JUVENILE SALMON AND NEARSHORE FISH USE IN SHALLOW INTERTIDAL HABITAT ASSOCIATED WITH CORNET BAY - 2015

2013 Aerial view of Cornet Bay nearshore area restored in 2012.
Source: www.SkagitCounty.net/maps/Imap, 2014

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INTRODUCTION

This report summarizes the results of beach seine fish sampling conducted in 2015 in association with nearshore habitat restoration at the Cornet Bay Day Use Area of Deception Pass State Park in Island County, Washington (Figure 1). The project, initiated in 2009 by the Island County Marine Resources Committee (MRC) and conducted in collaboration with Washington State Parks and the Northwest Straits Marine Conservation Foundation includes the restoration of approximately 1.24 acres of modified shoreline to natural habitat conditions.

Figure 1. Satellite photo showing Deception Pass Bridge upper left and Cornet Bay lower center. The yellow line indicates approximate boundary of Cornet Bay with Skagit Bay. Red box delineates area of Cornet Bay Restoration Project in Deception Pass State Park (Schmidt, 2013a).

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, closed to the public (Figure 2). Shoreline modifications and fill imported on-site in the 1970s converted the upper intertidal shoreline into a flat upland bench planted with grass (Figure 3).

Shoreline restoration completed in 2012 to improve nearshore habitat in Cornet Bay 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 (Figure 4).

The project supports 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 restoration, helped to characterize fish population and use at the project site. The sampling completed in 2013 and 2014 represented the first two years of post-restoration monitoring at the site. This 2015 report represents the seventh year of monitoring after project initiation in 2009 and the third year of sampling after the nearshore restoration was completed in 2012.

Figure 2.
The red box in this 2006 photo outlines the area selected for restoration (Schmidt, 2013a).

Figure 3. Photo looking northeast at modified shoreline, including bulkhead at the west end of the project area prior to removal and restoration.

Photo taken at established Photo Monitoring Station 1 on March 20, 2009.

Figure 4. Photo of restored shoreline taken at on March 4, 2013. Bulkhead and fill removed and shoreline topography restored to enhance nearshore habitat for fish and other species.

Source: - Schmidt, 2013b (Appendix B)

Forage fish spawn surveys have been completed for the past three consecutive summer seasons post restoration. The 2015 forage fish survey report is included as Appendix A to this report (Penttilla, 2015). Photographs of the project area taken during the forage fish surveys are also included in the Appendix.

Additional information regarding the Cornet Bay restoration project and annual reports documenting the results of fish sampling in years 2009 – 2014 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.

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 juvenile Chinook 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 are used to sample fish in shallow intertidal areas at ten locations along the shoreline of Cornet Bay Day Use Area within Deception Pass State Park. 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 5). The 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 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 includes 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. An YSI meter is used to measure water quality parameters, including water temperature, salinity and dissolved oxygen 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 (called 'full length') and then again at the estimated halfway point back to shore (called '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.

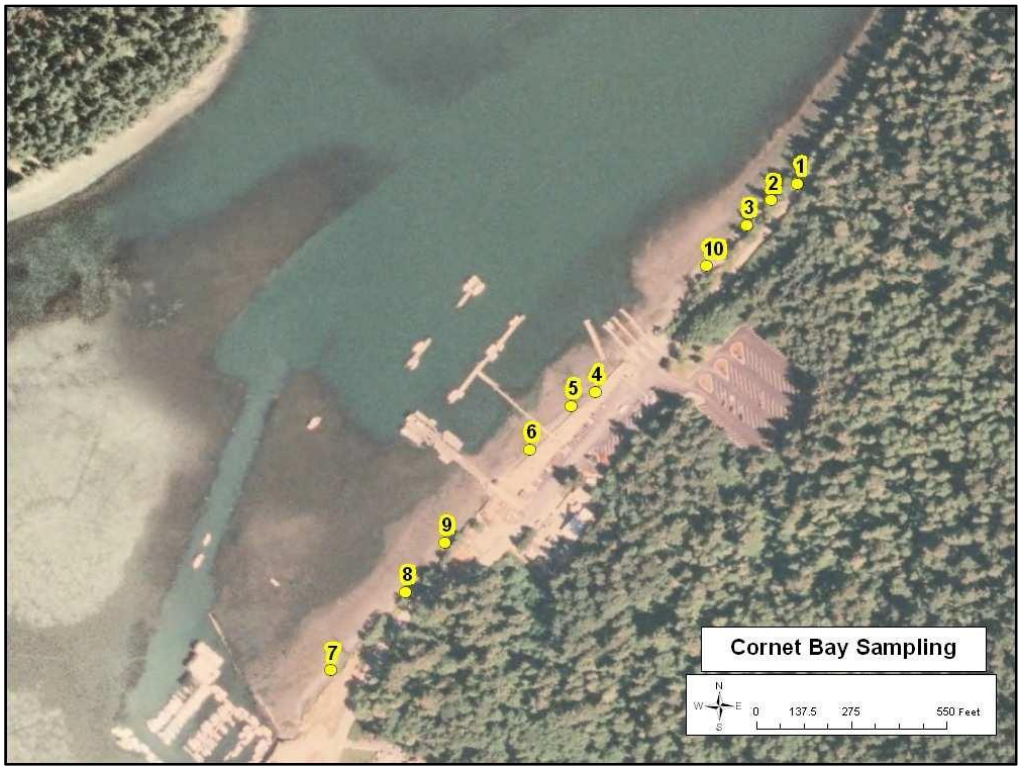

Figure 5. Established beach seine fish sampling locations at Cornet Bay (Keystone Environmental LLC, 2009).

RESULTS AND DISCUSSION

Beach Seine Effort

Cornet Bay beach seine fish sampling was conducted on February 27, March 13, March 27, April 10, April 24, May 8, May 22 and June 5, 2015. With the exception of March 27, 2015, when a net deployment problem occurred preventing fish capture at Station 2, beach seine sets were completed at each of the 10 established stations (#1-#10) established at the project site. In total, the Cornet Bay sampling effort in 2015 consisted of 79 beach seine sets completed in 8 days during the February through June time period (Table 1).

Table 1. Summary of beach seine effort (number of sets) at Cornet Bay, 2015.

Sampling effort (number of beach seine sets)	
Month	Seine Sets
February	10
March	19
April	20
May	20
June	10
Total	79

Environmental Conditions During Beach Seine Sampling

Tidal Stage and Water Depth

The majority of beach seine sampling occurred at depths slightly shallower than one meter of water (Table 2). Sampling dates were selected for tides that fell between +9 and +5 feet [Mean Lower Low Water (MLLW) = 0.0'].

Table 2. Water depth during beach seine sampling at Cornet Bay sites in 2015

Depth of beach area seined	
Maximum	1.15 meters
Minimum	0.2 meters
Average and 1 standard deviation (in parenth	0.6 (0.10) meters

Salinity, Temperature, and Dissolved Oxygen

Measurements of salinity, water temperature, and dissolved oxygen during each sampling session are shown in Figures 6, 7, and 8. For each date, measures were recorded at each net set, then averaged for that day. It should be noted that water quality parameter readings recorded during beach seining are spot measurements and do not represent a continuously measured record for interpreting overall basin conditions.

In 2015, minimum daily salinity was recorded at 25.1 parts per thousand (ppt) and the maximum concentration was 29.98 ppt. Since the project's initiation in 2009, the lowest minimum and highest maximum salinity concentrations during fish sampling were recorded in 2012 and 2013 as 20.7 ppt and 30.6 ppt, respectively (Schmidt, 2013a, 2013b).

Water temperature in the Cornet Bay nearshore showed a seasonal increase from February through June (Figure 7). Minimum and maximum water temperature were 9.1 degrees Celsius and 11.2 degrees Celsius, respectively. The lowest and highest water temperatures measured to-date during project beach seining were recorded as 5.9 degrees Celsius and 12.2 degrees Celsius in 2009 and 2012, respectively. (Keystone, 2009 and Schmidt 2013b). The minimum water temperature of 9.1 degrees Celsius recorded in 2015 is 1.2 degrees Celsius higher than the next highest reading of a minimum temperature recorded at 7.9 degrees in 2010 (Schmidt, 2010). With exception to 2009, all other minimum temperatures recorded during sampling in the past seven years have ranged between 7.1 degrees and 7.9 degrees Celsius.

Dissolved oxygen fluctuated between 6.1 mg/L and 8.85 mg/L. The lowest and highest dissolved levels recorded to-date during beach seine sampling were 5.3mg/L in 2014 and 10.4 mg/L in 2009, respectively (AES, 2015, Keystone, 2009).

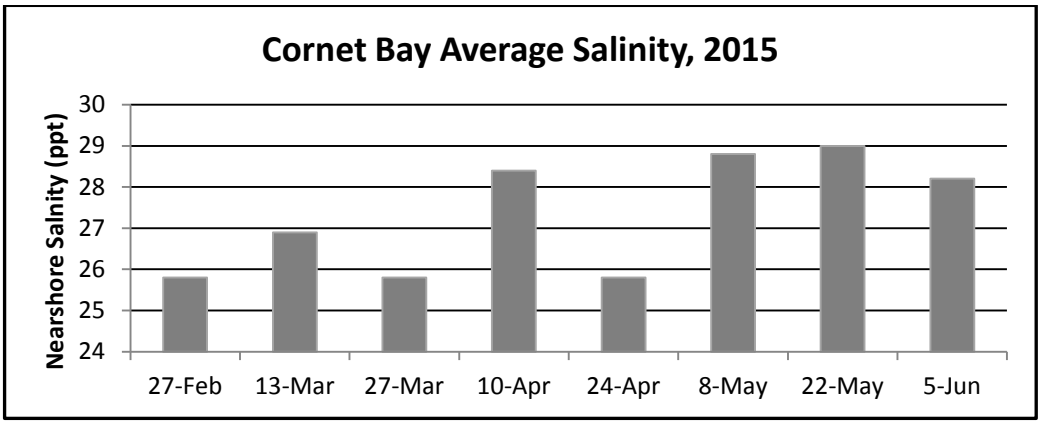

Figure 6. Average salinity at Cornet Bay beach seine sites during fish sampling in 2015.

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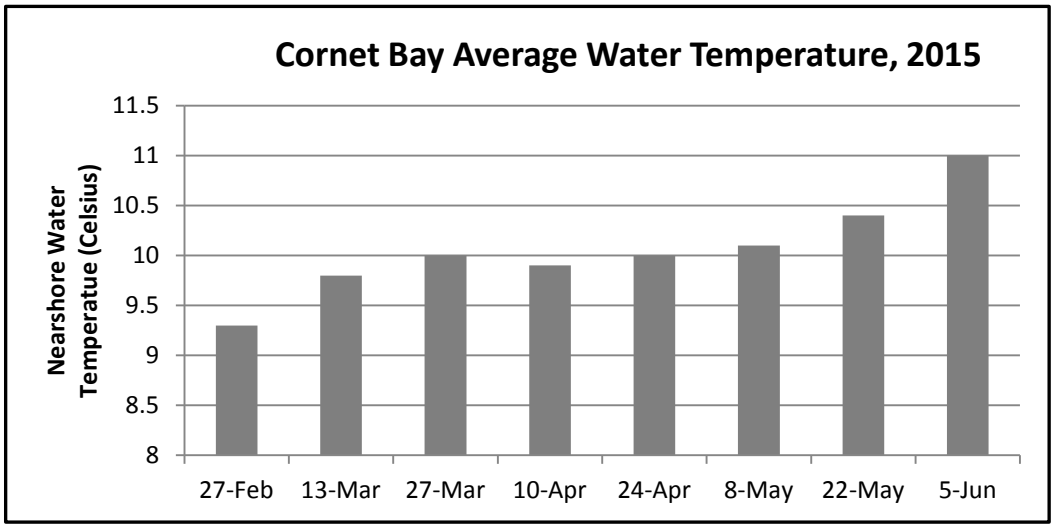


Figure 7. Average temperature at Cornet Bay beach seine sites during fish sampling in 2015

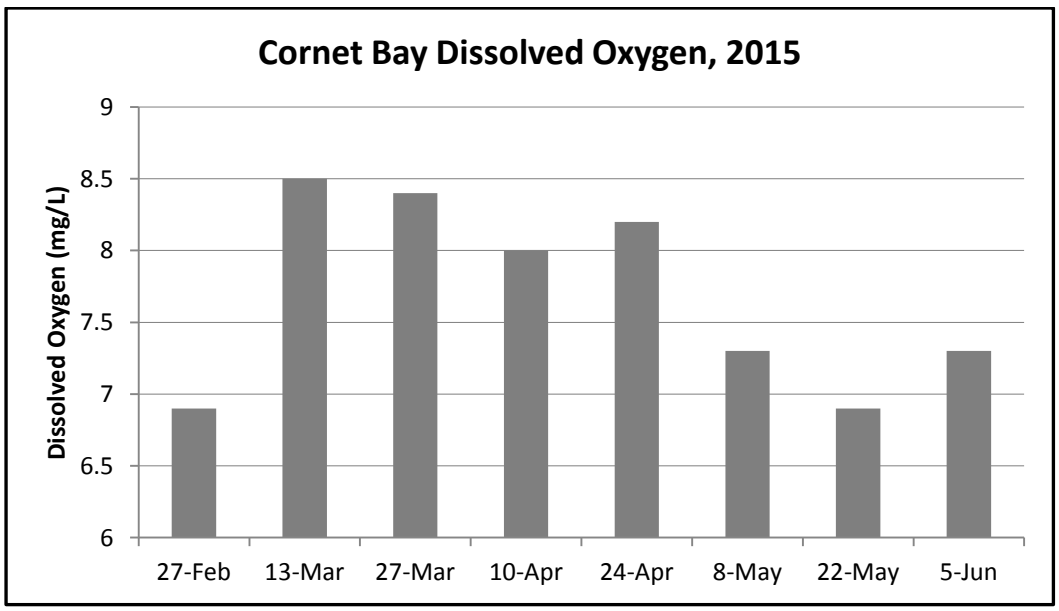


Figure 8. Average dissolved oxygen at Cornet Bay beach seine sites during fish sampling in 2015.

Catch by Species

A total of 8,845 fish representing at least 12 different species were caught during sampling in 2015 (Tables 3 and 4). Although all species in Table 3 were identified on one or more occasions, accuracy of identification of sculpin, gunnel and flatfish species was variable depending on the knowledge of the crew and the intensity of the catch to be processed on any given day. Therefore for quantitative analysis in Table 4 they are combined under "unspecified" sculpins, flatfish and gunnels.

Table 3. Fish species captured in 2015 during beach seine sampling at Cornet Bay.

Fish Species
Chinook salmon *Oncorhynchus tshawytscha*
Chum salmon *Oncorhynchus keta*
Coho salmon *Oncorhynchus kisutch*
Surf smelt, postnatal *Hypomesus pretiosis*
Pacific staghorn sculpin *Leptocottus armatus*
Sharpnose sculpin *Clinocottus acuticeps*
Threespine stickleback *Gasterosteus aculeatus*
Starry flounder *Platichtys stellatus*
Bay pipefish *Syngnathus leptorhynchus*
Saddleback gunnel *Pholis ornate*
Crescent gunnel, *Pholis laeta*
Shiner perch *Cymatogaster aggregate*

Consistent with the results of prior years of sampling, juvenile salmon comprised the large majority of fish captured (Table 5). Salmon represented over 92% of the total catch in 2015 (Table 5). The salmon catch was dominated by chum salmon (8,025), but included 160 Chinook and 1 coho. The Chinook catch in 2015 is the highest recorded for this species in all prior years of sampling for the project.

Cutthroat trout, represented by one fish in 2011, and a count of two in 2013, was not represented during 2014 or 2015 sampling. Being an odd year, no juvenile pink salmon were present in the nearshore during sampling in 2015.

Less than 8% of the catch consisted of 9 other fish species: sculpins, primarily Pacific staghorn, surf smelt, gunnels, shiner perch, flatfish and a very small number of the other species. This is first year since sampling was initiated in 2009 that greenling and snake prickleback were not recorded in the catch at the project site (Table 6).

Table 4. Total fish catch by species at Cornet Bay sites in 2015. (Mean catch per beach seine set is in parentheses; there were 79 sets.)

Fish species	***Nearshore catch***	
Juvenile salmonids:		
Chinook salmon *Oncorhynchus tshawytscha*	160	(1.4)
Chum salmon *Oncorhynchus keta*	8,025	(102.9)
Coho Salmon *Oncorhynchus kisutch*	1	(<0.1)
Total juvenile salmonids:	**8,186**	
Sculpin species:		
Unspecified sculpin	577	(7.4)
Flatfish species:		
Unspecified flatfish	6	(<0.1)
Surf smelt (P.L.) *Hypomesus pretiosis*	28	(0.4)
Gunnel species		
Unspecified gunnel	20	(0.3)
Other nearshore or estuarine fish species:		
Threespine stickleback *Gasterosteus aculeatus*	10	(0.13)
Shiner perch *Cymatogaster aggregata*	17	(0.22)
Bay pipefish *Syngnathus leptorhynchus*	1	(<0.1)
All fish	**8,845**	**(112)**

Table 5. 2009-2015 beach seining at Cornet Bay – salmonid species.

Year	***No. of days***	***No. of sets***	***Total catch- all fish species***	***Salmonid Species:***					***% catch salmonid***
				Chinook	***Chum***	***Pink***	***Coho***	***Cutthroat trout***	
2009	7	65	6,877	2	5,058	0	0	0	**74%**
2010	10	99	17,152	102	396	15,893	0	0	**95%**
2011	8	80	8,260	31	7,625	0	0	1	**93%**
2012	6	60	50,596	139	778	49,029	38	0	**97%**
2013	9	90	15,583	71	14,114	0	2	2	**91%**
2014	9	90	22,080	71	201	19,883	11	0	**91%**
2015	8	79	8,845	160	8,025	0	1	0	**92%**

Table 6. Non-salmon species caught in Cornet Bay seining 2009-2015 (all species with >20 captures in one or more years).

Year	*Other fish species*	*Sculpin sp.*	*Flatfish sp.*	*Gunnel sp.*	*Greenling sp.*	*Snake prickle - back*	*Surf smelt*	*Herring*	*Shiner perch*	*% catch not salmonid*
2009	1,817	1173	366	154	31	62	2	22	0	**26%**
2010	761	447	27	67	43	48	18	2	28	**5%**
2011	600	509	39	7	19	9	14	0	2	**8%**
2012	612	353	139	17	4	5	89	0	1	**3%**
2013	1,394	784	94	147	65	243	15	1	21	**9%**
2014	1,914	1435	242	65	17	44	27	0	57	**9%**
2015	659	580	6	20	0	0	28	0	17	**7%**

Juvenile Salmon

Table 7 details the number of each of the three salmon species caught during each sampling event in 2015. Juvenile salmon numbers peaked in early April. Juvenile Chinook salmon were present from February through April. Juvenile chum salmon were found from February into June. The only coho recorded during sampling in 2014 was caught on May 22nd. This timing for coho is consistent with the results of prior sampling years. In 2013 and 2014, coho was caught only during sampling events in May. In 2012 coho were caught in May as well as mid-June.

The decline in salmon numbers in nearshore by late June is not necessarily evidence that they have left the vicinity of Cornet Bay. Smaller juvenile Chinook salmon (< 70 mm) appear to prefer low gradient, shallow water with fine-grained substrates (silts and mud), low salinity and low wave energy. As they increase in size, they move to deeper water and use a greater diversity of Puget Sound habitats. Habitat use for chum salmon also appears to be size dependent. Chum fry < 50-60 mm tend to migrate along the shore in water < 2 meters deep, and to move farther offshore as they increase to more than 60 mm (Fresh, 2006).

Table 7. Number of salmon captured at Cornet Bay sites in 2015 on each survey day, by species.

	Chinook	*Chum*	*Coho*	*Total salmon*
27-Feb	46	7	0	53
13-Mar	71	174	0	245
27-Mar	6	612	0	618
10-Apr	33	4,770	0	4,803
24-Apr	4	730	0	734
8-May	0	1,690	0	1,690
22-May	0	34	1	35
5-Jun	0	8	0	8

Fish Size

The size of juvenile salmon was characterized by measuring fork length. At each draw of the net, the first 20 fish of each species were measured before release. Additional fish were just counted and released. The number of fish caught and measured by species is illustrated in Figure 9. For abundant species the number of fish measured was much less than the overall number captured when an abundant of fish was caught.

For comparison, the mean fork length was calculated for each species on each sampling date, as illustrated in Figure 10. Due to small sampling size, coho salmon was omitted from Figures 9 and 10.

Chinook

Of the 160 Chinook salmon that were captured, 131 were measured for recording fork lengths. Fork lengths ranged from 38 mm to 83 mm, with an average of 52 mm (1 standard deviation = 9.25). The average fork length of measured juvenile Chinook increased from 45 mm in February to 65 mm on April 10; however on April 24, the average fork length of the juvenile Chinook that were measured represented the smallest average size of 43 mm (Figure 10).

Chum

Of the 8,025 total chum captured, 579 were measured. Fork length ranged from 24 mm to 466 mm, with an average of 49 mm (1 standard deviation = 7.4). The average size of the measured Chum increased successively from the beginning of the sampling period in February through May, but decreased slightly in June at the end of the sampling period (Figure 10).

Coho

One coho with a fork length measuring 165 mm was captured at Station 8 on May 22, 2015.

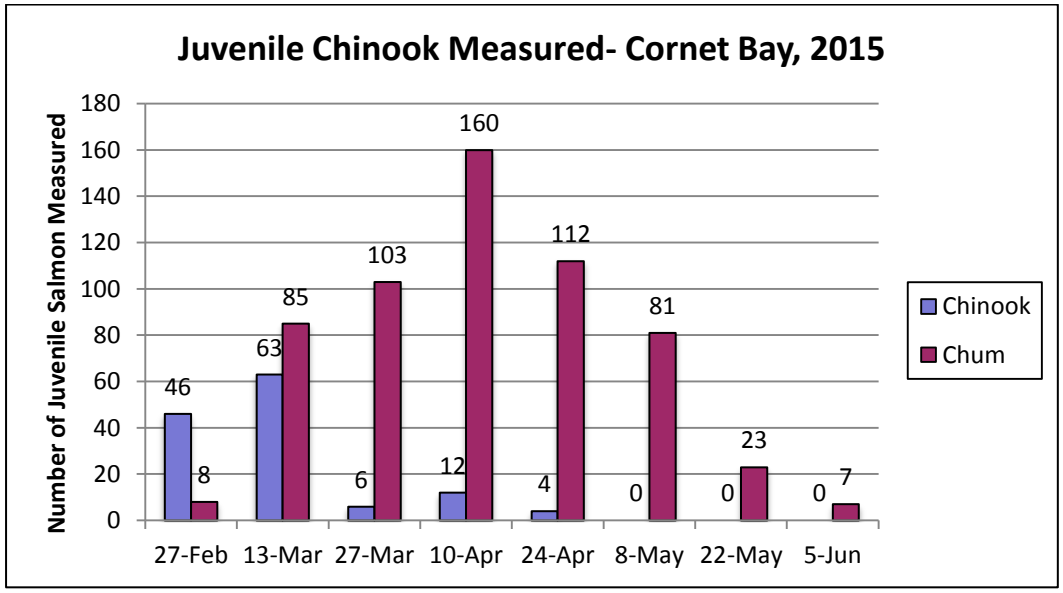


Figure 9. Number of juvenile salmon measured during fish sampling at Cornet Bay in 2015.

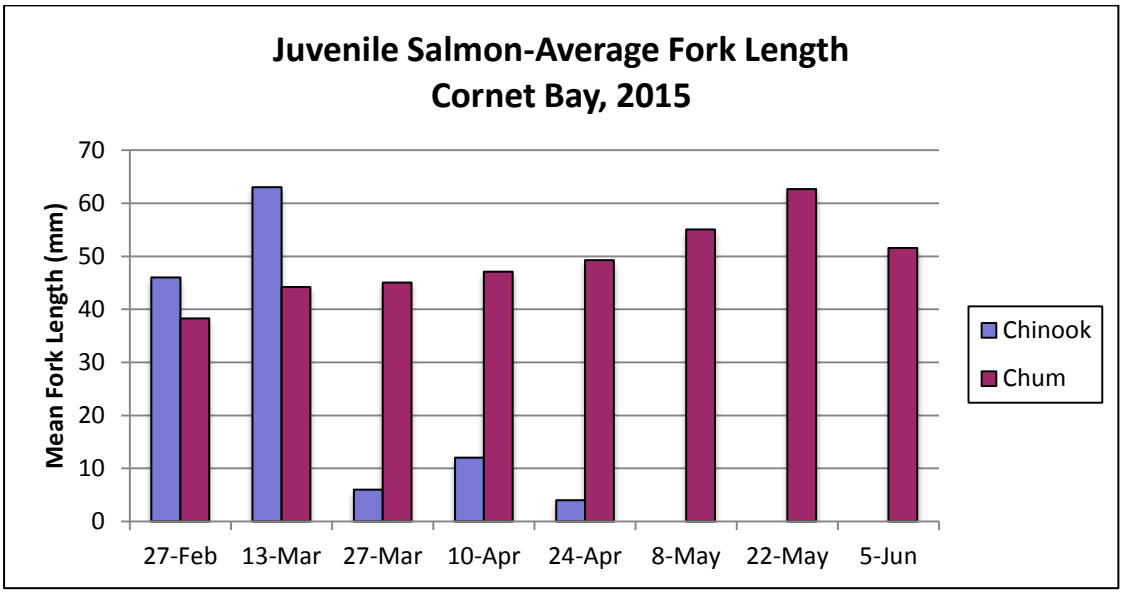


Figure 10. Average fork length of juvenile salmon measured during fish sampling at Cornet Bay in 2015.

Fish Community Composition

As in prior years, salmon and sculpin together represented over 99% of the total catch. Other fish species, comprising less than 1% of the catch, have been combined in Figure 11. Peak fish density, driven by juvenile chum salmon, occurred on April 10, 2015.

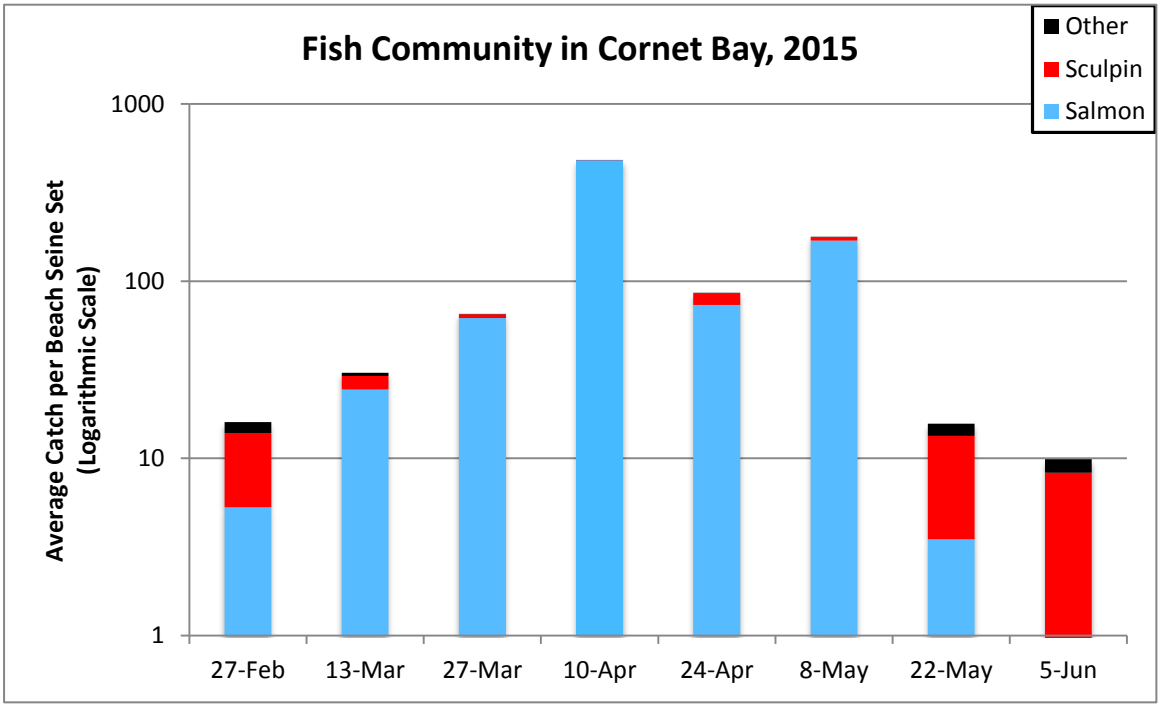


Figure 11. Fish community and relative abundance in Cornet Bay, 2015.

Variation in Fish Catch Among Sites

The number of fish netted at each sample site has been compared to determine whether there might by any clear difference in fish use among the ten sites (Schmidt, 2013a). All fish captures at each site over the season were combined and graphed in Figure 12.0 The four survey sites located along the "natural" shoreline northeast of the day use area are shown in green, the six sites located along altered shoreline, now restored, in red.

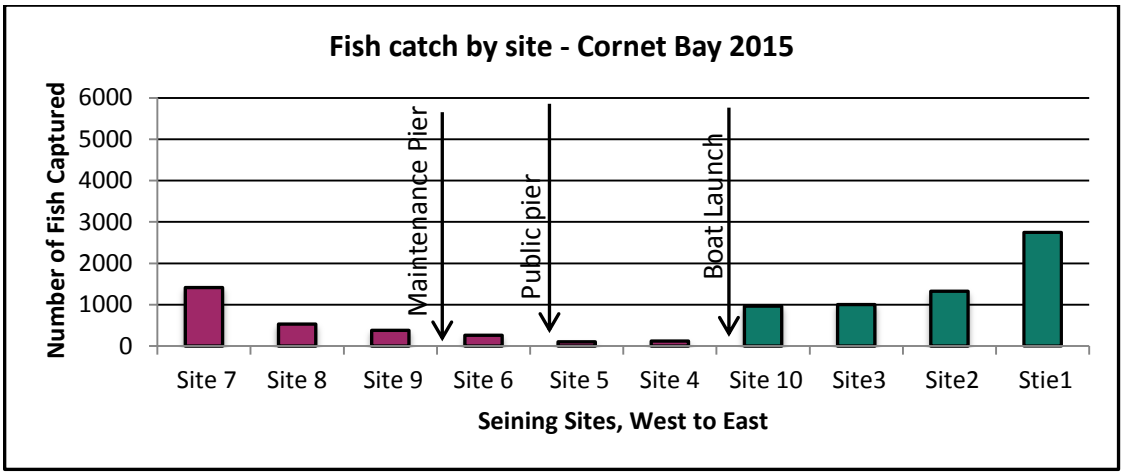


Figure 12. The total number of fish (all species represented) caught in 2015 along the natural shoreline sites (shown in green) at Cornet Bay was greater than those caught in the altered and recently restored sites (shown in red).

In 2015, the majority of the fish caught were present along the "natural" shoreline sites, #1 - #3 and #10, to the northeast of the boat launch (Figure 12). However when reviewing past years of sampling data, regular patterns in fish use at specific sites were not apparent. The numbers of fish caught were dispersed across the site in some years and it was recognized that netting a single large school of fish could have a strong influence on the data (Schmidt, 2013a).

The 2013 project report concluded that the sampling sites should be examined on a species by species basis as a means to identify any variation in fish use among altered versus natural sites, or differences within sites pre- versus post-restoration.). Although such differences are more likely to occur in resident non-salmon species than in the migratory salmon, site-specific data for the four salmon species caught in 2014 was reviewed (AES, 2015).

In 2014, the number of pink, chum and coho salmon caught along the natural shoreline sites #1 -#3 and #10, located to the northeast of Park's Day Use area exceeded the total numbers of these species caught at sites #4-#9 to the west. In comparison, the total number of Chinook salmon caught at the western sites was greater than those caught along the natural shoreline to the northeast.

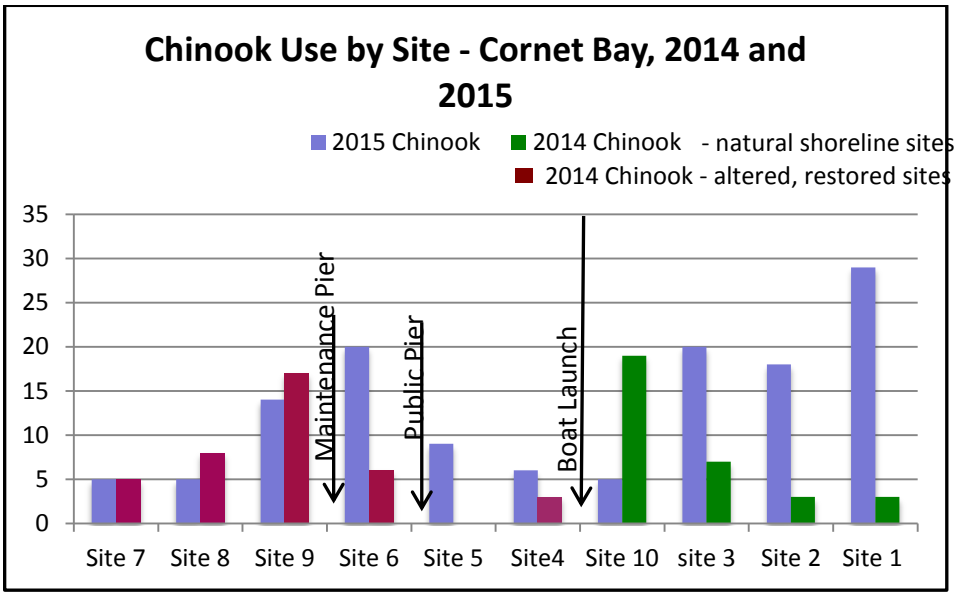
Figures 13 and 14 illustrate the use of Chinook and chum salmon across the sampling project area in 2014 and 2015. The number of salmon caught at each of the natural shoreline sites in 2014 is shown in green and the numbers of salmon caught at the altered and restored shoreline sites are shown in red. Chinook and chum salmon caught in 2015 are shown in purple and blue, respectively.

Chinook salmon use appears to be distributed across the project area, however in 2015 the numbers of Chinook caught at the natural shoreline sites was higher than at the altered restored sites to the west. These results are converse to those reported in 2014 (AES, 2014). In 2015, the largest numbers of Chinook salmon were caught at Site #1, located along the natural shoreline at the northeast end of the project area. In 2014, the largest numbers of Chinook were caught at Site #10, near the boat launch. In 2015, Chinook were additionally recorded at Site #5, located between the boat launch and the public pier. In 2014, no Chinook were caught at this location.

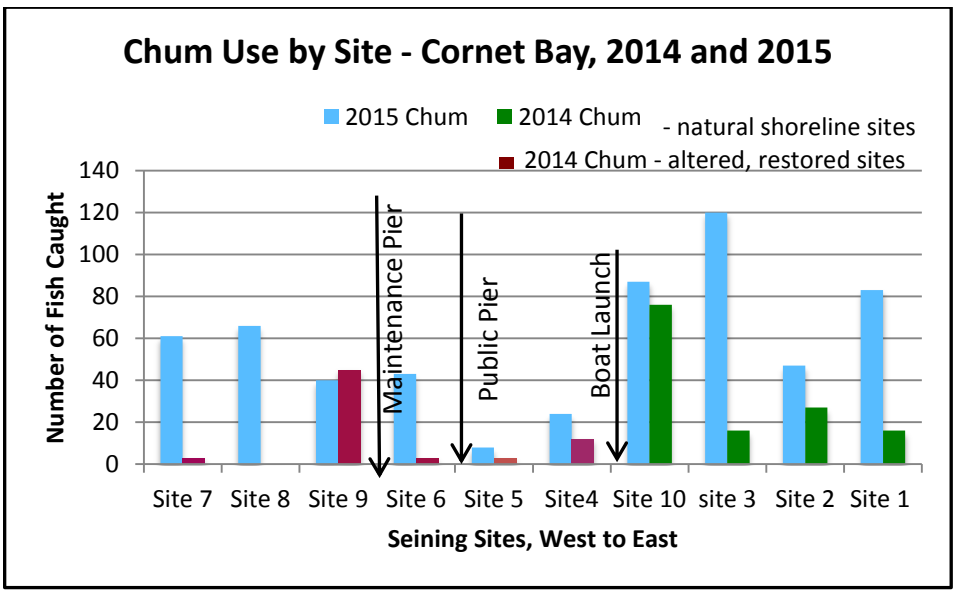
Chum salmon were distributed across the project area as well, however more Chum were caught at the natural shoreline sites along the northeast end of the project area than at the altered, restored sites to the west. These results for chum are similar to those reported in 2014 (AES, 2014). In 2015, the largest numbers of Chum salmon were caught at Site #3, located along the natural shoreline to the northeast of the boat launch. In 2014, the largest catch of chum was at Site #10, also located along the natural shoreline area, but further to the west. In 2015, chum salmon were additionally recorded at Site #8 along the shoreline near the western end of the project area. In 2014, no chum salmon were caught at this location.

Figure 15 illustrates the use of Staghorn sculpin across the project sampling area in 2015. The majority of the sculpins caught were located at the sites west of the boat launch. The numbers of sculpins caught along the natural shoreline, Sites #2, #3 and #10, located to the northeast of the boat launch, were low. No sculpins were caught at Site #1 located near the northeast end of the project area.

The results for surf smelt use in the project area were similar to those of sculpins, as illustrated in Figure 16. The largest numbers of Staghorn sculpin and surf smelt were caught at Site #9, located to the west of the maintenance pier.



Figures 13 and 14. Numbers of Chinook and Chum salmon caught in 2014 and 2015 at each sampling site. Salmon caught in 2014 at sites located along the natural shoreline are shown in green. Salmon caught along altered, recently restored sites of the project area shoreline are shown in red.



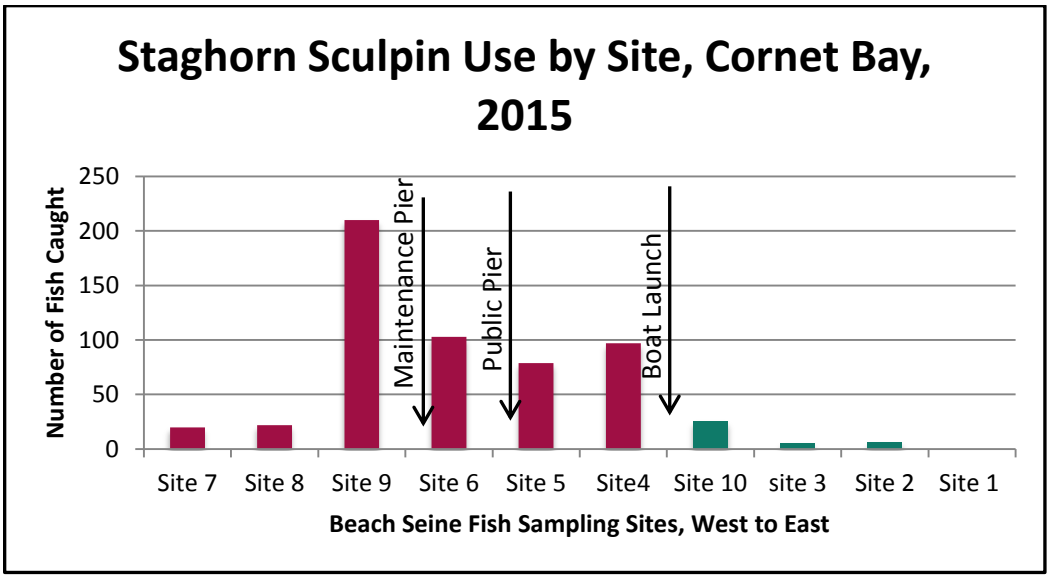


Figure 15. Numbers of Staghorn sculpins caught in 2015 along the natural shoreline sites in Cornet Bay are shown in green. The majority of the sculpins were caught at the altered and restored sties west of the boat launch (shown in red).

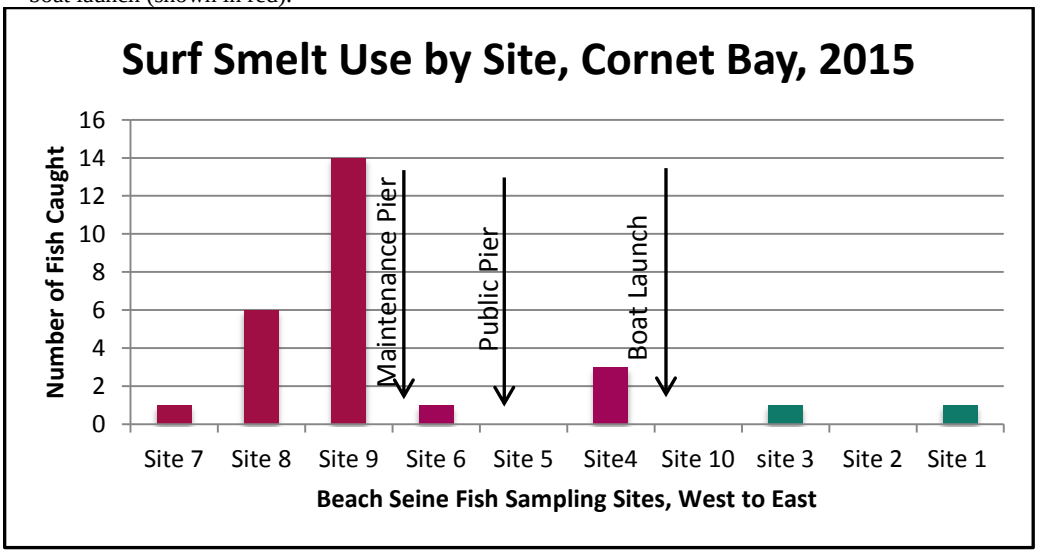


Figure 16. Numbers of surf smelt forage fish caught in 2015 along the natural shoreline sites in Cornet Bay are shown in green. The majority of the surf smelt caught were at the altered and restored sties to the west of the boat launch (shown in red).

SUMMARY

This report documents the seventh season of recording fish species composition and relative abundance in the shallow nearshore of the Cornet Bay day use area – four years of pre-restoration surveys along the altered shoreline and adjacent natural nearshore habitat, and three years of surveys after the restoration activity. Post-restoration surveys are anticipated to continue in 2016.

The surveys have established consistent use of the Cornet Bay shoreline by juvenile salmon in fry and parr stages, as well as by sculpins, gunnels, flatfish and other species. As the comparative pre- and post-restoration datasets accumulate, hypotheses should be established and tested statistically to look for effects of the restoration actions on the fish community. To further the review of fish use by species across the site, this report included site-specific analysis for Chinook and chum salmon, Staghorn sculpin and surf smelt fish based on the numbers of these fish caught during beach seine fish sampling in 2015.

Comparisons of the 2009-2015 project data with surveys of other areas of Skagit Bay shoreline has been recommended as a means to determine whether migrator salmon are more abundant in Cornet Bay than in other habitats.

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APPENDIX A.
2015 FORAGE FISH SURVEY REPORT AND PHOTOS (Penttila, 2015)