Surf Smelt Spawning in the Fidalgo Bay Aquatic Reserve

Findings from the analysis of twice-monthly samples (1350)

taken from beaches, Jan 2013 – Dec 2018.

Figure 1: Some of the many volunteers who collect and process samples in Fidalgo Bay twice each month

Abstract

The shores of the Fidalgo Bay Aquatic Reserve in Anacortes, WA have been surveyed twice monthly by trained volunteers from 2013 through 2018 for forage fish spawning success. The purposes are to: a. provide a long term set of trend information about where, when, how much and how successfully forage fish spawn; b. evaluate results of some restorations; c. document good and poor spawning habitat; and d. suggest possible shoreline improvements to promote increased spawning success. A total of 1350 samples were collected, analyzed, and recorded over six years of surveys.

We found that surf smelt (*Hypomesus pretiosus*), a species of forage fish, are very abundant in Fidalgo Bay and they spawn in large amounts on the beaches at high tides throughout the year. The highest spawning activity occurs during late Spring through early Fall. The surf smelt spawn on all the beaches that we can access for surveying. While differences appeared, no long-term trends are evident from our data. There is little shade on Fidalgo Bay beaches and the eggs die quickly when exposed to hot sun and the rate of egg survival to hatching is very low during summer. The survival rate is much better during fall through early winter.

Surf smelt spawn heavily on the rock-armored northwest shore along the Tommy Thompson Trail and it is exposed to long hot sunny days during the summer. We expected egg survival would be poor. However, high tides reach into the lower crevasses of the rocks, some of which are filled with sand and small gravel particles. The crevasses accumulate many eggs. Because they are well shaded from the hot sun, egg survival was high, even during the summer. A remarkable finding!

To increase survival of surf smelt spawning on Fidalgo Bay beaches, improved shading is necessary, especially during the summer. Adding sand and gravel along the riprap will fill more of the crevasses to increase suitable substrate in shaded areas, as well as raise the “beach” to compensate for rising sea levels.

As for other species of forage fish common to Washington State and that spawn on upper beaches, we did not detect sand lance spawning in any of our surveys. We suspect the sand and gravel substrate in Fidalgo Bay may be too coarse for them.

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Introduction

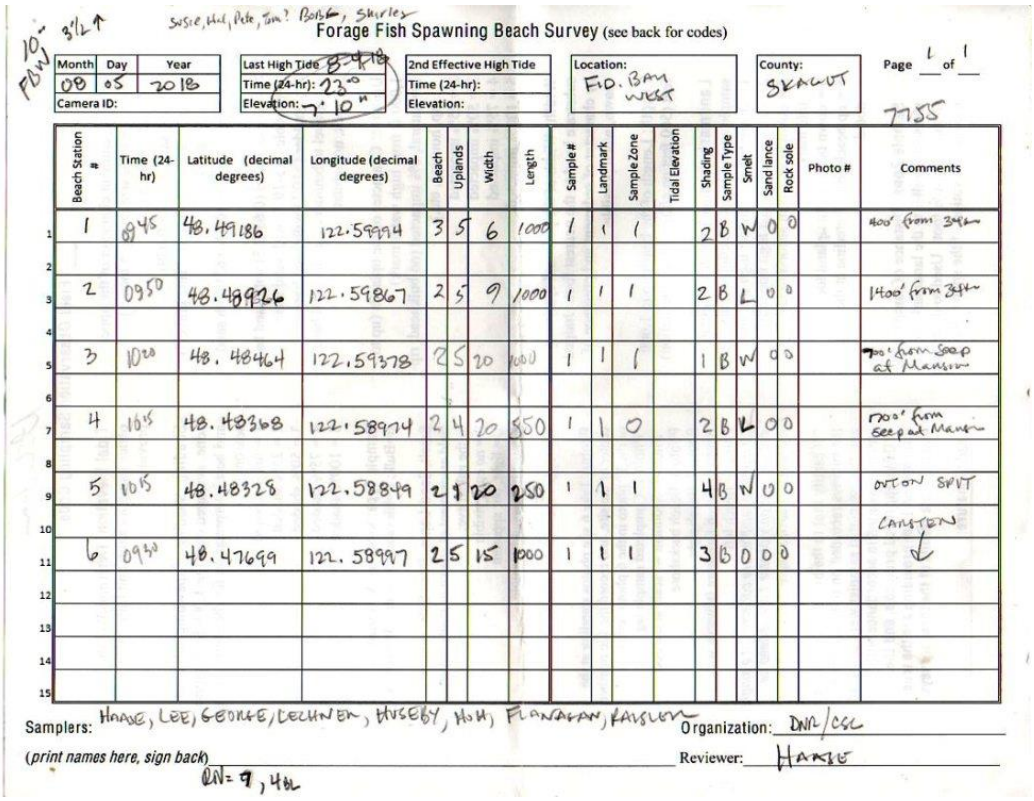
Much of Fidalgo Bay is a Washington State Aquatic Reserve of 781 acres, managed by Department of Natural Resources to protect the extensive eelgrass beds, tidal flats, small estuaries, forage fish habitat and salt marshes. It is an important stopover for migratory birds and a very productive place for **surf smelt** to spawn (release their eggs and sperm.)

Spawning happens at high tides on a mix of sand and small gravel, which covers much of the Fidalgo Bay shoreline. Surf smelt have long been known to spawn in Fidalgo Bay, sometimes in large numbers, but no comprehensive study has previously been done.

Surf smelt are schooling fish, one of many **"forage fish"**, and are an important food source for birds, salmon, and other animals and fish. They grow to 6" – 9" and live for several years. The fish aggregate in large schools and the eggs and milt are mixed in the water and settle on the fine gravel and sand. Each egg has a small, sticky "foot" which attaches to a piece of gravel or sand. Tidal action will then agitate them, and some will become buried down where they stay cool and moist. Incubation is about two weeks depending on weather conditions. On upcoming high tides, the newly hatched fish will wash out to shallow water to eat and grow.

In the summer of 2012, the Skagit Marine Resources Committee (MRC) (a group supported by Skagit County government to act as a catalyst for the protection and restoration of the marine waters, habitats and species of Skagit County to achieve ecosystem health and sustainable resource use) sponsored training for surf smelt spawning surveys. Training was conducted by Dan Penttila, a retired Washington Department of Fish and Wildlife (WDFW) fisheries biologist. About a dozen citizen volunteers attended the training course. Protocols, forms and equipment were used and practiced, including WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols FF 01, 02, 03, 04 and Vortex Method for sample processing. To practice collection methods after the training, seven fixed locations in Fidalgo Bay were sampled on four different dates for surf smelt spawning and the results were collected in a brief report for the MRC. The fixed locations were selected because of their range of shade coverages, beach conditions, shoreline modifications, and upland impacts in order to have information about surf smelt spawning at different kinds of sites. Data was entered on a field sheet as shown in Figure 3.

Beginning in 2013, the trained team worked with the Washington State Department of Natural Resources (DNR) Aquatic Reserve program and began to conduct twice monthly sampling of 12 fixed locations within the Reserve. Completed forms and samples were submitted for quality checks by DNR personnel and all information was entered into a comprehensive DNR spread sheet. The intent was to have a long term understanding of surf smelt spawning in the Fidalgo Bay Aquatic Reserve. Early in 2013 the fixed locations were abandoned for a more random method that could encompass all the available potential spawning locations. The Reserve was divided into a West beach stretch and an East beach stretch. Each began at the northern boundary of the Reserve (Little Crandall Spit on March Point for the east and a few meters south of 34th street in Anacortes for the west.) For a survey trip, the beginning sample location was determined randomly, as a location in multiples of 100 from 0 to 900 feet from the north boundary. Then other sample sites are every 1,000 feet beyond until the end of suitable beach. For each survey, two or three samples can be collected from the East side and four to six from the west. This method allows for over 73 possible sample sites, 100 feet apart, with each visited for sampling about 3 times per year. The thick blue lines on the following map (Figure 4) are sampled beaches.



Forage Fish Spawning Beach Survey (see back for codes)

Susie, Hal, Pete, Tom? Bobby, Shirley

Month	Day	Year
08	05	2018

Camera ID:

Last High Tide — Time (24-hr): 23:10 — Elevation: -7.10 ft

2nd Effective High Tide — Time (24-hr): — Elevation:

Location: FID. BAY WEST

County: SKAGIT

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	Beach Station #	Time (24-hr)	Latitude (decimal degrees)	Longitude (decimal degrees)	Beach	Uplands	Width	Length	Sample #	Landmark	Sample Zone	Tidal Elevation	Shading	Sample Type	Smelt	Sand lance	Rock sole	Photo #	Comments
1	1	0945	48.49186	122.59994	3	5	6	1000	1	1	1		2	B	W	0	0		400' from 3rd
2																			
3	2	0950	48.48926	122.59867	2	5	9	1000	1	1	1		2	B	L	0	0		1400' from 3rd
4																			
5	3	1020	48.48464	122.59378	2	5	20	1000	1	1	1		1	B	W	0	0		700' from Seep at Mansion
6																			
7	4	1015	48.48368	122.58974	2	4	20	850	1	1	0		2	B	L	0	0		700' from Seep at Mansion
8																			
9	5	1015	48.48328	122.58849	2	1	20	250	1	1	1		4	B	W	0	0		OYSTER SPIT
10																			CAMSTEN ↓
11	6	0930	48.47699	122.58997	2	5	15	1000	1	1	1		3	B	0	0	0		
12																			
13																			
14																			
15																			

Samplers: HAAGE, LEE, GEORGE, LECHNER, HUSEBY, HOH, FLANAGAN, KAISLER

Organization: DNR/CSL

(print names here, sign back)

Reviewer: HAAGE

DN = 9, 48L

Figure 3: A field sheet completed during a survey trip

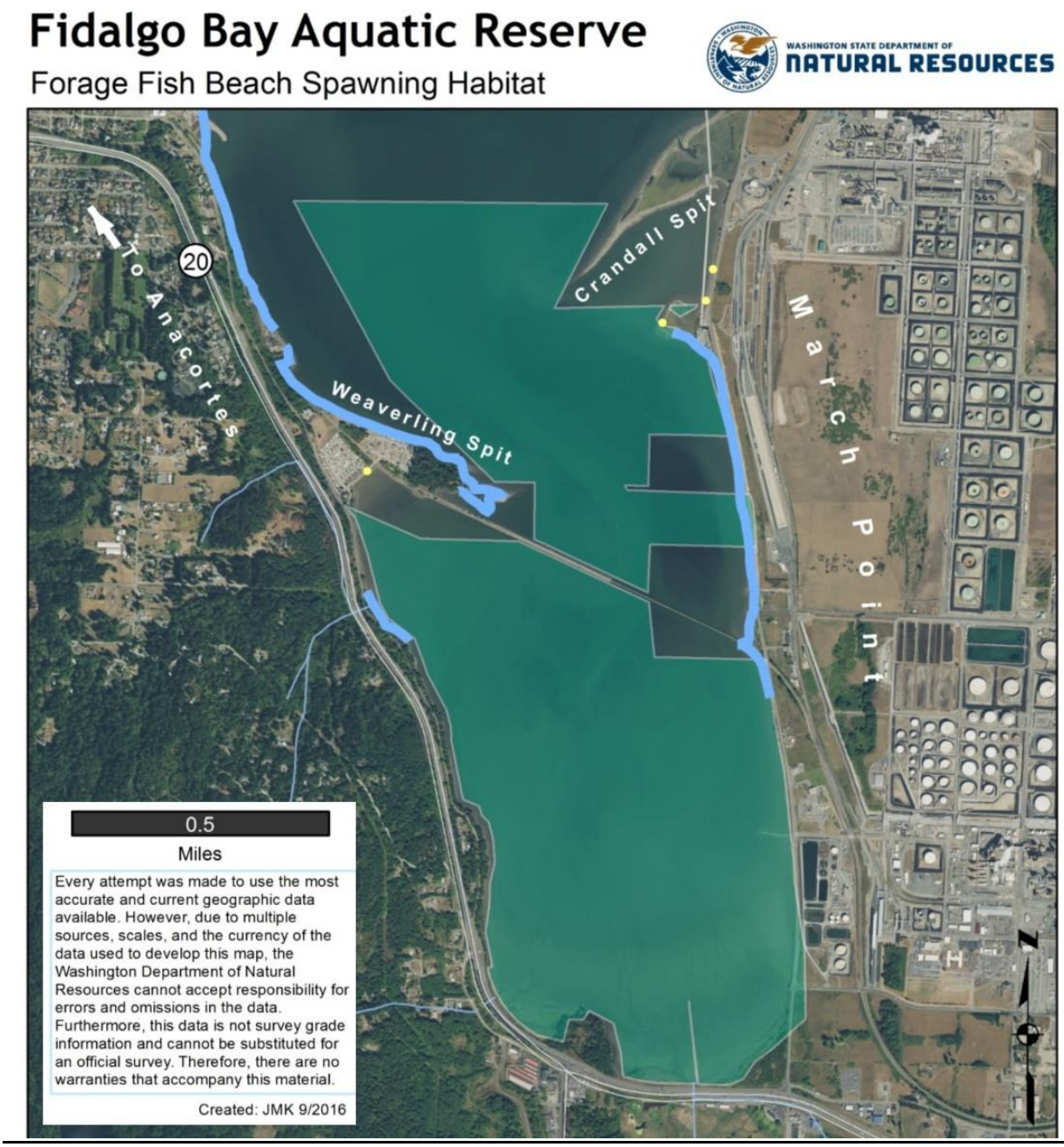


Figure 4: Map of Fidalgo Bay Aquatic Reserve

Within the span of six years (2013-2018), 1350 samples have been collected, processed, and analyzed for surf smelt hatching success. The data have been entered into the DNR spread sheet. Much of the data have been moved into the Washington State Department of Fish and Wildlife comprehensive Forage Fish Spawning data base.

The Fidalgo Bay Aquatic Reserve comprises the southern half of Fidalgo Bay. About half of the Aquatic Reserve area is north of Weaverling Spit and the Tommy Thompson trestle. The beaches there are known for surf smelt spawning because of the ideal composition of beach material (sand and fine

gravel) along the upper tidal zone. The southern part of the bay is very muddy and has little suitable beach material. There are about 7,000 feet of the suitable beach and another 3 or 4 individual "pockets" where samples can be taken. Much of the beach is bordered by armoring riprap and there is also little overhanging shade to help keep fertilized eggs cool and moist during their incubation period. More than half of the beach length, during several years, has been refreshed by adding materials more suitable for surf smelt spawning.

As of 2018, there were more than 25 volunteers trained and practiced for doing the surveys. A schedule for surveying each side of the bay twice during a month was distributed and individuals signed up as they were available. Usually four to six people participated in each survey. A survey took about 2 hours and sampled three to six locations, depending on the random starting location and side of the bay. During a month 18 – 19 different samples were taken for a total of about 220 per year and more than 1300 during the six years of effort. Many organizations, including the Friends of Skagit Beaches, Washington Department of Natural Resources, Resources for Sustainable Communities, Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee, and Skagit Marine Resources Committee provided funds for equipment and materials.

This report presents the results of numerous analyses of the data to answer a variety of questions about surf smelt spawning in Fidalgo Bay and to provide guidance for further beach improvements and **substrate** enhancements that could aid successful hatching.

Overview of WDFW Protocol Followed:

For each location (called a "**Beach Station**"), information and codes are entered on a field sheet (Figure 3) Including date, time, tide, coordinates, coarseness of beach, shading, and collection point relative to last tide to specify the exact sampling location. Sampler names are included along with a "checker" name who makes sure all fields are complete and with reasonable entries.

At each location "scoops" of gravel are taken at four equal intervals along a 100' line parallel to the water line and usually near and just below the last high tide line, with the center point being the recorded coordinates on the field sheet. About ¾ gallon of gravel is collected. The samples are carried to a central processing place – usually the Fidalgo Bay Resort and used by permission of the Samish Indian Nation. Each sample is rinsed through a stack of 4mm, 2mm, and 0.5mm sieves. The material in the 0.5mm sieve is washed into a small tub and either **"winnowed"** or **"blue bowled"** (since July 2015) until the lightest debris, sand grains and any surf smelt eggs remain.

The "blue bowl" is a gold-panning device that swirls water such that light particles (including eggs) rise to the top and go down a tube into a 0.5mm sieve. This method collects about 50% more eggs than the winnow method. We compared both methods and our data substantiate the superiority of the "blue bowl" technique.

Figure 5: Blue Bowl

The material caught in the sieve is put into in a sample jar and preserved for microscopic analysis. A surf smelt egg is spherical and about 1 mm in diameter. Some samples have thousands of eggs visible in the jar, others none.

Microscope work counts and records the total number of eggs in a sample jar or estimates the total if the sample has more than 100 eggs. For up to 100 eggs the number at various **stages of development** is recorded. (Eight stages, spread over an approximately two-week incubation time, can be identified.) All this information is recorded on a laboratory analysis sheet, with one line for each sample.

For the 6 years of surveys, 55% of the samples (n = 750) had eggs in them and 27% (n = 370) had 100 or more.

Further, 6% of the samples (n = 78) had 10 or more "late-eye" eggs and 3.5% of the samples (n = 49) had 15 or more "> 1 ½ coil" and "late-eye" eggs. These samples are referred to as "**ready to hatch"** or **"viable"** or "Low-mortality."

Finally, the sample jars, the field sheets and the analysis sheets are taken to the Aquatic Reserves program of the Washington State Department of Natural Resources in Olympia. Some are double checked there for quality purposes.

Eventually, the multitude of information for each sample is entered by DNR into a large Excel data sheet with a single line of more than 100 columns of possible data for each sample (1300 + lines.) It is from this data set that the following questions are addressed.

Questions proposed about surf smelt spawning

Our study goal is to learn more about forage fish spawning in the Fidalgo Bay Aquatic Reserve over a long period of time and to use the results to guide future actions regarding management and protection of these ecologically important species. A Fidalgo Bay Citizen Stewardship Committee has reached consensus on a few questions we will try to answer with the data collected.

Is there year-to-year variation in spawning patterns?

What is the effect of time of year on egg survival to hatching?

When and where are surf smelt eggs found?

How prolific is the spawning?

What per cent of eggs survive to hatching?

What are the effects of beach substrate on egg survival to hatching?

What are the effects of beach shading on egg survival to hatching?

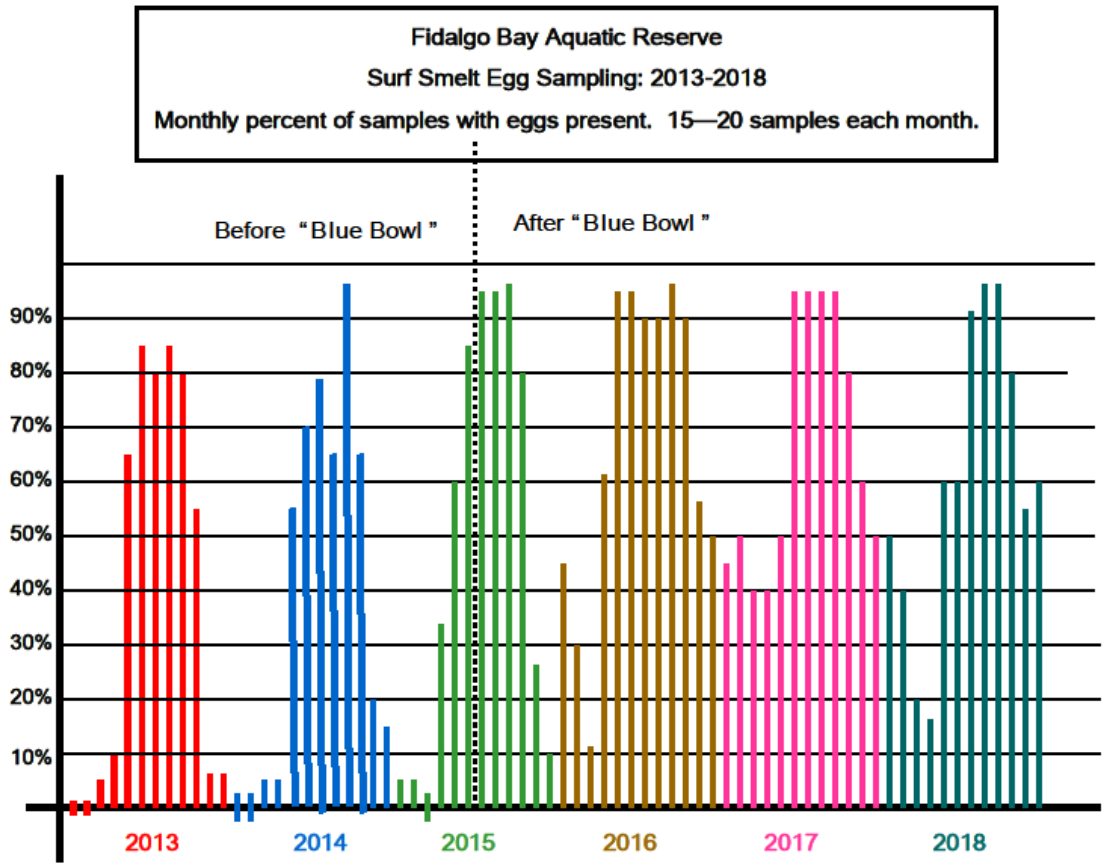
Figure 6: A very dense swath of recent spawning along the riprap of the Tommy Thompson trail

Data Analysis and Findings:

Timing

Does spawning show variation?

There is variation from year to year. For example, 2016 had more mid-year spawning while 2017 had more early-year spawning. 2018 had less mid-year spawning.



Graph 1: Fidalgo Bay surf smelt year-to-year spawning comparison

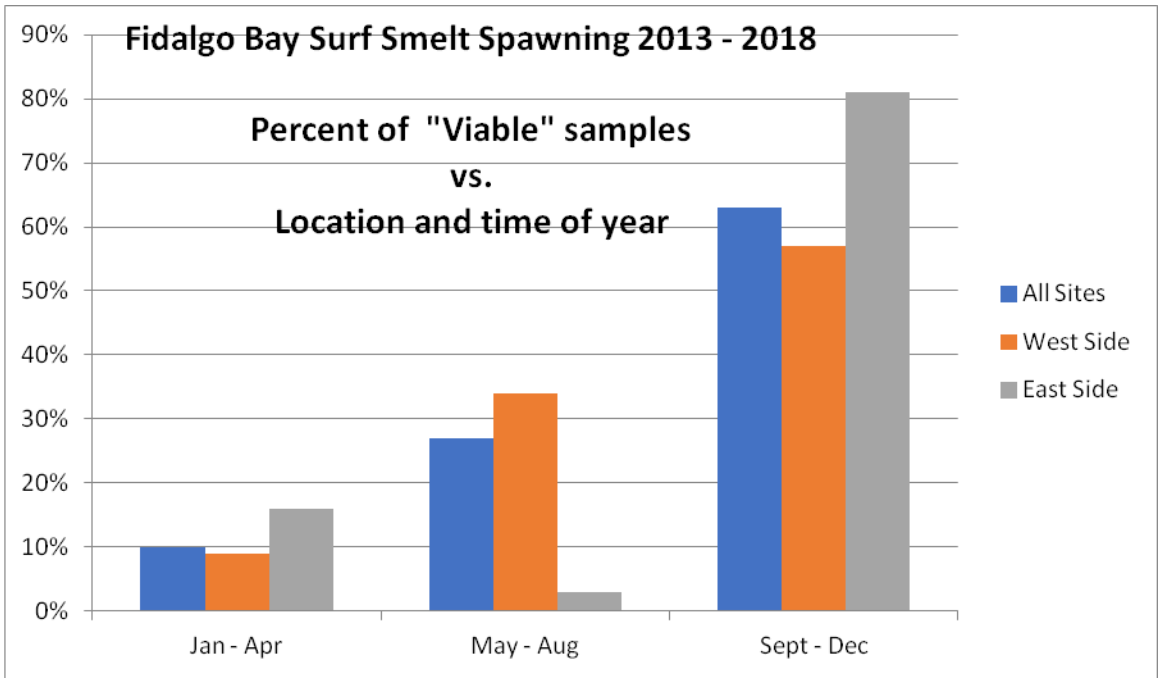
Figure 7: Collecting a sample near the high tide line on a Fidalgo Bay beach

What is the effect of the time of the year on egg survival to hatching?

Of the 49 100-egg samples with at least 15 eggs nearly ready to hatch **("viable"),** 10% (n = 5) were from January – Apr, 29% (n = 14) were from May – August, and 62% (n = 30) were from Sept – Dec. (See blue bar in Graph 2.)

East side survival (gray bar in Graph 2) is better in early and late months while west side (orange bar in Graph 2) survival is better in summer. (The west side has more shaded areas during summer.)

<u>Despite heavy spawning in the June – August time, survival is low during May - August especially compared to September - December.</u>



Graph 2: Viable Samples vs. Location and Time of Year

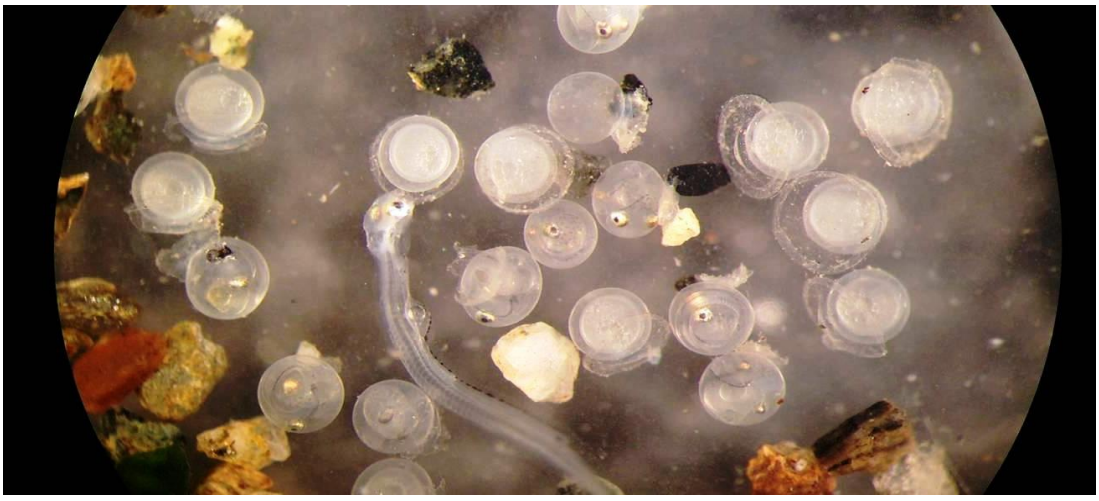
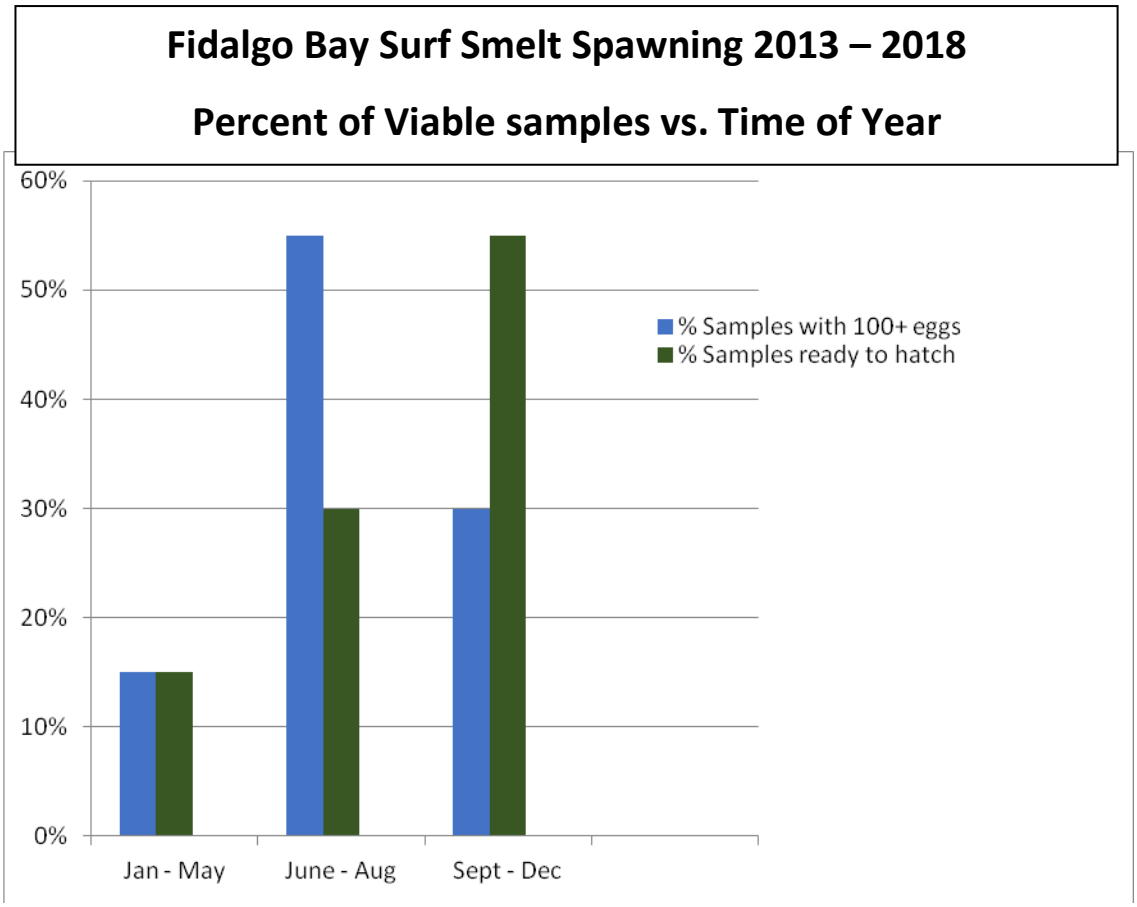


Figure 8: Many "late-eyed" eggs ready to hatch and a hatchling! Photo by Jamey Selleck

Of the 370 100-egg samples, 15% (n = 55) were from January – May, 55% (n = 203) were from June-August, and 30% (n = 112) from September – December (blue bar on Graph 3).

There were 28 samples with more than 15 “ready to hatch” eggs. The green bar in Graph 3 shows the percentage of the ready to hatch eggs. **Again, this shows the highest survival proportions in fall and early winter (September – December).**



Graph 3: Ready to Hatch Samples vs. Time of Year

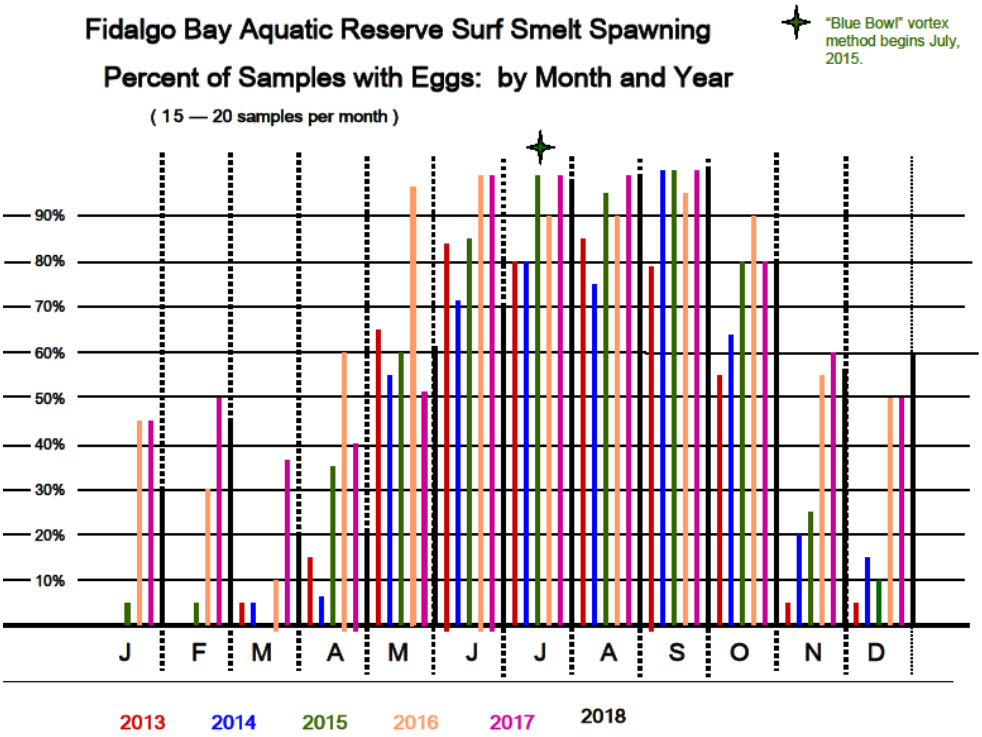
Figure 9: Checking for eggs in winnow tub – December cold and wet

Location

When and where are surf smelt eggs found?

Surf smelt eggs were found in about 55% of the 1350 samples (750 samples). They were found at all possible sample locations and months, with the majority between May and October.

Important Note: The "Blue Bowl" vortex method of extracting eggs from a gravel sample began in July 2015 and the number of samples with eggs then increased by nearly 50% during the winter and early spring when few eggs were present in a sample.

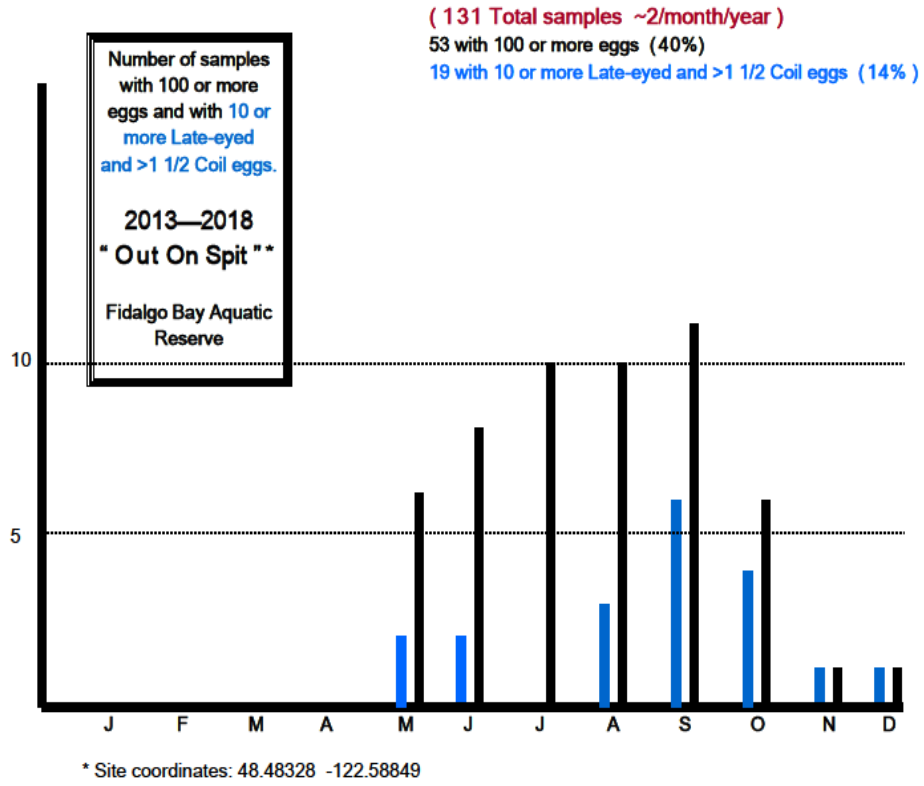


Graph 4: Fidalgo Bay Aquatic Reserve Surf Smelt Spawning 2013-2018 by month

Figure 10: Eggs visible on gravel in a rinsing sieve

Excellent shade and substrate site:

There is a totally natural and extremely well shaded site with a good **substrate** of sand and small gravel on the north side of the Weaverling spit about 500 feet east of the Samish RV Park Tribal Clubhouse. We try to collect a sample there twice a month and collected more than 130 between 2013 and 2018. **Graph 5 compares samples with 100 or more eggs which is 40% of samples (n= 53) to samples with 10 or more "ready to hatch" eggs which is 14 % of samples (n = 19). These values are much higher than the percentages from the 1350 total samples which had 27% with 100 or more eggs and 6% with 10 or more "ready to hatch" eggs.**

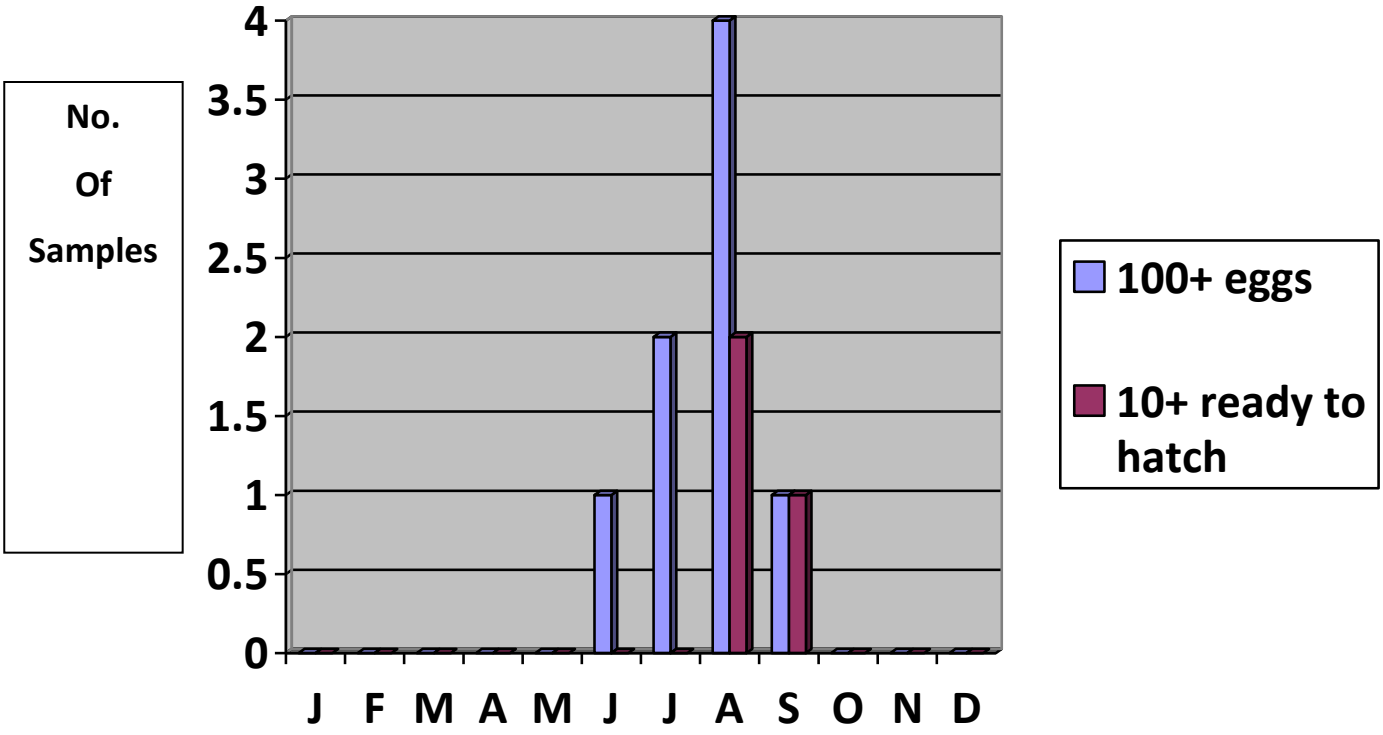


Graph 5: Occurrence of prolific and late development samples by month on Weaverling Spit

Figure 11: Weaverling Spit natural and well-shaded beach

A site in the south part of the bay:

South of Weaverling Spit and the Tommy Thompson Trail trestle, the bay is quite muddy and shallow with minimal flushing and little decent spawning substrate. In 2016, the Skagit Land Trust acquired property on the west shore of the south part and discovered quite a bit of spawning in the summer. We began regular sampling and have found periodic heavy spawning although at a lesser frequency than the bay overall. We also found samples with 10 or more "ready to hatch" eggs at a frequency typical of the bay overall. There is an ongoing effort to try to add some more suitable substrate like sand and small gravel to that stretch of beach and hopefully allow more spawning and hatching there.



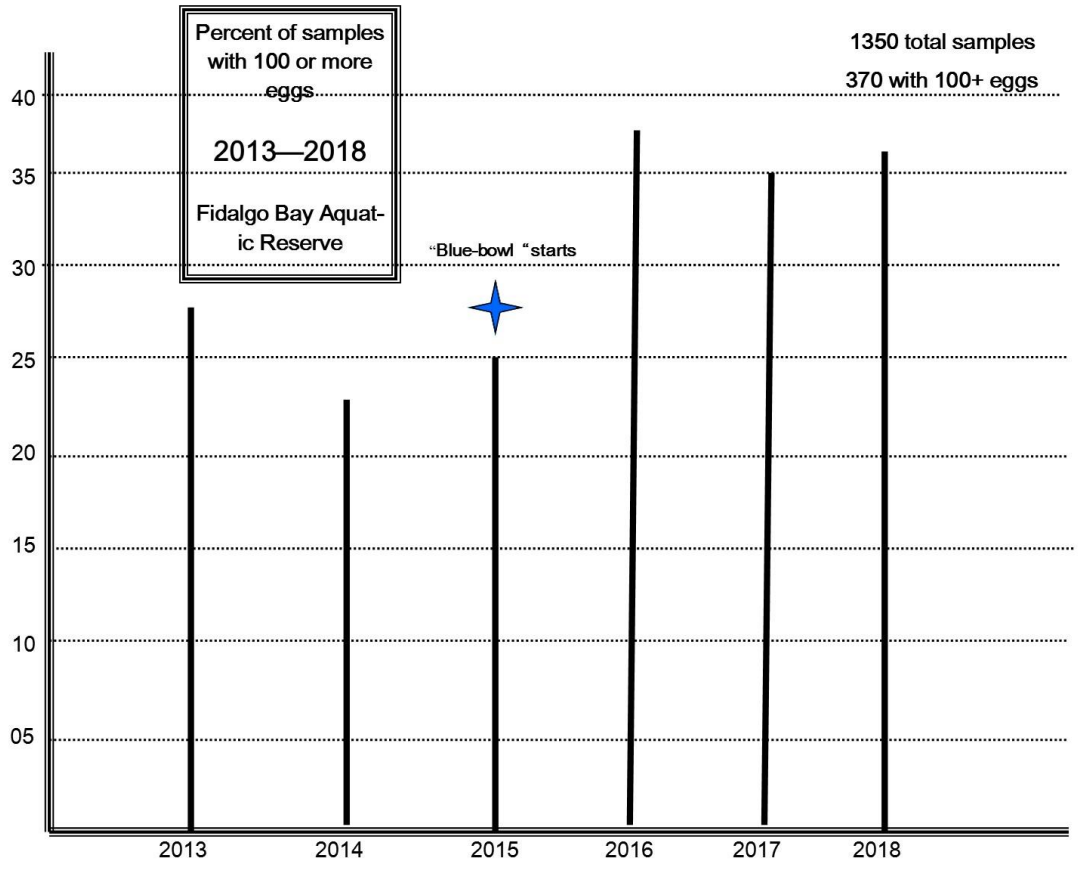
Graph 6: Fidalgo Bay surf smelt eggs on the southwest shore 2016-2018

Figure 12: Smelt (with eggs) stranded at high tide on southwest shore

Pec Cent Survival

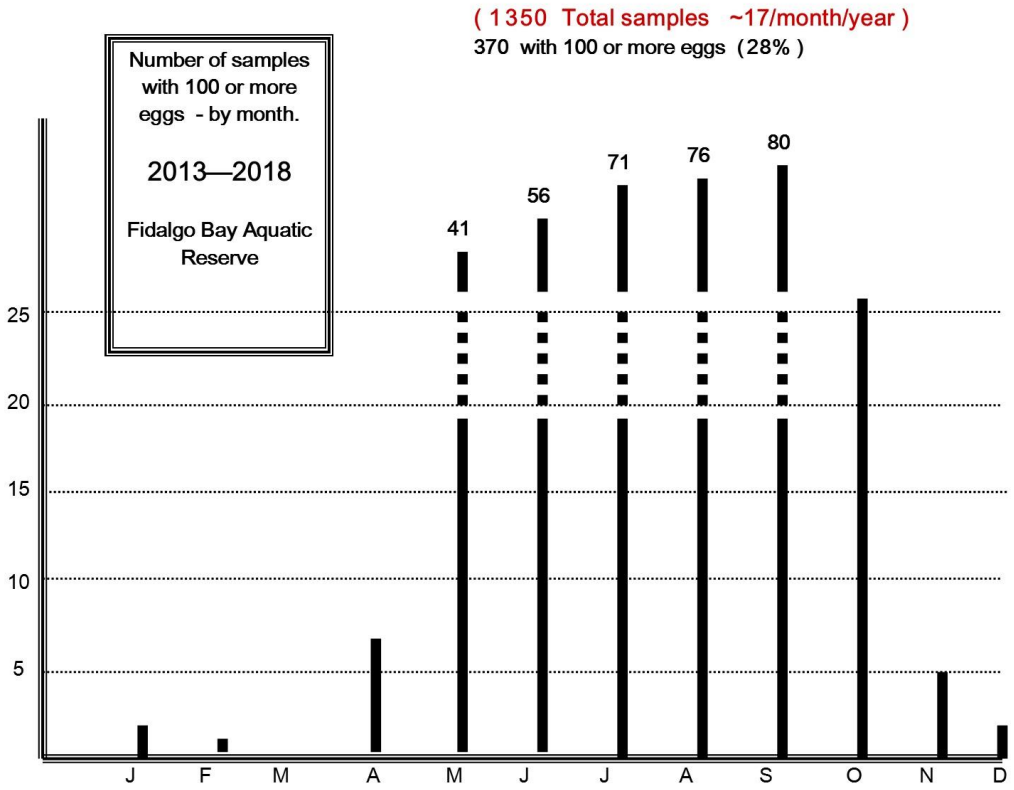
How prolific is the spawning?

Almost half (n = 370) of the 750 samples with eggs had 100 or more eggs – often thousands! Detailed egg counting stops at 100, with larger total numbers estimated during microscope analysis. These "prolific" samples were found largely from May through September and at most sample locations.



Graph 7: Percent of samples with 100+ eggs by year

Figure 13: These surf smelt were found beneath the nests of March Point Heronry near Fidalgo Bay



Graph 8: Number of samples with 100+ eggs by month

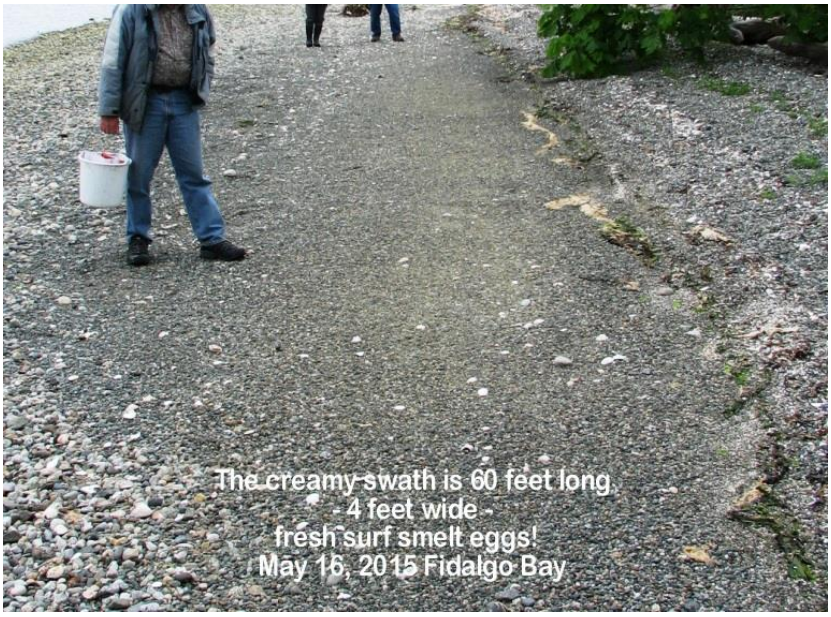
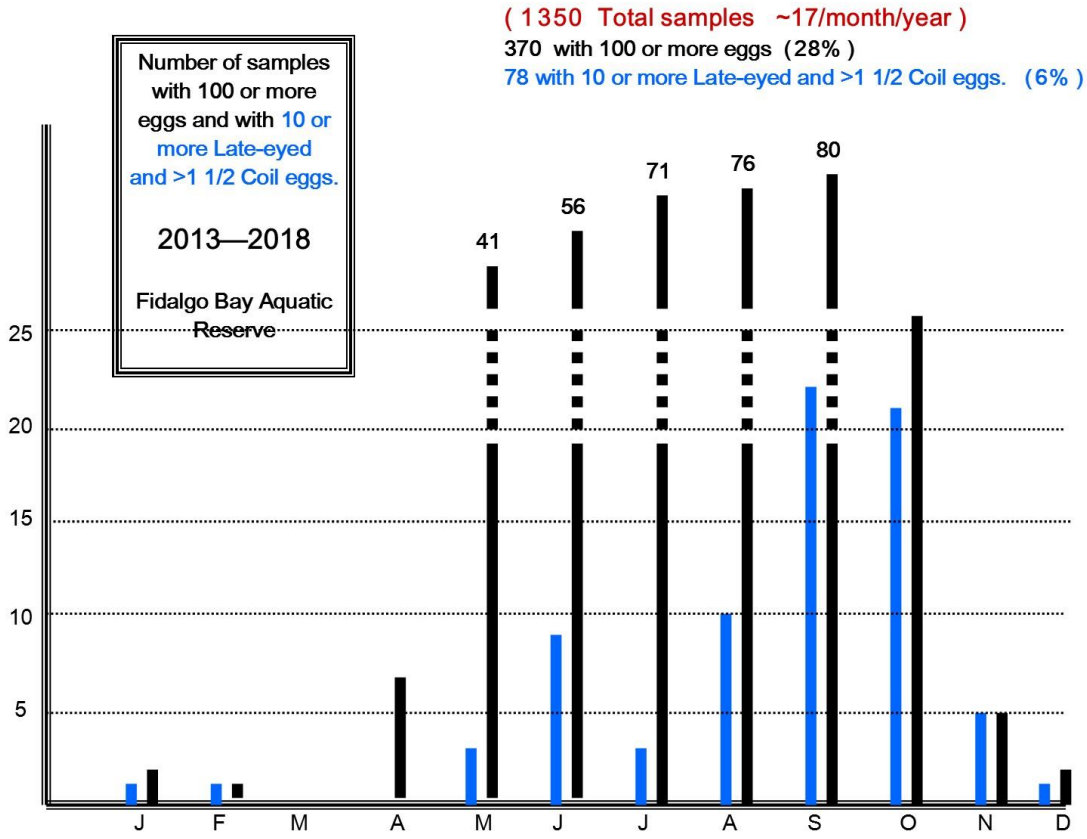


Figure 14: High density surf smelt eggs on beach May 16, 2015

What is the survival-to-hatching percentage of the eggs?

Surf smelt eggs take about 2 weeks to hatch and proceed through 8 distinguishable stages of development. The two "late stages" (> 1 ½ coil and late-eyed) happen within three or four days of hatching. About 10% (n = 78) of all samples with eggs (n = 750) had numerous (more than 10) "late stage" eggs, often with some just-hatched fish ("Viable samples"). The chart below shows that, while Fidalgo Bay surf smelt spawn prolifically from May through September, **improved survival occurs during September and October when there is more cloudy and cool weather than in May through August.**



Graph 9: Samples with 100+ eggs and late developmental stage by month

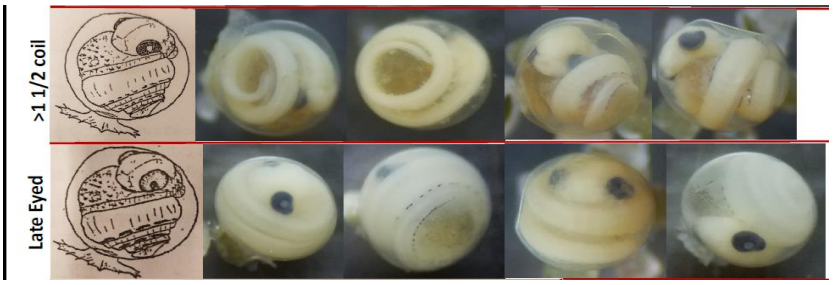
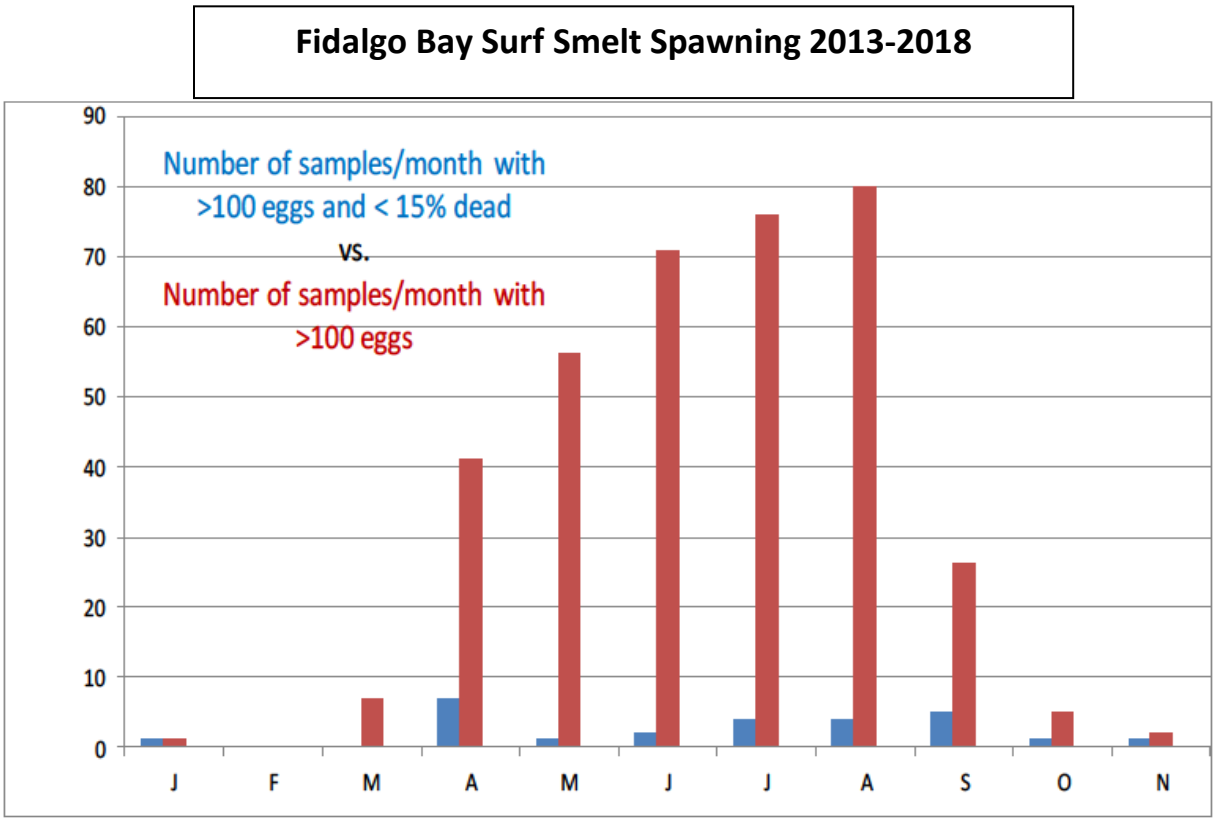


Figure 15: Microscope images of the two latest development stages – within a day or so of hatching

Of samples with more than 100 eggs (n = 370) 8% (n = 28) had 85 or more of the eggs still alive (less than 15 dead). **This high per cent survival (low mortality) was enhanced in very cool months.**



Graph 10: Samples with 100+ eggs and <15% mortality by month

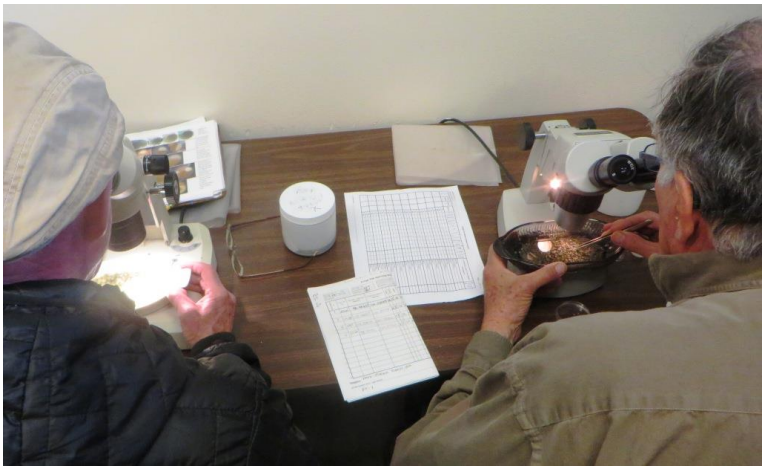


Figure 16: Microscope egg counting and analysis

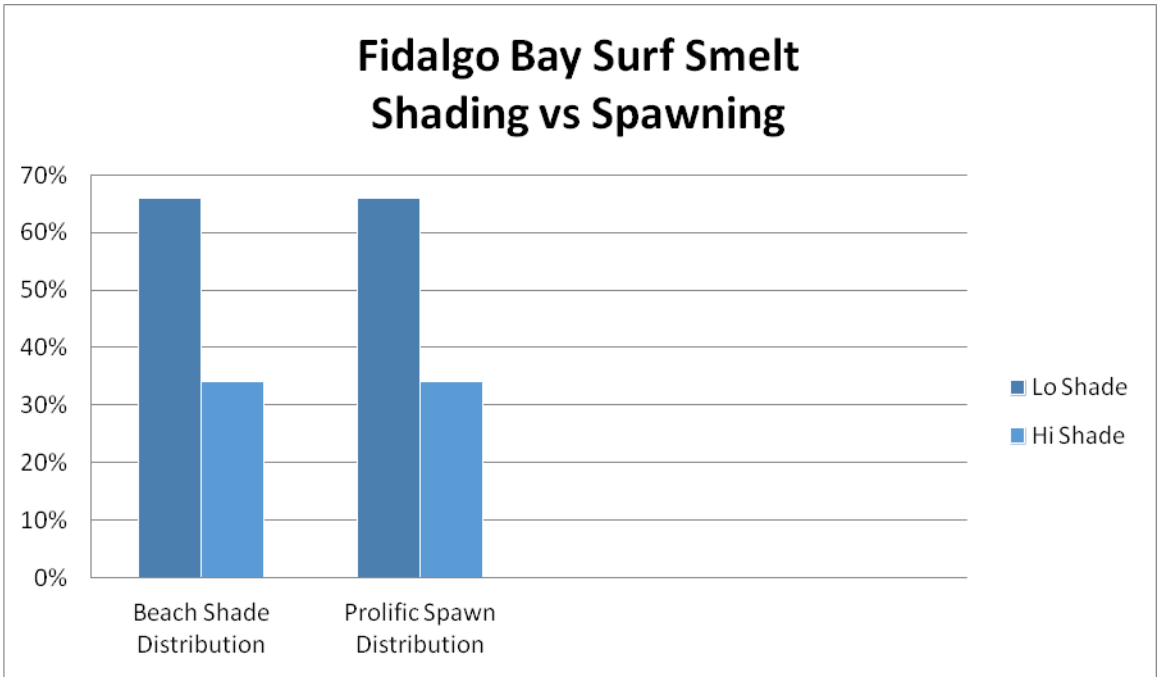
What are the effects of beach substrate on egg survival to hatching?

Substrate: **Almost the entire beach that was sampled had similar, suitable spawning substrate and so no comparisons between substrate types were made**. The substrate in Fidalgo Bay is composed of small gravel/pebbles and sand on the beaches, precluding any comparisons by substrate.

What are the effects of beach shading on spawning and survival to hatching?

Shading: The amount of beach shading varies greatly. Almost 2/3 of the beach is 25% or less shaded ("lo-shade") and the other 1/3 is equally divided between 50% shaded and 75% shaded ("hi-shade"). Only about 1% of the beach is fully shaded.

Of the 370 samples with 100 eggs or more (**prolific samples**), 65% (n = 264) of samples were found in "lo-shade" locations and the other 35% (n= 106) of samples were in "hi-shade" locations**. <u>Shading had no effect on prolific spawning in Fidalgo Bay.</u>**

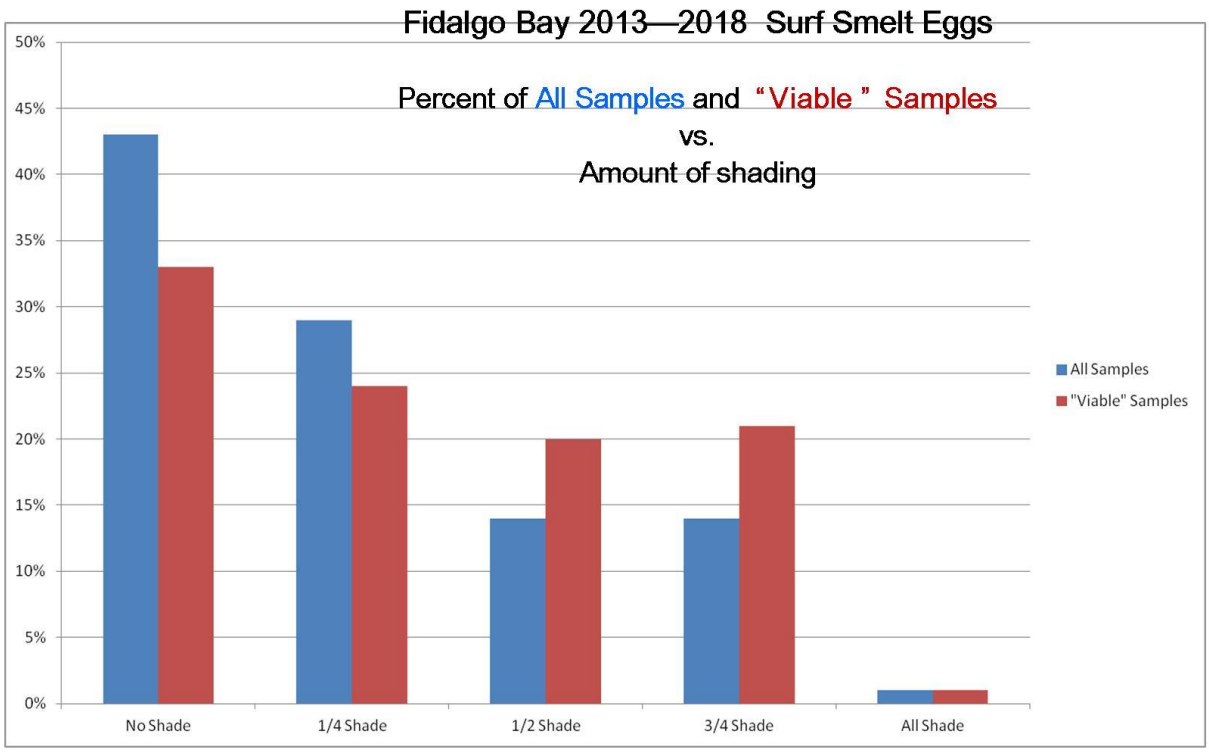


Graph 11: How shading effects prolific spawning

Figure 17: A long unshaded beach in Fidalgo Bay

Below are several findings about shade and egg survival in Fidalgo Bay.

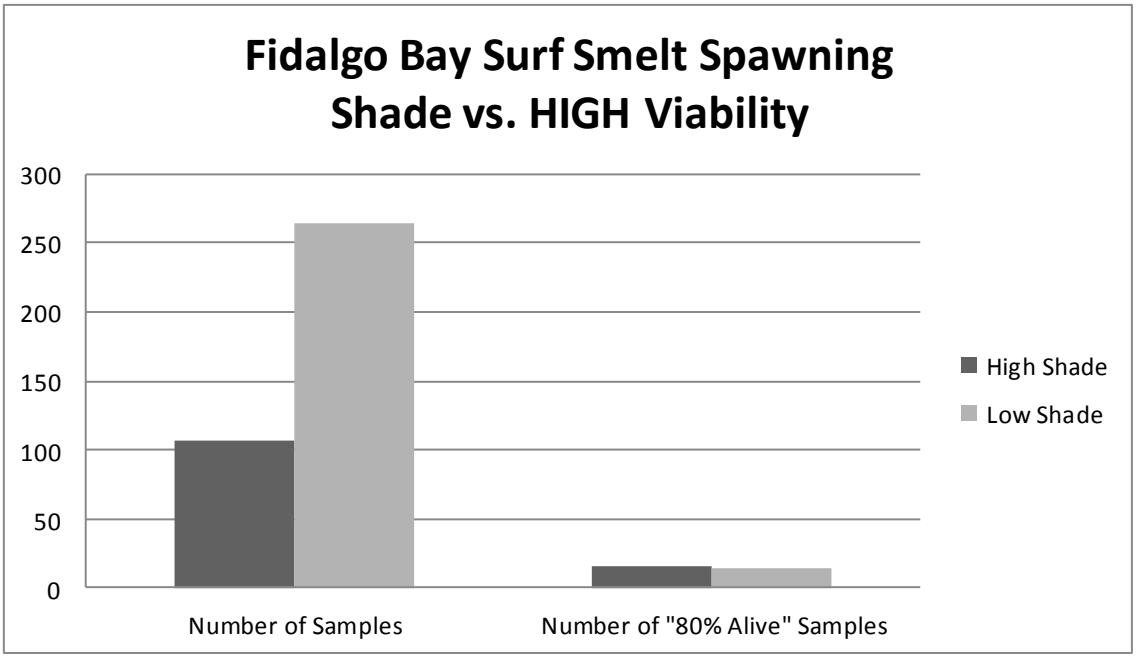
There were 1350 samples and 78 of them had 100 or more eggs with more than 10 eggs ready to hatch (viable samples). 41% of the viable samples (n = 32) were found on "Hi-shade" beaches (which represent just 35% of the entire beach. **Shading increases viability.**



Graph 12: Shading and number of viable eggs

Figure 18: Educational activity during a survey

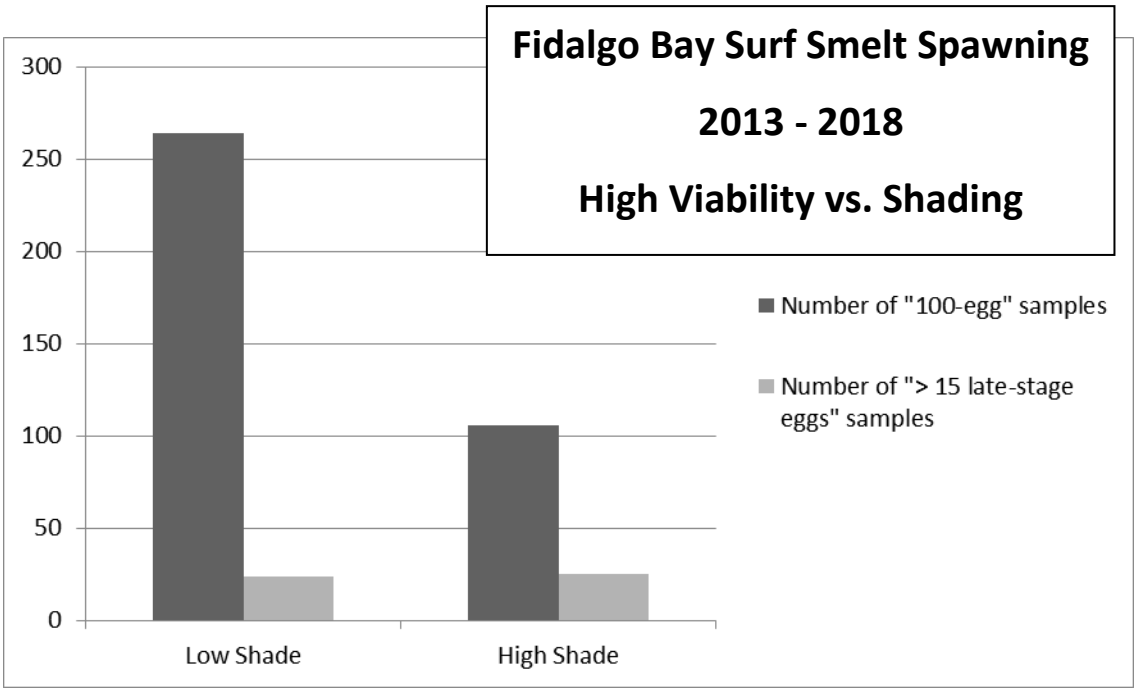
Of the 370 prolific (100 eggs) samples, 8% (n = 30) had 80% or more of the eggs ready to hatch. Fourteen of these were from 265 lo-shade locations and 16 were from 105 hi-shade locations. **Here is another demonstration of how shading increases survival.** (Note: finding samples with 80% live eggs is very rare and a 10-15% rate of live eggs is considered good. Surf smelt schools deposit thousands and thousands of eggs and only need very low survival rates to perpetuate the schools – like dandelions!)



Graph 13: High viability in shaded conditions

Figure 19: Rinsing sample to move eggs to lower sieve

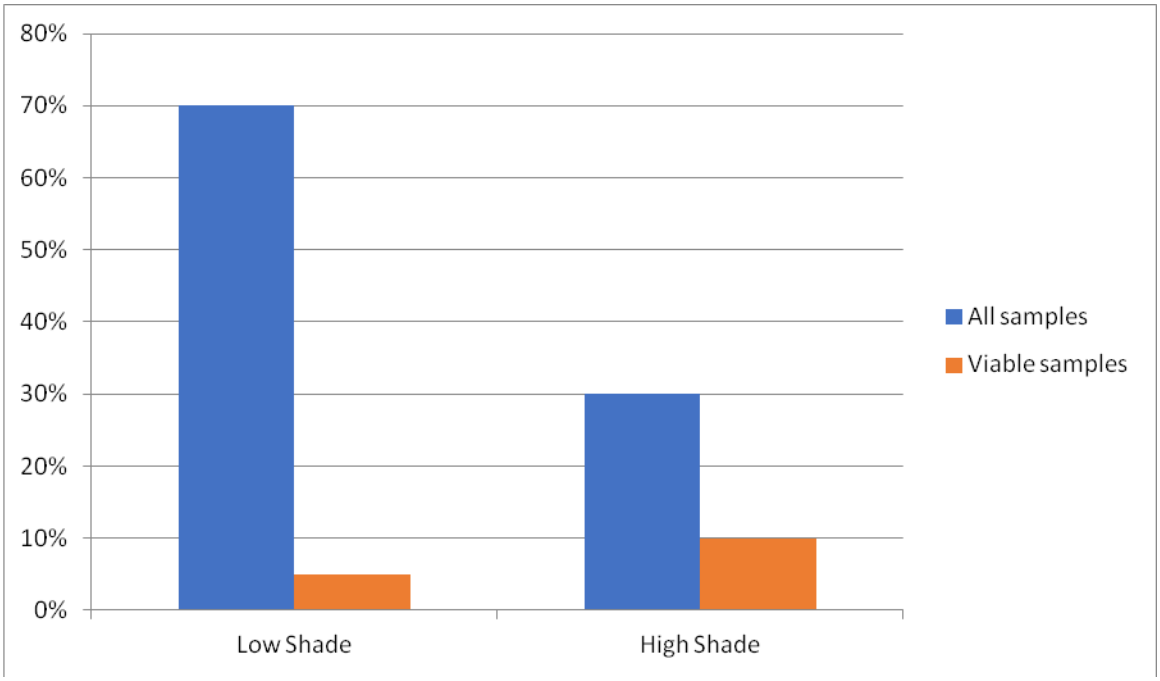
Forty-nine of the 370 100-egg samples had at least 15 of the eggs nearly ready to hatch. Twenty-four were from the 265 lo-shade beaches and 25 were from the 106 hi-shade beaches**. Hi-shade beaches have a higher hatching percentage.**



Graph 14: Late development vs. shading

Figure 20: Final samples ready for microscope analysis

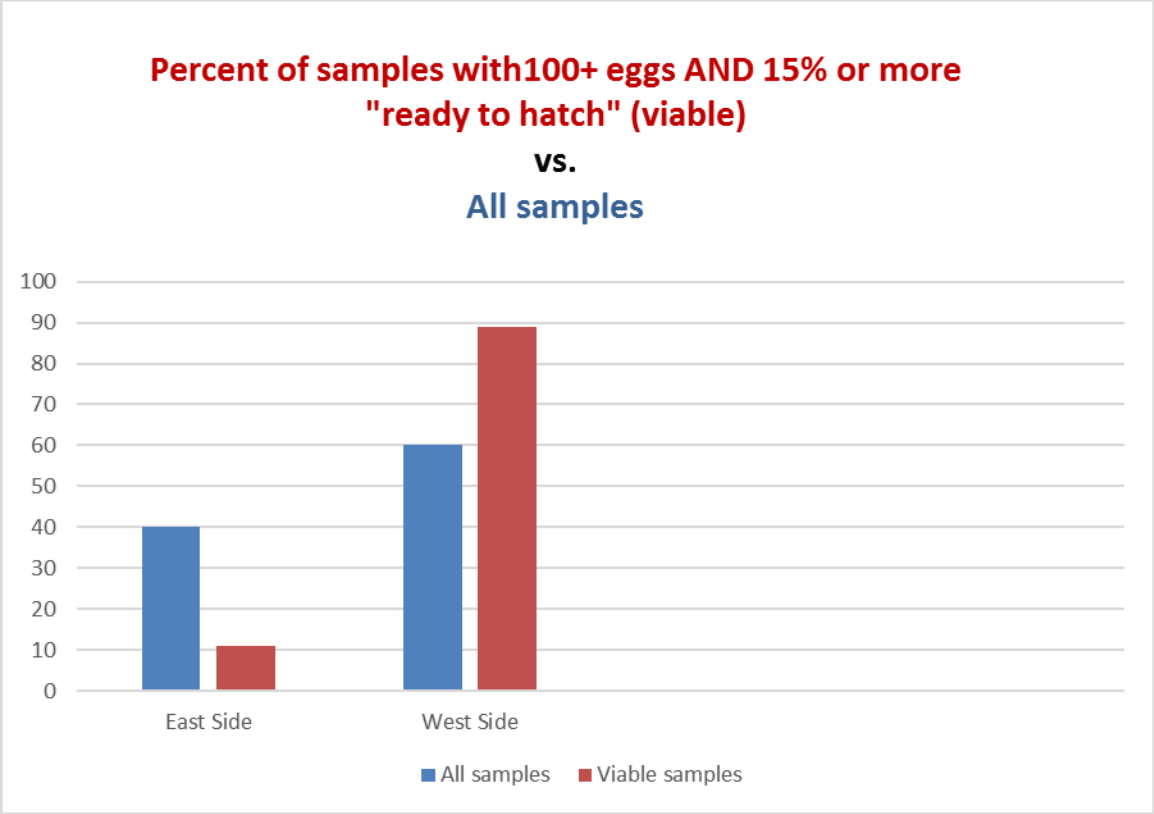
For all 1350 samples, 30% (n = 400) were from hi-shade locations and 70% (n = 950) were from lo-shade locations. 10% of the hi-shade samples showed good viability and just 5% of the lo-shade samples showed good viability. **Good shading has a substantial ability to promote survival to hatching.**



Graph 15: Comparison between high and low shade and viability of samples

Figure 21: Survey volunteers assist numerous school group science work projects in Fidalgo Bay

In Fidalgo Bay, the east side has almost no shade from vegetation and is exposed to long periods of high summer sunshine because it faces west. The west side also has little vegetation shade but faces east or north and has less hot summer sun exposure. In addition, half of the west side is bordered by the boulder riprap along the Tommy Thompson trail. The high tides reach just into the boulders and there are numerous crevices with captured sand and small gravel and shade. Spawning is prolific here and smelt fishers (dippers) are active in later summer when high tides are in the early evening**. Survival in the summer (and all year) on the west side is much higher than on the east, most likely due to this shading.**

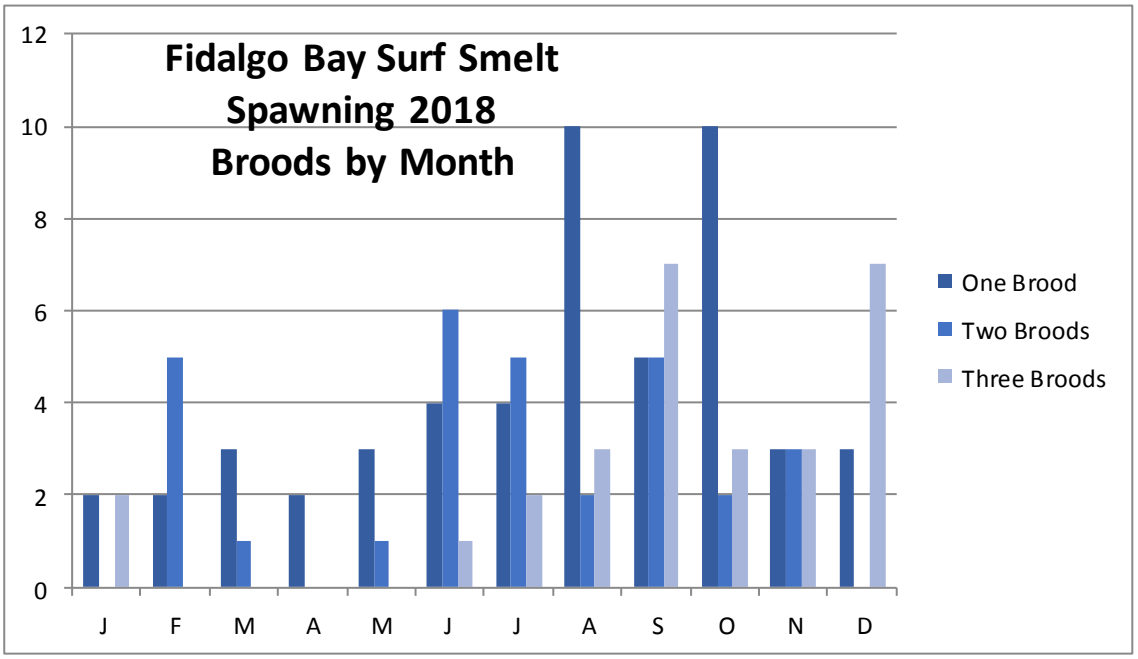


Graph 16: Survival percentages between west side and east side of Fidalgo Bay

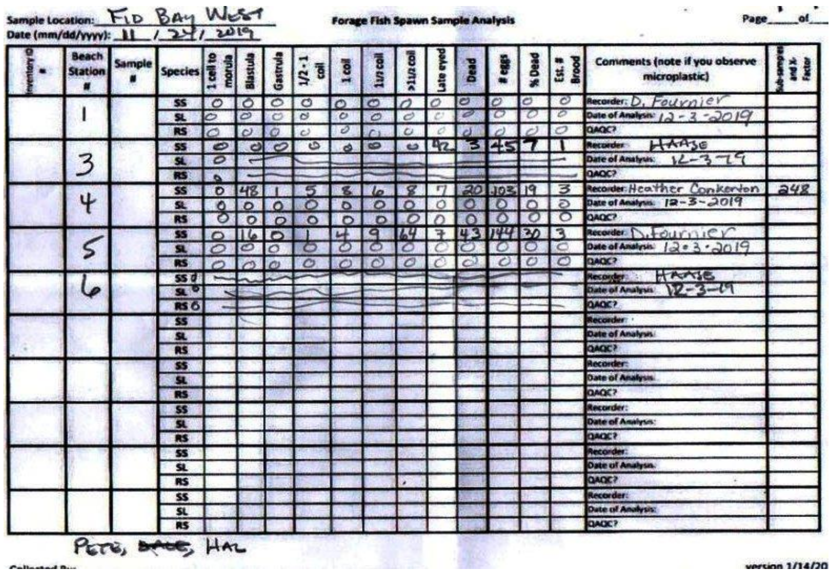
Figure 22: Elementary school groups get to help too.

Broods:

Eggs go through several "stages" during the approximately 14 days from spawning to hatching and we can tell if more than one spawning event is present in samples that have "live" eggs in them. We separate the eggs into three broods from "just spawned" to "ready to hatch". **Three-brood samples are most frequent later in the year when cooler and cloudy weather is more prevalent.**



Graph 17: Number of broods by month



Sample Location: FID BAY WEST | Forage Fish Spawn Sample Analysis | Page ___ of ___
Date (mm/dd/yyyy): 11 / 24 / 2019

Inventory ID #	Beach Station #	Sample #	Species	1 cell to morula	Blastula	Gastrula	1/2 - 1 coil	1 coil	1 1/2 coil	>1 1/2 coil	Late eyed	Dead	# eggs	% Dead	Est. # Brood	Comments (note if you observe microplastic)	Sub-samples and X-Factor
	1		SS	0	0	0	0	0	0	0	0	0	0	0	0	Recorder: D. Fournier	
			SL	0	0	0	0	0	0	0	0	0	0	0	0	Date of Analysis: 12-3-2019	
			RS	0	0	0	0	0	0	0	0	0	0	0	0	QAQC?	
	3		SS	0	0	0	0	0	0	0	42	3	45	7	1	Recorder: HAASE	
			SL	0												Date of Analysis: 12-3-19	
			RS	0												QAQC?	
	4		SS	0	48	1	5	8	6	8	7	20	103	19	3	Recorder: Heather Conkerton	248
			SL	0	0	0	0	0	0	0	0	0	0	0	0	Date of Analysis: 12-3-2019	
			RS	0	0	0	0	0	0	0	0	0	0	0	0	QAQC?	
	5		SS	0	16	0	1	4	9	64	7	43	144	30	3	Recorder: D. Fournier	
			SL	0	0	0	0	0	0	0	0	0	0	0	0	Date of Analysis: 12-3-2019	
			RS	0	0	0	0	0	0	0	0	0	0	0	0	QAQC?	
	6		SS 0													Recorder: HAASE	
			SL 0													Date of Analysis: 12-3-19	
			RS 0													QAQC?	
			SS													Recorder:	
			SL													Date of Analysis:	
			RS													QAQC?	
			SS													Recorder:	
			SL													Date of Analysis:	
			RS													QAQC?	
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			RS													QAQC?	
			SS													Recorder:	
			SL													Date of Analysis:	
			RS													QAQC?	

Collected By: PETE, ~~DAVE~~, HAL | version 1/14/20

Figure 23: A microscope lab-analysis sheet with three broods present at beach stations 4 and 5

Summary:

There is a LOT of surf smelt spawning in Fidalgo Bay. It happens all year with extensive peaking from late May through September. Spawning densities and timings vary from year to year with no lasting trends observed.

The survival-to-hatching rate is very poor because so little of the beach has shade from the hot sun of those peak months. The eggs dry out and die quickly. Fall appears to be the "sweet spot" in time when spawning is still quite active and there is more cloudy, cool weather and a lower angle of sun

Two actions would most enhance survival. Large, mature deciduous trees could be spotted along the beach front in front of the RV park. That would provide shady spots on the beach yet not block the view for the campers. Also, more sand and pea gravel could be dumped along the west side riprap. That would work into the nooks and crannies of the riprap and collect eggs and shade them from the summer sun.

In the past, the east side was refreshed with a lot of sand and pea gravel and it was then, and still is, good for spawning. But there is no shade and the survival-to-hatching rate of eggs there is very low. It is better to refresh where there already is shade, such as the southwest shore in the lower bay.

Glossary:

Beach Station – Naming convention on data sheets to note the number of a sampling site on the beach

Blue Bowl (vortex method) – A method of collecting eggs and light material after sieving the sediment samples

Forage fish – small, schooling fish that are food (forage) for larger fish, small mammals, and birds

Prolific samples – samples containing more than 100 eggs

Riprap – large rocks/boulders placed by people along beaches to prevent erosion

Spawning – a term used for when fish lay their eggs

Stages of Development – Morula: 1 – 5 hrs., Blastula: 6 – 12 hrs., Gastrula: 14 – 20 hrs., One – half coil: 1 – 2 days, one-coil: 3 – 5 days, One and one – half coil: 6 – 7 days, > one and one – half coil: 10 days, Late – eyed: 13 – 14 days

Substrate – the type of sediment on the beach classified by size such as mud, sand, and cobble

Surf smelt – a marine, schooling, small fish that lays eggs on the beach and is ecologically important

Viable samples – samples with most of the eggs nearly ready to hatch

Winnowing – sloshing a mixture of water and small pebbles with sand in a dishpan to allow any surf smelt eggs to float to the top for collection

Credits:

More than 100 individuals from all walks of life participated in the study and the analysis and reporting.

Late in 2018, a group gathered to develop the intent and scope and ideas for this report: Wayne Huseby, Eleanor Hines, Robert Lord, Tom Flanagan, Lilya Jaeren, Shirley Hoh, Dale Fournier, Regina Wandler, Dana Oster, Aileen Jeffries, Brad Smith and Gordon Sjogren. Many have continued to review and guide and contribute.

A special group of experienced scientists spent many personal hours to review, comment, and provide suggestions for improvement of the report: Dana Oster, Erica Bleke, Aileen Jefferies, Alice Sigurdson, Malis Yun, Brad Smith, Tom Flanagan.

Barbara Lechner and Michelle Marquardt developed an interpretation stand and materials and brought it to the beach, schools, and events many, many times and taught thousands of people about the life and value of forage fish.

Kurt Buchanan conjured up the idea of citizens being able to do this work and Dan Penttila had the faith to devote many hours to train the first group of us in 2012: Pete Haase, Tim Manns, Jack Middleton, Scott Peterson, Regan Weeks, Chris Wood, Gordon Sjogren, Jan Buchanan, Kurt Buchanan, Roz, Krumm, Chris Brown.

The Department of Natural Resources Aquatic Reserve staff and their seasonal Washington Conservation Corps folks provided data entry and quality control of our samples and data and reviewed our work all along the way.

And everyone who ever came along on a survey. Many participated a lot, many only a little. It all helped, we only cancelled one survey date (out of 144) due to unsafe driving conditions and never due to lack of help.

Principal author: Peter Haase