

Intertidal Forage Fish Spawning Surveys in the Fidalgo Bay Aquatic Reserve

Final Monitoring Report

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Puget Sound's most special places

Prepared for:

Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee

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Abstract

Fidalgo Bay Aquatic Reserve is an Environmental Reserve, part of the Washington Department of Natural Resources Aquatic Reserve Program. One of the primary objectives for the aquatic reserve is the preservation of critical forage fish spawning habitat. Forage fish beach spawning surveys are recognized as a reliable way to monitor forage fish spawning abundance and determine critical spawning habitat sites. This study focuses on the surf smelt spawning habitat and sampling was limited to the surf smelt spawning zones of the upper intertidal area.

The goals of the intertidal forage fish-spawning survey are to collect time-sensitive baseline data throughout the reserve and train and empower citizen scientists in conducting surveys using a standardized protocol. These goals have been met, although a continuing time series is necessary to detect effects of restoration efforts and continuing trends.

The sampling methods utilize a standardized protocol with classroom training and two several-hour field trips to Fidalgo Bay to acquaint surveyors with the procedures. Sampling by the Fidalgo Bay Citizen Stewardship Committee was conducted weekly. Fidalgo Bay was divided into the West side and the East side. Each side has four to six samples taken during a survey, depending on the random numbers (0-10) that determine the start points. In the East Section, 85 samples were obtained; in the West Section 127 samples were taken. Of the 212 samples collected, 103 samples contained fish eggs, all identified as surf smelt eggs. This program was successfully conducted with useful information collected. The program has adequate equipment and enthusiasm to continue the study into the future.

Introduction

The Fidalgo Bay Aquatic Reserve Forage Fish Beach Surveys have been conducted monthly since late in 2012. This project was developed and designed by the Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee (FBARCSC) with assistance from the Washington Environmental Council (WEC) and in association with the Washington Department of Natural Resources (WDNR) and Washington Department of Fish & Wildlife (WDFW). The survey is a continuation of surveys conducted by WDFW and WDNR Aquatic Reserves Program, Puget Sound Corps (PSC) staff and utilizes established WDFW protocols. The purpose of the program is to identify beach locations for the presence of Pacific Sand Lance (*Ammodytes hexapterus*) and Surf Smelt (*Hypomesus pretiosus*) eggs over time.

The Fidalgo Bay Aquatic Reserve was designated as a WDNR aquatic reserve in 2008. It encompasses approximately 650 acres of state-owned tidelands and bedlands. Figure 1 shows the boundaries of the aquatic reserve and the ownership of the tidelands and Figure 2 shows a regional view of the area.

This work has also been supported by the Skagit Marine Resources Committee, Friends of Skagit Beaches, and the Samish Indian Nation.

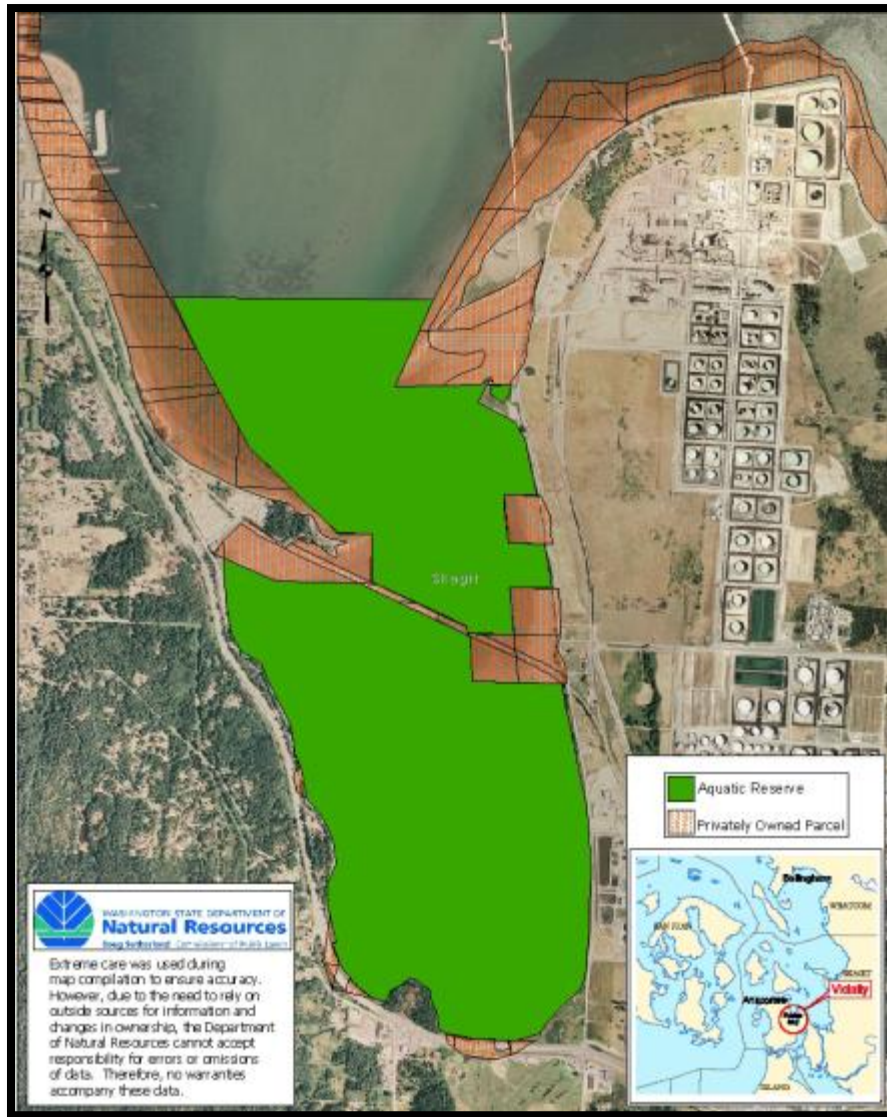


Figure 1: The Fidalgo Bay Aquatic Reserve boundaries (Source: WDNR, 2008)

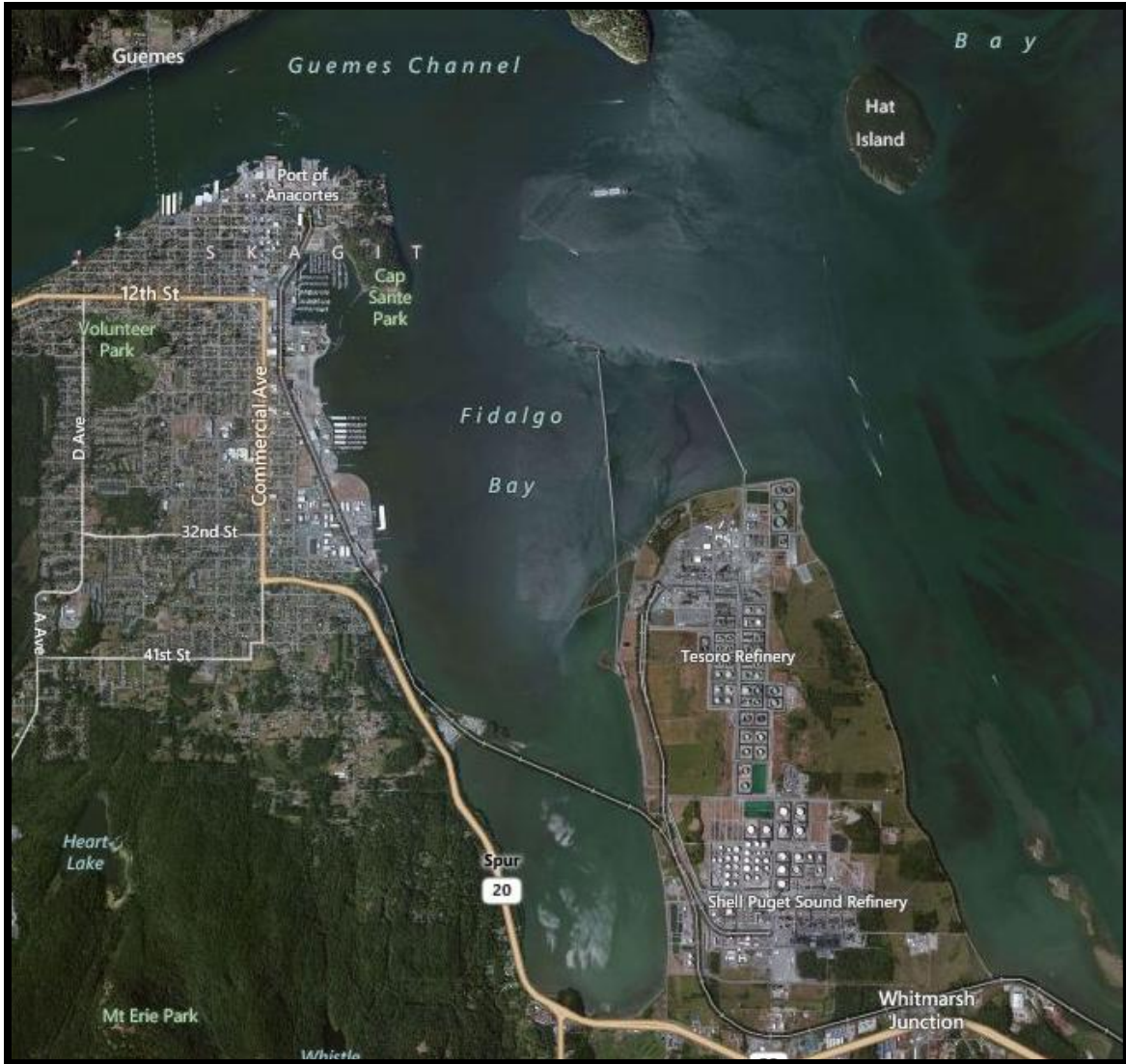


Figure 2: Aerial map showing the Fidalgo Bay Aquatic Reserve and surrounding areas (Source: Bing maps)

Fidalgo Bay Aquatic Reserve is an Environmental Reserve. One of the main goals for the aquatic reserve is to identify and conserve critical forage fish spawning habitat. A broader purpose is to conserve and enhance native habitats and their associated plant and wildlife species, with a special emphasis on forage fish, salmonids, and migratory birds (WDNR, 2008).

Fidalgo Bay is located in the Salish Sea, near Anacortes, Washington. It has been substantially impacted by human activities. This includes a revetment and trestle crossing the bay, fill placed along the shore, shoreline hardening, loss of upland vegetation, dredging, and dumping of wastes. Much of the riparian areas have been degraded and ecosystem functions compromised.

While the historic use of the area and potential restoration projects are challenging, the area still provides substantial ecosystem services, especially shallow, vegetated tidelands and bedlands used by spawning forage fish, developing salmon and other species, and numerous water and shore birds.

The management plan (WDNR, 2008) for the FBAR identifies four management goals:

Goal One: Preserve, restore, and enhance the functions and natural processes of aquatic nearshore and subtidal ecosystems of the aquatic reserve.

Goal Two: Protect habitat for Sensitive, Threatened and Endangered species.

Goal Three: Identify aquatic habitats and associated plant and wildlife species, with special emphasis on mudflats, sandflats, forage fish habitat, and eelgrass beds.

Goal Four: Provide opportunities for outdoor environmental education.

This monitoring program was developed to address these goals.

In the development of the 2012-13 Action Agenda, the Puget Sound Partnership (PSP) established a near-term action for forage fish in Marine Protected Areas, including the aquatic reserves (PSP, 2012)

B3.1 NTA 1: Marine Protected Area Effectiveness. By June 2014, PSP, in collaboration with WDFW and DNR will identify the threats, coverage gaps, and conservation concerns addressed by existing Puget Sound marine protected areas and assess the potential effectiveness of these MPAs to protect threatened species and habitats, including rockfish and forage fish.

The importance of forage fish in the Puget Sound ecosystems has long been recognized. WDFW (1998) established a policy (POL-C3012) on the management of forage fish that requires management policies based on monitoring data. A poster by Pierce, et al (2012) summarizes much of the past sampling of forage fish in Puget Sound.

A symposium on forage fish was held in September 2012 (Liedtke et al, 2013) that both summarized current work and presented new research. One of the conclusions of the symposium was that

“The lack of a reliable, and stock-specific, abundance estimate is a large data gap for most forage fish species in the Salish Sea. It is difficult to assess whether forage fish populations are stable, growing, or declining without a baseline population estimate and a means of assessing abundance on a relevant time scale. Herring are the only forage fish species in Puget Sound that are regularly monitored (by WDFW), and the group recommended that future effort be more balanced across all forage fish species.”

Pacific Sand Lance and Surf Smelt spawn in the gravel of the upper intertidal zone, depositing eggs in specific zones. Forage fish beach spawning surveys are recognized as a reliable way of monitoring forage fish spawning abundance and identify critical spawning habitat sites (Moulton and Penttila, 2001). This study focuses on the spawning of the surf smelt and sampling was limited to the surf smelt spawning zones of the intertidal zone.

Additional details regarding the development and design of the program are given in the Quality Assurance Project Plan (QAPP) *Intertidal Forage Fish Spawning Surveys in Washington Department of Natural Resources Aquatic Reserves* (Grilliot & Joyce, 2013).

Goals and Objectives

The goals of the intertidal forage fish-spawning survey are to:

- Collect time-sensitive baseline data throughout the reserve.
- Document changes over time in forage fish usage of the beaches using established methods that will provide data comparable across reserves and monitoring years.

The objectives of this project are to:

- Train and empower citizen scientists in conducting surveys using a standardized protocol
- Implement the surveys on a regular and consistent basis.
- Create a sustainable, locally operated structure to continue this work after the end of this grant.

Sampling Design and Procedures

The sampling design follows the WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols, Procedures for Obtaining Bulk Beach Substrate Samples (Penttila, 2011). Slight modifications of the protocol were made in steps 9 and 10 to eliminate the need to use preservatives when possible. The protocol is shown in the Appendix. Surveys were conducted every two weeks at randomly selected locations 1,000 feet apart. Essentially, the procedure was to document the location of the sampling transect, scoop out samples along the transect (Figure 3), pass the samples through a series of sieves (Figure 4), use a winnowing technique to separate the light fraction of the sample (Figure 5), and store that fraction in a sample jar. Once the samples were collected, labeled, and stored, they were transferred to WDNR staff for analysis.



Figure 3: Sampling along the transect line.



Figure 4: Sieving the sample.



Figure 5: Winnowing the sample.

Training

The original group of 12 volunteers was trained during the summer of 2012 by Dan Penttila, previously of WDFW and an expert on forage fish. There was classroom training of two hours about forage fish in general. Then there were two four-hour field trips in Fidalgo Bay on how to locate sites, collect samples, use of the GPS units, and filling out the various sections of the field sheet. After collecting samples, the volunteers practiced the sieving, winnowing, and preserving processes. Dan reviewed the activities and made suggestions throughout the training. The guided field trips were followed with four full-survey trips to practice the techniques. The training and a set of high-quality sieves were funded by the local Marine Resources Committee. Several additional volunteers joined the survey group since the beginning of the program. Many have become qualified surveyors by participating on multiple trips and practicing all the various steps. We expect to continually refresh and grow the team this way.

Narrative of the field research

Fidalgo Bay was divided into the West side and the East side. Each side has from four to six samples taken during a survey, depending on the random numbers (0 – 10) that determine the start points. Sample sites were 1,000 feet apart. Surveys were primarily conducted in the surf smelt zones of the beach and did not target the sand lance zones of the intertidal area, although there is some overlap of these zones. Only two “fixed” sites were sampled in the portion of the Reserve that is south of the trestle and Weaverling Spit because that area is mostly mud and very shallow. The fixed sites do have possible spawning habitat, although no evidence of spawning has been detected.

Each side was surveyed every two weeks, on alternating weeks. Thus, surveys were conducted at some location in the bay every week. There were typically two to four volunteers for each survey; at times, the group divided into two teams and surveyed the beach in two sections to reduce the time required for the survey.

The boat launch area of the Samish Indian Nation RV Park and Clubhouse on Weaverling Spit of Fidalgo Bay was used for our rinsing and sieving the gathered samples. The sieved, winnowed, and preserved samples and field sheet were saved and then transferred to the PSC when they were in the area. In turn, PSC provided empty sample jars and preservative as needed. The PSC was responsible for the detailed microscope analysis of the samples and reporting the results to FBARCSC. A brief narrative report for each survey trip was also produced and saved.

Outreach

Surf smelt spawn in Fidalgo Bay throughout the year with the greatest spawning from mid-April to early October when it is often very heavy in spots. Large schools spawning at an evening high tide is often a spectacular frenzy of smelt, dogfish, seals, birds, ringside watchers, and recreational dippers. Two educational signs about forage fish were displayed when the weather was nice and often get several curious people over for a little talk and demonstration. They ALWAYS tell us “Thank You” for our efforts. Interested “guests” accompanied us on a few survey trips, as well.

Results

The results of this study are the first observations for a multi-year study and some samples still await analysis. Therefore, the results are descriptive and are not intended to be used in statistical analysis.

The QAPP was approved in June 2013. While samples were collected in partnership with PSC prior to the QAPP approval, those samples were not considered part of this project. Therefore, the data shown here are from June 2013 to May 2014. During that period, 336 hours of volunteer time was spent doing the surveys.

Sampling

Sampling was divided into two sections, the East Section and the West Section. The number of samples taken in February and March are under-reported due to incomplete data sheets that will be addressed in future analysis, with reminders for proper adherence to field procedures in future training. Additionally, some of the samples taken in May need to be analyzed and included.

Of the recorded samples, 85 samples were obtained in the East Section; Figure 6 shows the frequency and number of samples taken in this section. The West Section had 127 samples taken and recorded, as shown in Figure 7. The locations of the samples are shown in Figure 8.

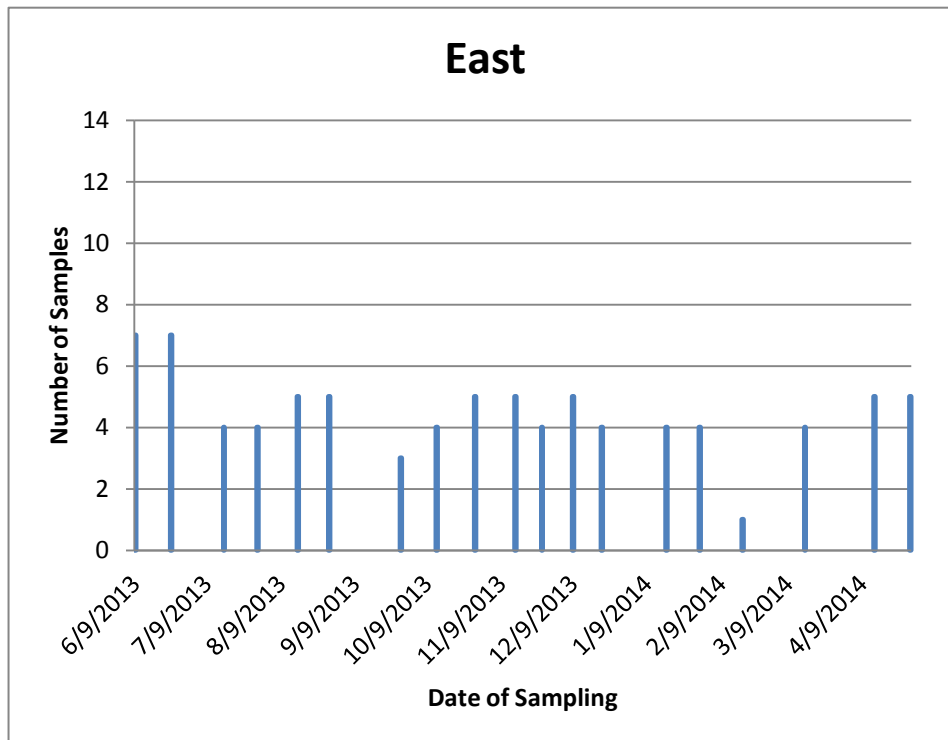


Figure 6: Number of samples taken in the East Section during each survey date.

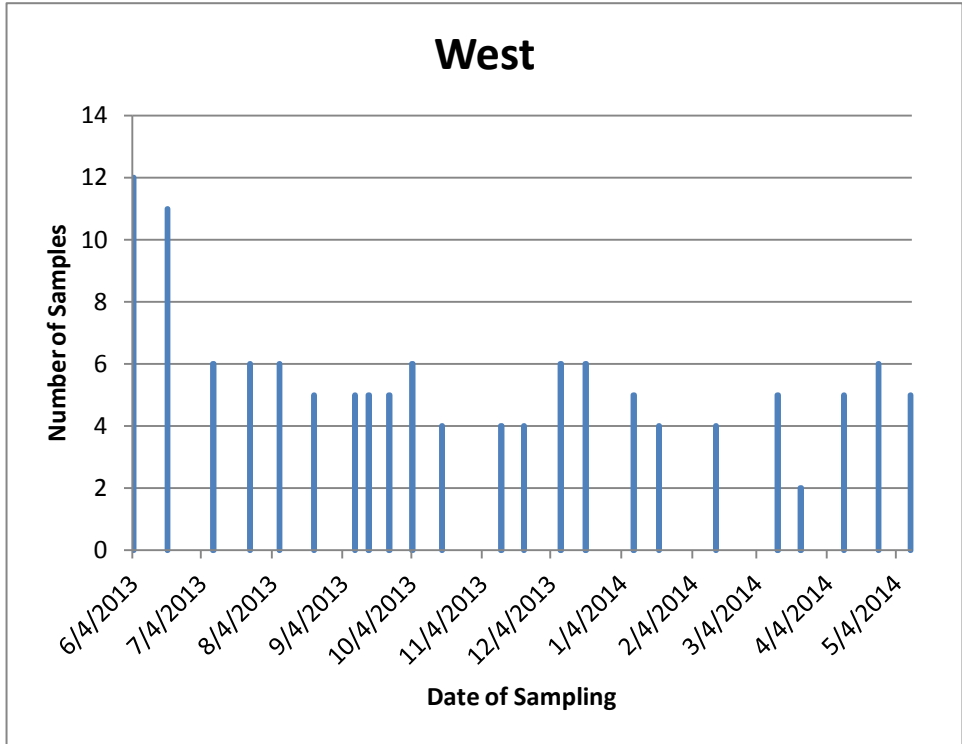


Figure 7: Number of samples taken in the West Section during each survey date.



Figure 8: Location of samples taken in Fidalgo Bay Aquatic Reserve.

Presence of Forage Fish Eggs

Of the 212 samples collected, 103 samples contained fish eggs, all identified as surf smelt eggs. No Sand lance eggs were found. Figures 9 and 10 shows the number of samples containing eggs by date.

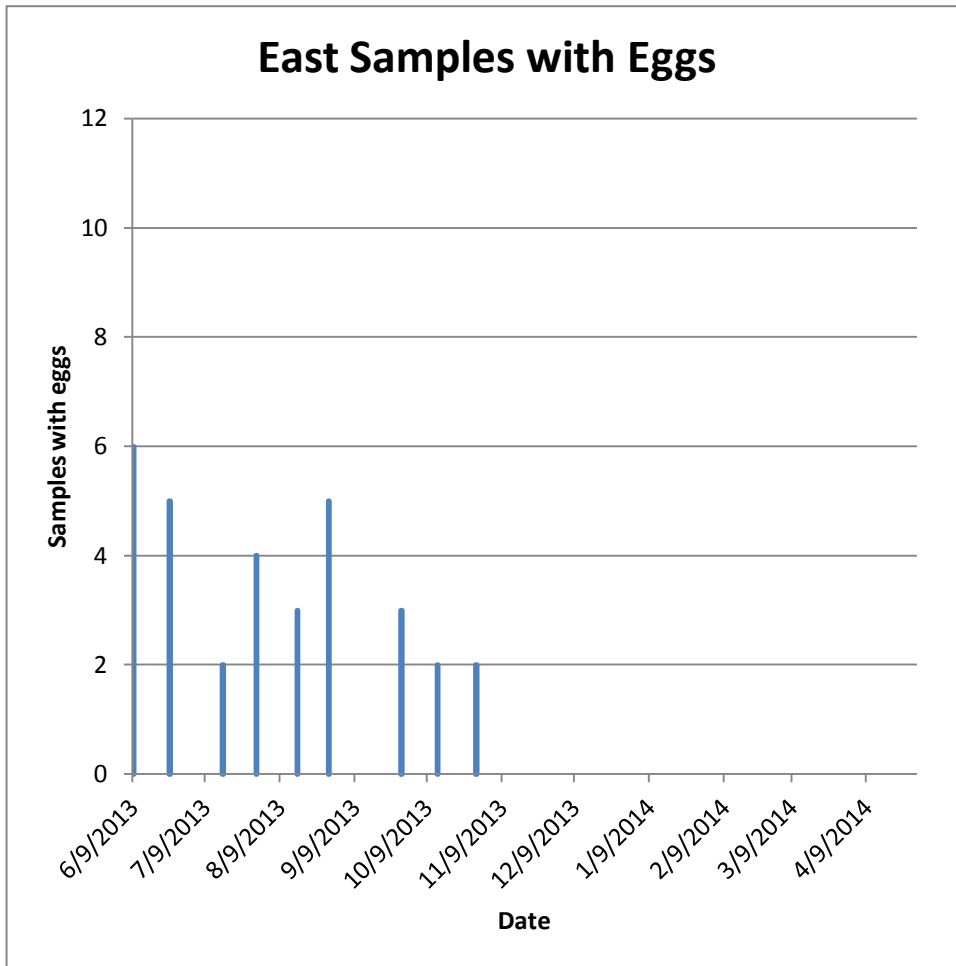


Figure 9: East section samples with surf smelt eggs by sampling date.

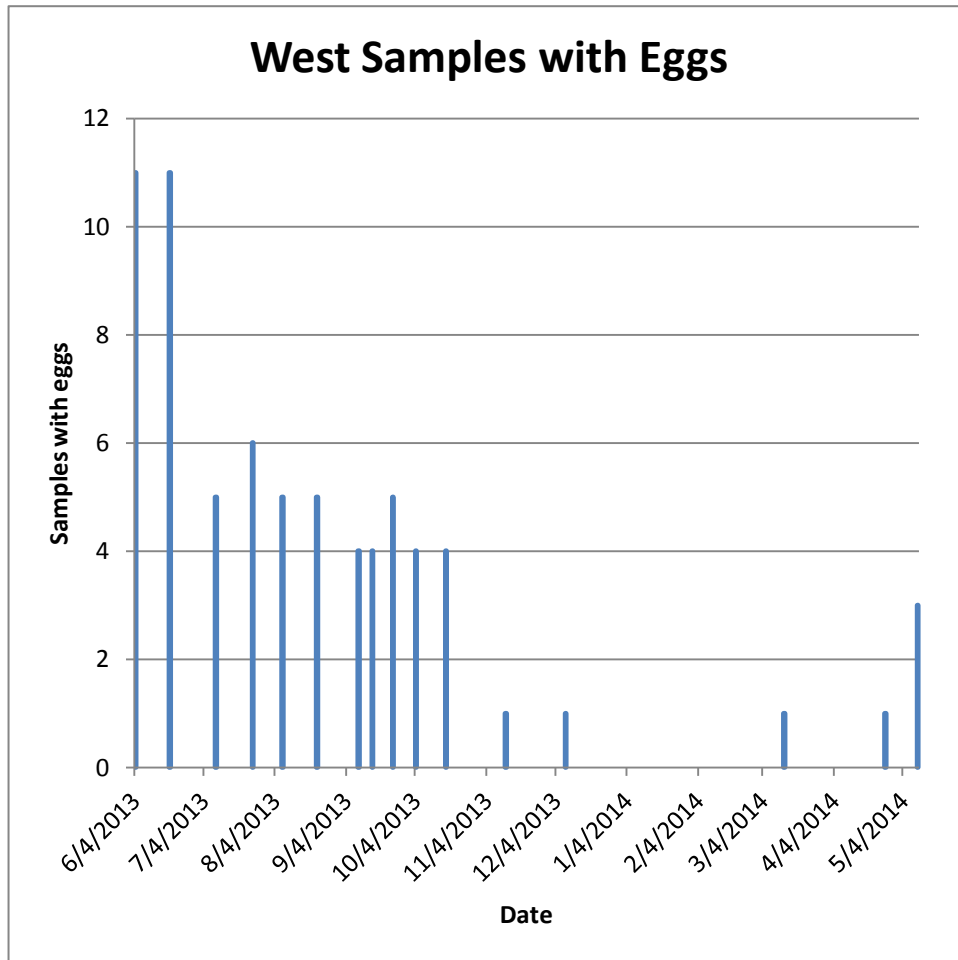


Figure 10: West section samples with surf smelt eggs by sampling date.

Established WDFW protocol requires a sample of two or more eggs to be indicative of spawning. A sample of a single egg is considered inconclusive in identifying spawning. Table 1 shows, by month, the number of samples that had two or more eggs, one egg, or no eggs. Again, samples from February, March, and May are underrepresented and will be corrected in the future.

Table 1: Samples indicting spawning by month

	Samples of >1 egg	Samples of 1 egg	Number of samples taken
Jun-13	33	0	37
Jul-13	16	1	20
Aug-13	18	0	21
Sep-13	15	1	18
Oct-13	10	1	19
Nov-13	1	0	16
Dec-13	1	0	21
Jan-14	0	0	17
Feb-14	0	0	4
Mar-14	0	0	4
Apr-14	1	1	21
May-14	1	2	5

Effort varied throughout the year, as fewer samples were collected when spawning was not expected to take place. While the low analysis rate in February and March might reduce the potential of identifying eggs, the intensive sampling in November-January and April-May indicate that most spawning occurs in the June-October time frame. However, the low samples analyzed for May might have affected the results, as a previous survey conducted in May 2013 found that of 37 samples, 22 samples contained more than one egg and three samples contained a single egg. Further analysis is needed to incorporate the analysis of the unanalyzed samples from February, March, and May.

Discussion

This was the first year of this study directed by FBARCSC, although WDFW had established and well-tested protocol for the collection and preservation of the samples and PSC provided assistance and training for established sampling procedures.

The stated goals and objectives were met. The first goal, to create a time-sensitive dataset of spawning throughout the reserve was achieved for surf smelt, the target of this study. The data indicates approximate dates of surf smelt spawning as well as quantity and geographic locations. Detailed microscopic analysis by WDNR should show development and mortality rates. The set of data collected is likely adequate to conduct additional types of analysis, including preferred spawning locations and effects of various types of beach substrate. This type of analysis requires additional resources that hopefully will be conducted in the future.

The second goal, to document change over time and area, has been addressed by systematically collecting data throughout the year, but needs additional years of sampling to detect any changes and

trends. By using a standardized protocol and training, the monitoring at FBAR should be compatible with monitoring at other reserves and areas.

At FBAR, much of the beach area that was surveyed has been refreshed or restored in a variety of ways during the past few years, so continuing monitoring over time should add to the knowledge of best practices for fostering or maintaining surf smelt spawning.

The establishment of the monitoring program meets the objectives of this project. Citizen scientists have been trained to collect samples using the established protocol, the sampling continues, and the program is planned to continue well past the end of this grant. The WDNR will be continuing their support of this program through 2015, and in the future, funds will be solicited from local organizations as well as other possible grant sources.

Completeness of the Survey

The target for completeness in this study is to collect beach samples for 95% of the planned bimonthly and monthly sampling events. The survey far exceeded that target as samples were collected four times a month from June 2013 to April 2014 and at least once in May 2014. However, as stated earlier, the samples were taken primarily in the intertidal areas where surf smelt spawn and did not specifically sample in the intertidal zone where sand lance spawn, although these zones do have some overlap. An additional study may be needed to survey sand lance spawning.

Assessment of the Feasibility of this Study

The study has been very successful for a number of reasons. Fidalgo Bay is a known spawning area and eggs are often found, and sometimes many, which helps to maintain motivation and excitement. The core group was very interested and well trained from the beginning. It was particularly beneficial to have so much time with Dan Penttila and his extensive knowledge and experience. A smaller group of volunteers has devoted many hours to the effort, especially during the chilly, damp, dark trips in the winter months. Getting periodic feedback from the WDNR about the samples helped everyone better understand the results and showed that the data is useful. The Puget Sound wide emphasis on forage fish is also a positive motivator. As other people in the area become aware and interested, they were invited to join the survey trips. It has been quite successful and is a great way to provide more education and recruit new folks to the effort.

Recommendations for any Modification of the Procedures and the Program

A survey team needs a set of equipment, most of which is low cost and easily obtainable. However, a high quality set of sieves, and access to Stockard's preservative solution is costly and difficult to obtain, so arrangements for that need be part of the initial plan and organization.

The field sheet has some columns that are not well explained that could use some review and possible simplification, especially those regarding landmarks. Additionally, some field sheets were not fully completed and resulted in some samples not being processed. To avoid that, a better quality control program needs to be implemented, such as completion of a full checklist prior to transferring the samples to WDNR.

The initial documentation for this project did not clearly state that this was a survey for surf smelt only by referencing only surveying for forage fish. Future documentation should clarify that this is a surf smelt survey.

For the program to work with citizen volunteers there needs to be a group that are well trained in the topic of forage fish and in the specific processes used in the survey. We find that most volunteers are not comfortable and proficient until they have been out in the field on two or three complete trips using all the various steps. It would be useful if the data could be summarized and popularized, in a few simple charts and graphs, and provided back to the groups on at least a quarterly basis. The program has many opportunities to engage with the public, and that kind of material would be most valuable to show and talk about.

It may also be of value to train and equip survey teams to do more of the detailed microscopic analysis. If they could do this immediately after a survey collection of samples, it would eliminate the need for preserving the samples with the Stockard's solution, which is a hazardous waste and unpleasant to work with.

Lastly, the results of a program like this should spur actions that can improve, and better protect, the population of forage fish in the survey area. In the FBAR case, better shading of known spawning locations is severely lacking. Yet after several years, and hundreds of volunteer hours, of collecting and analyzing data, nothing has been done other than insignificant symbolic shrub plantings that provide no shade at all to the key locations.

Conclusions

This program was successfully conducted with useful information collected. The program has adequate equipment and enthusiasm to continue the study into the near future and we hope that it will lead to better protection for existing habitat and enhancement where possible. Some minor modifications to the data-recording methods may be necessary to assure complete and accurate data collection. In addition to creating a substantial dataset on spawning of the Surf Smelt, the program had a substantial outreach program that will likely foster public stewardship of the reserve.

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Appendix: Sampling Design and Procedures

The sampling design follows the WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols, Procedures for Obtaining Bulk Beach Substrate Samples (Penttila, 2011). Slight modification of the protocol has been made in steps 9 and 10 to eliminate the need to use preservatives when possible. Descriptions of the winnowing method are given in the QAPP (Grilliot & Joyce, 2013). The sampling protocol is as follows:

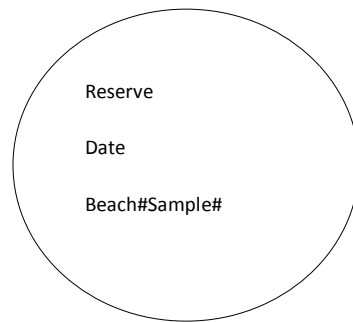
Note: Sampling should occur on the lowest tide practicable. Prior to sampling any site consult tide tables to ensure you will be able to access the +7-9 (surf smelt) and +5-8 (sand lance) tidal height. It may also be necessary to obtain permission to access the beach from private or corporate landowners.

Procedure:

1. Upon arriving on the beach, fill out the header information on the attached data sheet. Do not fill in "Reviewed by." Before conducting the first sample, describe the character of the upland and beach environment using the codes provided on the back of the data sheet. For additional details on sample codes, see Moulton and Penttila (2001).
2. Identify a landmark from which you will measure the distance to the bulk substrate sample tidal elevation. Typical landmarks include the upland toe of the beach, the last high tide mark or wrack line, and the edge of the water.
3. Measure the distance from the landmark to the tidal elevation to be surveyed.
4. Stretch a measuring tape at least 100 feet along the selected tidal height. Note that beach contours may cause the landmark to be "wavy" and that the tape should remain a consistent distance from the landmark.
5. Standing at the 50-foot mark of the measuring tape, record a GPS fix on the data sheet.
6. Using a 16-ounce sample jar or large scoop remove the top 5-10 cm (2-4 in) of sediment from the location recorded in Step 5 above. Place the sediment in an 8 inch x 24 inch polyethylene bag or large, sturdy ziplock. You may need to take two scoops to get sufficient sediment, depending on the coarseness of the beach.
7. Walk ten paces (single steps) along the measuring tape, repeat the sediment scooping action, and place the sediment in the bag. Move an additional ten paces and repeat. Move an additional ten paces, approximately to the end of the tape, and repeat. The bag should now have sediment from four locations along the tape and be at least $\frac{1}{2}$ to $\frac{3}{4}$ full. Place completed waterproof sample label in bag with sediment. Label should include reserve name, Beach# sample#, data and sampler initials.
8. If additional transects, representing various tidal heights, along the beach are to be surveyed, place the sample bag in a cool, shady place and repeat the above procedures at these additional locations. If no additional samples will be taken, move on to wet sieving and winnowing the sample as described in the companion protocol *Procedures for recovering winnowed light fractions subsamples of forage fish egg-sized material from bulk beach substrate samples*.
9. Place each winnowed subsample in a sample jar, making sure threads are clean to ensure a tight seal. Label each jar (in pencil) with reserve name, date, and beach# sample#. If samples may not be transported within 24hours, the preservative Stockard's Solution may be added. If it is added,

the closed jar should be inverted at least three times to be sure all the preservative is distributed. When using Stockard's Solution, mark the jar with a large X to indicate a preservative has been used. See Figure 11 as an example of labeling.

Figure 11: Example of labeling sample jar.



10. Store sample collections in a cool location, making sure the samples are not frozen. Transport samples to WDFW personnel for analysis within 24 hours of collection unless a preservative has been used.
11. If you have a camera, take several photos of the survey area showing sampling locations. Be sure to take photos from several perspectives (i.e., both up and down, as well as along, the beach). For each photo, record the cardinal direction you are facing on the data sheet in the comments field. For our purposes, one photo of the transect from either end is sufficient, but highly encouraged! Still important to record cardinal direction.