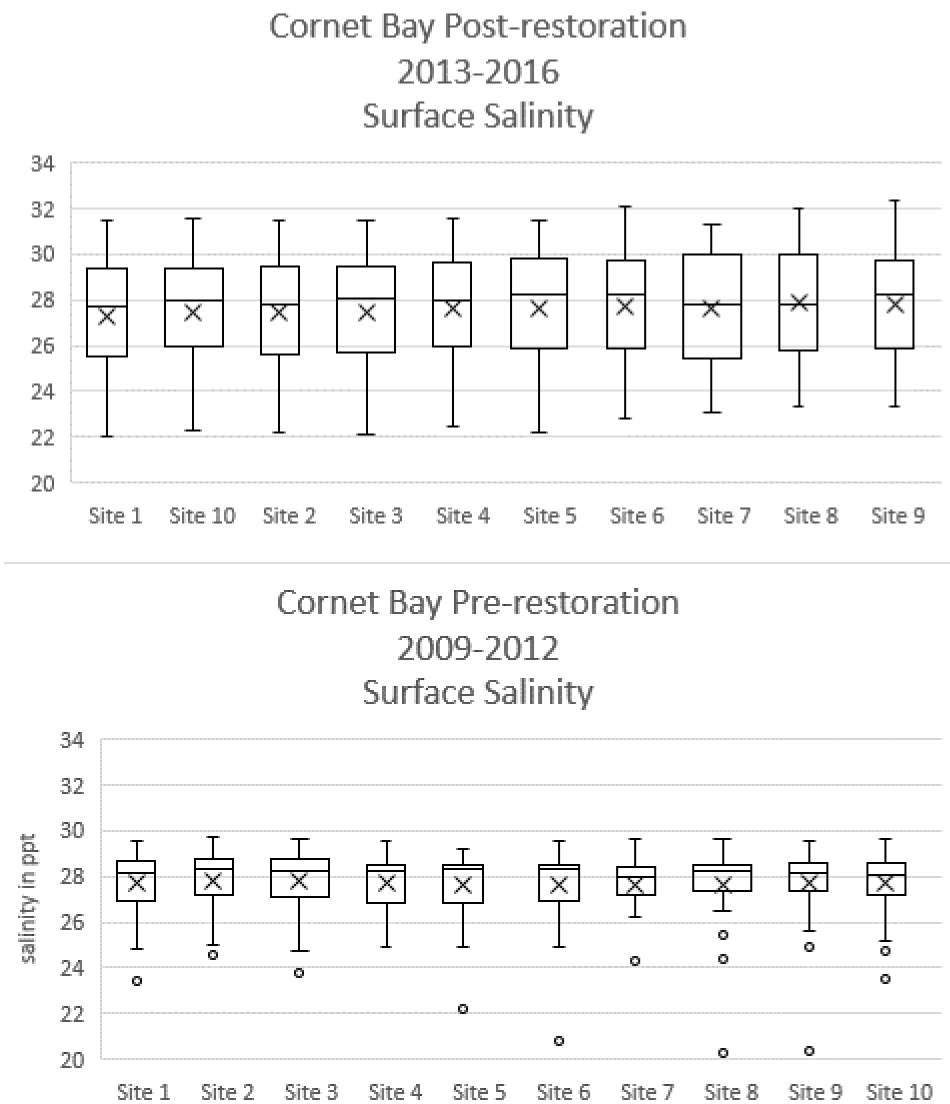



*Figure 12: Boxplot of dissolved oxygen as Cornet Bay. Boxes shows 25th and 75th percentiles. Whiskers show 5th and 95th percentiles. The "X" represents the mean marker. Circles (if present) represent outliers.*

*Table 6: ANOVA significance results for surface salinity at Cornet Bay. Years 2009 through 2012 are pre-restoration years, and years2013 through 2016 are post-restoration years. Salinity was measured at the furthest extent of the net set area from the bank.*

| Variable Type | Variable | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|---|
| Factor | Year | 1 | 9.6 | 9.621 | 2.089 | 0.149 |
| Factor | Site | 9 | 4.3 | 0.477 | 0.104 | 1 |
| Interaction | Year*Site | 9 | 4 | 0.441 | 0.096 | 1 |

*Table 7: Pairwise results of water surface salinity by year using Tukey's Honesty Significant Difference Test. P-values significant at the 0.05 level and bolded. Years 2009 through 2012 are pre-restoration years.*

| Year(i) | Year(j) | Difference | P-Value | Confidence Interfal | |
|---|---|---|---|---|---|
| | | | | lwr | upr |
| 2010 | 2009 | 0.106 | 1.000 | -0.715 | 0.927 |
| 2011 | 2009 | -0.063 | 1.000 | -0.882 | 0.756 |
| 2012 | 2009 | -1.153 | **0.002** | -2.031 | -0.275 |
| 2013 | 2009 | 0.157 | 0.999 | -0.641 | 0.955 |
| 2014 | 2009 | -3.076 | **0.000** | -3.874 | -2.278 |
| 2015 | 2009 | -0.260 | 0.980 | -1.083 | 0.563 |
| 2016 | 2009 | 1.968 | **0.000** | 1.161 | 2.776 |
| 2011 | 2010 | -0.169 | 0.998 | -0.947 | 0.608 |
| 2012 | 2010 | -1.259 | **0.000** | -2.099 | -0.420 |
| 2013 | 2010 | 0.051 | 1.000 | -0.705 | 0.807 |
| 2014 | 2010 | -3.182 | **0.000** | -3.938 | -2.427 |
| 2015 | 2010 | -0.366 | 0.847 | -1.148 | 0.417 |
| 2016 | 2010 | 1.862 | **0.000** | 1.096 | 2.628 |
| 2012 | 2011 | -1.090 | **0.002** | -1.927 | -0.253 |
| 2013 | 2011 | 0.220 | 0.987 | -0.533 | 0.973 |
| 2014 | 2011 | -3.013 | **0.000** | -3.767 | -2.260 |
| 2015 | 2011 | -0.197 | 0.995 | -0.977 | 0.583 |
| 2016 | 2011 | 2.031 | **0.000** | 1.268 | 2.795 |
| 2013 | 2012 | 1.310 | **0.000** | 0.493 | 2.127 |
| 2014 | 2012 | -1.923 | **0.000** | -2.740 | -1.106 |
| 2015 | 2012 | 0.893 | 0.029 | 0.051 | 1.735 |
| 2016 | 2012 | 3.121 | **0.000** | 2.295 | 3.948 |
| 2014 | 2013 | -3.233 | **0.000** | -3.964 | -2.503 |
| 2015 | 2013 | -0.417 | 0.706 | -1.175 | 0.342 |
| 2016 | 2013 | 1.811 | **0.000** | 1.070 | 2.553 |
| 2015 | 2014 | 2.817 | **0.000** | 2.058 | 3.575 |
| 2016 | 2014 | 5.045 | **0.000** | 4.303 | 5.786 |
| 2016 | 2015 | 2.228 | **0.000** | 1.460 | 2.997 |

### Dissolved Oxygen

Dissolved oxygen (DO) was variable throughout the sampling season month to month and year to year (Table 8). But site to site during the same sampling day was fairly consistent (Table 9). There appeared to be a slight trend towards decreasing DO between March and June (Figure 13) which would be consistent with an increase in primary production due to longer daylight hours. There were concerns with the DO sensor on the equipment during the 2015 and 2016 sampling year. Two water quality meters were used at the same time for results comparison. Both pieces of equipment calibrated successfully but often differed in readings in the field. Therefore, caution should be used when attempting to extract information from the DO results.

*Table 8: ANOVA significance results for full depth bottom dissolved oxygen at Cornet Harbor. P-Value are significant at the 0.05 level.*

| Variable Type | Variable | Df | Sum Sq | Mean Sq | F value | Pr(>F) |
|---|---|---|---|---|---|---|
| Factors | Year | 1 | 4.2 | 4.224 | 8.073 | 0.00464 |
| | Site | 9 | 7.7 | 0.8561 | 1.633 | 0.102 |
| | Month | 4 | 24.75 | 6.187 | 12.56 | 7.88E-10 |

*Table 9: Pairwise results of full depth bottom dissolved oxygen by strata at Cornet Bay using Tukey's Honesty Significance Test. P-values are significant at the 0.05 level.*

| Strata(i) | Starta(j) | diff | p adj | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | lwr | upr |
| Site 10 | Site 1 | -0.03644 | 1 | -0.44779 | 0.374911 |
| Site 2 | Site 1 | -0.15651 | 0.970216 | -0.56621 | 0.253193 |
| Site 3 | Site 1 | -0.08837 | 0.999604 | -0.49972 | 0.322976 |
| Site 4 | Site 1 | -0.22111 | 0.787529 | -0.63081 | 0.18859 |
| Site 5 | Site 1 | -0.18238 | 0.922898 | -0.59208 | 0.22732 |
| Site 6 | Site 1 | -0.26611 | 0.549151 | -0.6742 | 0.141992 |
| Site 7 | Site 1 | -0.3103 | 0.336312 | -0.72335 | 0.102744 |
| Site 8 | Site 1 | -0.34418 | 0.193967 | -0.75553 | 0.067169 |
| Site 9 | Site 1 | -0.27619 | 0.499394 | -0.68589 | 0.133511 |
| Site 2 | Site 10 | -0.12007 | 0.995572 | -0.53142 | 0.291281 |
| Site 3 | Site 10 | -0.05194 | 0.999996 | -0.46493 | 0.361057 |
| Site 4 | Site 10 | -0.18467 | 0.919011 | -0.59602 | 0.226678 |
| Site 5 | Site 10 | -0.14594 | 0.981889 | -0.55729 | 0.265408 |
| Site 6 | Site 10 | -0.22967 | 0.747865 | -0.63942 | 0.180086 |
| Site 7 | Site 10 | -0.27386 | 0.530257 | -0.68854 | 0.140818 |
| Site 8 | Site 10 | -0.30774 | 0.348232 | -0.72073 | 0.10525 |
| Site 9 | Site 10 | -0.23975 | 0.702271 | -0.6511 | 0.171598 |
| Site 3 | Site 2 | 0.068134 | 0.999955 | -0.34322 | 0.479484 |
| Site 4 | Site 2 | -0.0646 | 0.99997 | -0.4743 | 0.345098 |
| Site 5 | Site 2 | -0.02587 | 1 | -0.43557 | 0.383828 |
| Site 6 | Site 2 | -0.1096 | 0.997655 | -0.5177 | 0.298499 |
| Site 7 | Site 2 | -0.15379 | 0.97487 | -0.56684 | 0.259252 |
| Site 8 | Site 2 | -0.18767 | 0.911161 | -0.59902 | 0.223677 |
| Site 9 | Site 2 | -0.11968 | 0.995545 | -0.52938 | 0.290019 |

| | | | | | |
|---|---|---|---|---|---|
| Site 4 | Site 3 | -0.13274 | 0.990722 | -0.54409 | 0.278613 |
| Site 5 | Site 3 | -0.09401 | 0.999346 | -0.50536 | 0.317343 |
| Site 6 | Site 3 | -0.17773 | 0.933843 | -0.58748 | 0.232021 |
| Site 7 | Site 3 | -0.22193 | 0.795718 | -0.63661 | 0.192754 |
| Site 8 | Site 3 | -0.25581 | 0.622785 | -0.6688 | 0.157186 |
| Site 9 | Site 3 | -0.18782 | 0.910774 | -0.59917 | 0.223534 |
| Site 5 | Site 4 | 0.03873 | 1 | -0.37097 | 0.448431 |
| Site 6 | Site 4 | -0.045 | 0.999999 | -0.45309 | 0.363103 |
| Site 7 | Site 4 | -0.08919 | 0.999588 | -0.50224 | 0.323855 |
| Site 8 | Site 4 | -0.12307 | 0.994673 | -0.53442 | 0.28828 |
| Site 9 | Site 4 | -0.05508 | 0.999993 | -0.46478 | 0.354622 |
| Site 6 | Site 5 | -0.08373 | 0.999729 | -0.49182 | 0.324373 |
| Site 7 | Site 5 | -0.12792 | 0.993121 | -0.54097 | 0.285125 |
| Site 8 | Site 5 | -0.1618 | 0.96397 | -0.57315 | 0.24955 |
| Site 9 | Site 5 | -0.09381 | 0.999336 | -0.50351 | 0.315892 |
| Site 7 | Site 6 | -0.0442 | 0.999999 | -0.45565 | 0.36726 |
| Site 8 | Site 6 | -0.07807 | 0.999853 | -0.48783 | 0.331678 |
| Site 9 | Site 6 | -0.01008 | 1 | -0.41818 | 0.398013 |
| Site 8 | Site 7 | -0.03388 | 1 | -0.44856 | 0.380802 |
| Site 9 | Site 7 | 0.034111 | 1 | -0.37893 | 0.447157 |
| Site 9 | Site 8 | 0.06799 | 0.999956 | -0.34336 | 0.47934 |

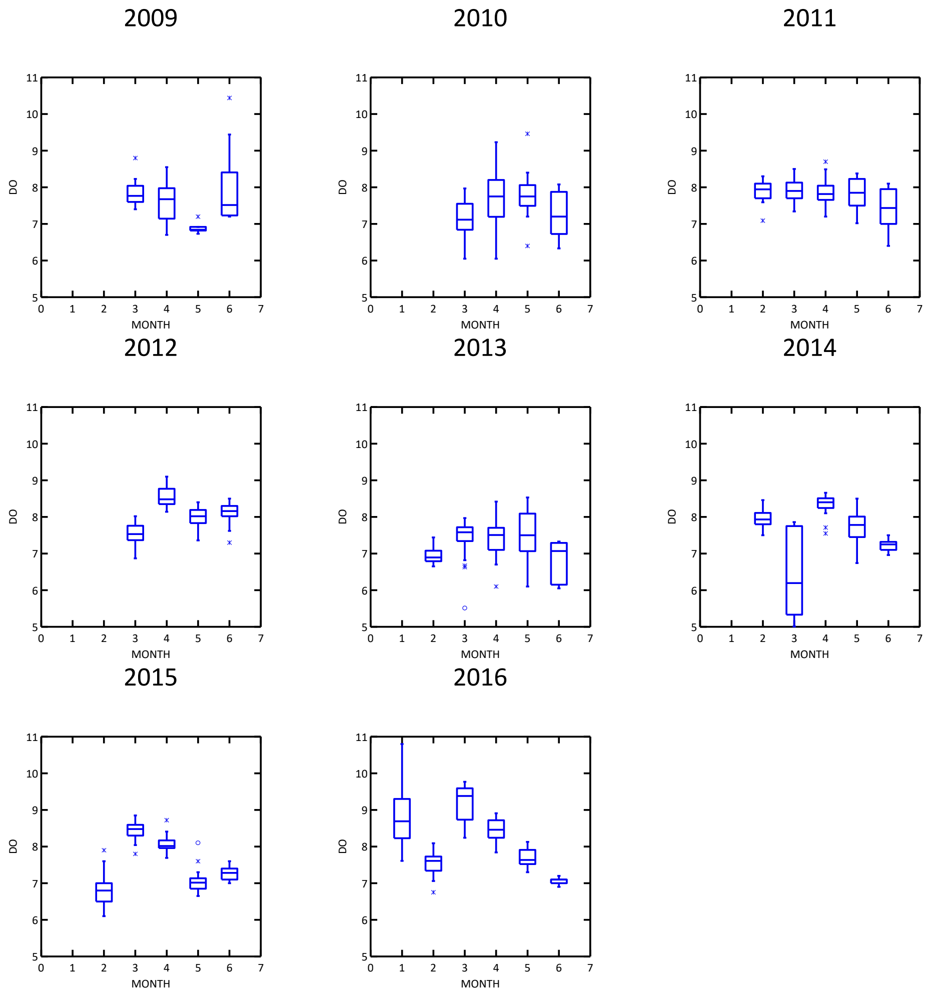



*Figure 13: Boxplot of DO by year and month. Boxes show 25th and 75th percentiles. The "X" represents the mean marker. Whiskers show 5th and 95th percentiles. Circles (if present) represent outliers. Month 1 = January.*

## Water Quality Summary

The water quality sampling protocols were designed to support the fish sampling data and not to assess restoration effectiveness. However, the water quality data did not exhibit any statistical significance between years, months or locations and remained fairly consistent throughout the study period. There were some interesting and unexplained trends in temperature. At Cornet, 2015 was found to be slightly warmer than the other years. It is not known how local this affect was but Crescent Harbor had a normal temperature year in 2015 and recorded 2013 as the warmest of the 2011-2016 study there. It was encouraging to see that at no time during the Cornet study, did the temperature measure warmer than the level thought to be stressful to salmonids (15 degrees Celsius). The salinity and dissolved oxygen data showed no variety in trends.

## FISH ABUNDANCE

Thirty four different species were identified throughout the study. Salmon comprised of 72 – 97% of the total annual catch. The greatest percentage of fish alternated between chum (*Oncorhynchus keta)* and pink (*Oncorhynchus gorbuscha)* juvenile salmon (odd and even years respectively). Total annual catch by species by year is described in Table 10. Dungeness crab (*Cancer magister*) and shrimp (that were not identified by species) were often observed. A table of the species, number and catch per unit effort for each site each sampling day is included in Appendix B. Though trends were not statistically examined for non-salmonids, Table 10 shows that in 2013, a spike in abundance was observed for chum juvenile salmon, juvenile sculpin , juvenile gunnels, whitespotted greenling (*Hexagrammos stelleri*) and snake pricklebacks (*Lumpenus sagitta)*. All but one of the silverspotted sculpin (*Blepsias cirrhosis)* encountered were caught in 2013. Two of the three cutthroat trout (*Oncorhynchus clarkii)* encountered during the 8 year study were also caught in 2013. Sand sole (*Psettichthys melanostictus)* and English sole (*Parophrys vetulus*) were caught only in 2009 and 2014 in Cornet Bay. This is similar to the sampling conducted at Crescent Harbor where English sole were only caught in 2014 during that study that was conducted from 2011 to 2015 (Beamer et al 2016).

*Table 10: Total annual catch for each species, by year. The bold values for chum and pink juvenile salmon represent the largest percentage of catch by individual species for each year.*

| **Species** | **2009** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | ***Totals*** |
|---|---|---|---|---|---|---|---|---|---|
| *Salmon:* | | | | | | | | | |
| **Chinook salmon** ***Oncorhynchus tshawytscha*** | 2 | 102 | 31 | 139 | 71 | 73 | 161 | 171 | *750* |
| **Chum salmon** ***Oncorhynchus keta*** | **5058** | 396 | **7545** | 779 | **14114** | 196 | **8025** | 511 | *36624* |
| **Coho salmon** ***Oncorhynchus kisutch*** | 0 | 0 | 0 | 37 | 2 | 11 | 1 | 3 | *54* |
| **Pink salmon** ***Oncorhynchus gorbuscha*** | 0 | **15890** | 0 | **49029** | 0 | **19955** | 0 | **3479** | *88353* |
| **Cutthroat trout** ***Oncorhynchus clarkii*** | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 0 | *3* |
| *Cottids (sculpins):* | | | | | | | | | |
| **Sculpin** | 109 | 120 | 2 | 2 | 202 | 0 | 0 | 2 | *437* |
| **Juvenile sculpin** | 0 | 0 | 0 | 0 | 0 | 226 | 6 | 35 | *267* |
| **Buffalo sculpin** ***Enophrys bison*** | 12 | 1 | 0 | 0 | 3 | 1 | 0 | 0 | *17* |
| **Pacific staghorn sculpin** ***Leptocottus armatus*** | 1031 | 300 | 505 | 348 | 563 | 1393 | 567 | 329 | *5036* |
| **Great sculpin** ***Myoxocephalus polyacanthocephalus*** | 14 | 14 | 1 | 0 | 2 | 3 | 0 | 1 | *35* |
| **Sharpnose sculpin** ***Clinocottus acuticeps*** | 16 | 6 | 1 | 1 | 7 | 5 | 4 | 1 | *41* |
| **Silverspotted sculpin** ***Blepsias cirrhosus*** | 0 | 1 | 0 | 0 | 7 | 0 | 0 | 0 | *8* |
| *Flatfishes:* | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Juvenile flatfish** | 0 | 0 | 0 | 0 | 0 | 21 | 0 | 4 | *25* |
| **Unknown flatfish** | 314 | 4 | 1 | 94 | 41 | 0 | 0 | 0 | *454* |
| **English sole** ***Parophrys vetulus*** | 9 | 0 | 0 | 0 | 0 | 90 | 0 | 11 | *110* |
| **Starry flounder** ***Platichtys stellatus*** | 36 | 23 | 38 | 45 | 53 | 18 | 6 | 8 | *227* |
| **Sand sole** ***Pegusa lascaris*** | 7 | 0 | 0 | 0 | 0 | 98 | 0 | 0 | *105* |
| *Forage fish:* | | | | | | | | | |
| **Pacific sandlance** ***Ammodytes hexapterus*** | 0 | 0 | 0 | 1 | 4 | 6 | 0 | 0 | *11* |
| **Surf smelt** ***Hypomesus pretiosis*** | 2 | 18 | 14 | 89 | 15 | 27 | 27 | 8 | *200* |
| **Pacific herring** ***Clupea pallasii*** | 22 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | *25* |
| *Other nearshore fishes:* | | | | | | | | | |
| **Gunnels** ***Pholidae spp*** | 15 | 1 | 0 | 0 | 126 | 3 | 1 | 1 | *147* |
| **Penpoint gunnel** ***Apodichthys flavidus*** | 17 | 10 | 0 | 0 | 1 | 7 | 0 | 0 | *35* |
| **Crescent gunnel** ***Apodichthys flavidusv*** | 48 | 27 | 1 | 2 | 0 | 0 | 2 | 0 | *80* |
| **Saddleback gunnel** ***Pholis ornate*** | 74 | 29 | 6 | 15 | 20 | 56 | 18 | 9 | *227* |
| **Dwarf wrymouth** **Cryptacanthodes aleutensis** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | *1* |
| **Pile perch** ***Rhacochilus vacca*** | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | *2* |
| **Shiner perch** ***Cymatogaster aggregate*** | 0 | 28 | 2 | 3 | 21 | 57 | 17 | 221 | *349* |
| **Kelp greenling** ***Hexagrammos decagrammus*** | 0 | 43 | 19 | 4 | 0 | 20 | 0 | 8 | *94* |
| **Whitespotted greenling** ***Hexagrammos stelleri*** | 31 | 0 | 0 | 0 | 65 | 0 | 0 | 2 | *98* |
| **Arrow Goby** ***Clevelandia ios*** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | *1* |
| **Bay pipefish** ***Syngnathus leptorhyncus*** | 0 | 0 | 0 | 0 | 2 | 0 | 1 | 3 | *6* |
| **Pacific tomcod** ***Microgadus proximus*** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | *1* |
| **Snailfishes** ***Liparidae spp.*** | 3 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | *15* |
| **Snake prickleback** ***Lumpenus sagitta*** | 62 | 48 | 9 | 5 | 243 | 44 | 0 | 13 | *424* |
| **Threespine stickleback** ***Gasterosteus aculeatus*** | 2 | 9 | 4 | 2 | 9 | 18 | 10 | 13 | *67* |
| **Tube-snout** ***Aulorhynchus flavidus*** | 0 | 60 | 0 | 0 | 0 | 0 | 0 | 3 | *63* |
| **Unknown** | 0 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | *10* |

## JUVENILE SALMONID ABUNDANCE

Pink and chum juvenile salmon made up the majority of the abundance of all fish caught. Chinook, coho and cutthroat juvenile salmon were also encountered during the study. However, due to low numbers caught, coho and cutthroat were not included in the analyses below.

The number of Chinook juvenile salmon caught each year increased, on average, across the time of the study. The trend for chum and pink juvenile salmon abundance rose until 2012 and then fell with pink juvenile salmon dropping at a faster rate than chum juvenile salmon (Figure 14). Chum juvenile salmon were more numerous in odd years when pink juvenile salmon were not present. Chinook juvenile salmon were the most numerous in even years, when pink juvenile salmon were present, for the first half of the study. However, in 2014, Chinook juvenile salmon did not increase during the pink juvenile salmon out-migration year but did increase during the increased chum juvenile salmon out-migration in 2015. It is unclear if the reduction in the chum and pink juvenile salmon abundance, which corresponded in timing with the restoration, was due to an overall reduction in these populations within the Whidbey Basin or if this was a site-specific condition that was being exhibited in these results

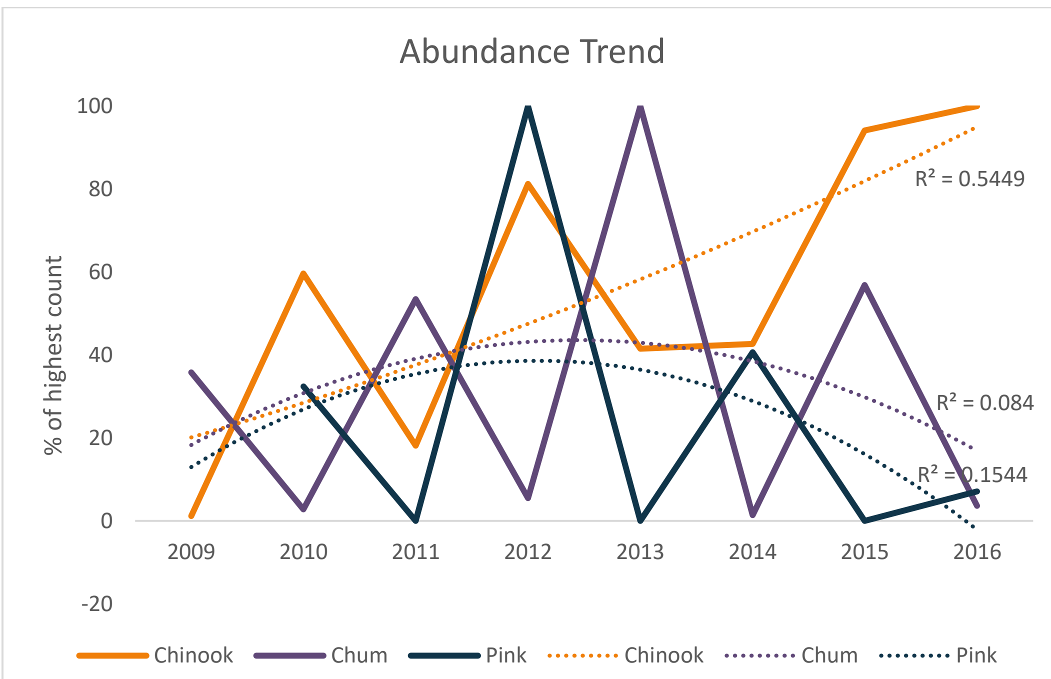



*Figure 14: Sum of catch of each species for each year with trend lines.*

Chinook juvenile salmon catch data from Cornet was compared to data from the Skagit River mainstem trap near Mount Vernon, WA operated by Washington Department of Fish and Wildlife (Anderson, 2016). Outmigration of Chinook sub yearlings from the Skagit does not follow a pattern relative to the pink juvenile salmon run like was observed in Cornet.

The number of Chinook juvenile salmon caught at Cornet jumped from 71 and 73 animals in 2013 and 2014, respectively, to 161 and 171 in 2015 and 2016, respectively. The increase in Chinook juvenile salmon that were caught in 2015 and 2016 does not appear to be a reflection of a regional increase in production of Chinook juvenile salmon as the mainstem trap results indicate reduced outmigration during the time period that increases were observed at Cornet (Figure 15).

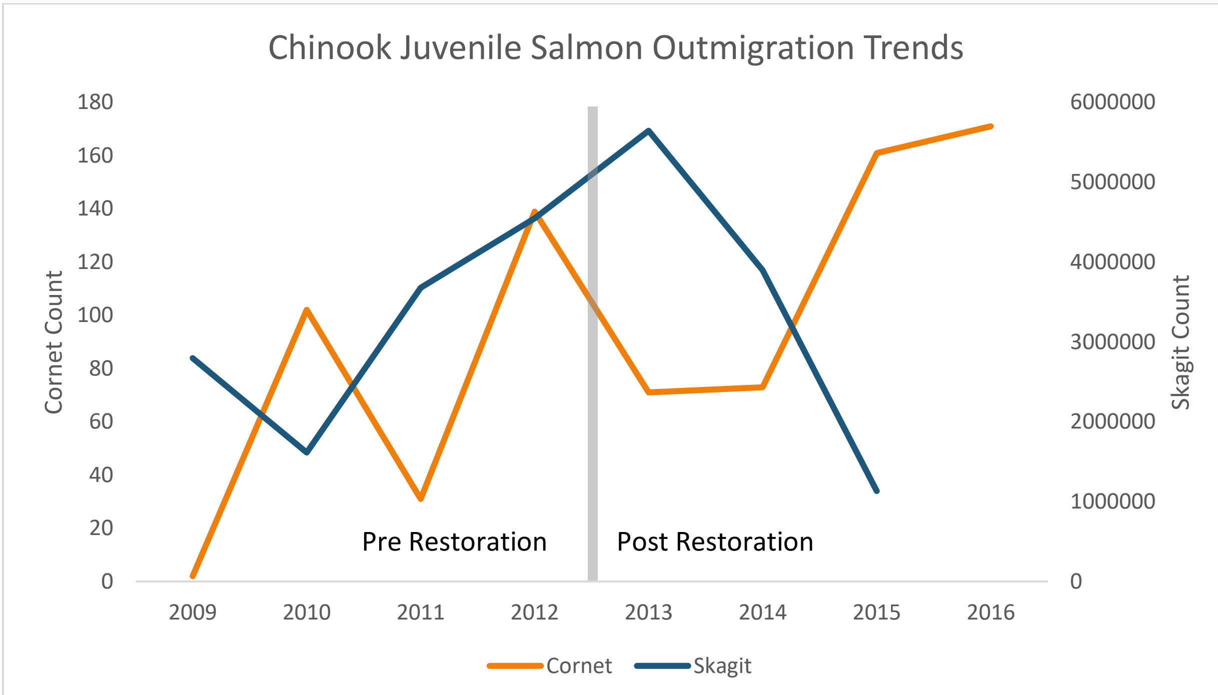



*Figure 15: Chinook juvenile salmon abundance in Cornet vs Skagit River out-migrant trap.*

## JUVENILE SALMONID SITE UTILIZATION

Site utilization by juvenile salmon was examined for potential trends relating to pre and post restoration. Sites 4, 5, 6 and 9 were restored 3 months prior to sampling in 2013. For pre- and post-restoration, Chinook and chum juvenile salmon were caught in higher densities at the control sites and pink juvenile salmon density was highest at sites 4, 5, 6 and 9 (Figure 16 ). After restoration, densities for chum and pink juvenile salmon increased in control areas compared to restoration sites (Figure 19 and Figure 20). It was expected to find utilization for restored sites increase, not decrease. In contrast, Chinook juvenile salmon use of the restoration sites increased compared prior to construction (Figure 17 and Figure 18). Since restoration, though pink and chum juvenile salmon initially used the control sites more, the population density for both species is increasing at the restored sites (Figure 16). It is possible that utilization of the restored sites will continue to increase and equal the use of the control sites as the restored beach stabilizes and the vegetation grows large enough to provide better shade.

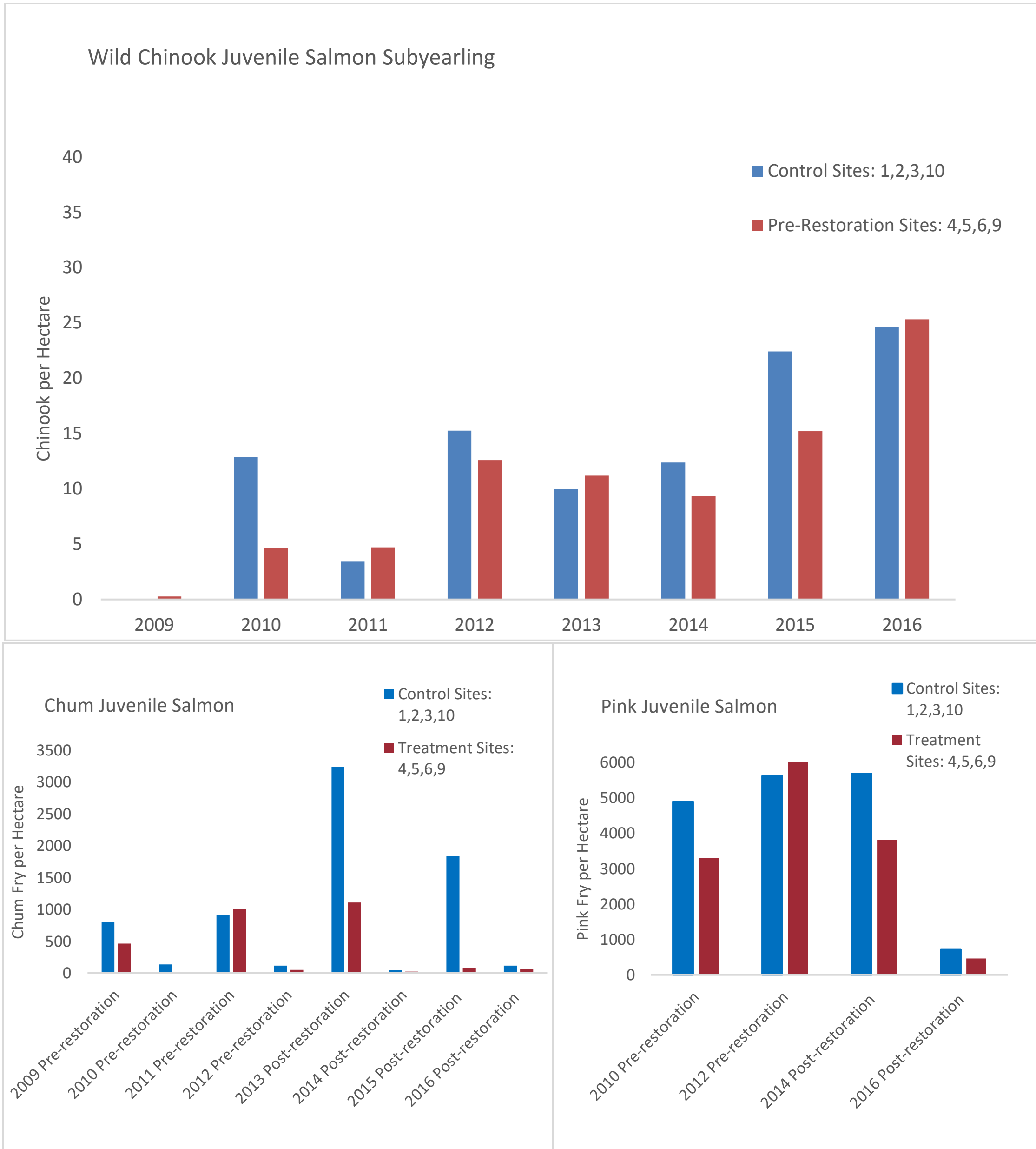



*Figure 16: Site utilization by year of Chinook, pink and chum juvenile salmon within control and restoration sites.*

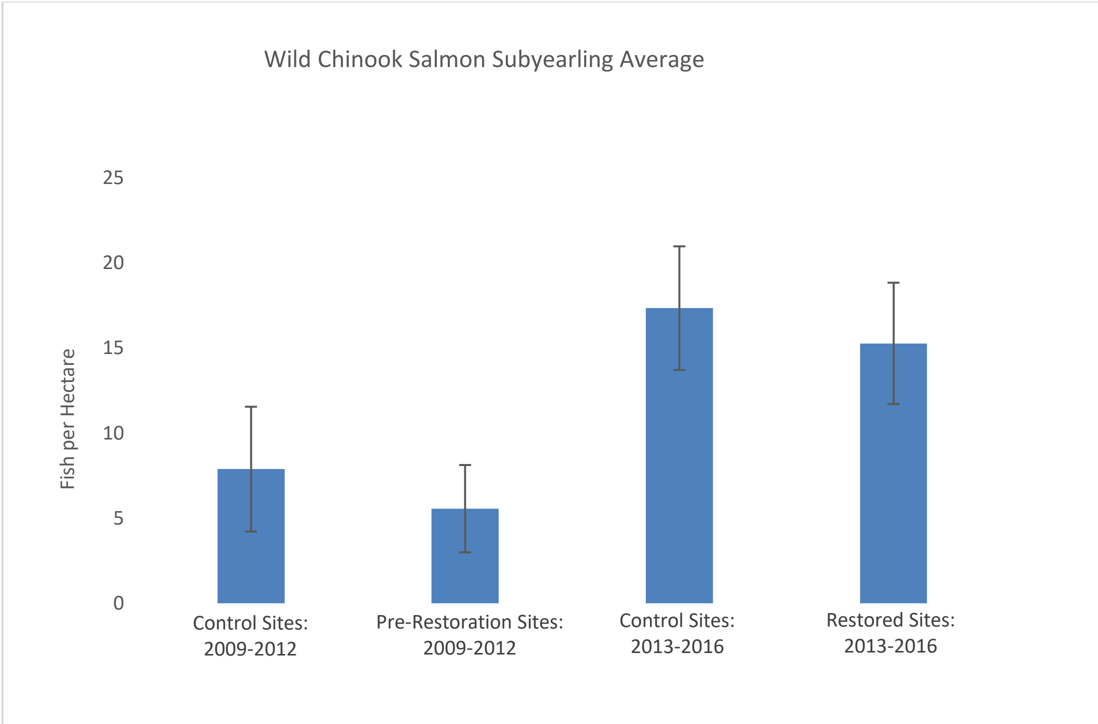
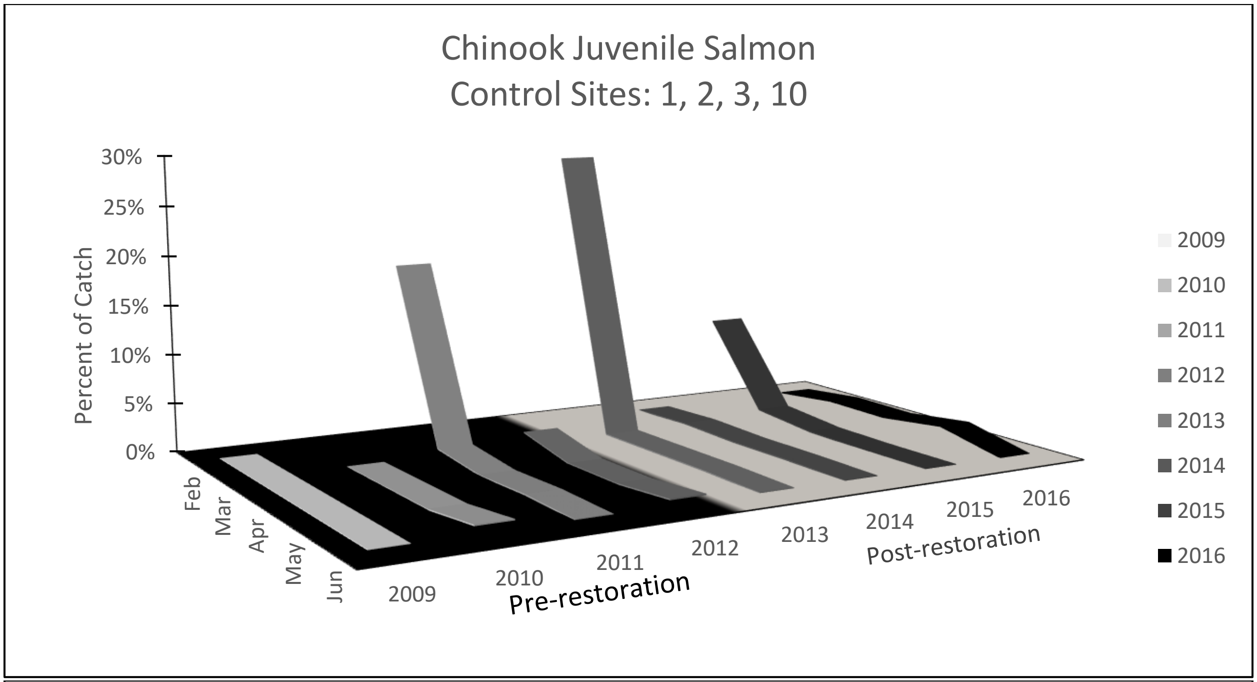



*Figure 17: Average density of subyearling Chinook salmon within control and restoration sites with standard error.*



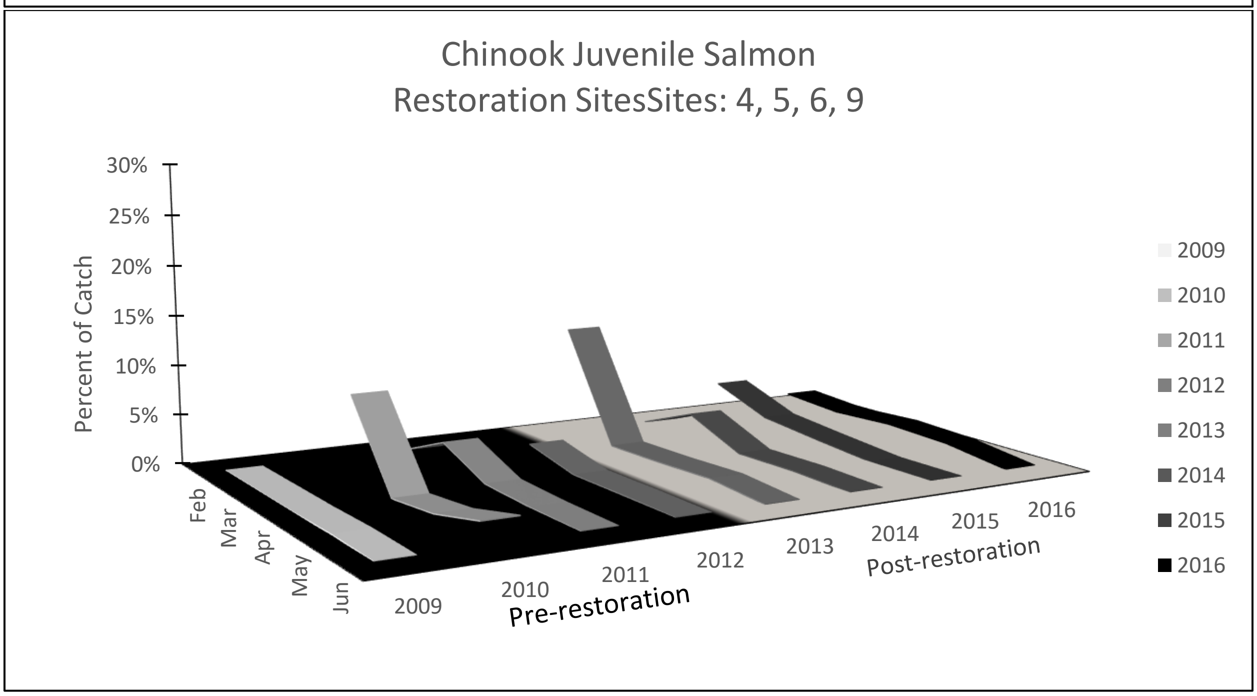




*Figure 18: Site utilization by Chinook juvenile salmon at Cornet Bay pre- and post-restoration.*

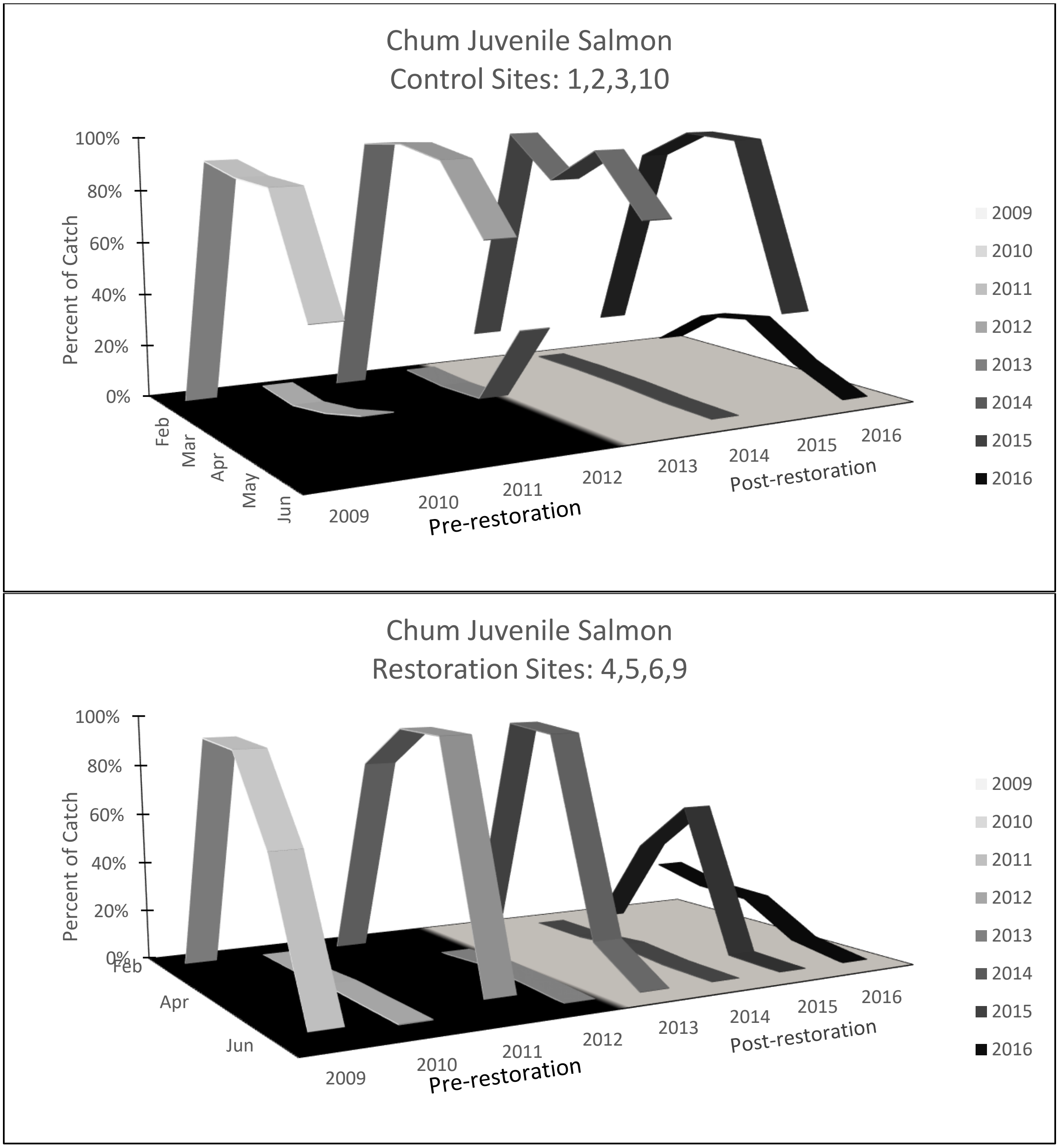
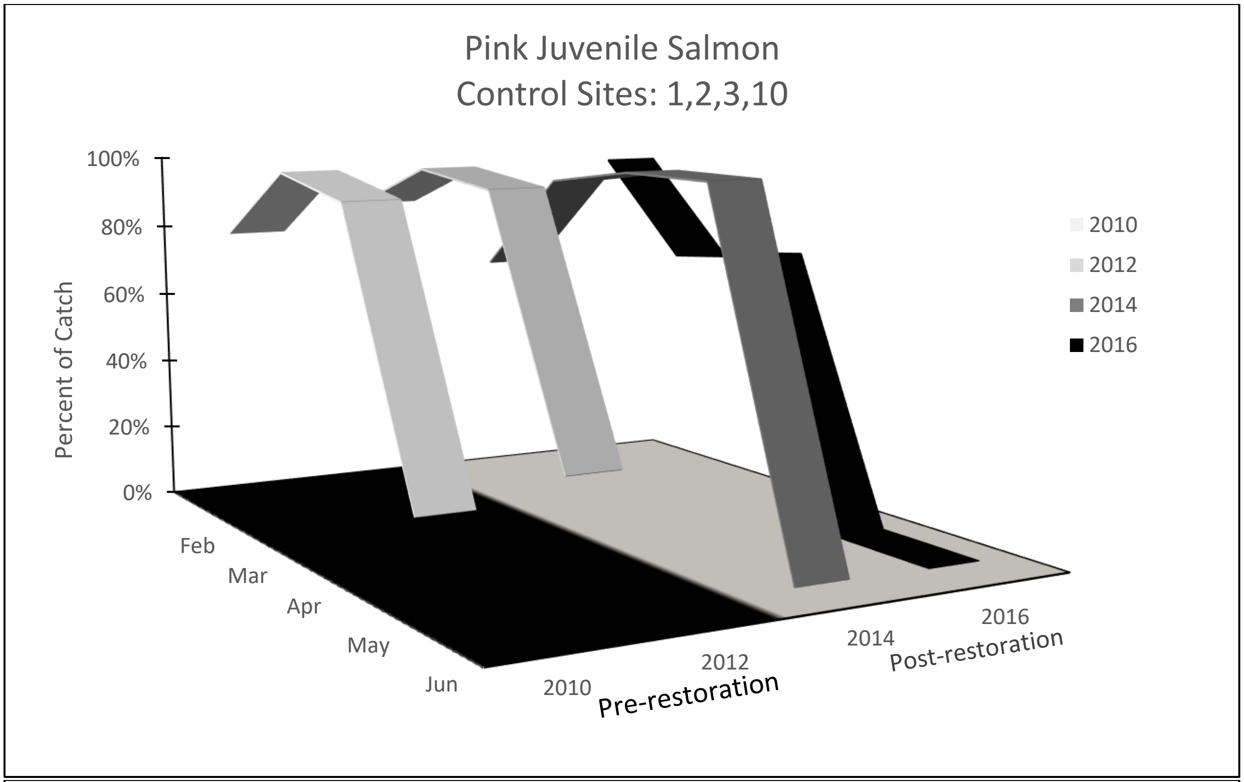



*Figure 19: Site utilization by chum juvenile salmon at Cornet Bay pre- and post-restoration.*



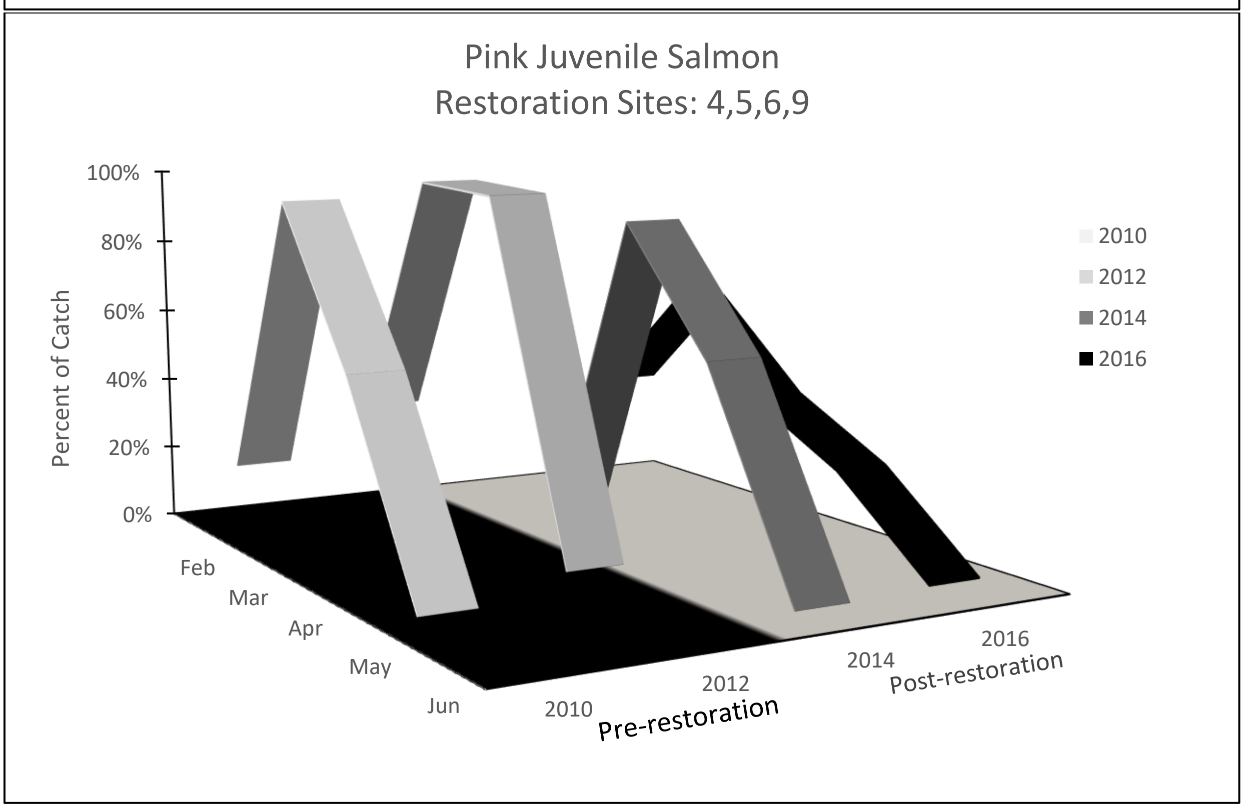




*Figure 20: Site utilization by pink juvenile salmon at Cornet Bay pre- and post-restoration.*

## JUVENILE SALMON TIMING

Chinook juvenile salmon have been pulsing out earlier each year (Figure 21). In 2010 the highest catch per unit effort (cpue) was in late May and was in early May 2012. 2011 and 2013 saw very few Chinook juvenile salmon caught without much of a timing trend that could be discerned.  A bimodal pulse was observed in 2014 and 2015, which is the outmigration pattern observed at the Skagit mainstem trap (Anderson, pers comm 2016). The pulses in 2014 were equal size in mid-April and mid-March. By 2015, the largest pulse was in early March. In 2016, the pulse was singular but large and occurred also in early May.

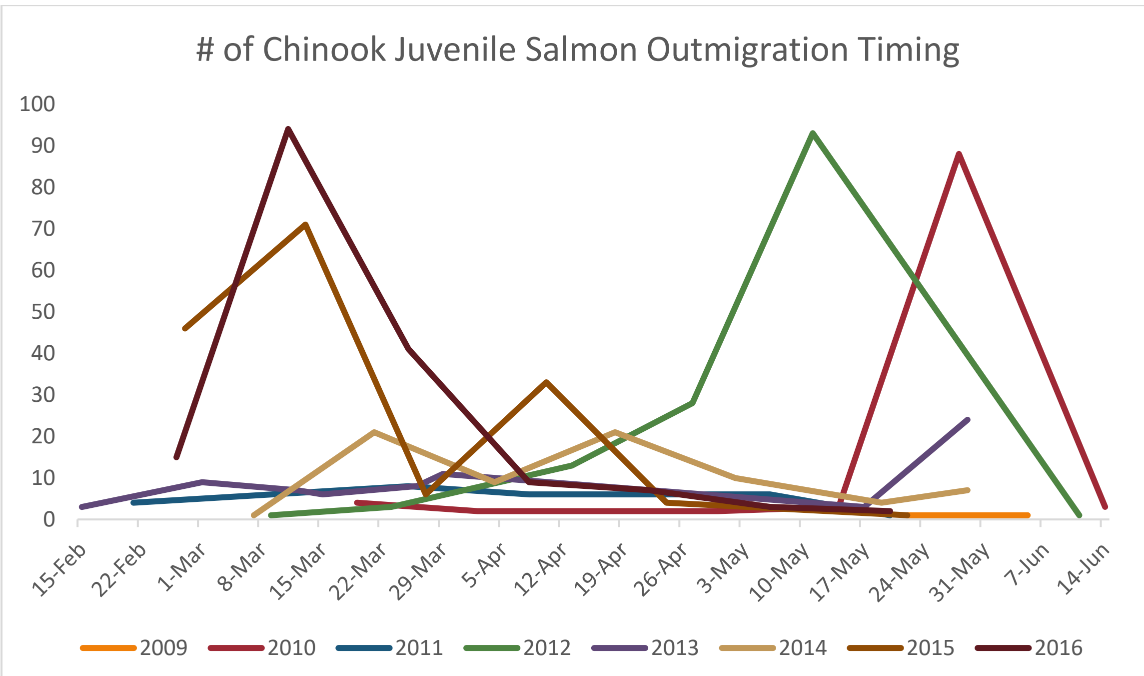



*Figure 21: Timing of outmigration by Chinook juvenile salmon by year.*

Chum juvenile salmon outmigrants generally showed up at Cornet in mid-March and pink juvenile salmon in early April. Chum juvenile salmon appeared to have a pulse throughout their outmigration efforts, while the outmigration of pink juvenile salmon was concentrated in a single pulse (Figure 22 and Figure 23).

In 2010 and 2012, the Chinook juvenile salmon outmigration timing was in one pulse, similar to the pink juvenile salmon outmigration pattern.

In 2014-2015, when Chinook juvenile salmon presence overlaps with chum juvenile salmon to a higher degree, Chinook also have a bimodal pulse pattern similarly observed in chum juvenile salmon outmigration patterns.

Chinook juvenile salmon were most numerous in early March before significant numbers of chum or pink juvenile salmon were present. They were also numerous mid-April to mid-May when pink juvenile salmon were present. The lowest CPUE was observed mid-March to late April, which is the time that chum juvenile salmon CPUE was generally highest.

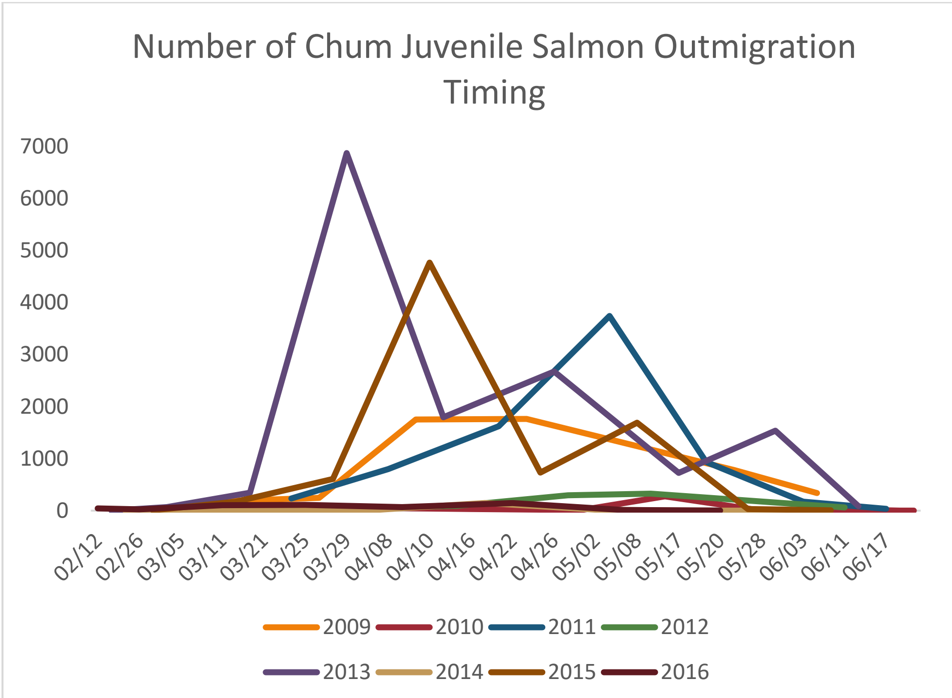



*Figure 22: Timing of outmigration by chum juvenile salmon by year.*

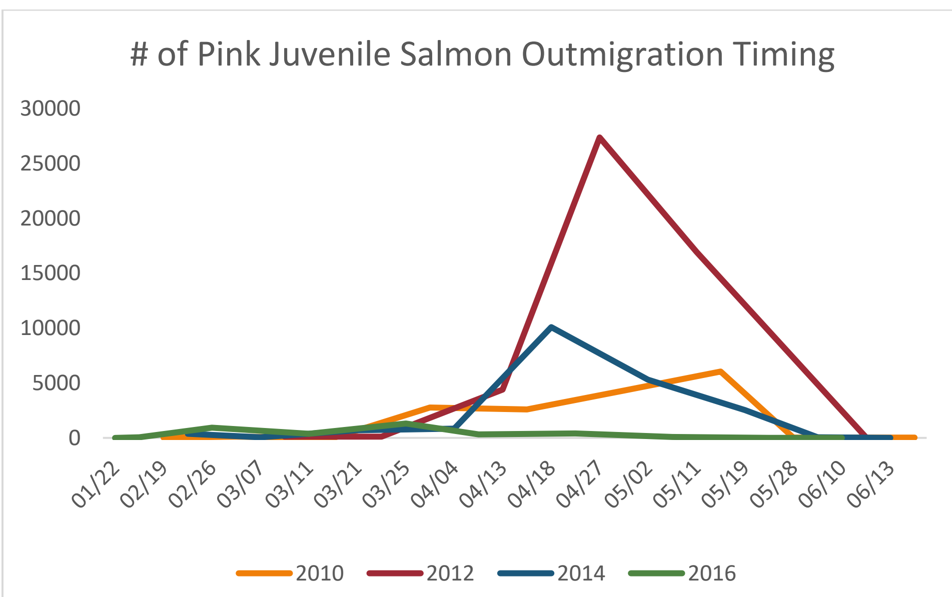



*Figure 23: Timing of outmigration by pink juvenile salmon by year.*

## Fish Lengths

The late timing of the outmigration that was observed for Chinook juvenile salmon in 2010 resulted in fish that were significantly larger than those observed in other years being an average of 33.3 mm larger (Table 11). 2010 saw fewer outmigrants pass the Skagit mainstem trap than in 2009 and 2011. 2013 had significantly larger Chinook juvenile salmon than 2011 or 2012 and were 13 and 12 mm longer, respectively. These results were counter to what was found at Crescent Harbor where Chinook juvenile salmon in 2014 and 2015 were longer than those measured in 2013. The only other statistically significant difference found between years for lengths in Cornet Bay was between Chinook juvenile salmon in 2016 who were 6mm shorter than in 2014.

*Table 11: Pairwise results Chinook juvenile salmon fork length at Cornet Bay by year using Tukey's Honesty Significance Test. P-values are significant at the 0.05 level and bolded.*

| Year(i) | Year(j) | diff | p-Value | 95% Confidence Interval | |
|---|---|---|---|---|---|
| | | | | lwr | upr |
| 2010 | 2009 | 26.771 | 0.066 | -0.882 | 54.424 |
| 2011 | 2009 | -8.833 | 0.980 | -36.921 | 19.254 |
| 2012 | 2009 | -8.018 | 0.987 | -35.412 | 19.375 |
| 2013 | 2009 | 4.300 | 1.000 | -23.282 | 31.882 |
| 2014 | 2009 | -5.554 | 0.999 | -33.115 | 22.007 |
| 2015 | 2009 | -9.355 | 0.968 | -36.758 | 18.048 |
| 2016 | 2009 | -11.795 | 0.895 | -39.176 | 15.587 |
| 2011 | 2010 | **-35.605** | **0.000** | -44.229 | -26.980 |
| 2012 | 2010 | **-34.789** | **0.000** | -40.778 | -28.800 |
| 2013 | 2010 | **-22.471** | **0.000** | -29.268 | -15.674 |
| 2014 | 2010 | **-32.325** | **0.000** | -39.038 | -25.612 |
| 2015 | 2010 | **-36.126** | **0.000** | -42.156 | -30.096 |
| 2016 | 2010 | **-38.566** | **0.000** | -44.499 | -32.632 |
| 2012 | 2011 | 0.815 | 1.000 | -6.938 | 8.568 |
| 2013 | 2011 | **13.133** | **0.000** | 4.741 | 21.526 |
| 2014 | 2011 | 3.279 | 0.932 | -5.045 | 11.604 |
| 2015 | 2011 | -0.522 | 1.000 | -8.306 | 7.263 |
| 2016 | 2011 | -2.961 | 0.941 | -10.671 | 4.748 |
| 2013 | 2012 | **12.318** | **0.000** | 6.668 | 17.969 |
| 2014 | 2012 | 2.464 | 0.879 | -3.084 | 8.013 |
| 2015 | 2012 | -1.337 | 0.989 | -6.037 | 3.363 |
| 2016 | 2012 | -3.776 | 0.193 | -8.351 | 0.799 |
| 2014 | 2013 | **-9.854** | **0.000** | -16.267 | -3.441 |
| 2015 | 2013 | **-13.655** | **0.000** | -19.349 | -7.961 |
| 2016 | 2013 | **-16.095** | **0.000** | -21.686 | -10.503 |
| 2015 | 2014 | -3.801 | 0.438 | -9.394 | 1.792 |

| | | | | | |
|---|---|---|---|---|---|
| 2016 | 2014 | **-6.240** | **0.013** | -11.729 | -0.752 |
| 2016 | 2015 | -2.440 | 0.749 | -7.068 | 2.189 |

## Fish Presence/Absence and Abundance Summary

The abundance of pink juvenile salmon increased until 2012. Then, abundance decreased starting in 2013. It is likely that this is related to an overall reduction in the pink juvenile salmon outmigration in Whidbey Basin and not an artifact of the restoration. The pulse of pink juvenile salmon in late April each year was just prior to the second pulse of Chinook juvenile salmon so competition with Chinook juvenile salmon is an unlikely factor affecting the decrease in abundance. Pink juvenile salmon used the pre-restored sites to much larger degree than the control sites in 2012. But they used control sites more after the restoration was completed.

The abundance of chum juvenile salmon increased over time and peaked in 2013. There was a gradual decline from 2014 on but not to the same degree seen in the pink juvenile salmon population. Chum juvenile salmon were much more abundant in years when pink juvenile salmon were not present. Chum juvenile salmon outmigrate in two pulses with the early pulse being the most abundant and a few weeks later than the first pulse of Chinook juvenile salmon. The second pulse of chum juvenile salmon and Chinook juvenile salmon overlap in timing. A larger proportion of the total catch of chum juvenile salmon was consistently found in the control sites more frequently than the restored sites, both before and after restoration.

The abundance of Chinook juvenile salmon sampled increased on average throughout the length of the study with the largest increases in 2015 and 2016. Chinook juvenile salmon used both restored and control sites to a similar degree throughout the study. This increase was despite a dramatic reduction of the number of outmigrants emerging from the Skagit River. They were found in two pulses, similar to the pattern of the Skagit outmigration. The largest pulse was the first one observed each year, which came earlier every year.

Despite the overall drop in abundance of pink and chum juvenile salmon, there is a trend of using the restored sites to a greater degree later in the study. For all 3 species, the proportion found at the restored sites, compared to the control sites, increased between 2013 and 2016. In other words, of the juvenile salmon present, there was a shift from most to them being found in the control sites to a more even distribution across the control and restored sites as the restoration sites matured post construction.

# CONCLUSIONS

1. No statistically significant differences were found in water temperature year to year or site to site. 2015 was one degree Celsius warmer than 2009-2014. Site 4, adjacent to the boat ramp on the up-drift side was slightly warmer than the other sites, but not statistically significantly so.
2. Juvenile salmon populations in Cornet Bay increased in abundance until 2013. Chum and pink juvenile salmon populations declined between 2013 and 2016.
3. Chinook juvenile salmon continued to increase throughout the length of the study. This is despite lower outmigration numbers counted at the Skagit mainstem trap, which saw an increase in abundance from 2010 to 2013 and a decrease in 2014 and 2015.
4. The main restoration at Cornet was conducted in the fall of 2012 and the site went through one winter before the 2013 outmigration.
5. Pink juvenile salmon consistently used the sites 4, 5, 6 and 9 before and after restoration over the control sites. This may be a function of these sites being further up the Bay with a potentially lower energy environment.
6. Both chum and pink juvenile salmon demonstrated a shift of site utilization to the control sites to a greater degree post restoration. Pink juvenile salmon abundance remained greatest at the restoration sites but a higher percentage of the total catch was found at the control sites.
7. Chinook juvenile salmon differed from chum and pink juvenile salmon site utilization in that their proportional use of the restored sites increased post restoration in 2013.
8. The year, 2010, that the Skagit mainstem trap recorded the lowest abundance between 2009 and 2015, was one of the highest abundance years for Chinook juvenile salmon in Cornet. The outmigration pulse in 2010 was mid-May and resulted in the largest Chinook juvenile salmon measured, on average, for the duration of the study. 2012 had a later peak pulse but the lengths measured were average.
9. The second largest length averages were measured in 2013. Chinook juvenile salmon measured at Crescent in 2013 by Beamer et al were found to be smaller, not larger, than previous years.

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# APPENDIX A: WATER QUALITY BOX PLOTS

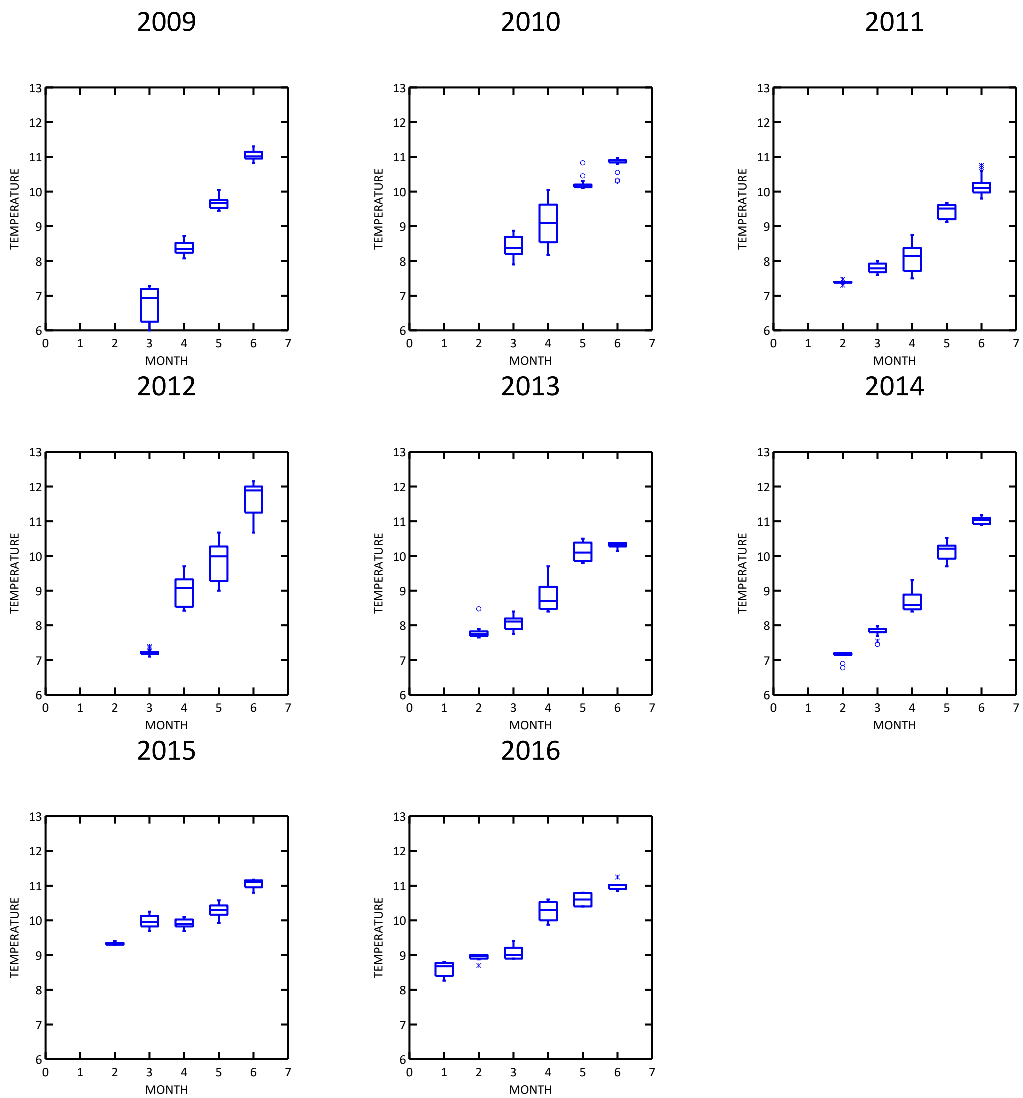


*Figure 24: Boxplot of surface water temperature. Whiskers show 5th and 95th percentiles. The "X" represents the mean marker. Circles (if present) represent outliers.*

# APPENDIX B: FISH ASSEMBLAGES

*Table 12: Details of Beach Seine effort (number of sets) at Cornet Bay by site, month, year.*

| Year | Month | Control 1 | Control 2 | Control 3 | Pre-Rest 4 | Pre-Rest 5 | Pre-Rest 6 | Pre-Rest 7 | Pre-Rest 8 | Pre-Rest 9 | Control 10 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009 | March | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 19 |
| | April | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 9 |
| | June | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | **Total** | **7** | **7** | **6** | **7** | **7** | **7** | **7** | **7** | **7** | **6** | **68** |
| 2010 | Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Mar | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Apr | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 |
| | May | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Jun | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | **Total** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **100** |
| 2011 | Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Mar | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Apr | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Jun | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | **Total** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **80** |
| 2012 | March | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | April | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | June | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | **Total** | **6** | **6** | **6** | **6** | **6** | **6** | **6** | **6** | **6** | **6** | **60** |
| | | | | | | | | | | | | |
| **Year** | **Month** | **Control 1** | **Control 2** | **Control 3** | **Post-Rest 4** | **Post-Rest 5** | **Post-Rest 6** | **Pre-Rest 7** | **Pre-Rest 8** | **Post-Rest 9** | **Control 10** | **Total** |
| 2013 | Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Mar | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 |
| | Apr | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | **Total** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **90** |
| 2014 | Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Mar | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Apr | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 30 |
| | Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | **Total** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **9** | **90** |
| 2015 | Feb | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Mar | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Apr | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | **Total** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **8** | **80** |
| | | | | | | | | | | | | |
| **Year** | **Month** | **Control 1** | **Control 2** | **Control 3** | **Post-Rest 4** | **Post-Rest 5** | **Post-Rest 6** | **Post-Rest 7** | **Pre-Rest 8** | **Post-Rest 9** | **Control 10** | **Total** |
| 2016 | Jan | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | Feb | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Mar | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Apr | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | May | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 20 |
| | Jun | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 10 |
| | **Total** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **10** | **100** |
| **Grand Total** | | **67** | **67** | **66** | **67** | **67** | **67** | **67** | **67** | **67** | **66** | **668** |

## Catch by Species per Year

*Table 13: Count of each species (catch per unit effort in brackets) caught by site each year.*

2009

| Count of Species with CPUE: 2009 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Salmonids | | | | | | | | | | |
| Chinook salmon, unmarked, subyearling *Oncorhynchus tshawytscha* | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) |
| Coho salmon, unmarked *Oncorhynchus kisutch* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Pink Salmon, <60mm *Oncorhynchus gorbuscha* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chum salmon, <65mm *Oncorhynchus keta* | 32 (4.57) | 44 (6.29) | 62 (10.33) | 65 (9.29) | 65 (9.29) | 61 (8.71) | 20 (2.86) | 23 (3.29) | 8 (1.14) | 56 (9.33) |
| Cutthroat trout *Oncorhynchus clarkii* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Sculpin | | | | | | | | | | |
| Buffalo sculpin *Enophrys bison* | 1 (0.14) | 1 (0.14) | 2 (0.33) | 1 (0.14) | 0 (0) | 2 (0.29) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| English sole *Parophrys vetulus* | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 3 (0.5) |
| Great sculpin *Myoxocephalus polyacanthocephalus* | 1 (0.14) | 1 (0.14) | 2 (0.33) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Pacific staghorn sculpin *Leptocottus armatus* | 1 (0.14) | 1 (0.14) | 3 (0.5) | 6 (0.86) | 5 (0.71) | 6 (0.86) | 5 (0.71) | 6 (0.86) | 6 (0.86) | 5 (0.83) |
| Sculpin, Unknown | 1 (0.14) | 3 (0.43) | 1 (0.17) | 1 (0.14) | 1 (0.14) | 2 (0.29) | 2 (0.29) | 1 (0.14) | 0 (0) | 3 (0.5) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0 (0) | 1 (0.14) | 3 (0.5) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Flat Fish | | | | | | | | | | |
| Sand sole *Psettichthys melanostictus* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 1 (0.14) | 1 (0.14) | 0 (0) | 0 (0) |
| Unknown flatfish Unknown | 0 (0) | 0 (0) | 2 (0.33) | 2 (0.29) | 4 (0.57) | 3 (0.43) | 1 (0.14) | 2 (0.29) | 2 (0.29) | 2 (0.33) |
| Starry flounder *Platichtys stellatus* | 1 (0.14) | 0 (0) | 2 (0.33) | 1 (0.14) | 1 (0.14) | 1 (0.14) | 3 (0.43) | 3 (0.43) | 2 (0.29) | 2 (0.33) |
| Forage Fish | | | | | | | | | | |
| Surf smelt *Hypomesus pretiosis* | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Pacific herring *Clupea pallasii* | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Other Nearshore or Estuary Fishes | | | | | | | | | | |
| Crescent gunnel *Pholis laeta* | 2 (0.29) | 1 (0.14) | 1 (0.17) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Arrow Goby *Clevelandia ios* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) |
| Snailfish *Liparidae spp* | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) |
| Gunnel, Unknown | 1 (0.14) | 1 (0.14) | 1 (0.17) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0.17) |
| Penpoint gunnel *Apodichthys flavidus* | 3 (0.43) | 2 (0.29) | 2 (0.33) | 0 (0) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Saddleback gunnel *Pholis ornate* | 2 (0.29) | 1 (0.14) | 2 (0.33) | 2 (0.29) | 1 (0.14) | 1 (0.14) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Threespine stickleback *Gasterosteus aculeatus* | 1 (0.14) | 0 (0) | 1 (0.17) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) |
| Snake prickleback *Lumpenus sagitta* | 1 (0.14) | 0 (0) | 0 (0) | 3 (0.43) | 2 (0.29) | 2 (0.29) | 1 (0.14) | 1 (0.14) | 1 (0.14) | 0 (0) |
| Whitespotted greenling *Hexagrammos stelleri* | 2 (0.29) | 3 (0.43) | 1 (0.17) | 1 (0.14) | 0 (0) | 0 (0) | 1 (0.14) | 1 (0.14) | 0 (0) | 2 (0.33) |
| Grand Total | 20 (2.86) | 18 (2.57) | 27 (4.5) | 24 (3.43) | 21 (3) | 23 (3.29) | 17 (2.43) | 20 (2.86) | 12 (1.71) | 21 (3.5) |

2010

| Count of Species with CPUE: 2010 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Salmonids** | | | | | | | | | | |
| Chinook salmon, unmarked subyearling *Oncorhynchus tshawytscha* | 1(0.1) | 0(0) | 15(1.5) | 17(1.7) | 1(0.1) | 1(0.1) | 3(0.3) | 1(0.1) | 3(0.3) | 7(0.7) |
| Coho salmon, unmarked *Oncorhynchus kisutch* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Pink, <60mm *Oncorhynchus gorbuscha* | 83(8.3) | 41(4.1) | 63(6.3) | 73(7.3) | 61(6.1) | 44(4.4) | 62(6.2) | 12(1.2) | 22(2.2) | 12(1.2) |
| Chum salmon, <65mm *Oncorhynchus keta* | 46(4.6) | 38(3.8) | 30(3) | 12(1.2) | 9(0.9) | 24(2.4) | 3(0.3) | 0(0) | 0(0) | 0(0) |
| Cutthroat trout *Oncorhynchus clarkii* | 5(0.5) | 4(0.4) | 4(0.4) | 2(0.2) | 3(0.3) | 3(0.3) | 1(0.1) | 0(0) | 0(0) | 0(0) |
| **Flat fish** | | | | | | | | | | |
| Starry flounder *Platichtys stellatus* | 0(0) | 0(0) | 2(0.2) | 3(0.3) | 0(0) | 5(0.5) | 1(0.1) | 0(0) | 1(0.1) | 2(0.2) |
| Unknown flatfish | 0(0) | 0(0) | 1(0.1) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) |
| **Sculpin** | | | | | | | | | | |
| Pacific staghorn sculpin *Leptocottus armatus* | 2(0.2) | 1(0.1) | 6(0.6) | 4(0.4) | 5(0.5) | 7(0.7) | 9(0.9) | 5(0.5) | 6(0.6) | 6(0.6) |
| Great sculpin *Myoxocephalus polyacanthocephalus* | 3(0.3) | 2(0.2) | 0(0) | 2(0.2) | 1(0.1) | 2(0.2) | 0(0) | 0(0) | 0(0) | 0(0) |
| Silverspotted sculpin *Blepsias cirrhosus* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) |
| Sculpin *Unknown* | 1(0.1) | 1(0.1) | 1(0.1) | 2(0.2) | 3(0.3) | 2(0.2) | 2(0.2) | 2(0.2) | 1(0.1) | 2(0.2) |
| Sharpnose sculpin *Clinocottus acuticeps* | 1(0.1) | 0(0) | 3(0.3) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Buffalo sculpin<br>*Enophrys bison* | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Forage Fish** | | | | | | | | | | |
| Pacific herring<br>*Clupea pallasii* | 0(0) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Surf smelt<br>*Hypomesus pretiosis* | 3(0.3) | 0(0) | 2(0.2) | 1(0.1) | 0(0) | 1(0.1) | 1(0.1) | 0(0) | 1(0.1) | 1(0.1) |
| **Other Nearshore or Estuary fish** | | | | | | | | | | |
| Gunnel | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) |
| Penpoint gunnel<br>*Apodichthys flavidus* | 2(0.2) | 2(0.2) | 0(0) | 1(0.1) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 1(0.1) |
| Saddleback gunnel<br>*Pholis ornate* | 3(0.3) | 0(0) | 1(0.1) | 1(0.1) | 3(0.3) | 2(0.2) | 0(0) | 0(0) | 1(0.1) | 2(0.2) |
| Snake prickleback<br>*Lumpenus sagitta* | 1(0.1) | 0(0) | 0(0) | 1(0.1) | 2(0.2) | 3(0.3) | 1(0.1) | 1(0.1) | 0(0) | 2(0.2) |
| Shiner perch<br>*Cymatogaster aggregate* | 0(0) | 2(0.2) | 0(0) | 1(0.1) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Threespine stickleback<br>*Gasterosteus aculeatus* | 1(0.1) | 0(0) | 1(0.1) | 2(0.2) | 1(0.1) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) |
| Tubesnout<br>Aulorhynchus flavidus | 0(0) | 0(0) | 0(0) | 1(0.1) | 0(0) | 1(0.1) | 0(0) | 0(0) | 1(0.1) | 0(0) |
| Crescent gunnel<br>*Pholis laeta* | 2(0.2) | 0(0) | 0(0) | 1(0.1) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Kelp greenling<br>*Hexagrammos decagrammus* | 3(0.3) | 4(0.4) | 2(0.2) | 1(0.1) | 1(0.1) | 3(0.3) | 3(0.3) | 3(0.3) | 2(0.2) | 1(0.1) |
| Snailfish<br>*Liparidae* | 0(0) | 1(0.1) | 1(0.1) | 2(0.2) | 0(0) | 1(0.1) | 0(0) | 0(0) | 1(0.1) | 1(0.1) |
| Grand Total | 35(3.5) | 24(2.4) | 32(3.2) | 31(3.1) | 26(2.6) | 36(3.6) | 22(2.2) | 16(1.6) | 21(2.1) | 26(2.6) |

2011

| Count of Species with CPUE: 2011 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Salmonids:** | | | | | | | | | | |
| Chinook salmon, unmarked subyearling<br>*Oncorhynchus tshawytscha* | 2(0.25) | 3(0.38) | 2(0.25) | 4(0.5) | 2(0.25) | 5(0.63) | 8(1) | 0(0) | 4(0.5) | 0(0) |
| Coho salmon, unmarked<br>*Oncorhynchus kisutch* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Pink, subyearling<br>*Oncorhynchus gorbuscha* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chum salmon, subyearling *Oncorhynchus keta* | 81(10.13) | 103(12.88) | 81(10.13) | 46(5.75) | 60(7.5) | 74(9.25) | 45(5.63) | 81(10.13) | 41(5.13) | 70(8.75) |
| Cutthroat trout *Oncorhynchus clarkii* | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Sculpin** | | | | | | | | | | |
| Great sculpin *Myoxocephalus polyacanthocephalus* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) |
| Pacific staghorn sculpin *Leptocottus armatus* | 2(0.25) | 0(0) | 6(0.75) | 3(0.38) | 8(1) | 7(0.88) | 7(0.88) | 6(0.75) | 6(0.75) | 5(0.63) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Flat fish:** | | | | | | | | | | |
| Starry flounder *Platichtys stellatus* | 1(0.13) | 0(0) | 0(0) | 2(0.25) | 1(0.13) | 1(0.13) | 5(0.63) | 1(0.13) | 2(0.25) | 1(0.13) |
| Unknown flatfish | 1(0.13) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Forage Fish** | | | | | | | | | | |
| Surf smelt *Hypomesus pretiosis* | 0(0) | 1(0.13) | 0(0) | 0(0) | 0(0) | 3(0.38) | 0(0) | 2(0.25) | 0(0) | 2(0.25) |
| **Other Nearshore or Estuary fish** | | | | | | | | | | |
| Threespine stickleback *Gasterosteus aculeatus* | 0(0) | 0(0) | 1(0.13) | 0(0) | 1(0.13) | 0(0) | 0(0) | 0(0) | 1(0.13) | 1(0.13) |
| Saddleback gunnel *Pholis ornate* | 0(0) | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) | 0(0) | 2(0.25) | 0(0) | 0(0) |
| Shiner perch *Cymatogaster aggregate* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) |
| Crescent gunnel *Pholis laeta* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) |
| Snake prickleback *Lumpenus sagitta* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) | 0(0) | 0(0) |
| Kelp greenling Hexagrammos decagrammus | 2(0.25) | 1(0.13) | 2(0.25) | 1(0.13) | 1(0.13) | 2(0.25) | 0(0) | 2(0.25) | 0(0) | 0(0) |
| Grand Total | 13(1.63) | 16(2) | 11(1.38) | 17(2.13) | 13(1.63) | 18(2.25) | 21(2.63) | 16(2) | 22(2.75) | 14(1.75) |

2012

| Count of Species with CPUE: 2012 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Salmonids** | | | | | | | | | | |
| Chinook salmon, unmarked subyearling | 2(3.33) | 23(0.33) | 10(0.17) | 30(0) | 24(0) | 14(0) | 10(0) | 12(0.17) | 8(0) | 4(0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Oncorhynchus tshawytscha* | | | | | | | | | | |
| Coho salmon, unmarked, *Oncorhynchus kisutch* | 20(13.17) | 2(7.83) | 1(10.67) | 0(11) | 0(6.83) | 0(13.33) | 0(12.83) | 1(7.5) | 0(10.17) | 0(6.67) |
| Pink, <60mm, *Oncorhynchus gorbuscha* | 79(9.83) | 47(8) | 64(7.33) | 66(10.5) | 41(5.33) | 80(4.67) | 77(8) | 45(3.17) | 61(1.83) | 40(5.67) |
| Chum salmon, <65mm, *Oncorhynchus keta* | 59(0) | 48(0) | 44(0) | 63(0) | 32(0) | 28(0) | 48(0) | 19(0) | 11(0) | 34(0) |
| Cutthroat trout, *Oncorhynchus clarkii* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Flat Fish** | | | | | | | | | | |
| Starry flounder *Platichtys stellatus* | 0(0) | 1(0.17) | 1(0.17) | 2(0.33) | 1(0.17) | 3(0.5) | 2(0.33) | 2(0.33) | 0(0) | 4(0.67) |
| Unknown flatfish *Unknown* | 0(0) | 0(0) | 3(0.5) | 1(0.17) | 3(0.5) | 4(0.67) | 3(0.5) | 3(0.5) | 3(0.5) | 1(0.17) |
| **Sculpin** | | | | | | | | | | |
| Pacific staghorn sculpin *Leptocottus armatus* | 3(0.5) | 3(0.5) | 5(0.83) | 2(0.33) | 6(1) | 6(1) | 6(1) | 5(0.83) | 5(0.83) | 5(0.83) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.17) | 0(0) | 0(0) |
| Unknown Sculpin *Unknown* | 0(0) | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.17) |
| **Forage Fish** | | | | | | | | | | |
| Sandlance *Ammodytes hexapterus* | 0(0) | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Surf smelt *Hypomesus pretiosis* | 1(0.17) | 1(0.17) | 1(0.17) | 0(0) | 2(0.33) | 0(0) | 1(0.17) | 2(0.33) | 1(0.17) | 1(0.17) |
| **Other Nearshore or Estuary Fishes** | | | | | | | | | | |
| Saddleback gunnel *Pholis ornate* | 1(0.17) | 1(0.17) | 1(0.17) | 1(0.17) | 0(0) | 1(0.17) | 1(0.17) | 0(0) | 1(0.17) | 1(0.17) |
| Crescent gunnel *Pholis laeta* | 1(0.17) | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Threespine stickleback *Gasterosteus aculeatus* | 0(0) | 1(0.17) | 0(0) | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Shiner perch *Cymatogaster aggregate* | 0(0) | 1(0.17) | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Snake prickleback *Lumpenus sagitta* | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.17) | 0(0) |
| Pacific tomcod *Microgadus proximus* | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Kelp greenling *Hexagrammos decagrammus* | 1(0.17) | 0(0) | 1(0.17) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Grand Total | 20(3.33) | 23(3.83) | 27(4.5) | 20(3.33) | 20(3.33) | 23(3.83) | 23(3.83) | 23(3.83) | 19(3.17) | 24(4) |

2013

| Count of Species with CPUE: 2013 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Salmonids** | | | | | | | | | | |
| Chinook salmon, unmarked subyearling *Oncorhynchus tshawytscha* | 9(1) | 5(0.56) | 5(0.56) | 10(1.11) | 0(0) | 1(0.11) | 19(2.11) | 1(0.11) | 6(0.67) | 12(1.33) |
| Coho salmon, unmarked *Oncorhynchus kisutch* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.11) |
| Pink, <60mm *Oncorhynchus gorbuscha* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Chum salmon, <65mm *Oncorhynchus keta* | 118(13.11) | 137(15.22) | 112(12.44) | 67(7.44) | 63(7) | 44(4.89) | 101(11.22) | 93(10.33) | 107(11.89) | 88(9.78) |
| Cutthroat trout *Oncorhynchus clarkii* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.11) | 1(0.11) | 0(0) | 0(0) |
| **Flat Fish** | | | | | | | | | | |
| Starry flounder *Platichtys stellatus* | 0(0) | 1(0.11) | 1(0.11) | 1(0.11) | 2(0.22) | 4(0.44) | 2(0.22) | 0(0) | 2(0.22) | 1(0.11) |
| Unknown flatfish | 1(0.11) | 0(0) | 1(0.11) | 0(0) | 4(0.44) | 2(0.22) | 2(0.22) | 1(0.11) | 1(0.11) | 2(0.22) |
| **Sculpin** | | | | | | | | | | |
| Unknown sculpin | 1(0.11) | 1(0.11) | 1(0.11) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 1(0.11) | 1(0.11) | 2(0.22) |
| Pacific staghorn sculpin *Leptocottus armatus* | 2(0.22) | 4(0.44) | 4(0.44) | 7(0.78) | 9(1) | 8(0.89) | 5(0.56) | 6(0.67) | 9(1) | 6(0.67) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0(0) | 0(0) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 2(0.22) | 0(0) | 2(0.22) |
| Great sculpin *Myoxocephalus polyacanthocephalus* | 0(0) | 0(0) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Silverspotted sculpin *Blepsias cirrhosus* | 2(0.22) | 2(0.22) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Buffalo sculpin *Enophrys bison* | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Forage Fish** | | | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Surf smelt *Hypomesus pretiosis* | 2(0.22) | 1(0.11) | 0(0) | 0(0) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 1(0.11) |
| Pacific herring *Clupea pallasii* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) |
| Pacific sandlance *Ammodytes hexapterus* | 0(0) | 1(0.11) | 2(0.22) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Other Nearshore or Estuary Fish** | | | | | | | | | | |
| Unknown | 0(0) | 1(0.11) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Gunnel *Pholidae spp* | 1(0.11) | 1(0.11) | 0(0) | 2(0.22) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Bay pipefish *Syngnathus griseolineatus* | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Penpoint gunnel *Apodichthys flavidus* | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Saddleback gunnel *Pholis ornate* | 3(0.33) | 2(0.22) | 0(0) | 0(0) | 1(0.11) | 2(0.22) | 0(0) | 0(0) | 0(0) | 0(0) |
| Threespine stickleback *Gasterosteus aculeatus* | 2(0.22) | 0(0) | 1(0.11) | 0(0) | 1(0.11) | 0(0) | 1(0.11) | 0(0) | 1(0.11) | 1(0.11) |
| Shiner perch *Cymatogaster aggregate* | 3(0.33) | 0(0) | 1(0.11) | 2(0.22) | 0(0) | 2(0.22) | 1(0.11) | 0(0) | 0(0) | 0(0) |
| Snake prickleback *Lumpenus sagitta* | 0(0) | 0(0) | 0(0) | 3(0.33) | 2(0.22) | 2(0.22) | 2(0.22) | 2(0.22) | 1(0.11) | 0(0) |
| Whitespotted greenling *Hexagrammos stelleri* | 3(0.33) | 3(0.33) | 3(0.33) | 2(0.22) | 0(0) | 3(0.33) | 1(0.11) | 1(0.11) | 2(0.22) | 1(0.11) |
| Grand Total | 31(3.44) | 27(3) | 28(3.11) | 28(3.11) | 26(2.89) | 31(3.44) | 22(2.44) | 25(2.78) | 30(3.33) | 27(3) |

2014

| Count of Species with CPUE: 2014 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Salmonids** | | | | | | | | | | |
| Chinook salmon, unmarked subyearling *Oncorhynchus tshawytscha* | 3(0.33) | 4(0.44) | 5(0.56) | 4(0.44) | 0(0) | 1(0.11) | 4(0.44) | 8(0.89) | 22(2.44) | 23(2.56) |
| Coho salmon, unmarked *Oncorhynchus kisutch* | 1(0.11) | 1(0.11) | 8(0.89) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Pink, <60mm *Oncorhynchus gorbuscha* | 121(13.44) | 86(9.56) | 90(10) | 63(7) | 44(4.89) | 27(3) | 4(0.44) | 21(2.33) | 30(3.33) | 72(8) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Chum salmon, <65mm *Oncorhynchus keta* | 14(1.56) | 23(2.56) | 15(1.67) | 11(1.22) | 3(0.33) | 3(0.33) | 2(0.22) | 0(0) | 25(2.78) | 32(3.56) |
| Cutthroat trout *Oncorhynchus clarkii* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Sculpins** | | | | | | | | | | |
| Buffalo sculpin *Enophrys bison* | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Great sculpin *Myoxocephalus polyacanthocephalus* | 1(0.11) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Juvenile sculpin *Cottidae spp* | 5(0.56) | 5(0.56) | 3(0.33) | 3(0.33) | 29(3.22) | 71(7.89) | 2(0.22) | 2(0.22) | 27(3) | 8(0.89) |
| Pacific staghorn sculpin *Leptocottus armatus* | 8(0.89) | 8(0.89) | 16(1.78) | 51(5.67) | 94(10.44) | 134(14.89) | 86(9.56) | 69(7.67) | 150(16.67) | 61(6.78) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0(0) | 0(0) | 2(0.22) | 2(0.22) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **Flat Fish** | | | | | | | | | | |
| English sole *Parophrys vetulus* | 2(0.22) | 0(0) | 0(0) | 0(0) | 0(0) | 29(3.22) | 2(0.22) | 2(0.22) | 19(2.11) | 0(0) |
| Juvenile flatfish *Pleuronectiformes spp* | 6(0.67) | 0(0) | 1(0.11) | 0(0) | 5(0.56) | 6(0.67) | 1(0.11) | 0(0) | 0(0) | 2(0.22) |
| Sand sole *Psettichthys melanostictus* | 1(0.11) | 0(0) | 6(0.67) | 4(0.44) | 20(2.22) | 0(0) | 0(0) | 1(0.11) | 0(0) | 21(2.33) |
| Starry flounder *Platichtys stellatus* | 2(0.22) | 4(0.44) | 4(0.44) | 1(0.11) | 4(0.44) | 2(0.22) | 0(0) | 0(0) | 0(0) | 5(0.56) |
| **Forage Fish** | | | | | | | | | | |
| Pacific sandlance *Ammodytes hexapterus* | 1(0.11) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 3(0.33) |
| Surf smelt *Hypomesus pretiosis* | 8(0.89) | 2(0.22) | 11(1.22) | 0(0) | 1(0.11) | 1(0.11) | 1(0.11) | 0(0) | 2(0.22) | 1(0.11) |
| **Nearshore or Estuary Fish** | | | | | | | | | | |
| Gunnel *Pholidae spp* | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Penpoint gunnel *Apodichthys flavidus* | 1(0.11) | 5(0.56) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Saddleback gunnel *Pholis ornate* | 19(2.11) | 19(2.11) | 5(0.56) | 7(0.78) | 3(0.33) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 0(0) |
| Shiner perch *Cymatogaster aggregate* | 0(0) | 1(0.11) | 5(0.56) | 16(1.78) | 11(1.22) | 3(0.33) | 4(0.44) | 10(1.11) | 7(0.78) | 0(0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Snake prickleback *Lumpenus sagitta* | 1(0.11) | 12(1.33) | 3(0.33) | 19(2.11) | 0(0) | 6(0.67) | 1(0.11) | 0(0) | 1(0.11) | 0(0) |
| Dwarf wrymouth *Cryptacnthodes aleutensis* | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Kelp greenling *Hexagrammos decagrammus* | 2(0.22) | 5(0.56) | 5(0.56) | 2(0.22) | 0(0) | 1(0.11) | 0(0) | 0(0) | 4(0.44) | 1(0.11) |
| Threespine stickleback *Gasterosteus aculeatus* | 2(0.22) | 1(0.11) | 4(0.44) | 1(0.11) | 3(0.33) | 1(0.11) | 0(0) | 1(0.11) | 0(0) | 5(0.56) |
| Pile perch *Rhacochilus vacca* | 0(0) | 0(0) | 0(0) | 1(0.11) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Unknown | 0(0) | 0(0) | 1(0.11) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Total | 200(22.22) | 180(20) | 186(20.67) | 185(20.56) | 220(24.44) | 286(31.78) | 108(12) | 114(12.67) | 287(31.89) | 234(26) |

2015

| Count of Species with CPUE: 2015 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Salmonids | | | | | | | | | | |
| Chinook salmon, unmarked subyearling Oncorhynchus tshawytscha | 29(3.63) | 18(2.25) | 20(2.5) | 6(0.75) | 9(1.13) | 20(2.5) | 5(0.63) | 5(0.63) | 14(1.75) | 5(0.63) |
| Coho salmon, unmarked, Oncorhynchus kisutch | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) | 0(0) | 0(0) |
| Pink, <60mm *Oncorhynchus gorbuscha* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Chum salmon, <65mm *Oncorhynchus keta* | 82(10.25) | 46(5.75) | 107(13.38) | 24(3) | 8(1) | 43(5.38) | 61(7.63) | 65(8.13) | 40(5) | 84(10.5) |
| Cutthroat trout *Oncorhynchus clarkii* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Sculpin | | | | | | | | | | |
| Juvenile flatfish *Pleuronectiformes spp* | 0(0) | 0(0) | 0(0) | 4(0.5) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Pacific staghorn sculpin *Leptocottus armatus* | 0(0) | 6(0.75) | 5(0.63) | 66(8.25) | 109(13.63) | 83(10.38) | 20(2.5) | 22(2.75) | 143(17.88) | 25(3.13) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0(0) | 0(0) | 0(0) | 1(0.13) | 1(0.13) | 0(0) | 0(0) | 0(0) | 0(0) | 2(0.25) |

| Flat Fish | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Starry flounder *Platichtys stellatus* | 0(0) | 0(0) | 0(0) | 0(0) | 4(0.5) | 0(0) | 1(0.13) | 0(0) | 0(0) | 1(0.13) |
| Forage Fish | | | | | | | | | | |
| Surf smelt *Hypomesus pretiosis* | 1(0.13) | 0(0) | 1(0.13) | 3(0.38) | 0(0) | 1(0.13) | 1(0.13) | 6(0.75) | 14(1.75) | 0(0) |
| **Nearshore or Estuary Fish** | | | | | | | | | | |
| Bay pipefish Syngnathus griseolineatus | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) |
| Crescent gunnel Pholis laeta | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.13) | 1(0.13) | 0(0) | 0(0) | 0(0) |
| Saddleback gunnel Pholis ornate | 2(0.25) | 1(0.13) | 4(0.5) | 1(0.13) | 1(0.13) | 3(0.38) | 1(0.13) | 3(0.38) | 1(0.13) | 0(0) |
| Shiner perch Cymatogaster aggregate | 2(0.25) | 2(0.25) | 0(0) | 4(0.5) | 0(0) | 7(0.88) | 0(0) | 2(0.25) | 0(0) | 0(0) |
| Threespine stickleback *Gasterosteus aculeatus* | 1(0.13) | 5(0.63) | 1(0.13) | 0(0) | 0(0) | 3(0.38) | 0(0) | 0(0) | 0(0) | 0(0) |
| Grand Total | 117(14.63) | 78(9.75) | 138(17.25) | 109(13.63) | 132(16.5) | 161(20.13) | 90(11.25) | 104(13) | 212(26.5) | 118(14.75) |

2016

| Count of Species with CPUE: 2016 | Site 1 | Site 2 | Site 3 | Site 4 | Site 5 | Site 6 | Site 7 | Site 8 | Site 9 | Site 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Salmonids | | | | | | | | | | |
| Chinook salmon, unmarked subyearling *Oncorhynchus tshawytscha* | 22(2.2) | 9(0.9) | 1(0.1) | 23(2.3) | 0(0) | 24(2.4) | 14(1.4) | 2(0.2) | 19(1.9) | 31(3.1) |
| Coho salmon, unmarked *Oncorhynchus kisutch* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) | 2(0.2) | 0(0) |
| Pink, <60mm *Oncorhynchus gorbuscha* | 87(8.7) | 81(8.1) | 35(3.5) | 53(5.3) | 37(3.7) | 42(4.2) | 53(5.3) | 65(6.5) | 80(8) | 86(8.6) |
| Chum salmon, <65mm *Oncorhynchus keta* | 58(5.8) | 55(5.5) | 13(1.3) | 24(2.4) | 8(0.8) | 38(3.8) | 31(3.1) | 29(2.9) | 69(6.9) | 53(5.3) |
| Cutthroat trout *Oncorhynchus clarkii* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Sculpin | | | | | | | | | | |
| Great sculpin *Myoxocephalus polyacanthocephalus* | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Juvenile sculpin *Cottidae spp* | 2(0.2) | 2(0.2) | 0(0) | 0(0) | 2(0.2) | 1(0.1) | 2(0.2) | 1(0.1) | 12(1.2) | 2(0.2) |
| Pacific staghorn sculpin *Leptocottus armatus* | 0(0) | 6(0.6) | 13(1.3) | 16(1.6) | 37(3.7) | 42(4.2) | 50(5) | 11(1.1) | 113(11.3) | 22(2.2) |
| Sharpnose sculpin *Clinocottus acuticeps* | 0(0) | 0(0) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Unknown Sculpin *Cottidae spp* | 0(0) | 0(0) | 0(0) | 1(0.1) | 0(0) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) |
| Flat Fish | | | | | | | | | | |
| English sole *Parophrys vetulus* | 0(0) | 0(0) | 1(0.1) | 0(0) | 4(0.4) | 3(0.3) | 0(0) | 0(0) | 0(0) | 3(0.3) |
| Juvenile flatfish *Pleuronectiformes spp* | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) | 2(0.2) |
| Starry flounder *Platichtys stellatus* | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) | 5(0.5) | 0(0) | 0(0) | 1(0.1) | 1(0.1) |
| Forage Fish | | | | | | | | | | |
| Surf smelt *Hypomesus pretiosis* | 1(0.1) | 0(0) | 0(0) | 3(0.3) | 0(0) | 1(0.1) | 1(0.1) | 0(0) | 0(0) | 2(0.2) |
| Nearshore or Estuary Fish | | | | | | | | | | |
| Kelp greenling *Hexagrammos decagrammus* | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 8(0.8) | 0(0) | 0(0) | 0(0) | 0(0) |
| Bay pipefish *Syngnathus griseolineatus* | 0(0) | 1(0.1) | 2(0.2) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Saddleback gunnel *Pholis ornate* | 0(0) | 0(0) | 2(0.2) | 2(0.2) | 1(0.1) | 2(0.2) | 1(0.1) | 0(0) | 1(0.1) | 0(0) |
| Shiner perch *Cymatogaster aggregate* | 1(0.1) | 9(0.9) | 13(1.3) | 18(1.8) | 40(4) | 9(0.9) | 0(0) | 1(0.1) | 0(0) | 11(1.1) |
| Snake prickleback *Lumpenus sagitta* | 0(0) | 0(0) | 0(0) | 0(0) | 8(0.8) | 2(0.2) | 0(0) | 0(0) | 0(0) | 1(0.1) |
| Threespine stickleback *Gasterosteus aculeatus* | 2(0.2) | 3(0.3) | 1(0.1) | 0(0) | 2(0.2) | 1(0.1) | 0(0) | 2(0.2) | 1(0.1) | 1(0.1) |
| Tubesnout *Aulorhynchus flavidus* | 0(0) | 1(0.1) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 1(0.1) | 0(0) |
| Whitespotted greenling *Hexagrammos stelleri* | 0(0) | 0(0) | 1(0.1) | 0(0) | 1(0.1) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| Total | 174(17.4) | 167(16.7) | 83(8.3) | 142(14.2) | 142(14.2) | 178(17.8) | 153(15.3) | 112(11.2) | 300(30) | 215(21.5) |