Whatcom Marine Resources Committee (MRC)

2025 Forage Fish Monitoring Final Report

Prepared by: Austin Rose and Dana Flerchinger, Whatcom MRC Staff

Whatcom County Public Works—Natural Resources

Reporting Period: October 2024-September 2025

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Abstract

The Whatcom MRC participates in a regional effort, led by the Washington Department of Fish and Wildlife (WDFW), to characterize populations of the two species of forage fish that spawn on Puget Sound beaches: Pacific sand lance and surf smelt. This project has included a successful collaboration between WDFW, the Northwest Straits Initiative, and the MRC's citizen scientists, which has improved knowledge of forage fish spawning grounds in Washington State.

The MRC recruits and trains volunteers to conduct spawning surveys at priority beaches in Whatcom County as identified by the MRC and WDFW. During the reporting period, surveys were conducted monthly at Little Squalicum Beach and every other month at Clayton Beach using forage fish survey protocols developed by WDFW. MRC staff and volunteers conducted the forage fish survey sample collection and processing, then sent the condensed samples to WDFW for egg counting, identification, and analysis. From October of 2024-June of 2025, 234 surf smelt eggs were found at Little Squalicum Beach and 1 surf smelt egg was found at Clayton Beach. Forage fish samples from the remainder of the reporting period (July-September) are awaiting analysis by WDFW.

Gathering data on forage fish spawning grounds can result in legal protections of spawning beaches, can inform potential soft shore restoration projects for Whatcom County, and can be used to assess the effectiveness of local restoration projects. The MRC will continue to work with local partners to identify and prioritize critical areas to be monitored for forage fish spawning throughout Whatcom County.

Project Goals

Because forage fish are a vital component of the food web in the Salish Sea, the Washington Department of Fish and Wildlife (WDFW) monitors their population status, spawning locations, and how they respond to shoreline development. The MRC serves as a local partner to WDFW to support their statewide sampling efforts and expand the impact of the study. As such, the goal of the forage fish monitoring project is to survey local beaches for forage fish to support state wide sampling and to inform potential soft shore restoration projects for Whatcom County.

Project Engagement

Forage fish monitoring efforts rely on community volunteers and staff from Whatcom County Public Works (WCPW). The scope of forage fish monitoring efforts in Whatcom County is shaped in part by project partners including the City of Bellingham, the Port of Bellingham, and the Northwest Straits Foundation. Since 2023, the MRC has conducted forage fish surveys along Squalicum Beach and Clayton Beach. Little Squalicum was chosen with the MRC's knowledge and support of shoreline restoration projects recently completed by the City of Bellingham and the Port of Bellingham. Clayton Beach was chosen in partnership with the Northwest Straits Foundation and the Skagit MRC in preparation for a proposed shoreline restoration project.

Partners/ Organizations

- **Washington Department of Fish and Wildlife (WDFW):** Coordinated data analysis, supplies for volunteers, training, and on the beach sampling practice and refreshers. Developed and provided protocols.
- **Northwest Straits Commission (NWSC):** Coordinated with MRC project managers and WDFW staff to provide supplies/materials and training to volunteers. Received samples from the MRC and transferred to WDFW.
- **Whatcom County Public Works (WCPW) MRC Staff:** Set sampling dates, managed volunteer coordination, led sampling and processing efforts following protocols, tracked training needs, and coordinated with NWSC and WDFW. Created county reports and managed data.
- **The City of Bellingham:** Completed restoration of the Little Squalicum Estuary in 2024, aiming to restore tidal and sedimentary processes, to improve fish passage, and to return saltmarsh, mudflat and estuary habitats to an area where historical wetlands had been lost.
- **The Port of Bellingham:** Completed a shoreline enhancement project at Squalicum Beach to remove industrial fill, wood waste, and large slabs of broken concrete from the shoreline, creating a much larger and more accessible beach and creating priority habitat for forage fish.
- **Northwest Straits Foundation:** Provided suggestions to the MRC to monitor Clayton Beach in partnership with the Skagit MRC in preparation for a proposed shoreline restoration project at this location.

Participants

Forage fish survey efforts depend on community volunteers and staff with WCPW. A full volunteer list is included in Appendix A. Throughout the reporting period, 12 volunteers participated, contributing over 65 hours of volunteer time to the project.

Volunteers assist with forage fish sample collection and processing. Photo credits: Dana Flerchinger, MRC staff.

Methods

Sample collection, processing, and analysis were conducted according to WDFW protocols (See Appendix B). Activities were conducted by or under direct supervision of MRC staff and MRC volunteers that have completed the WDFW forage fish survey training. The MRC also created and followed a Standard Operating Procedure (See Appendix C), that provided step by step instructions on survey planning, equipment cleaning, and other survey details. Forage fish surveys were conducted monthly when the tide was below 5ft for the entirety of the survey process.

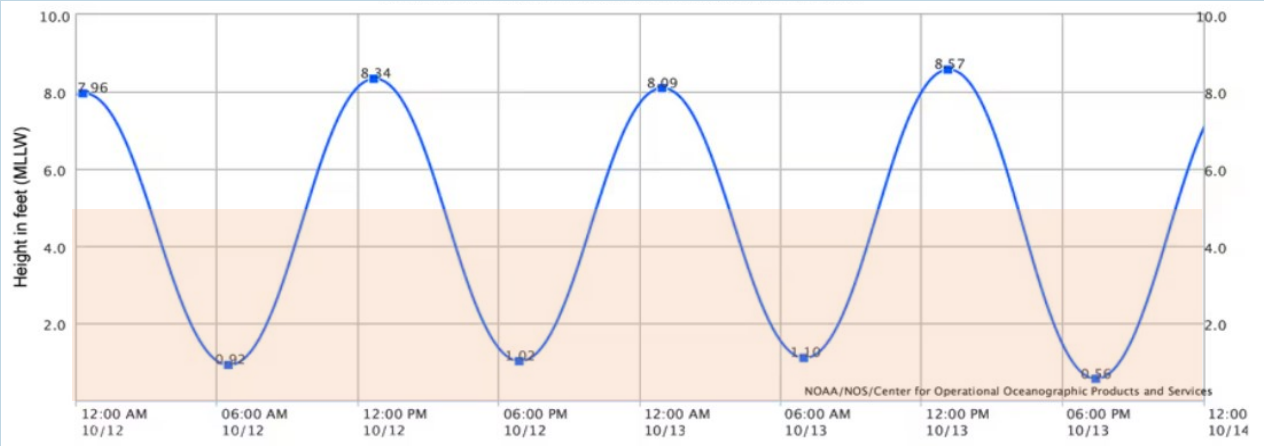

Figure 1: Example tide table showing appropriate tide window (less than 5 feet highlighted in tan) for the surveys.

Methods

- A bulk sediment sample is collected and condensed to concentrate eggs.
- While conducting the bulk sediment sample collection, photos are taken to effectively characterize each of the sampling locations.
- Field data is entered into an iForm application on the MRC's field tablet, which is accessible to WDFW.

Left: Bulk substrate collection. Photo credit: Dana Flerchinger, MRC staff. **Right:** Photo characterizing a sample location along measuring tape. Photo credit: Eleanor Hines, MRC volunteer.

- Samples go through a wet sieving and winnowing process to obtain subsamples of forage fish egg-sized material from bulk beach substrate samples.
- A vortex method is used to separate lighter forage fish eggs from heavier sediment. The smaller volume of beach material that is then transferred to WDFW for lab analysis.

Left: Wet sieving and winnowing process. **Right:** The vortex method. Photo credit: Austin Rose, MRC staff.

Methods: Little Squalicum Beach

The MRC collects bulk sediment samples from 4 locations along Squalicum Beach, within the beach nourishment areas of the two recent restoration projects completed by the City of Bellingham and Port of Bellingham.

Forage Fish Survey Station ID	Latitude, Longitude
LSE-1 (Reference Site)	48˚45.804, -122˚ 30.834
LSE-2 (Near Estuary Tidal Channel)	48˚45.870, -122˚ 30.027
LSE-3 (Beach Nourishment)	48˚45.936, -122˚ 31.261
LSE-4 (Beach Nourishment)	48˚45.967, -122˚ 31.391

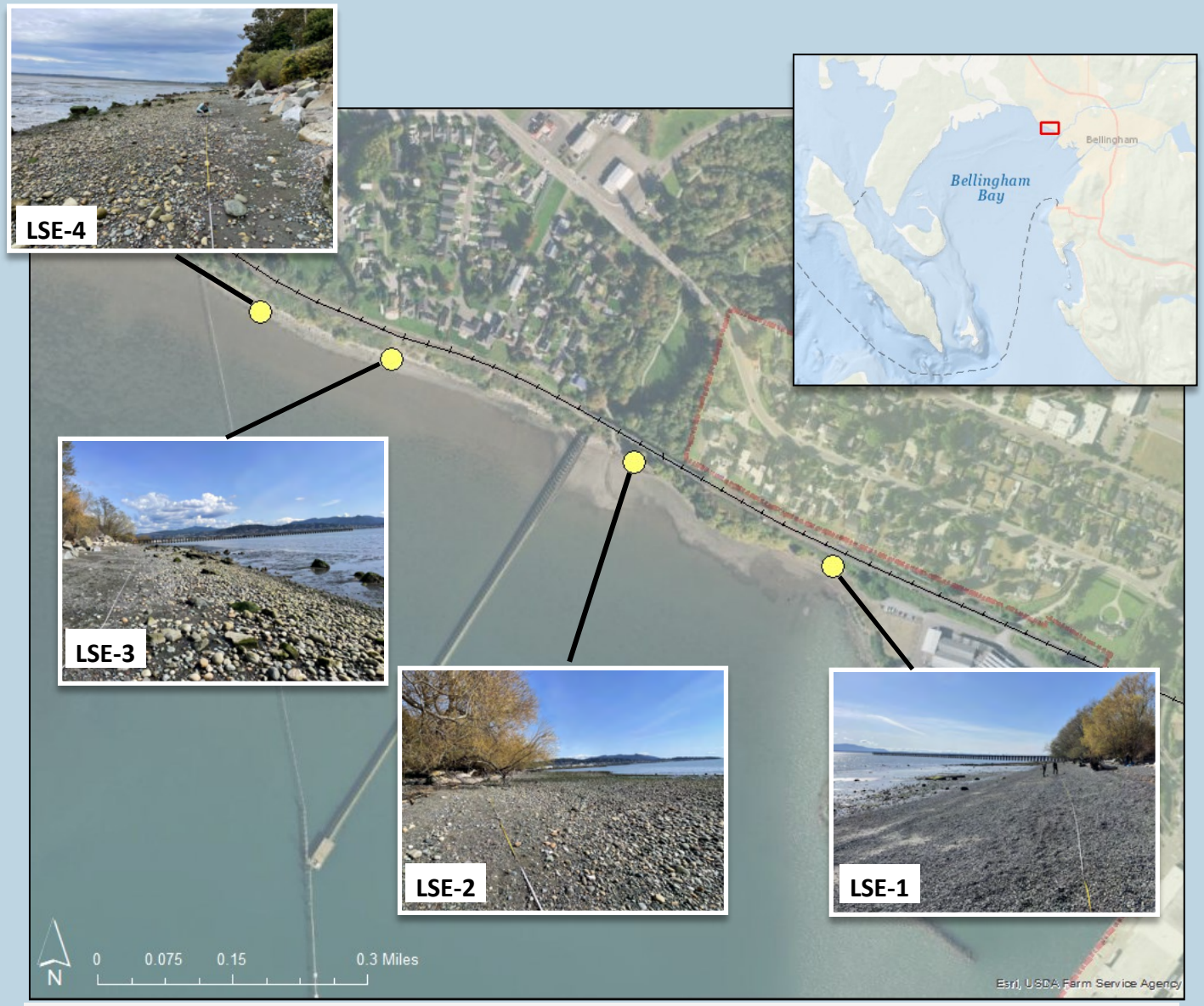

Figure 2: Sampling locations along Little Squalicum Beach. Photo credits: Dana Flerchinger, MRC staff.

Methods: Clayton Beach

In partnership with the Northwest Straits Foundation and the Skagit MRC, the Whatcom MRC conducts forage fish surveys at Clayton Beach every other month (the Whatcom MRC switches off with the Skagit MRC as this site is right on the county line). The MRC collects bulk sediment samples from 2 locations that are randomly selected relative to an established midpoint on the beach. These surveys are conducted in anticipation for a proposed nearshore restoration project at Clayton Beach.

Forage Fish Station ID	Latitude, Longitude
Clayton Beach (Restoration Site)	48° 38.41236, - 122° 28.89498

Figure 3: Sampling locations at Clayton Beach. Photo credit: Dana Flerchinger, MRC staff.

Results: Little Squalicum Beach

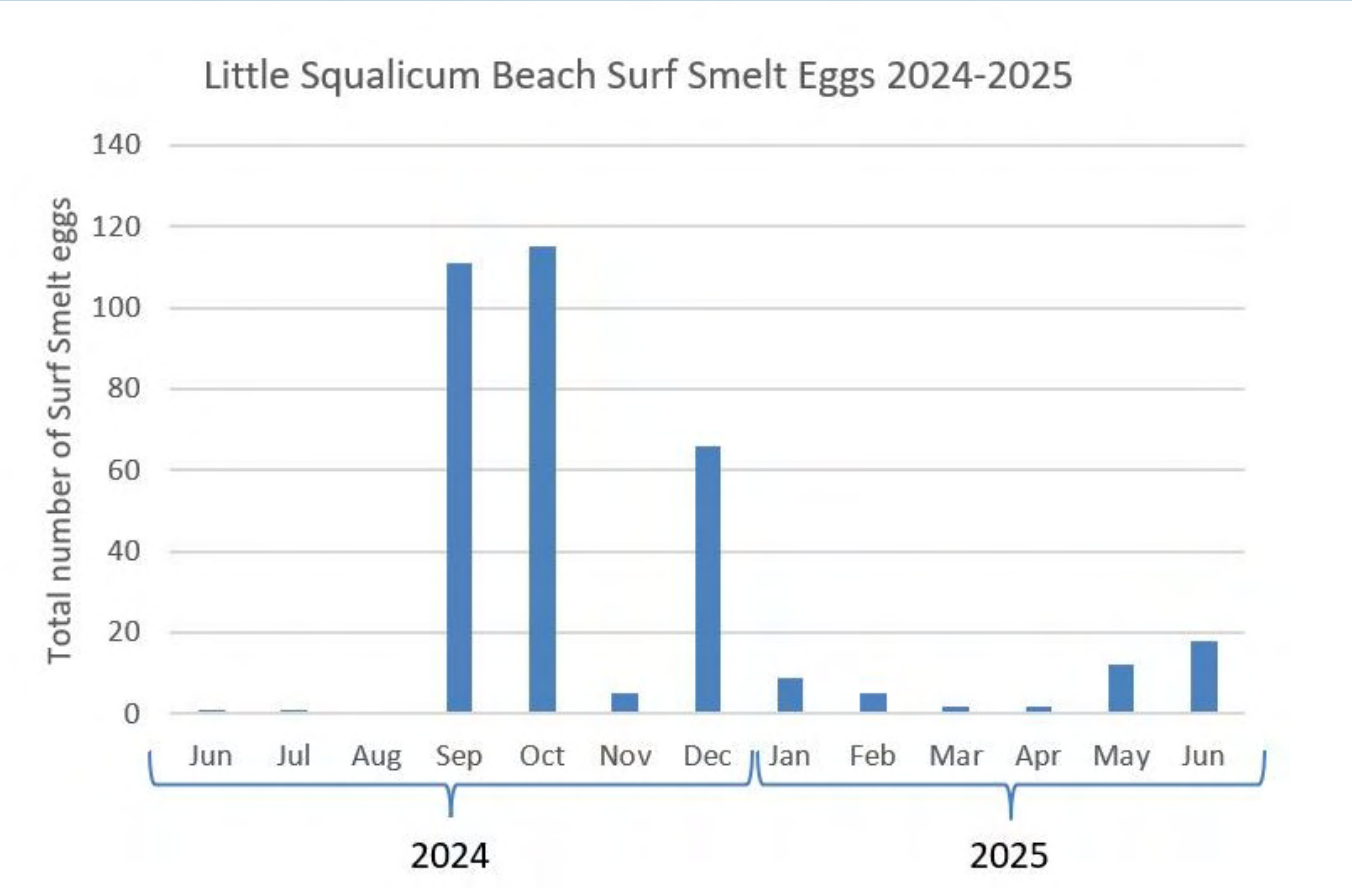

Figure 4: Surf smelt eggs found at Little Squalicum Beach from 2024-2025. Total number of surf smelt eggs represent the combined counts at each of the 4 sites at Little Squalicum Beach. However, site LSE-1 had the majority of the eggs. Data from 2025 only goes until June as WDFW has not yet processed the samples from July-September of 2025 due to capacity limitations. All raw data are included in Appendix D.

Results: Clayton Beach

The surveys at Clayton Beach started in October of 2023. Since then, only two surf smelt eggs have been found (in December of 2023 and February 2025). Samples from May through September of 2025 are awaiting analysis by WDFW. All data is included in Appendix D.

Outcomes

The MRC continued to gather data on forage fish spawning grounds by monitoring two locations in Whatcom County for forage fish eggs. This project included successful collaboration between WDFW, the Northwest Straits Initiative, and MRC volunteers, improving knowledge of forage fish spawning grounds in Washington State.

Outputs

Over the course of the monitoring season:

- 60 samples were collected over 18 sampling events at Little Squalicum Beach and Clayton Beach
- 12 volunteers participated
- Over 65 volunteer hours were contributed

Clayton Beach sampling location. Photo credits: Dana Flerchinger, MRC staff.

Results in Context

All of the finalized data state wide is currently available in the Marine Beach Spawning map, with results through November 2024 for all partner agencies (this was updated in July 2025). While the spawn 'presence' data is visible, this map includes and can display all surveys that were conducted in the history of this project, regardless of presence. The public map hosted on WDFW's website allows the user to filter by date, collecting organization, species, etc, this data is also available in ArcGIS online as a public layer (search "forage fish") which allows any analysis to be conducted.

Lessons Learned and Next Steps

As coastal development and the impacts of climate change and sea level rise continue to impact shorelines throughout Whatcom County, identifying areas of critical habitat for forage fish spawning will be essential to effectively protect these vital populations. The MRC will continue to work with local partners to identify and prioritize critical areas to be monitored for forage fish spawning throughout Whatcom County.

WDFW balances reporting requirements and field requests from many different groups throughout the year, which can result in delays receiving forage fish egg presence results from the sediment samples collected. In the future, MRC staff will be in communication with WDFW far in advance to ensure that more results could be ready to include in final reporting.

Appendices

- **Appendix A**: Participating Volunteer List and Volunteer Email Distribution List
- **Appendix B**: WDFW Forage Fish Survey and Processing Protocols
- **Appendix C**: Forage Fish Survey MRC Standard Operating Procedures
- **Appendix D**: Raw Forage Fish Data from WDFW

Appendix A:

Participating Volunteer List and Volunteer Email Distribution List

MRC
Whatcom County

Name (print)	Date	E-mail Address or Phone No.	Hours Volunteered
Itzel Perez Morales	10/15/2024	iperez mo@co.whatcom.wa.us	3
Priscilla Drewry	11/12/2024	pdrewry@co.whatcom.wa.us	2
Itzel perez Morales	11/13/2024	see above	3
Joey Lane	11/13/2024	joeylane@whidbey.com	3
Priscilla	12/9/2024	See above	3
Zoe Fry	1/23/2025	Zoef@re-sources.org	2
Zoe Fry	2/21/2025	↓	3
Lindsay Hoessini	3/13/2025	theister01@gmail.com	1
Zoe Fry	3/14/2025	See above	2.5
Zoe Fry	4/10/25	See above	2
Morgan Keller	5/13/25	MKeller@co.whatcom.wa.us	1
Lindsay Hoessini	5/14/25	see above	1.5
Morgan Keller	6/17/25	See above	3
BTC Students (20)	6/17/25	bpalm@btc.edu (BTC Hatchery manager)	3
Lindsay Hoessini	7/10/25	See above	2
Morgan Keller	7/11/25	See above	3
Morgan Keller	8/25/25	See above	3
Laura Hanna	8/25/25	laura0401@live.com	3
Laura Hanna	9/18 + 9/19/25	See above	5
Michael Cecil	9/19/25	cecil@leon-environmental.com	3
Alina Bulthuis	9/19/25	a.bulthuis@gmail.com	3

First Name:	Last Name:	Email Address:	Notes:	Date Added:
Alice	Sigurdson	asigurdson@yahoo.com		Oct-19
Amanda	Weiss	rosiejo80@gmail.com		Oct-19
Amy	Keiper	keiperame@gmail.com		Oct-19
Analiese C.	Burns	acburns@cob.org		Oct-19
Andrea	Vance	pdxgirl@gmail.com		Oct-19
Ann	Brooking	brookingann@yahoo.com		April 2019
Annie	Thomas	anniethomas910@gmail.com		Oct-19
Antonia	Parrish	parrishantonia@gmail.com		April 2019
Atina	Casas	atinacasas@gmail.com		Oct-19
Austin	Hengy	austin.hengy@yahoo.com		March-2020
Barbara	King	brfking@aol.com		Oct-19
Bea	Acland	beaacland@hotmail.com		Oct-19
Bob	Seaman	rlseaman@peoplepc.com		Oct-19
Braelan	Barnett	bbraelan@gmail.com		Oct-19
Brooke	McIntyre	mcintyba@gmail.com		Oct-19
Candice	Cross	Candiceleecross@gmail.com		March-2020
Chelsea	Hilmoe	chelsea.hilmoe@gmail.com		April 2019
Cherri	Cousins	cherri24.cc@outlook.com		Oct-19
Chris	Johnson	chrisjhnsn8@gmail.com		Oct-19
Christeen	Glass	cpgwest@yahoo.com		Oct-19
Christina	Bemment	chrysbemm@gmail.com		Oct-19
Christine	Austin	chrisot64@gmail.com		March-2020
Christy	Bell	cbell507@msn.com		April 2019
Colin	Ridgley	colinzridgley@gmail.com		Oct-19
Connie	Miller	whidbeycf@hotmail.com		Oct-19
Doug	Stark	starkdna@gmail.com		Oct-19
Drew	Morris	drewmorris.zeyda@gmail.com		April 2019
Dylan	Bruce	akdylan17@gmail.com		Oct-20
Elsie	Wattson Lamb	elsievz1@gmail.com		Oct-19
Emily	Lozeau	emilylozeau@gmail.com		Oct-19
Eric	Jackson	ejackisback@gmail.com		Oct-19
Erica (DNR)	Bleke	erica.bleke@dnr.wa.gov		Oct-19

Gillian	B	retto122@gmail.com		20-Dec
Heather	Murray	Heatherlfm@gmail.com		April 2019
Holly	Hansmeier	hollyhansmeier@hotmail.com		April 2019
Jackie	Sior Hackett	jackelynjhackett@gmail.com		March-2020
Jacquelyn	Styrna	Jacquelyn.styrna100@gmail.com		April 2019
James	Ridgley	ridgeman@sbcglobal.net		Oct-19
Jamie	Powell	jamielcpowell@gmail.com		April 2019
Janis	Olson	olsonjanis1@gmail.com		April 2019
Jessi	Peterson	jpeterson42@hotmail.com		March-2020
Jill	Bliss	jill@jillbliss.com		April 2019
Jim	Ashby	ashby.jim@gmail.com		March-2020
Joelle	Blais	joelle.blais21@hotmail.com		Oct-19
John	Bremer	john.bremer@comcast.net		Oct-19
Jonathan	Hucke	jonathanhucke@gmail.com		Oct-19
Judith	Akins	sunsetjam@gmail.com		April 2019
Katherin	Mitchell	katherin.mitchell@gmail.com		April 2019
Katherine	Myrvold	k.m.myrvold@gmail.com		April 2019
Kathy	Ketteridge	kketteridge@gmail.com		8-Jun
Kelland	Harrison	kellandsemail@gmail.com		April 2019
Kendra	Aldrich	kendra.aldrich@gmail.com		March-2020
Kimberly	Adamson	kimiadamson@gmail.com		Oct-19
Kristi	Short	kristileeshort@gmail.com		Oct-19
Kristin	Fredericks	kristin.fredericks@gmail.com		Oct-19
Kristin	Wilmes	dodderk@gmail.com		March-2020
Kriswell	Weyrauch	k.weyrauch@yahoo.com		Oct-19
Laura	Ward	lauramward4282@gmail.com		March-2020
Leslie	Sigurdson	leslie.sigurdson24@gmail.com		April 2019
Lindsey	Parker	lindsey.parker2816@gmail.com		April 2019
Lisa	Balton	lisazebra@msn.com		Oct-19
Mathew	Pellinger	matp12@live.com		Oct-19
Melissa	Morin	morin.melissam@gmail.com		April 2019
Michael	Olsen	molsen@syix.com		Oct-19
Michelle	Joseph	michellejoseph102@gmail.com		Oct-19

Mike	MacKay	starsailor@fidalgo.net		April 2019
Monica and Kaleb	Craig	craig.monica11@gmail.com		Oct-19
Morgan	McGoldrick	morganb.mcgoldrick@gmail.com		April 2019
Morrigan	Harrington	Daftmorrigan@gmail.com		March-2020
Nancy	Orlowski	Nmorlowski@yahoo.com		March-2020
Oceanna	Boulanger	oceanna234@gmail.com		Oct-19
Patrick	Staymates	misterbackpacker@yahoo.com		April 2019
Peggy	Ratermann	Ratermann.peggy@gmail.com		April 2019
Rachel	Arnold	frogfishes@gmail.com		Jan-2020
Raena	Anderson	raena.anderson@gmail.com		Oct-19
Raymond	Paraiso	ray.paraiso1297@aol.com		Oct-19
Ryan	Robie	ryroster@gmail.com		April 2019
Sally	Vaux	vauxs@wwu.edu		April 2019
Sara Brooke	Benjamin	sbbenjamin@cob.org		Oct-19
Sofie	Broznowski	broznowski.sofie@gmail.com		April 2019
Steven	Steffens	steffensinc@msn.com		April 2019
Stu	Currier	stucurrier729@gmail.com		April 2019
Suzy	Tonini	stonini@gmail.com		Oct-19
Teresa	Van Haalen	vhaalen@comcast.net		Oct-19
Thomas	Harron	thomharron@gmail.com		Oct-19
Tim	Hankins	hanktim1949@gmail.com		13-Sep
Vicki	Roy	Royvicki54@yahoo.com		April 2019
Whitney	Oehlerking	whitoehlerking@gmail.com		Oct-19
William	James	bill.james010@gmail.com		Oct-19
Yarrow	Greer	yea_44@hotmail.com		March-2020
Zachary	Pattek	zspattek@gmail.com		April 2019
		douglac6@outlook.com		Oct-19
		gmatyszak@msn.com		Oct-19
		jlandsem@comcast.net		Oct-19
		budelsky@comcast.net		Oct-19
		atnylen@frontier.com		Oct-19
Zosha		sophiapakker@gmail.com		2023
Lindsay	Hosseini	lheister01@gmail.com		2023

Victoria		vmlarnach@gmail.com		2023
Lauren	Sommer	laurenjsommer@gmail.com		2023
Heather	Merchant	hfmerchant@yahoo.com		2023
Avery	Garritano	garritano.avery8@gmail.com		2023
Tess	Reding Hoffart	teresaredinghoffart@gmail.com		2023
Megan	Corbiere	meg.corbiere@gmail.com		2023
Casey		caseyrhart16@gmail.com		2023
Mary Ann	Percy	earthling27@gmail.com		2023
Dawn	Hunter	arcanereveries@gmail.com		2023
Henry	Pfeffer	henrypfeffer@yahoo.com		2023
Ashely	Gamboa	nowisthemoment@gmail.com		11/1/2023
Jack	Gates	jagates35@gmail.com		11/14/2023
Lydia	Swets	lydiaswets@gmail.com		11/20/2023
Laura	McRoberts	laura.mcroberts96@gmail.com		12/18/2023
Emma	Nestvold	e.nestvold@gmail.com		12/18/2023
Hugh		hughlk@bu.edu		2/2/2024
Erin	Page	epage@co.whatcom.wa.us	WCPW Engineering	7/22/2024
Joey	Lane	joeylane@whidbey.com		7/23/2024
Sydney	Jantsch	sydneyj@lummi-nsn.gov	Lummi Natural Resources	7/30/2024
Taryne	Vanhulle	taryne.vanhulle@wsdot.wa.gov	WSDOT Envi Specialist	7/30/2024
Lizzie	Lutes	lizzi.lutes@dfw.wa.gov	WDFW wildlife biologist- met	10/28/2024
Kathy	Ketteridge	kathy@gobluecoast.com	MRC project lead	12/6/2024
Zoe	Fry	zoef@re-sources.org	RE Sources Americore	12/12/2024
Avery	Maverick	Avery.Maverick@naturaldes.com	MRC Member	2/13/2025
Lindsay	Davis	linzd@hotmail.com	reached out to Austin	5/29/2025
Noelle	Beecroft	noelle.beecroft@wsu.edu		
Laura	Hanna	laura0401@live.com	reached out to austin	6/30/2025

Appendix B:

WDFW Forage Fish Survey and Processing Protocols

WDFW Intertidal Forage Fish Spawning Habitat Survey Summary

Procedures for obtaining bulk beach substrate samples

Field materials needed:

Measuring tape (100+ feet)
16-ounce plastic jar or large scoop
8 inch x 24 inch polyethylene bag (or large, sturdy ziplock)
Handheld GPS device
Tide table
Digital camera
Hypsometer (if available)
Data sheet and sample tags (preprint on Write-in-the-Rain paper)

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 (surf smelt) and +5 (sandlance) 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. Note that linear measurements along the beach face serve as an index of tidal height but do not directly quantify *vertical* tidal height. If available, a hypsometer can be used to measure vertical sampling height.

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'.

5. Standing at one end 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 6 above. Place the sediment in an 8 inch x 24 inch polyethylene bag or large,

sturdy ziplock. You will need to take several scoops to get sufficient sediment, depending on the coarseness of the beach.

7. Walk about 33' along the measuring tape, repeat the sediment scooping action, and place the sediment in the bag. Move an additional 33' and repeat. Move an additional 33', 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 ½ to ⅔ full.

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.

9. 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.

* Moulton, L.L., and Penttila, D.E. 2001. Field manual for sampling forage fish spawn in intertidal shore regions. Field Manual, MJM Research and Washington Department of Fish and Wildlife, Lopez Island, WA. PDF available on request from Dayv Lowry at WDFW (dayv.lowry@dfw.wa.gov).

Original protocol by Dan Penttila, WDFW. Reformatted by Dayv Lowry, WDFW.

WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols

Laboratory procedure for determining forage fish egg presence/absence from preserved "winnowed light fraction" beach substrate samples

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Laboratory materials needed:

Fume hood (alternatively, winnowed light fraction samples can be carefully washed before analysis)*
Latex or nitrile gloves*
Spoon
Oval microscope dish
Dissecting microscope with 10-20x power
Watchglasses/small Petri dishes
Fine-point (watchmakers) forceps
Data/tally sheets
Paper towels
Buckets/pans/sample jars (to collect waste, accumulated samples, etc.)

*Depending on the preservative used, samples may be toxic or carcinogenic. Take proper precautions.

Note: This procedure describes a second reduction of bulk substrate material collected during field sampling and is best used for determining spawn presence/absence. If detailed egg stage counts are needed, use the associated document "Laboratory procedure for counting and staging forage fish eggs."

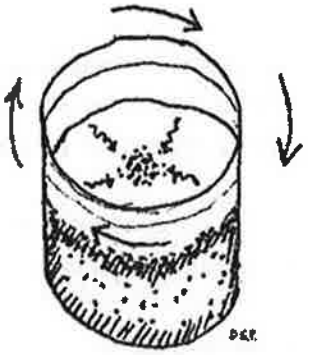
Procedure:

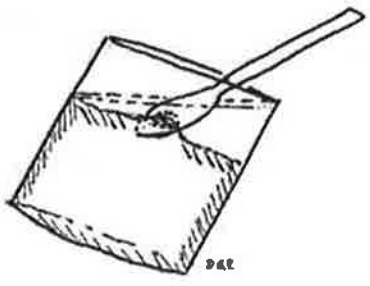
1. Stir "winnowed light fraction" sample jar contents with spoon.

2. Swirl jar in clockwise manner to impart rotation to fluid and surface layer of contents, causing light material to move to center of jar.

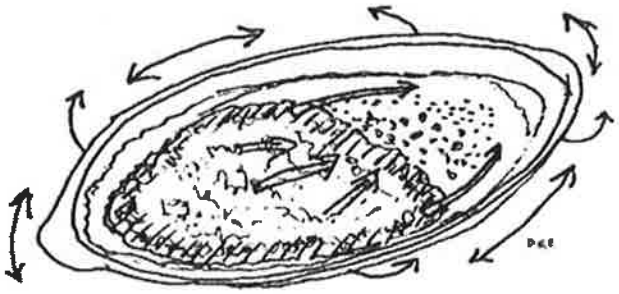
3. Carefully tilt jar. Slowly scoop center mound of light material with spoon into oval microscope dish.

4. Repeat steps 1-3 four times, accumulating about 400 grams of light material in microscope dish.

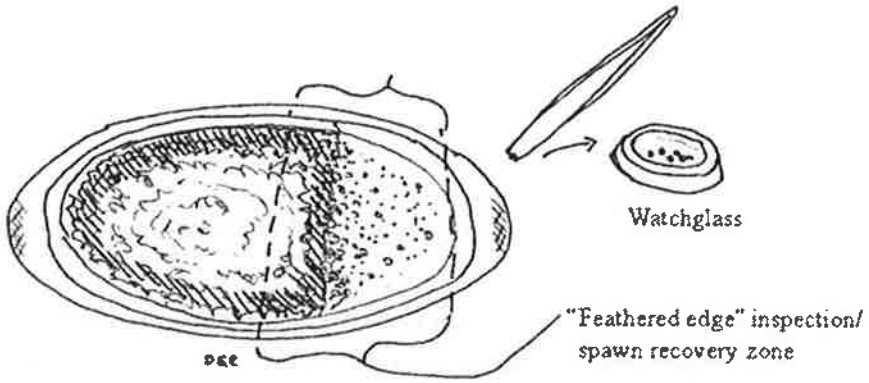




5. Add water to microscope dish. Swirl/tilt/yaw dish to suspend lightest material and concentrate it along feathered edge of the deposit in the dish.



6. Place dish on microscope stage. Inspect zone around feathered edge of deposit. Remove eggs to watchglass with forceps.



7. Reverse dish to redistribute sediment. Repeat steps 5+6 three more times, or until eggs cease to be detected around feathered edge of deposit. Species assignment may be made at this time or after completing processing (see attached egg identification guide).

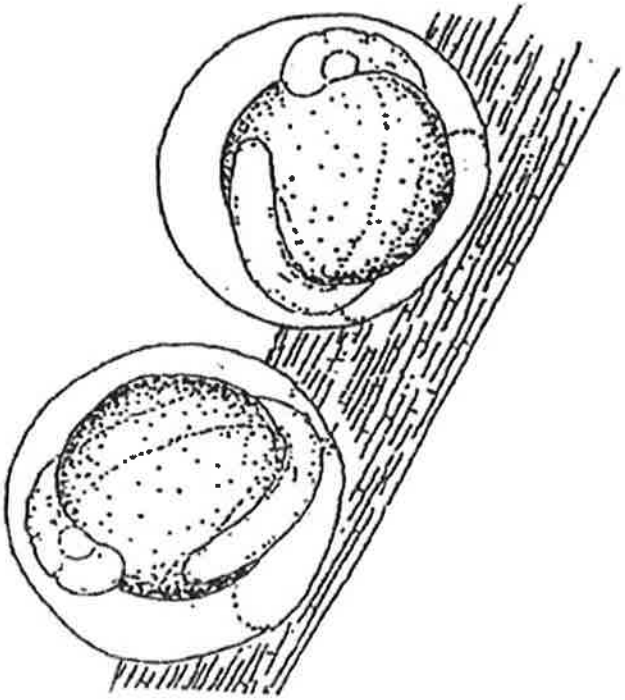
8. If steps 1-7 produce zero eggs, or only a single egg, repeat the procedure with a second sample of material from the same jar of "winnowed light fraction." The WDFW standard for documenting a spawning site for a given species is 2 eggs in a single "winnowed light fraction" sample.

9. Either preserve eggs for future counting and staging, or identify eggs in watchglass (see attached egg identification guide) to determine the species present.

10. Complete survey findings, as well as preserved egg samples if taken, should be sent to Phillip Dionne at Phillip.Dionne@dfw.wa.gov and/or WDFW, Habitat Program, 1111 Washington St SE, Olympia, WA 98501.

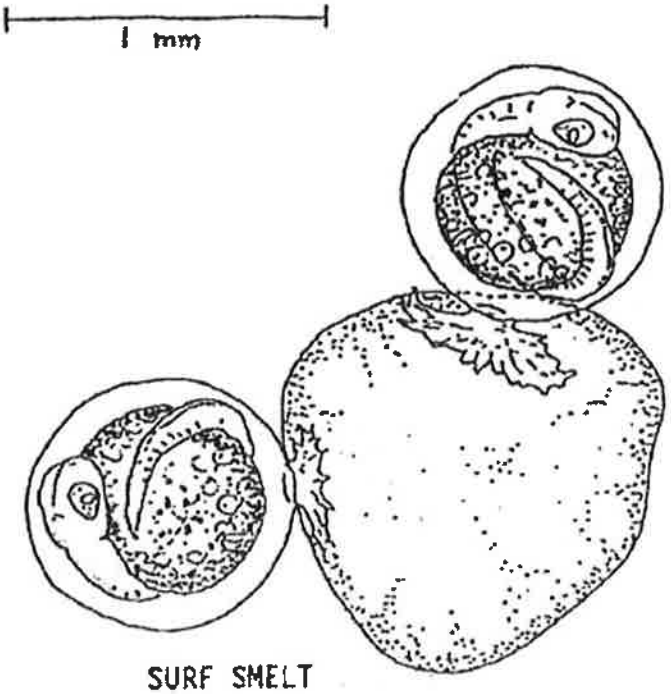
Original protocol by Dan Penttila, WDFW. Reformatted by Dayv Lowry, WDFW.

Forage Fish Eggs of Puget Sound



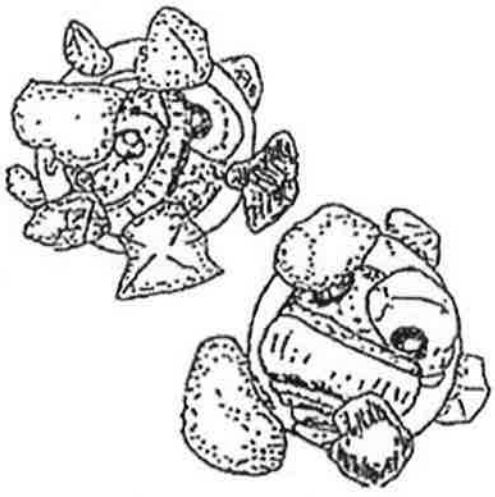
PACIFIC HERRING

almost entirely deposited on marine vegetation; distinct shell attachment sites; self-adhesive in layers or clumps.



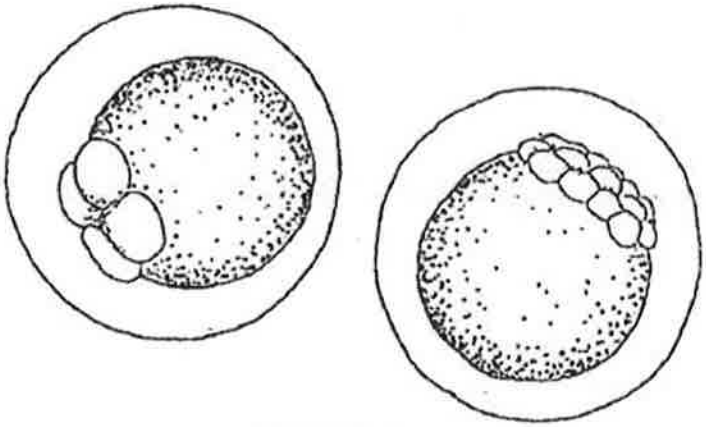
SURF SMELT

single pedestal-like attachment site; non-self-adhesive; entirely in beach sediment particles.



PACIFIC SAND LANCE

relatively small; multiple sand grain attachment sites; egg off-round/milky; 1 large oil droplet in yolk.

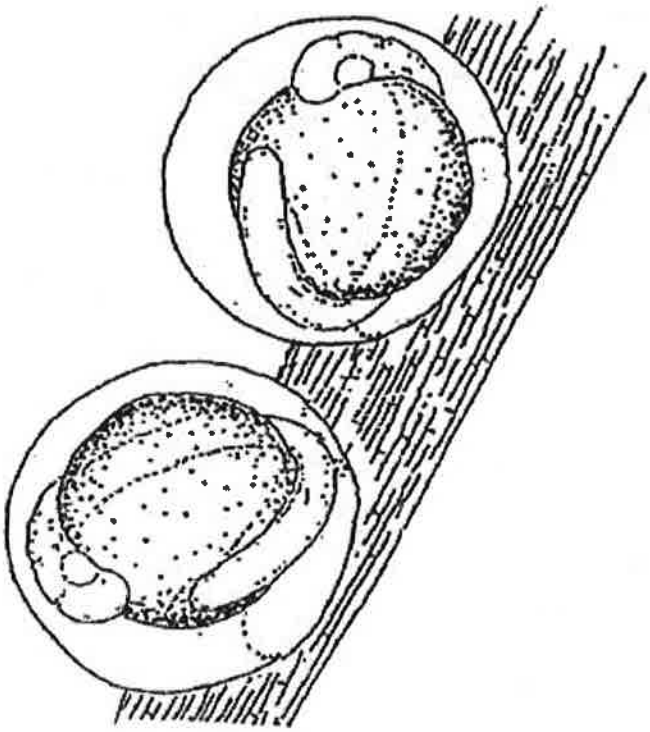


ROCK SOLE

egg perfectly spherical; very clear; no visible attachment sites; non-self-adhesive.

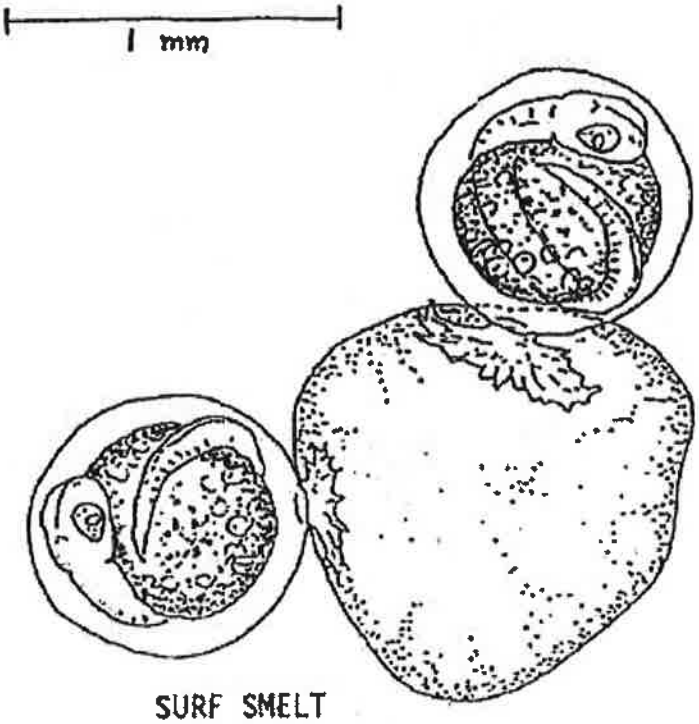
D&P.

Forage Fish Eggs of Puget Sound



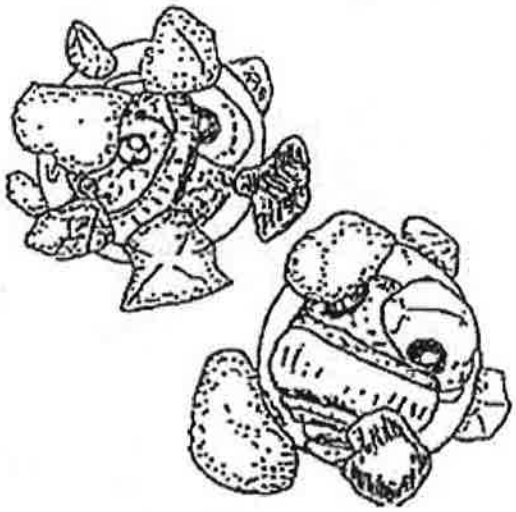
PACIFIC HERRING

almost entirely deposited on marine vegetation; distinct shell attachment sites; self-adhesive in layers or clumps.



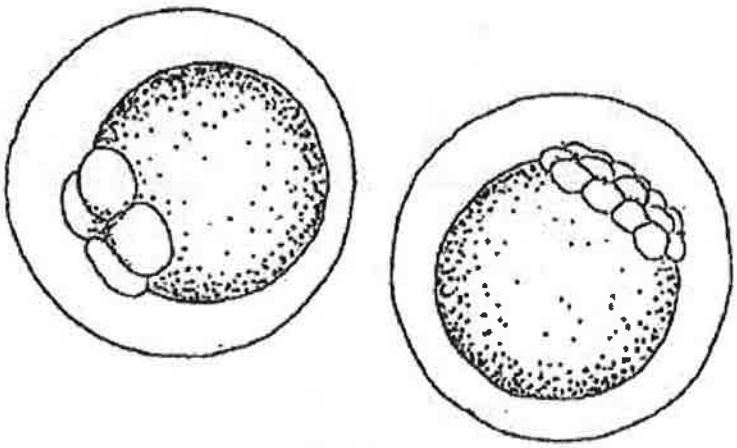
SURF SMELT

single pedestal-like attachment site; non-self-adhesive; entirely in beach sediment particles.



PACIFIC SAND LANCE

relatively small; multiple sand grain attachment sites; egg off-round/milky; 1 large oil droplet in yolk.

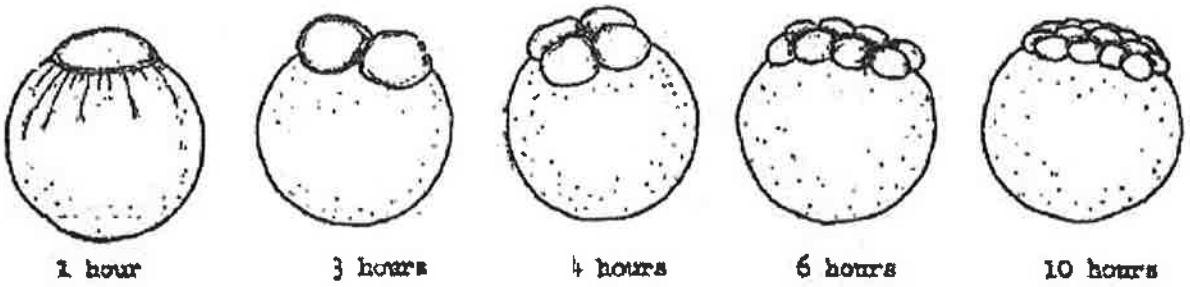


ROCK SOLE

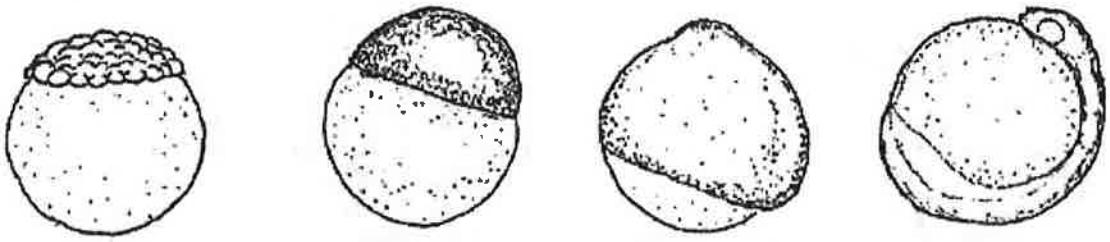
egg perfectly spherical; very clear; no visible attachment sites; non-self-adhesive.

DEP

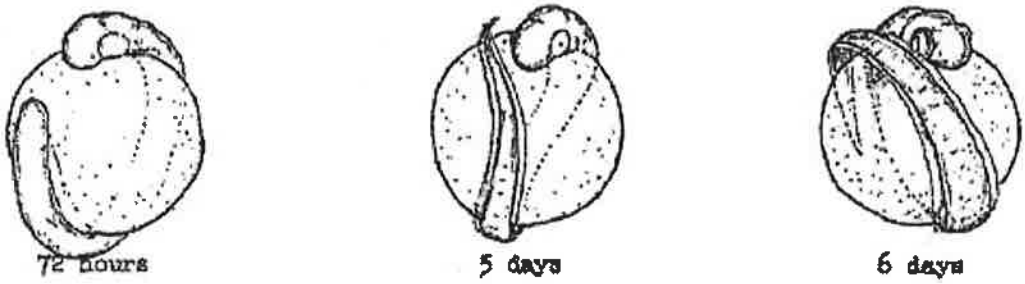
Embryonic Development Stages – Pacific herring



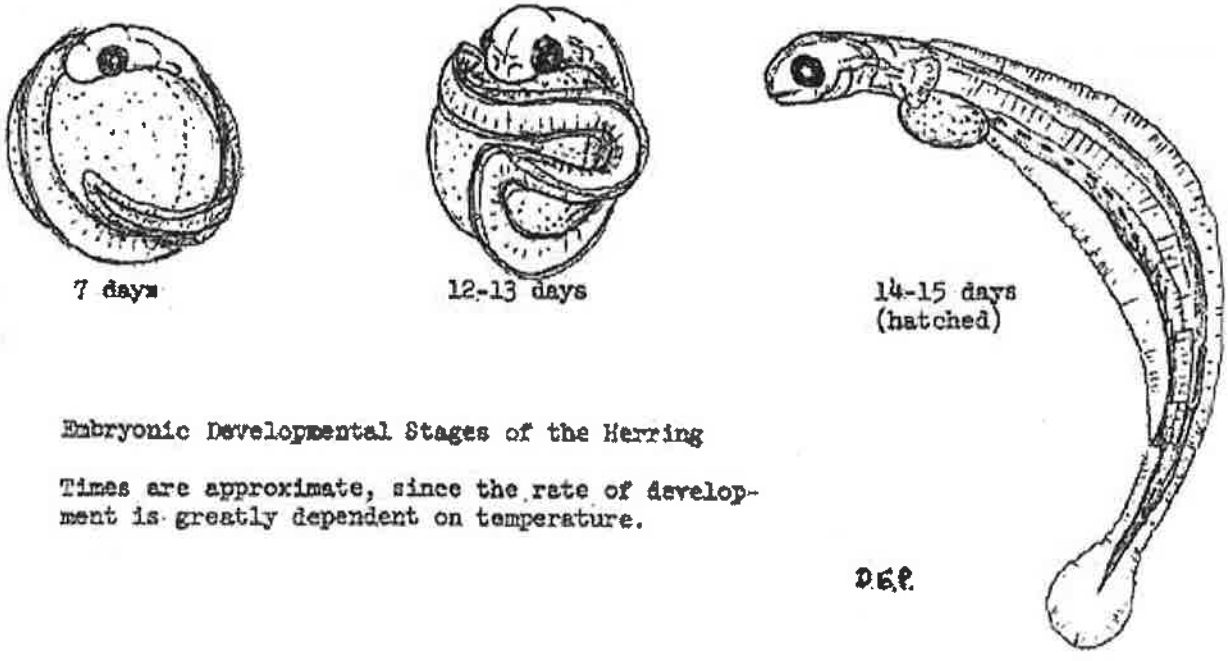
1 hour | 3 hours | 4 hours | 6 hours | 10 hours



12 hours | 24 hours | 45 hours | 60 hours



72 hours | 5 days | 6 days



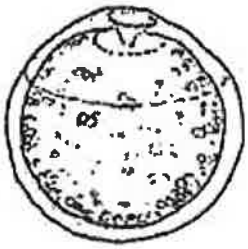
7 days | 12-13 days | 14-15 days (hatched)

Embryonic Developmental Stages of the Herring

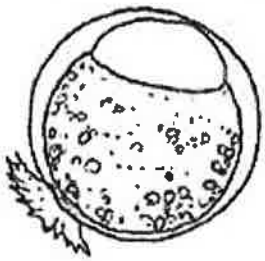
Times are approximate, since the rate of development is greatly dependent on temperature.

DEP

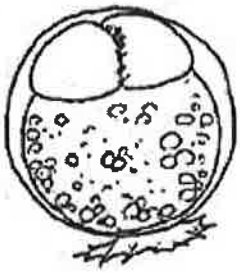
Embryonic Development Stages – Surf smelt



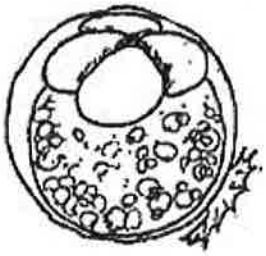
Unfertilized Egg



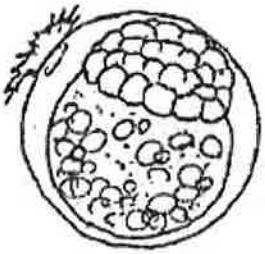
1 cell
½ hour



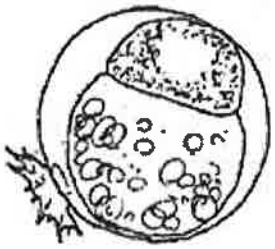
2 cells
1 hour



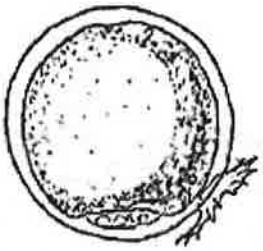
4 cells
3 hours



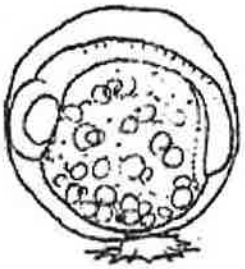
early blastula
5 hours



late blastula
8 hours

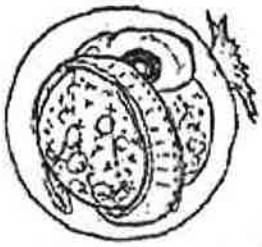


yolk plug (gastrula)
14 hours



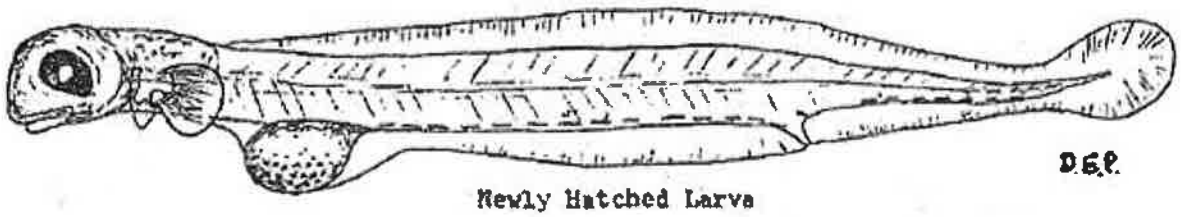
1½ days

4 days



6 days
(1½ cells)

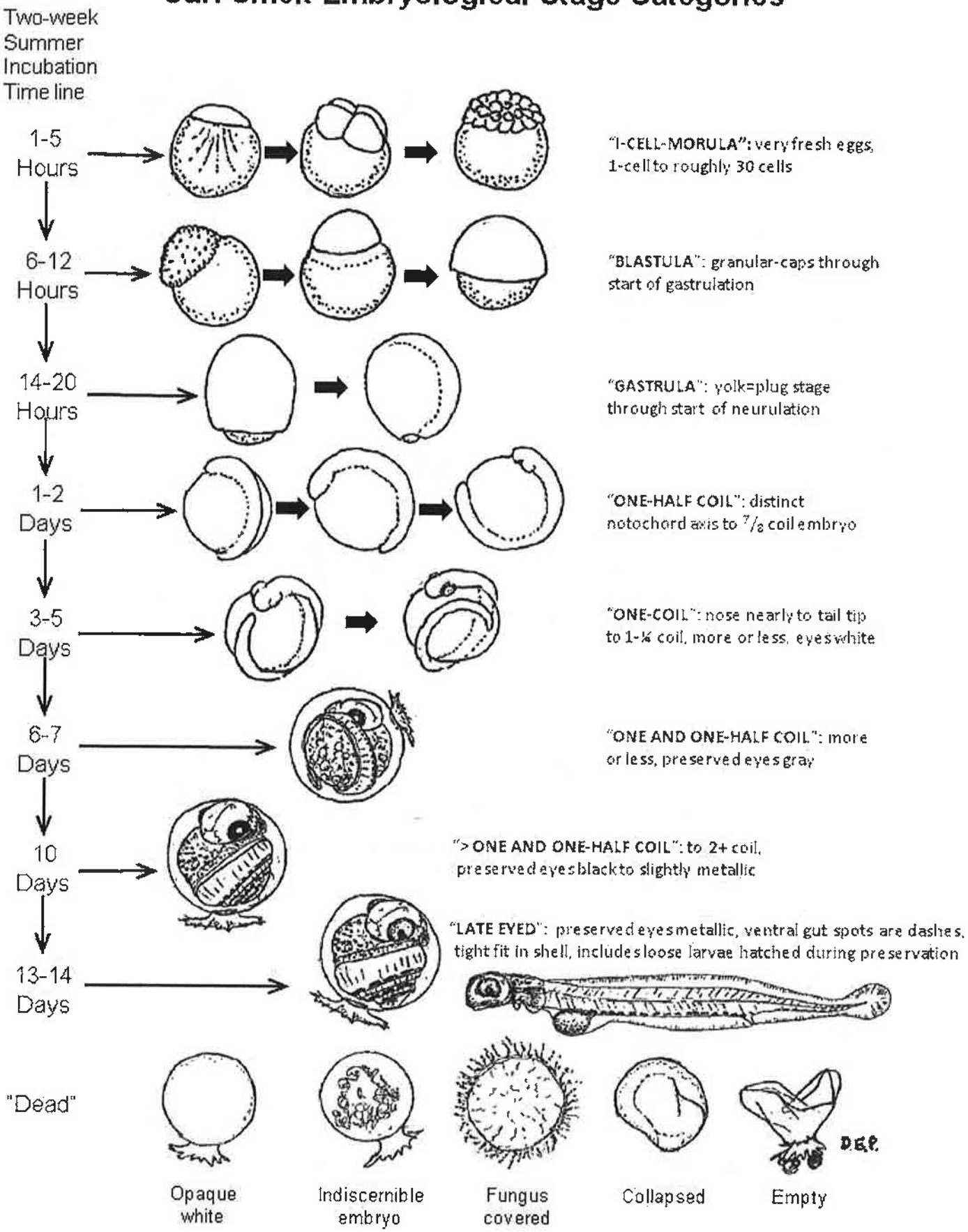
13 - 14 days
(just prior to hatching)



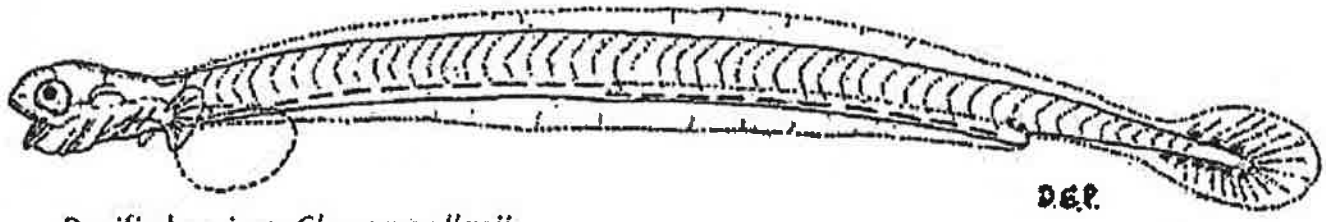
D.G.P.

Newly Hatched Larva

Surf Smelt Embryological Stage Categories



Identification Guide to Larval Forage Fishes of Puget Sound

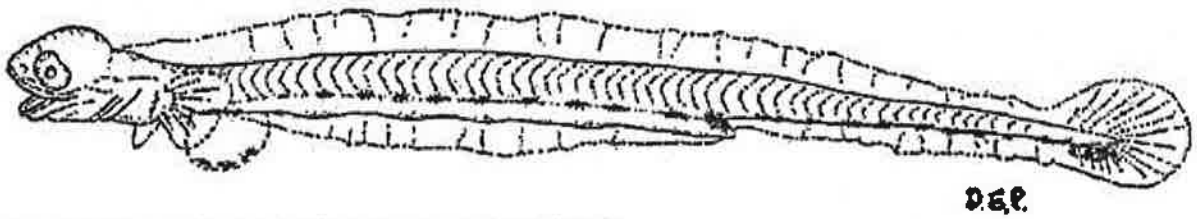


Pacific herring, *Clupea pallasii*

1. Head-vent distance about 90% of standard length
2. Ventral chromatophores in two parallel rows, with a distinct break to closer spacing, with no overlap, about the middle of the gut
3. About 40 myomeres between the pectoral fins and vent
4. Yolk sac immediately behind pectoral fins, unpigmented

Surf smelt, *Hypomesus pretiosus*

1. Head-vent distance about 80% of standard length, 17-20 ventral gut spots
2. Ventral chromatophores in a single row, with 2 parallel rows above it on the anterior ¾ of the gut
3. About 50 myomeres between the pectoral fins and vent
4. Yolk sac markedly behind pectoral fins, ventral surface with many tiny chromatophores

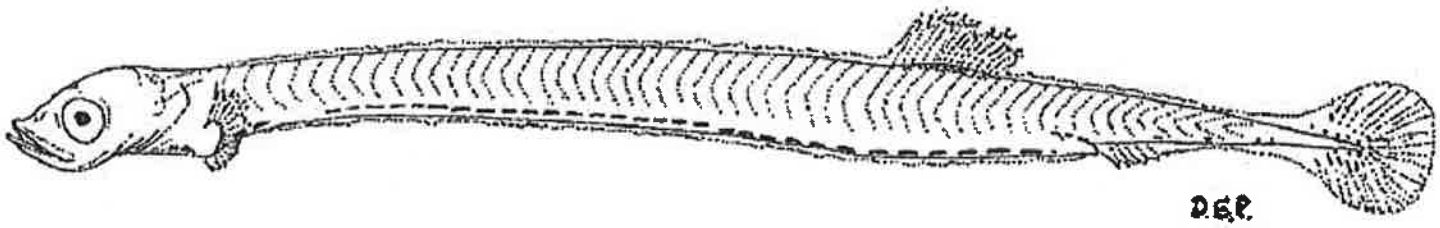


Pacific sand lance, *Ammodytes hexapterus*

1. Head-vent distance about 60% of standard length
2. Ventral chromatophores in two parallel continuous rows, becoming very closely spaced posterior of vent
3. About 35myomeres between the pectoral fins and vent
4. Yolk sac immediately behind pectoral fins, ventral line with 3 chromatophores

All figures approximately 15 times natural size.

Larval Forage Fishes of Puget Sound

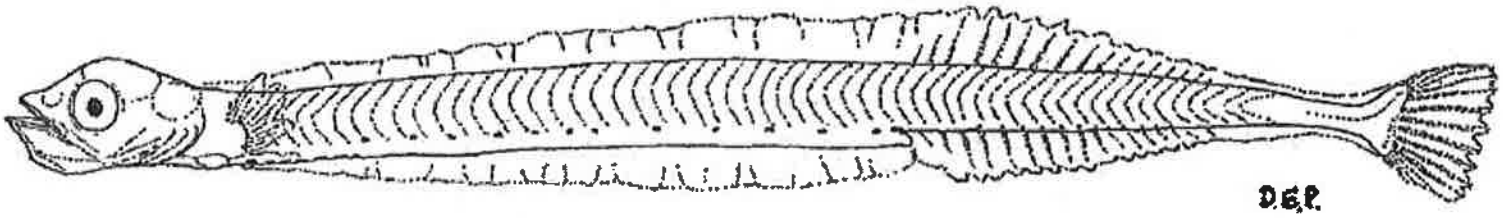


Pacific herring, *Clupea pallasii*

- Row of chromatophores on either side of gut, with distinct break to closer spacing along posterior half of gut; no overlapping

Surf smelt, *Hypomesus pretiosus*

- Row of chromatophores on either side of gut, overlapping with single row of chromatophores on ventral midline of gut
- Rayless adipose fin present

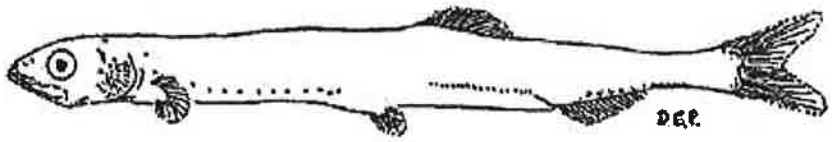


Pacific sand lance, *Ammodytes hexapterus*

- Widely spaced row of chromatophores on either side of gut
- Wide membranous fins continuous on dorsal and ventral midlines, fin rays appearing posterior to anus

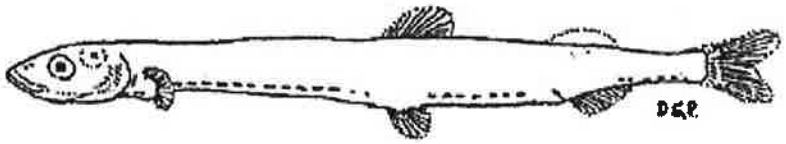
All figures approximately 10-12 times natural size.

Identification of Post-Larval Forage Fishes of Puget Sound



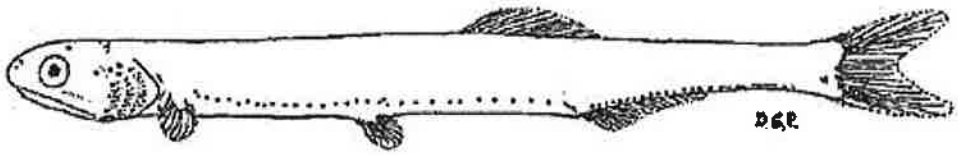
Pacific herring, *Clupea pallasii*

- Insertion of dorsal fin posterior to pelvic fins
- Rows of ventral chromatophores distinct only anterior to pelvic fins



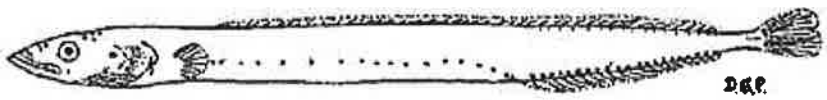
Surf smelt, *Hypomesus pretiosus*

- Insertion of dorsal fin at or slightly anterior to pelvic fins
- Rows of ventral chromatophores very distinct along entire gut, interrupted at pelvic fins
- Distinct, rayless adipose fin present



Northern Anchovy, *Engraulis mordax*

- Insertion of dorsal fin posterior to pelvic fins
- Rows of ventral chromatophores continuous along entire gut
- Mouth large, subterminal with overhanging upper jaw



Pacific sand lance, *Ammodytes hexapterus*

- Dorsal fin continuous from pectoral fins to caudal peduncle
- General body form long, slender, with snake-like swimming motions
- Head pointed with distinctly jutting lower jaw
- Pelvic fins absent

Fishes of this stage are 30-35 mm in standard length and semi-transparent. All figure are pictured 3-4 times their natural size.

Forage Fish Spawn Sample Analysis

Page ____ of _____

Recorder_____

Sample Location	Day	Month	Year

Beach Number	Sample Number	Species	1 cell to morula	Blastula	Gastrula	1 / 2 - 1 coil	1 coil	1½ coil	>1½ coil	Late eyed	Dead	# Eggs	% Dead	Est. # broods	Comments

Version 1.0, July 2011

Sample Location:________________________

Forage Fish Spawn Sample Analysis

Page_____of_____

Date (mm/dd/yyyy): ______/______/________

Recorder____________________

Beach Station #	Sample #	Species	1 cell to morula	Blastula	Gastrula	1/2 - 1 coil	1 coil	11/2 coil	>11/2 coil	Late eyed	Dead	# eggs	% Dead	Est. # brood	Comments
		SS													
		SL													
		RS													
		SS													
		SL													
		RS													
		SS													
		SL													
		RS													
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Collected By:______________________

SS:Surf Smelt, SL: Sand Lance, RS: Rock Sole

version 6/11/14

Sample Location:______________________________

Date (mm/dd/yyyy): _____/_____/________

Forage Fish Spawn Sample Analysis

Recorder______________________

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
		SS													
		SL													
		RS													
		SS													
		SL													
		RS													
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Collected By:______________________________

SS:Surf Smelt, SL: Sand Lance, RS: Rock Sole

WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols

Procedures for recovering "winnowed light fractions" subsamples of forage fish egg-sized material from bulk beach substrate samples

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Field materials needed:

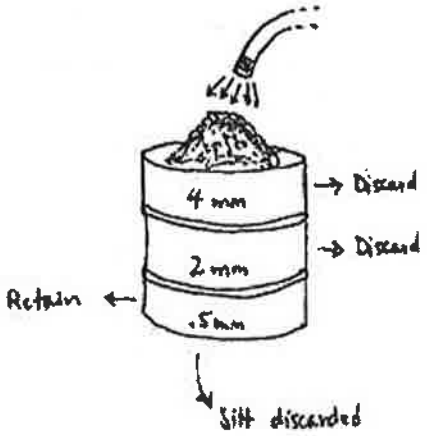
Nested set of 4-mm, 2-mm, and 0.5-mm sieves/screens (Nalgene or stainless steel preferred over brass, for durability)
Buckets for discarded material (2-4), may have several large holes drilled near lip as rinse water outlets
1-2 gallon plastic dishpans
400-ml wide-mouthed sample jars
Freshwater hose work area with sufficient drainage (or extra buckets for saltwater rinsing)
Area to discard waste gravel
Ethyl alcohol or Stockard's solution† (only needed when samples will not be analyzed immediately)
Pencil and Rite-in-the-Rain paper (cut into small squares for labeling samples)

Procedure:

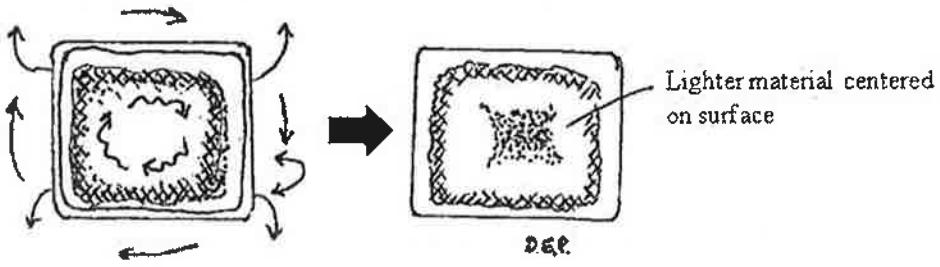
1. Thoroughly wet-screen material through set of 4-mm, 2-mm, and 0.5-mm sieves/screens, using buckets of shore-side water at site or freshwater hose elsewhere. Screens should be carefully cleaned between samples.

2. Discard material retained in 4-mm and 2-mm sieves/screens.

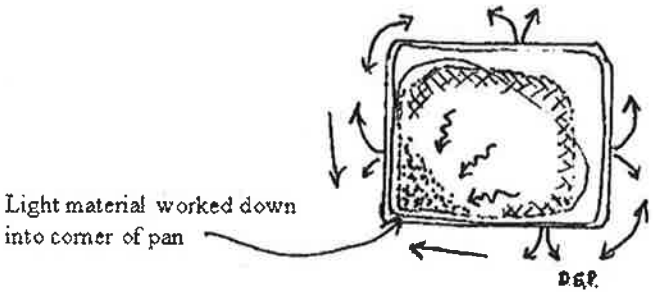
3. Place material from 0.5-mm sieve/screen ("egg-sized material") in rectangular dishpan and cover with ~1 inch of water.



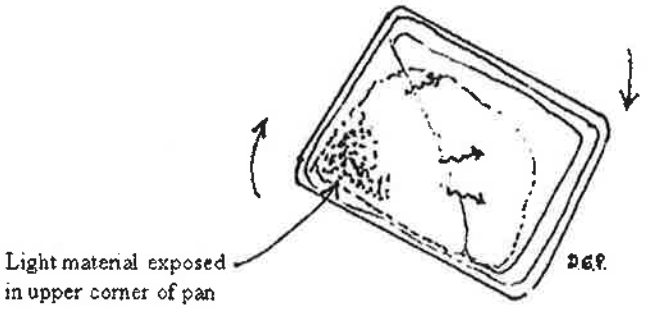
4. Rotate/tilt/yaw dishpan of material to impart rotation to water and cause lighter material to rise to the surface, where it should accumulate toward the center of the pan. Observe behavior of shell fragments and organic particles to get indication of behavior of forage fish eggs.

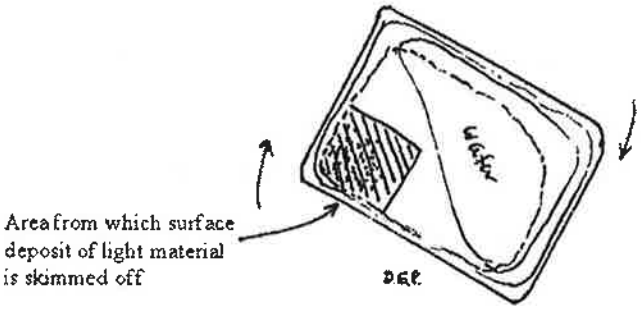


5. Tilt/swirl/agitate pan contents to move lighter material accumulated at center down to lower left corner of pan.



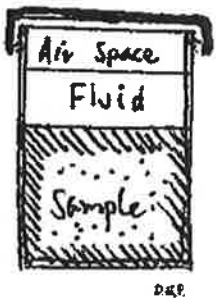
6. Carefully tilt pan to decant water to opposite corner of pan, slowly exposing lower left corner material above water's surface.





7. Holding pan in the tilted position, carefully use a wide-mouthed sample jar to skim the surface 1 inch of material from the lower left corner of the deposit.

8. Repeat steps 4-7 approximately three more times, or until the sample jar is ~⅔ full of material.



9. If sample will not be analyzed within a few days in the laboratory, top-off sample jar with ethyl alcohol or Stockard's solution[†] and shake well to distribute fluid. Note that long-term storage is also possible with these preservatives. If genetic samples are desired 95% nondenatured ethyl alcohol should be used.

10. Fit lid loosely onto sample jar to allow gas to escape (preserved samples will emit carbon dioxide as the acidic preservative dissolves shell material in the sample).

11. Store sample jars in leak-proof containers in well-ventilated area to prevent accumulation of carbon dioxide in enclosed areas. Note: both gas and some preservative, if present, will escape.

[†] Stockard's solution contains formaldehyde, which is carcinogenic. 1 l Stockard's solution = 50 ml formalin (37% aqueous formaldehyde), 40 ml glacial acetic acid, 60 ml glycerin, 850 ml fresh water (1 l = 0.2642 gal; 1 gal = 3.785 l).

Original protocol by Dan Penttila, WDFW. Reformatted by Dayv Lowry, WDFW.

- Draw a line through any fields you're not collecting so they know it's not forgotten.
- Lead must sign back of sheet
- Must use codes on back of this sheet. Pick a sediment size!! ~~not~~ no decimals.

Forage Fish Spawning Beach Survey (see back for codes)

Month	Day	Year
Camera ID:		

Last High Tide
Time (24-hr):
Elevation:

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

look at tide chart

Location: must be more specific if 2 groups taking samples on same day (Fidalgo Bay A and B)

County:

Page ___ of ___

record only if high tide before your last high tide is higher than your high tide.

	Beach Station #	Time (24-hr)	Latitude (decimal degrees) 3-5 decimals	Longitude (decimal degrees)	Beach	Uplands	Width	Length	Sample #	Landmark	Sample Zone	Tical Elevation	Shading	Sample Type	Smelt	Sand lance	Rock sole	Photo #	Comments
1		Time you select sample site ↓ if you put a stake in the ground at 1030 and ~~Sample~~ Stake at 1045 you write 1030				only Rank based on things you see from Beach								B ↓ always	W probably all zeros	W		use your camera's file name	
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			

Take photos w/ scale from your Beach.

Samplers: _____ **Organization:** _____

(print names here, sign back) _____ Reviewer: _____

if only one sample can be taken - take in Dam Board. This is about 5 ft down (sample transect) down from last high tide of 2nd effective high tide. It is an area where wave energy mixes different sediment types and eggs accumulate in this area. High likelihood of Surf smelt and Herring, not much Sand lance. You can do a 2nd elevation for sand lance if you want to.

Revised 4/2014

Field Observation Sampling Code

Beach: Sediment character of the upper beach (particle size range in inches)
0 = mud (<0.0025)
1 = pure sand (0.0025-0.079)
2 = pea gravel (0.079-0.31, "fine gravel") with sand base
3 = medium gravel (0.31-0.63) with sand base
4 = coarse gravel (0.63-2.5) with sand base
5 = cobble (2.5-10.1) with sand base
7 = boulder (>10.1) with sand base
8 = gravel to boulders without sand base
9 = rock, no habitat

NO #6

Uplands: Character of the uplands (up to 100 ft. from high water mark)
1 = natural, 0% impacted (no bulkhead, rip-rap, housing, etc.)
2 = 25% impacted
3 = 50% impacted
4 = 75% impacted
5 = 100% impacted

Width: Width of the potential spawning substrate band to the nearest foot. Judged by character of sediment and presence of spawn, when possible. (mud is not Trying to characterise over your habitat. Whole stretch of Beach.

Length: Length of the beach up to 1,000 feet (500 feet on either side of the station). Stand at your GPS Site look both directions. Take the greater of the two distances of Habitat and Multiply by 2

Landmark: landmark for determining sample zone where collection occurs
1 = down beach from last high tide mark
2 = up beach from last high tide mark
3 = down beach from second to last high tide mark
4 = down beach from upland toe
5 = up beach from waterline at the time noted

Sample Zone: Distance of sample zone transect parallel to the landmark, in feet to the nearest ½ foot. Used to determine the tidal elevation of the spawn deposit.

Tidal Elevation: Determined in the office using location and time data provided.

Shading: Shading of spawning substrate zone, averaged over the 1,000 foot station and best interpretation for the entire day and season
1 = fully exposed
2 = 25% shaded
3 = 50% shaded
4 = 75% shaded
5 = 100% shaded

Sample Type: S=Scoop; V=Visual; B=Bulk; E=Elevation; P=Permit

Smelt, Sand Lance, Rock Sole: subjective field assessment of spawn intensity apparent to the naked eye:
0 = no eggs visible
L = light, but apparent → if you grab from Dam Board and see an egg
M= medium, readily visible → you grab a hand full of sediment from Dam Board and see eggs.
H = heavy, broadly abundant → if you see eggs at your feet
W = eggs observed in winnow

Photos: Take 6 site photos standing near the center of the site, and record the file number of the 1st photo in the 6 photo series.
***Photo 1:** Completed sample tag
***Photo 2:** Sediment w/ scale at transect
Photo 3: Beach backshore ~~take pict~~
Photo 4: Beach right
Photo 5: Beach foreshore (towards water)
Photo 6: Beach left
**If multiple samples are collected at a single station, then only photos 1 and 2 need be repeated for each subsequent sample.*

make sure to capture Beach

****I certify that to the best of my abilities, the surveys recorded on this data sheet and the associated samples were collected and documented in accordance with WDFW approved protocols, and the information I am providing are the true and accurate results of the these surveys.**

Lead Signature: _____

Email survey results to:

- The Habitat Biologist
- HPAapplications@dfw.wa.gov
- ForageFish@dfw.wa.gov

need new subject line for MRC's

Use the email subject: "Forage Fish Survey (APP ID #)."
In the body of the message, indicate the date and results of the survey.
Attach a PDF copy of the completed field and lab data sheets.
Attach the photos from the most central beach station (more than 10 photos will likely be too large).

Useful links:

Hydraulic Code Rules, Chapter 220-660 WAC:
http://apps.leg.wa.gov/wac/default.aspx?cite=220-660

Approved work windows, Chapter 220-660-300 WAC:
http://app.leg.wa.gov/WAC/default.aspx?cite=220-660-330

Marine Beach Spawning Forage Fish Ecology (links to methods, data sheets, etc.):
http://wdfw.wa.gov/conservation/research/projects/marine_beach_spawning/

WDFW Forage Fish Map:
http://wdfw.maps.arcgis.com/home/webmap/viewer.html?webmap=19b8f74e2d41470cbd80b1af8ded d6b3&extent

List of biologists approved by WDFW to conduct beach spawning forage fish surveys:
http://wdfw.wa.gov/licensing/hpa/technical_assistance.html, click "*WDFW Trained Biologists*" link under the "*Forage Fish Beach Spawning Surveys*" bullet.

NOAA Tides and Currents (good for tidal datum and observed tide data)
http://tidesandcurrents.noaa.gov/map/

University of South Caroline Tide Predictions (can export minute by minute tide prediction):
http://tbone.biol.sc.edu/tide/sites_uswest.html

Puget Sound Nearshore Reports (Technical Report 2007-03 is all about Puget Sound forage fish):
http://www.pugetsoundnearshore.org/technical_reports.html

Washington Coastal Atlas (lots of cools stuff, but no forage fish layer):
https://fortress.wa.gov/ecy/coastalatlas/tools/Map.aspx

Theodolite App (easy way to get photos with GPS and Date/Time stamp):
https://itunes.apple.com/us/app/theodolite/id339393884?mt=8

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

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Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

Date:	Date:	Date:
Location:	Location:	Location:
Beach Station #	Beach Station #	Beach Station #
Sample #	Sample #	Sample #

A brief introduction
to the new

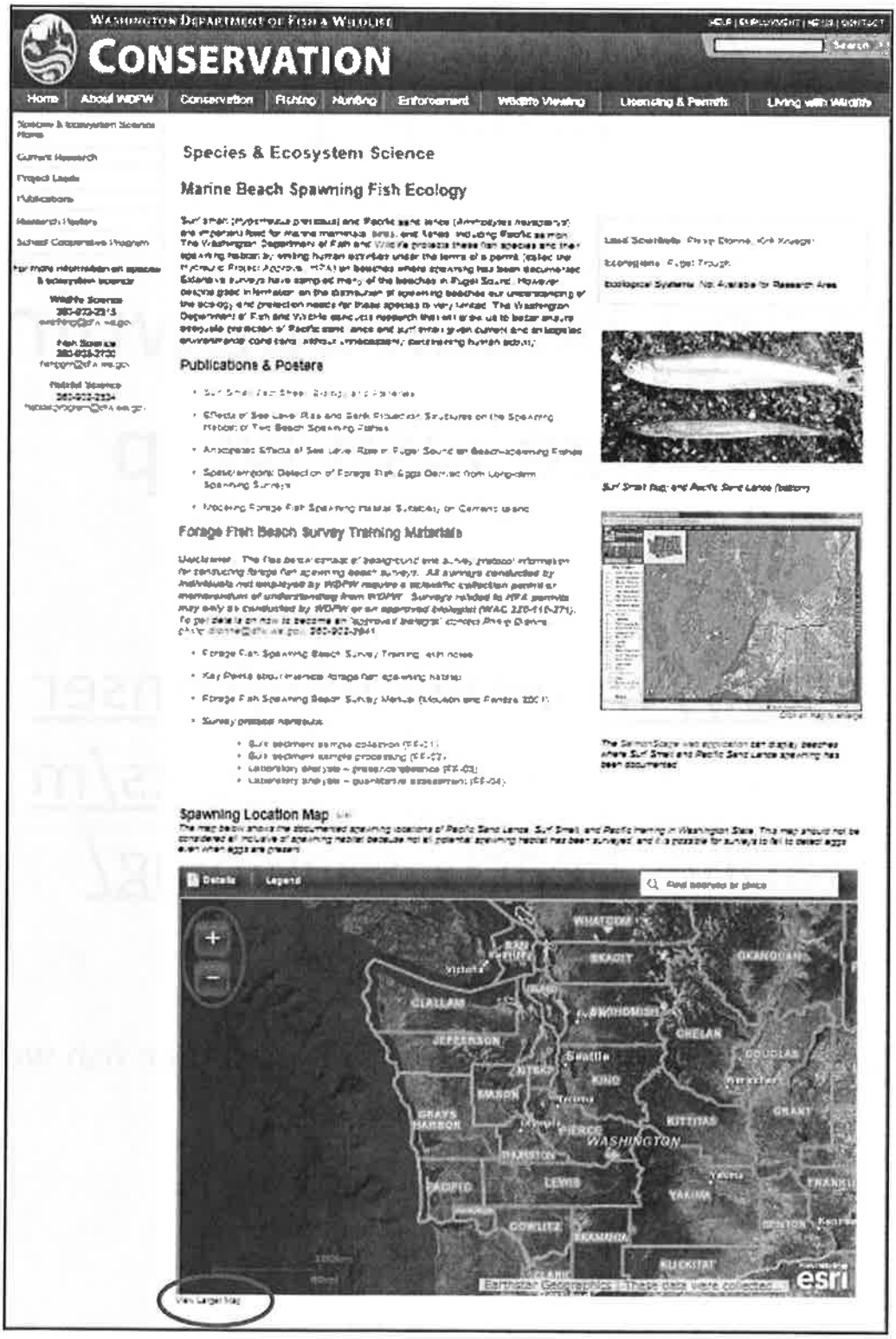
Marine Beach Spawning Forage Fish Map

http://wdfw.wa.gov/conservation/research/projects/marine_beach_spawning/

Begin by accessing the marine beach spawning forage fish web page at the address above.

When the page opens, the map is at the bottom of the page. You can zoom in or out on the map, but for more options, click the "View Larger Map" link under the bottom left corner of the map.

Note that the link to SalmonScape is still active, but SalmonScape does not currently include marine forage fish data.



The map should open in a new window with the legend to the left.

The Surf Smelt and Sand Lance layers do not become visible until you zoom in. You can click on a forage fish layer and survey information will pop up. You can also click on the cross hair icon to zoom into your approximate location.

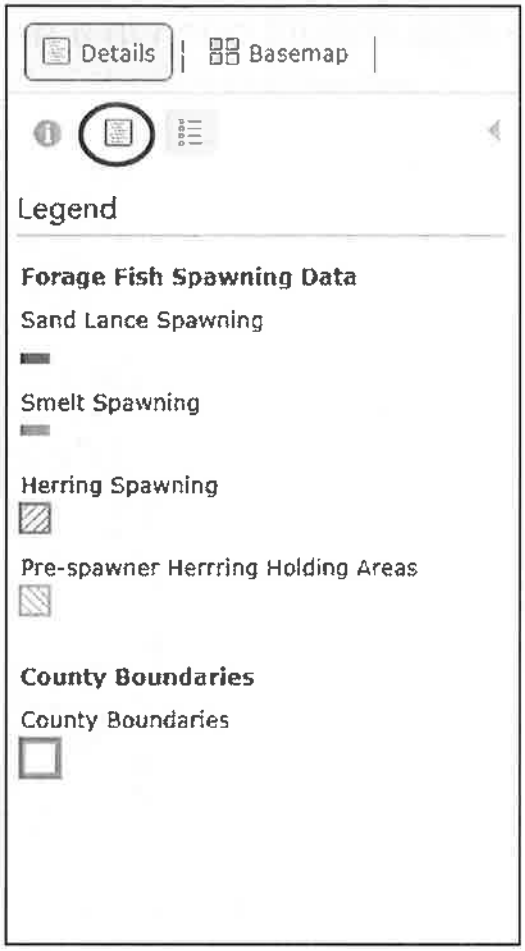
You can also turn map layers on and off.

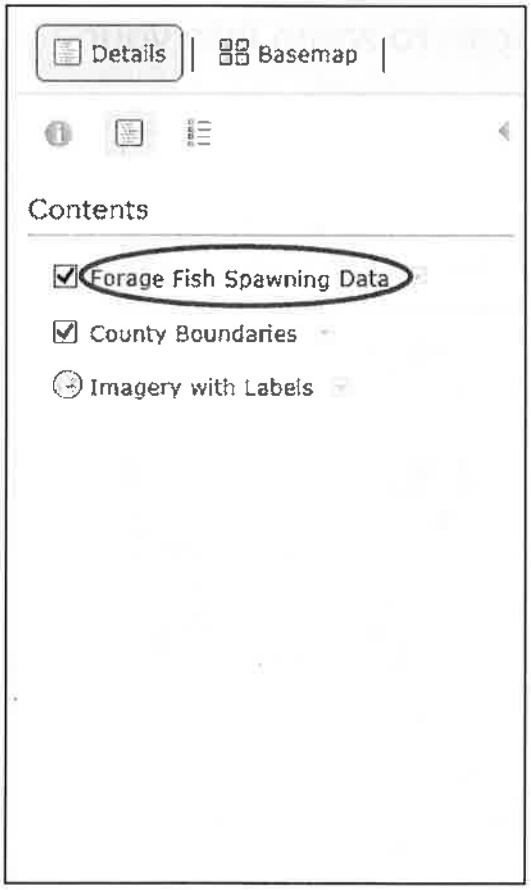
1st, click on the "Contents" icon.

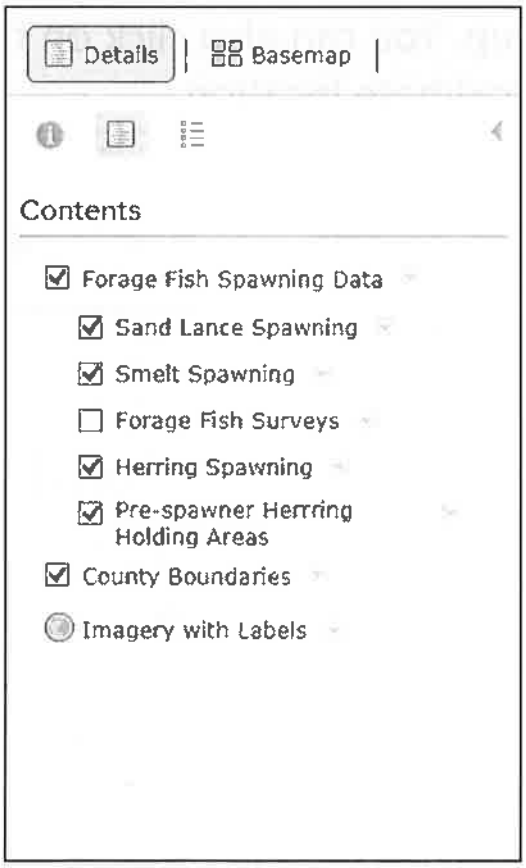
Then click on the words "Forage Fish Spawning Data" (*not* the check box or the drop down arrow).

Now you can use the check boxes to toggle different layers on or off.

Note that the "Forage Fish Surveys" layer is already off.





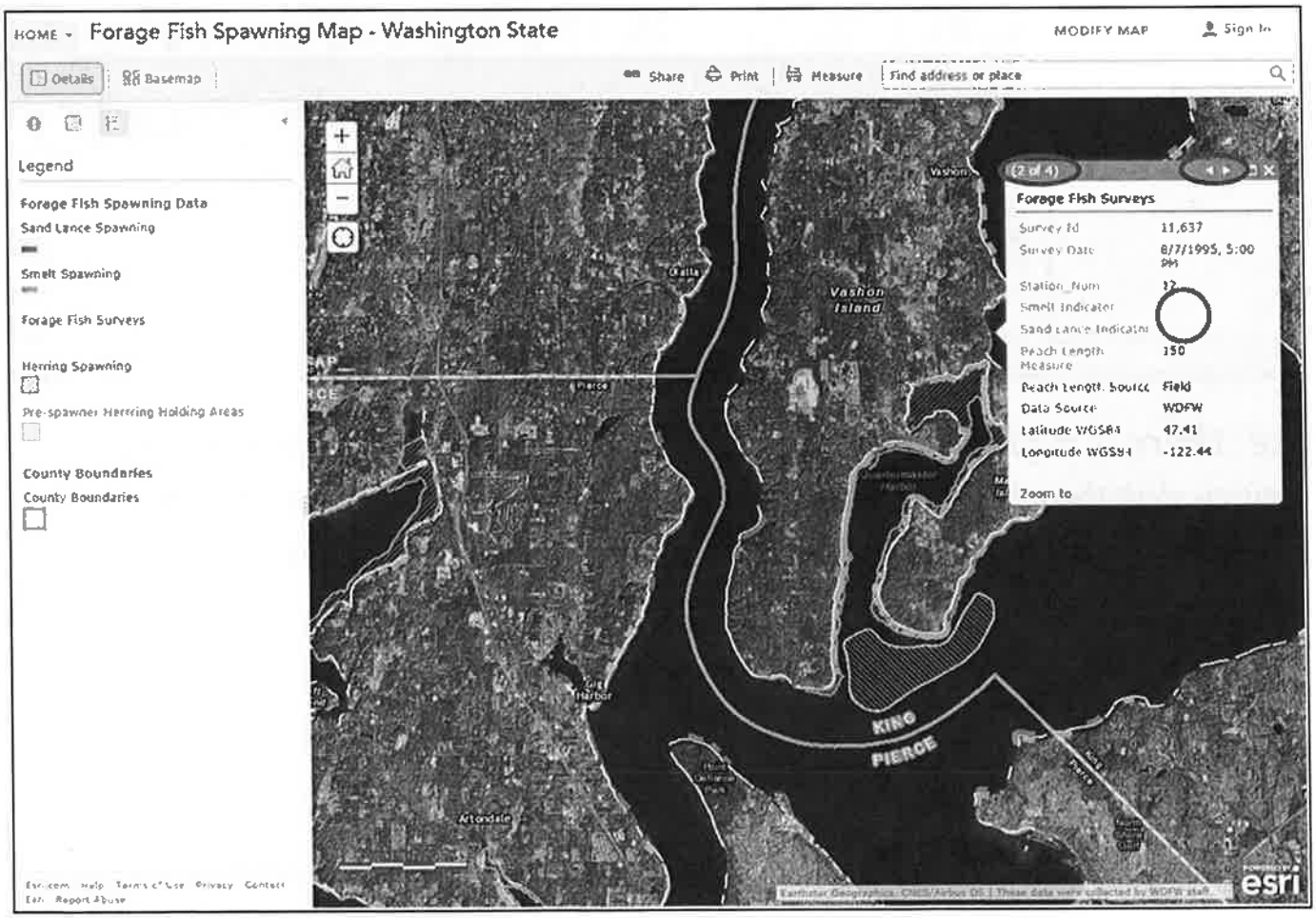


Once you've selected the layers you are interested in, you can toggle back to the legend by clicking the legend icon.

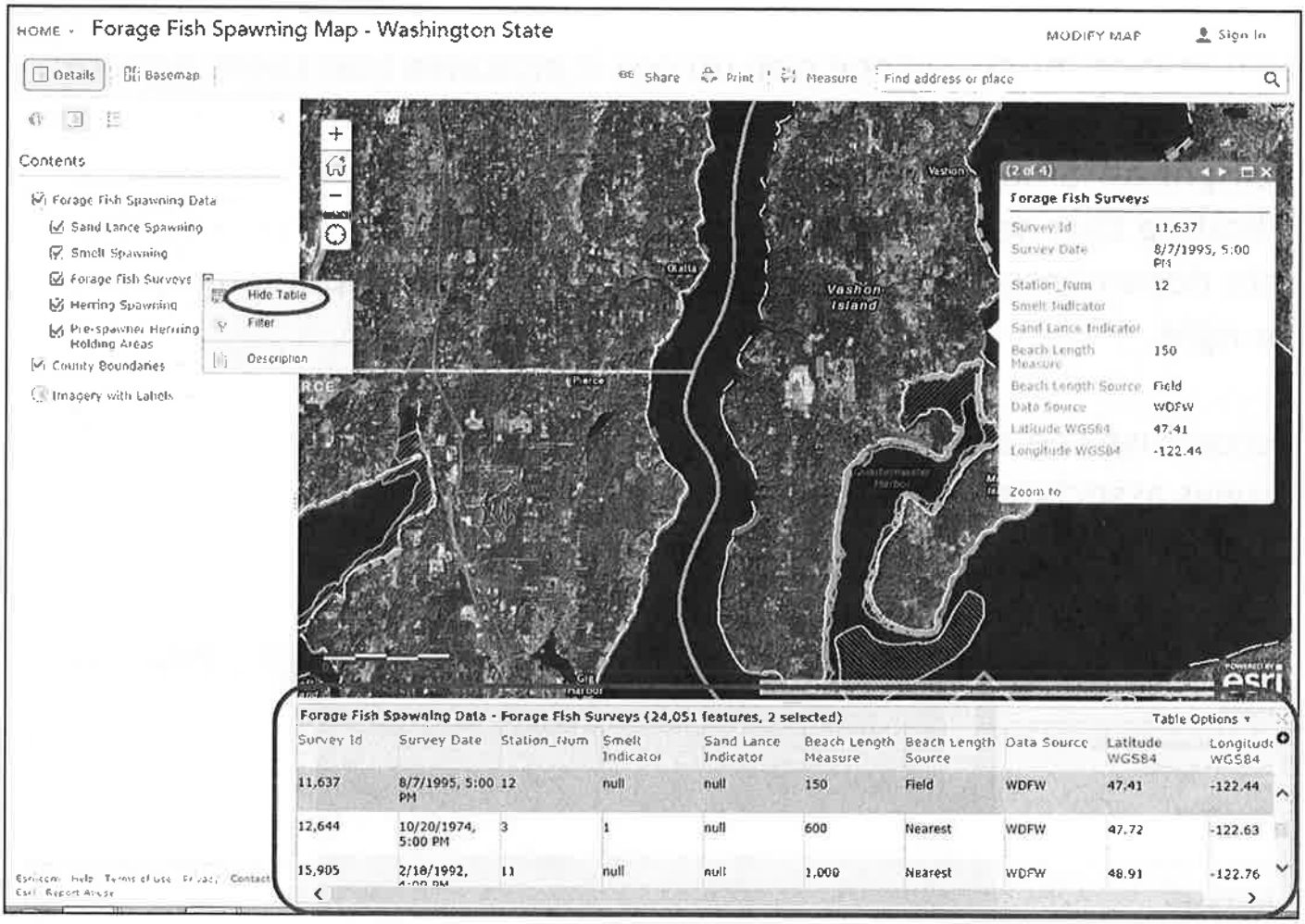
In the image below we have selected the "Forage Fish Surveys" layer and can see the associated survey summary.

Note that at the top of the pop up box it indicates that there is more than one survey associated with this line segment. Also, the space to the right of "Smelt Indicator" and "Sand Lance Indicator" is blank indicating that neither were documented during the survey. If either were documented there would be a "1" in the corresponding space to the right.

You can use the arrows at the top of the box to scroll through the other surveys associated with the line segment.



A table of survey information can also be displayed or hidden by going to the "Contents" and hovering over the desired layer and selecting either the "Show Table" or "Hide Table" icon. You can also use the filter option to limit the data shown.



Note: *there is a glitch that occurs when transferring data from our primary database to the map that results in all of the survey dates being shifted to one day earlier than they actually occurred.*

You can also click on the "Info" icon to see the last time the map was updated, or to access the "More Details..." link to learn more about the map.

If you have any questions about this map, or the data it represents, please contact Habitat Scientist, Phillip Dionne at: phillip.dionne@dfw.wa.gov.

Vortex method for separation of forage fish eggs from beach sediment

Addendum to the 2006 revision of
Field Manual for Sampling Forage Fish Spawn in Intertidal Shore Regions

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Olympia, WA 98501
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July 2015

Washington Department of FISH and WILDLIFE

Introduction

Washington Department of Fish and Wildlife (WDFW) biologists have assessed marine shorelines for evidence of forage fish spawning (presence of eggs) since the 1970's. During this time, we have developed effective protocols for collecting and identifying forage fish eggs from beaches. These protocols are contained in the *San Juan County forage fish assessment project: Field Manual for sampling forage fish spawn in intertidal shore regions* (field manual; Moulton and Penttila 2001, revised 2006). The field manual describes the sampling process from beach site selection and sediment sample collection through condensing bulk sediment samples to laboratory analysis.

The current document, *Vortex method for separation of forage fish eggs from beach sediments*, describes an alternative method for condensing bulk samples to concentrate eggs to those described in the field manual. The vortex method generally results in a smaller volume of beach material retained for lab analysis and thus aids in egg identification by reducing the amount of material that must be sorted through. We intend the vortex method to be used in place of the "winnowing" method described in steps 3 through 8 on pages 24 and 25 of the field manual by Moulton and Penttila (2006).

As described in the on pages 24 and 25, the first step in treating the bulk sample is to sieve the sample through progressively finer sieves (4 mm, 2 mm, and 0.5 mm mesh). Only the material collected in the 0.5 mm sieve is retained for further processing. During the winnowing process, the condensed sample material is transferred to a square wash basin where it is covered with a thin layer of water and agitated to suspend and concentrate the lighter material, including eggs above the heavier material. This top layer of lighter material is collected and retained for laboratory analysis (examination of material by microscope) to identify and count the eggs.

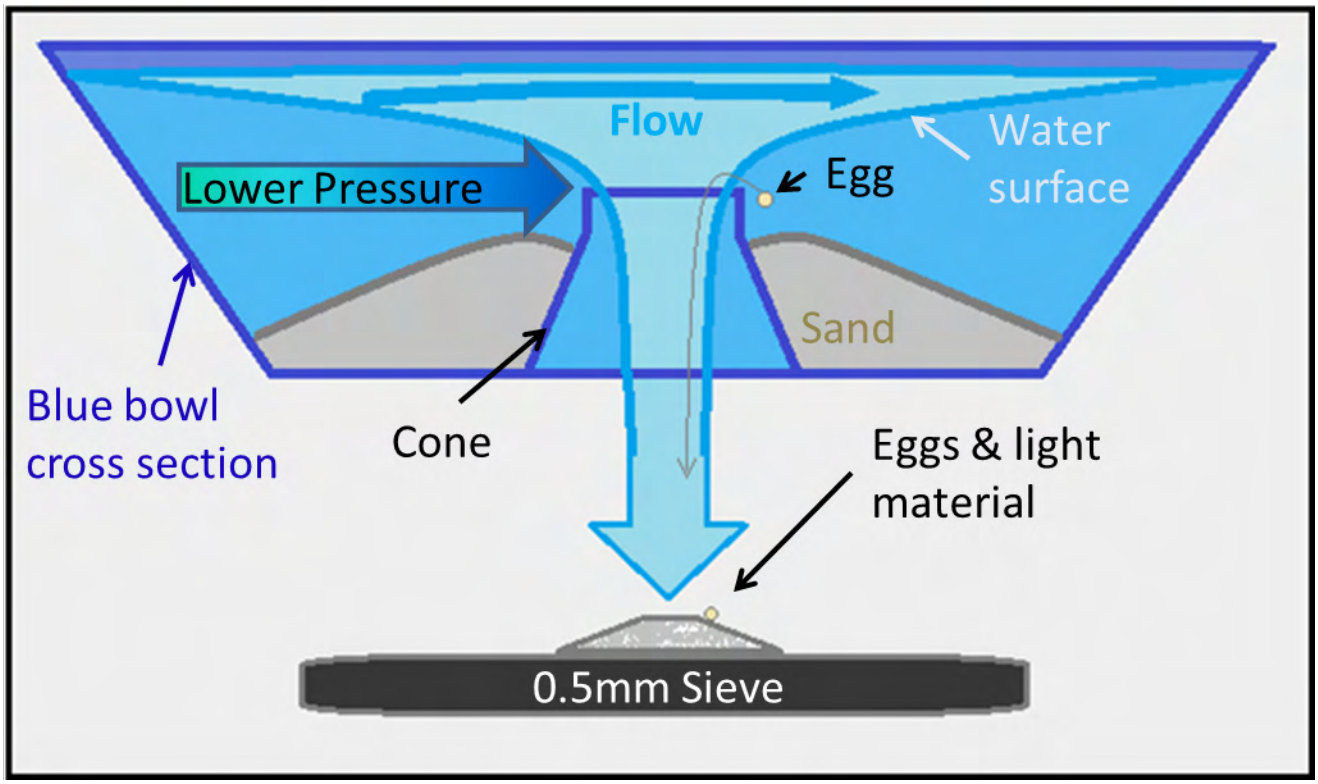
The vortex method also follows sieving. The condensed material collected in the 0.5 mm sieve is added to a hydrocyclone device consisting of a circular bowl and a recirculating electric water pump to create a vortex that concentrates the light material. Thus, this method replaces the agitation process described above.

We compared the two condensing methods and found the vortex method has a higher egg recovery rate than the winnow method (average smelt egg recovery rate, winnow method: 59%, vortex method: 90%) and results in a smaller volume of material to process in the lab. In light of these improvements in efficiency, we recommend the vortex method for condensing bulk samples after sieving. However, before any modifications are made to your sampling program, be advised that careful consideration should be given to potential impacts to results and whether results from the two methods are directly comparable. Please consult with WDFW staff if you would like to discuss compatibility with WDFW data standards.

This document contains a description of the process and system that we have designed and tested. Modifications to the process or system we describe below may alter the efficiency of the system and consequently lead to results that are not comparable with our results. Those who intend to utilize the vortex method should obtain training prior to implementation. Biologists using these methods for regulatory surveys must complete the WDFW training. Additional information and resources for training are provided on page 11 of this document.

How it works

- The movement of the water through the bowl creates a vortex resulting in a pressure gradient.
- The material in the water moves from higher pressure at the edge to lower pressure in the middle of the bowl.
- Less dense materials, such as eggs, move towards the center faster than more dense materials.
- The raised cone in the middle of the bowl reduces the amount of sand and other dense material that leaves the bowl.
- The water leaving the blue bowl passes through a 0.5 mm sieve before being returned to the water reservoir.
- The sieve collects only the material that is egg size or greater.



Materials

A list of URLs for parts vendors is included on page 12 of this document.

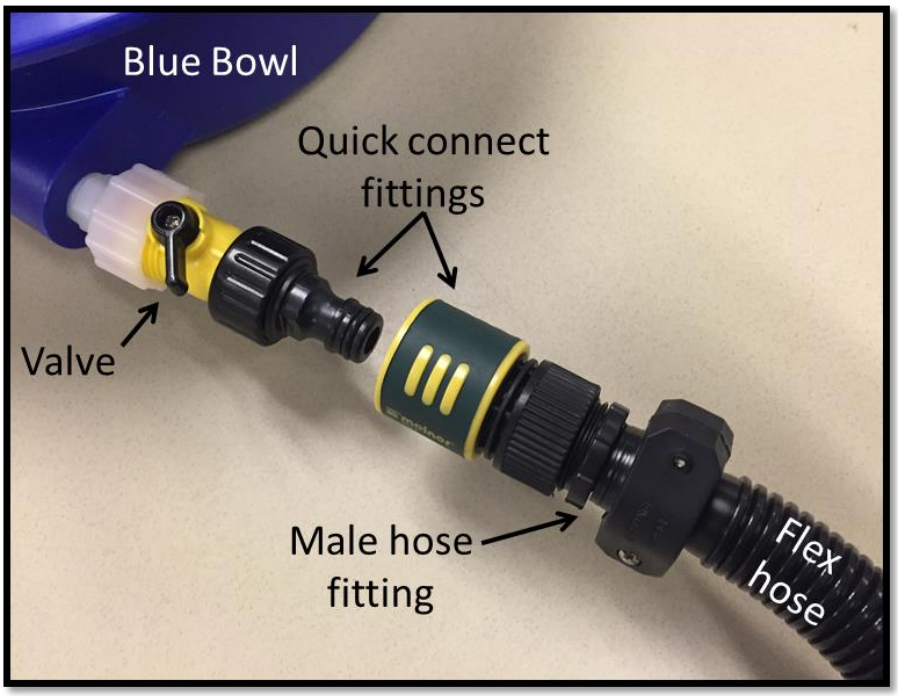
One 18 gallon tote with lid
One blue bowl gold concentrator
One 750 to 1000 gph submersible electric water pump
One, two foot length of ¾" flex hose
One, ¾" hose clamp
One, ¾" male thread hose end kit
One adjustable hose valve
One quick connect hose fittings kit with female thread
One, 0.5 mm sieve (this can be the same sieve used to sieve the bulk sample)
Three shims
One, 250 to 1000 ml wash bottle
One rubber spatula
One plastic spoon
Sample jars

Tools for assembly:
Screw driver
Metric ruler
Permanent marker
Box cutter

Optional: The unit can be configured with a bilge pump and 12 volt battery to allow for use at locations where electricity is not available.

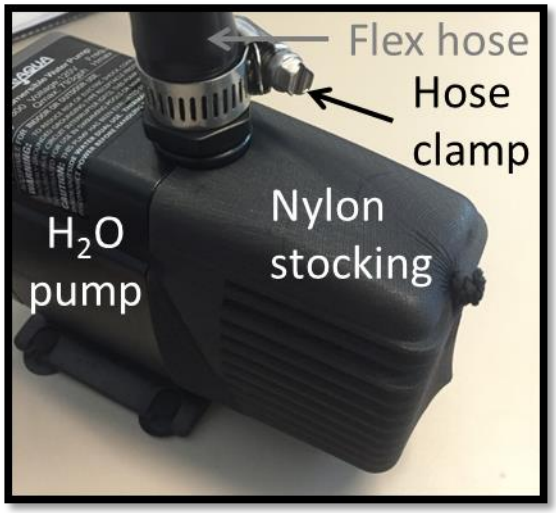
Assembly

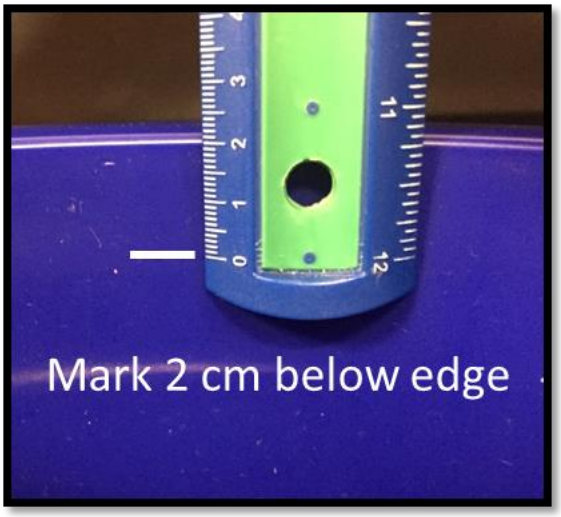
1. First assemble the pump with the flex hose, hose clamp, male hose end, adjustable valve and one side of the quick connect hose fitting. Attach the other side of the quick connect hose fitting to the blue bowl.



2. Use a nylon stocking or pantyhose to stretch over the water intake of the pump to act as a filter and ensure that any eggs that may inadvertently fall into the water reservoir are not passed though the pump to other samples.

3. Use a ruler and a permanent marker to make a mark 2 cm below the inner edge of the blue bowl at several locations around the bowl.



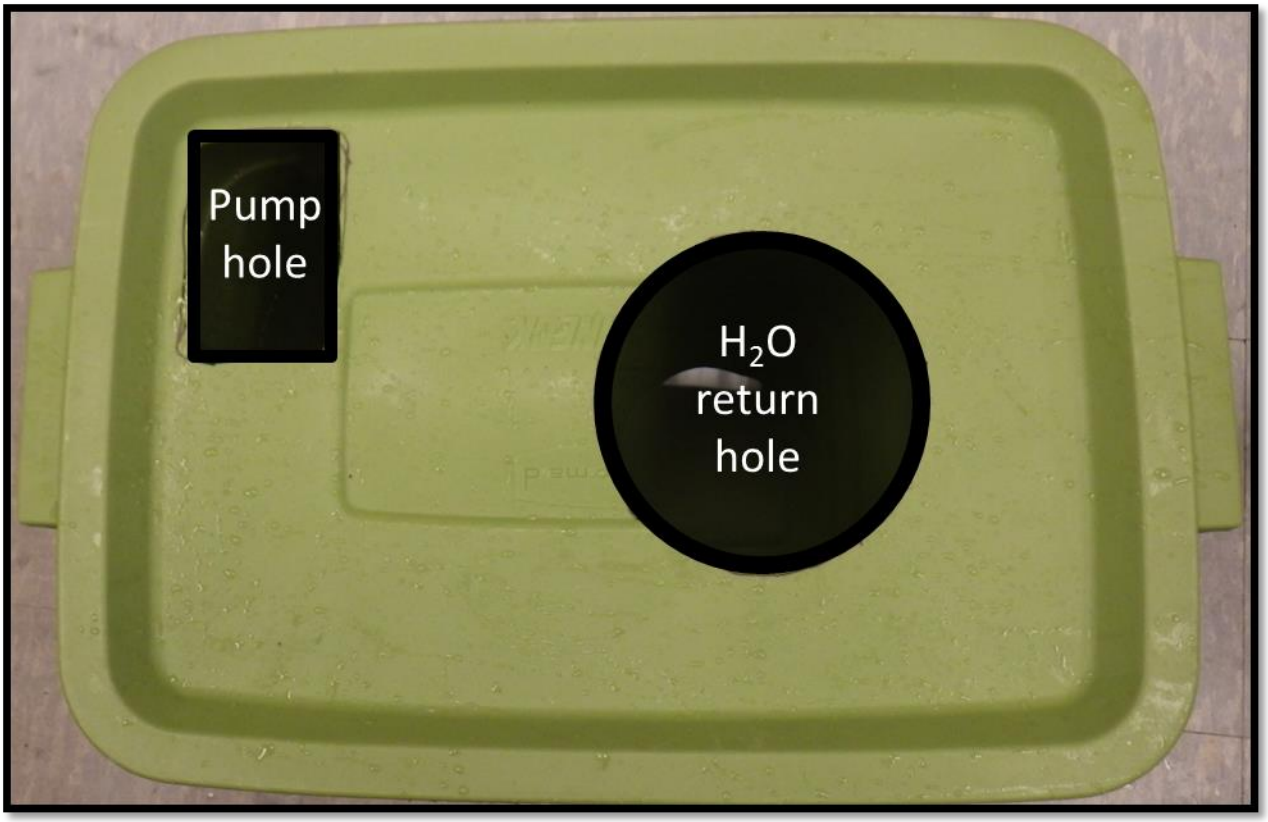


Assembly

4. Next, modify the tote lid by cutting two holes; one for the pump and one for water to return after passing through the blue bowl and the sieve.

The pump hole should be large enough for the pump to pass through and should be located so that the flex hose can be easily connected to the blue bowl without kinking.

The water return hole should be smaller than the outer diameter of your sieve so that the sieve can rest on the lid without falling through the hole. Sieves are generally 8” to 12” in diameter.



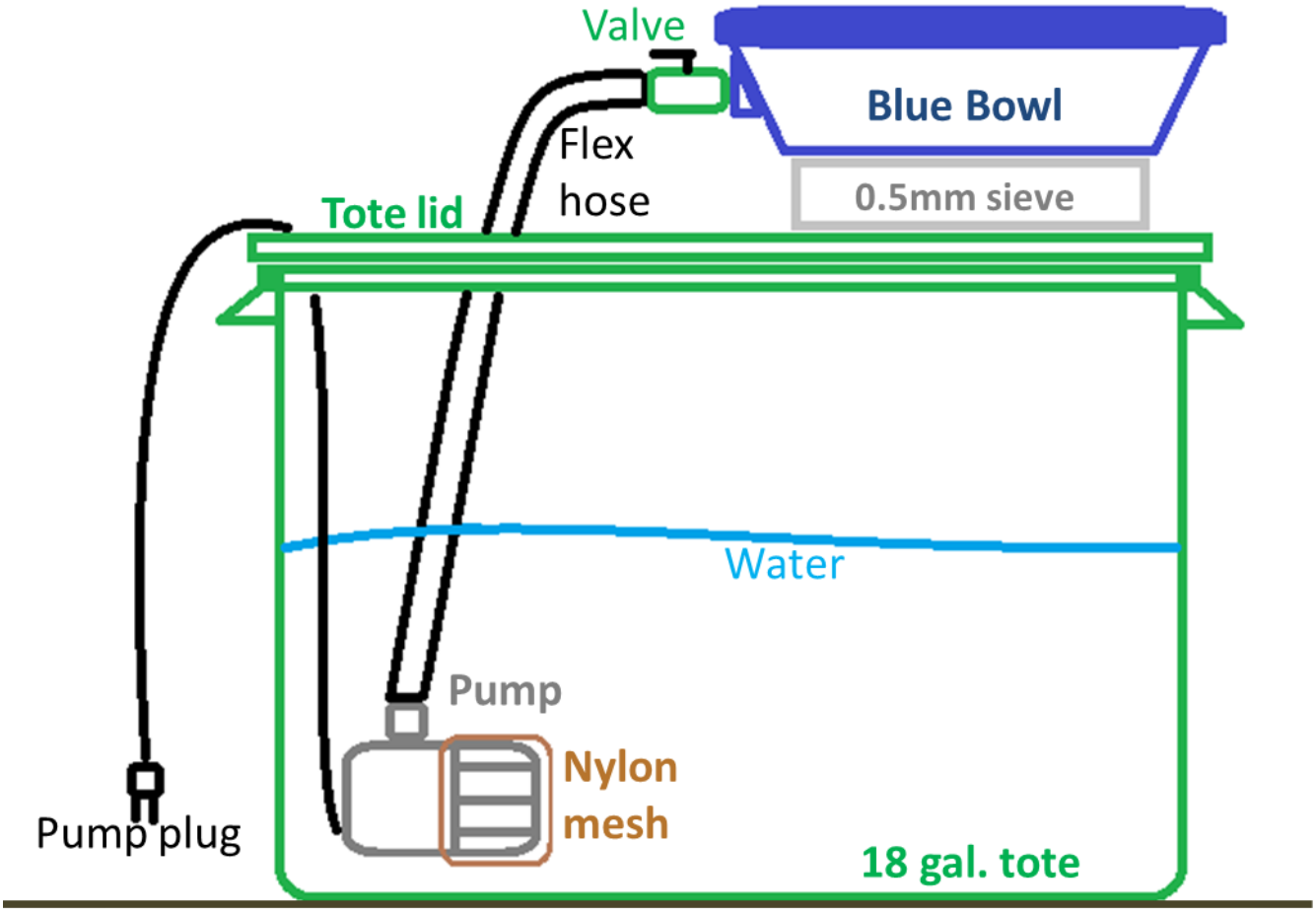
Set up

1. Remove any equipment stored within the tote and place the tote on a relatively level surface.

2. Add enough water to the tote so that the pump will be covered by several inches of water when connected.

3. Attach the tote lid, place the 0.5 mm sieve over the water return hole, place the blue bowl on top of the sieve, and connect the pump to the bowl.

4. Add water to the bowl to aid in determining if it is near level. Use the shims to level the bowl if needed by placing them under the edge of the sieve.



Sample processing

Note: Before each sample is processed, the blue bowl and sieve should be rinsed and the pump should be run briefly with the valve open while disconnected from the blue bowl to avoid any possible cross contamination between samples.

Once your vortex unit is setup and the bulk sample has been sieved to retain the sediment in the 0.5 mm sieve, you are ready to run the sample.

1. Open the valve about ½ way and turn on the power to the pump.

   The pump should not be left on with the valve closed as the hose may rupture.

2. Use the valve to adjust the flow as needed to ensure that water is not overflowing the outer edge of the blue bowl. A vortex will form draining through the center of the bowl.

3. Add up to about 60 oz. of the sieved sediment to the bowl. The rubber spatula and wash bottle may be used to help add the sediment to the bowl.

   If you have more sediment you may need to divide the sample and repeat the process.

4. Once the sediment has been added, open the valve all the way, or until the water is about 1 to 2 cm from the edge of the bowl. You should aim to keep the water level within about 2 cm of the edge of the bowl for steps 5 and 6 of the sampling process.

   It is common for the water level to drop after you add sediment due to the decreased water velocity caused by the rough surface of the sediment.

Sample processing

5. Using a sturdy plastic spoon or the spatula, stir the sediment from the middle to the edge of the bowl by sliding the spoon down the edge of the cone, across the bottom of the bowl, then up the side.

   A plastics spoon is preferred over metal because it will not scratch the surface of the bowl. Scratches may affect the flow of water and may create areas where sediment or eggs could be trapped.

   Move around the perimeter of the bowl as you stir while paying special attention to areas where the sediment has piled up or accumulated around the cone. This will help suspend eggs and ensure that they aren't being buried under the sand.

6. Stir for 1 to 3 minutes, and then allow the bowl to run undisturbed for about 10 seconds before turning off the pump and closing the valve.

   It is important to close the valve quickly after turning off the pump to avoid material being sucked back into the hose.

7. Once the water has settled, examine the sediment in the area immediately around the cone for eggs. If eggs are observed, skim them off with a spoon or pipette and add them to the sample jar.

Sample processing

8. Remove the blue bowl from the sieve and with the aid of a wash bottle, rinse the material captured by the sieve into a sample jar.

9. Once the material from the sieve is in the sample jar, strain off as much water as possible (being careful not to lose eggs), cover the sample material with preservative and insert the appropriate sample label before securing the lid to the sample jar.

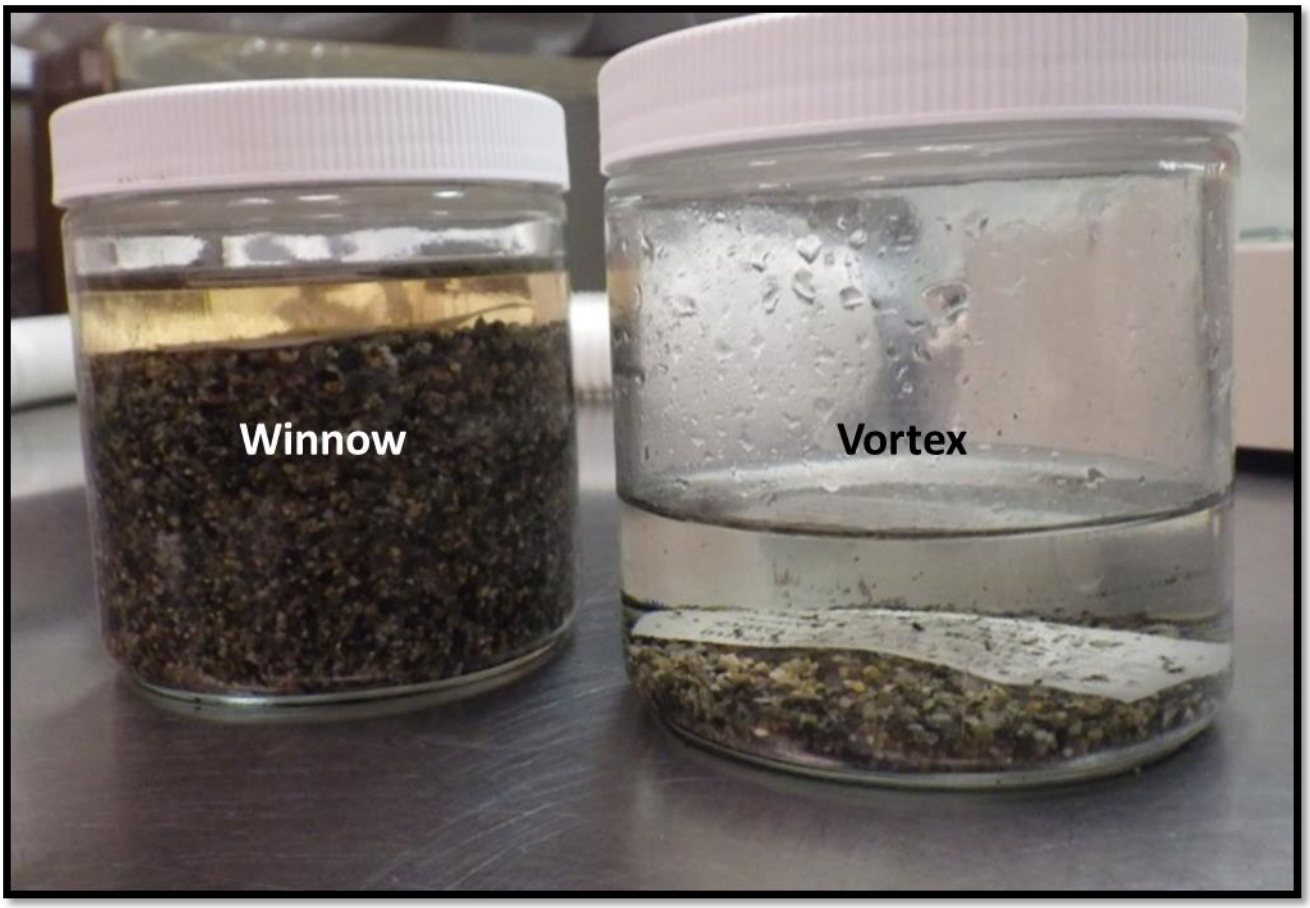
   The sample is now ready for lab processing.

Notes for lab processing

The laboratory procedures described in the field manual by Moulton and Penttila (2006) describe the process of further winnowing and reducing the sample prior to analysis with a dissecting microscope.

We have found that the volume of material retained after processing with the vortex method is typically so small that no additional winnowing or reduction is necessary. Instead, the entire preserved sample can generally be inspected for eggs in a standard 10 cm petri dish in just two or three batches.

For samples with a high volume of material in the condensed sample, it may be appropriate to apply the additional condensing process described in the field manual laboratory procedures.



Additional Resources

For training, consultation, or more information about WDFW forage fish studies, please contact Phillip Dionne at: *Phillip.Dionne@dfw.wa.gov; 360-902-2641*

Sampling protocols, identification guides, maps and other materials are available online at: *wdfw.wa.gov/conservation/research/projects/marine_beach_spawning/*

Field Manual:
Moulton, L., and D. E. Penttila. "San Juan County forage fish assessment project: Field Manual for sampling forage fish spawn in intertidal shore regions First Edition." *San Juan County Marine Resource Committee and Northwest Straits Commission, La Conner, WA.* (2001).

Acknowledgments: Special thanks Ned Pittman for assembling the first prototype for the vortex method, to Kira Kranzler for photos and organizing methods testing, and to numerous Washington Conservation Corps interns for participating in the methods testing.

Parts vendors

The use of product brand names, images, vendor names and web addresses for the sources or descriptions of materials are included for convenience to aid in the identification of the materials used by WDFW in the development of these methods and do not represent an endorsement of the vendor or the product by the WDFW or its staff.

18 gallon tote: http://www.homedepot.com/p/Rubbermaid-18-Gal-15-9-10-in-x-16-1-2-in-x-23-9-10-in-Storage-Tote-in-Green-1823619/203297506

Blue bowl (includes hose valve): http://www.blackcatmining.com/mining-equipment/blue-bowl.cfm

750 – 1000 gph water pump: http://www.ebay.com/itm/Active-Aqua-Submersible-Water-Pumps-Aquarium-Reservoir-Fountain-Pond-Hydroponics-/111476699981

¾" flex hose: http://www.blackcatmining.com/mining-equipment/flex-hose.cfm

¾" quick–connect hose connection (with or without valve): http://www.amazon.com/Gilmour-2939Q-Premium-Complete-Quick-Connect/dp/B000E1AHVW

¾” male thread hose repair kit: http://www.tacomascrew.com/Products/Couplers-Connectors/Gilmour-01M-Garden-Hose-Repair-Ends?CAWELAID=120168600000024660&CAGPSPN=pla&catargetid=120168600000026509&cadevice=c&gclid=CKD8kczP6sYCFZJgfgod9PMKiw

0.5 mm sieve: https://www.fishersci.com/shop/products/fisherbrand-u-s-standard-stainless-steel-sieves-8-in-dia-2-in-d/0488110q
A 1/50 inch fine mesh sieve is an alternative: http://www.goldfeverprospecting.com/keclsc.html

Shims: http://www.homedepot.com/p/Unbranded-8-in-Composite-Shim-Bundle-of-12-SHM1-12-TW/202807695

Rubber spatula: http://www.amazon.com/Farberware-Color-Silicone-Spoon-Spatula/dp/B005GT01KE

Appendix C:

Forage Fish Survey MRC Standard Operating Procedures

Forage Fish Survey Standard Operating Procedures
8.24.2020

Planning survey

1. Using dairki.org, find a suitable survey time in which the tide will be below 5ft for the entirety of the sample process.
2. Copy and paste volunteer emails into the BCC line of email to protect everyone's privacy.
3. Use sample email text (found in Box), if desired, and change all necessary information

Sampling

1. Ensure that you have:
    a. The volunteer sign-in form
    b. 2 field sheets
    c. Device for collecting digital data
    d. 1 pencil
    e. 2 collection bags
    f. The tape measure
    g. The green hand shovel
    h. 2 bread bag ties (or a way to secure bags)
    i. 2 sample tags
2. Meet volunteers and walk down to starting point (see Figure 1)
    a. Little Squalicum Estuary: line up tree with train trestle behind it
    b. Marine Park: line up Birch tree with the tree behind it
3. Find the most recent rack line and determine this is the last high tide mark.
4. From the starting point, walk tape measure out to 100 feet to your right of the starting point. Lay the 100ft transect along the rack line. See Figure 1.
    a. Collecting sample
        i. Using the green shovel, fill ¼ of the plastic bag with sediment at each of the following points: 0ft, 33ft, 66ft, 99ft (¼ of bag at 4 sample locations = one full bag)
        ii. Only gather the top layer of sediment in each sample location. Remove large rocks and seaweed before shoveling sediment into bag - these do not need to be included in the sample.

iii. After taking photos, place sample tag on top of collected sediment in bag and seal with bread bag tie or a knot.

b. Collecting data

i. Walk to the 50ft mark of the transect
ii. Open iForm on device
iii. Tap on Forage Fish Spawning Beach Survey
iv. Tap the '+' at the bottom of the screen
v. Enter date, organization (Whatcom MRC), and location (Little Squalicum Estuary or Marine Park)
vi. Using the free Tide Alert app, enter the last high tide and 2nd most effective high tide
vii. Tap on 'Samples'
viii. Enter Beach Station # 1
ix. Enter Sample # 1
x. Enter the time
xi. Select 'Regular' for Sample Taken
xii. Open barcode scanner and allow the app to access your camera. This will open your device camera. Hold camera up to barcode on sample tag and wait for device to recognize the barcode number. You will not have to press any buttons. Ensure that the number in the device is the number on the sample tag.
xiii. Tap on the blank space under 'GPS location'
xiv. Hit refresh and then tap 'Done' in the upper right hand corner
xv. Write these coordinates onto the paper field sheet. Now is a good time to go back and fill in the time, beach station #, and all information at the top of the field sheet.
xvi. You do not need to re-enter the coordinates in the spaces that say 'Manual Entry if Needed' unless step xiv didn't work.
xvii. Tap on 'Beach' and tap on the appropriate substrate size. See back of field sheet for measurements and further explanation.
xviii. Repeat for 'Uplands.' Understand that the uplands are categorized as human impacts (rip rap, culverts, train trestles, parking lots, bulkheads, etc.) on the beach both upbeach from the transect, but also 500ft down the beach on either side of that 50ft mark at which you are standing.
xix. Enter the beach width, beach length, landmark, sample zone (in feet), and shading. See back of field sheet for definitions.
xx. Use the Tide Alert app again to determine the tidal elevation at the time of sample collection.
xxi. Enter Sample Type as 'B - Bulk'
xxii. Select the appropriate level of eggs seen by the naked eye when sampling on a scale of 0 to W. See back of field sheet for definitions.
    1. Smelt
    2. Sand lance
    3. Rock sole

xxiii. Tap on the white space below ‘Completed Sample Tag Photo.’ Tap ‘take a picture with camera.’ Write all appropriate information on the tag and take a close-up photo of the tag so that all written information can be clearly read.

xxiv. Tap on the white space below ‘Sediment With Scale at Transect Photo.’ Tap ‘take a picture with camera.’ Place sample tag on the ground near the tape measure. Take a photo of the tag on top of the substrate with the device at knee level. WDFW will use this photo and the black/white scale at the bottom of the tag to characterize the substrate. It’s ok that you can’t read the writing on the tag.

xxv. Tap on the white space below ‘Beach Backshore Photo.’ Tap ‘take a picture with camera.’ Take a photo at eye-level of the backshore.

xxvi. Tap on ‘Beach Right Photo’ and turn to your right. Take photo.

xxvii. Continue moving in a clockwise motion to take the foreshore and beach left photos. Think of the beach backshore as 12 noon, the beach right as 3pm, the foreshore as 6pm, and the beach left as 9pm.

xxviii. Under ‘Landowner Interaction’ select whether or not you had any positive or negative interactions with the public. Neither of these sites are private property, so there won’t be any landowners, but WDFW would still like to know what the public reaction is to our forage fish sampling. Select ‘None’ if you did not interact with any members of the public.

xxix. Enter any comments, if necessary.

xxx. Tap ‘Done’ or ‘Save’ - either one works

xxxi. IMPORTANT AND EASY TO MISS: Tap the blank white space below ‘**I certify that…’

xxxii. Use your finger to sign on the line. Tap ‘submit.’

xxxiii. Tap ‘Save’

xxxiv. Go back to paper field sheet and fill in every box. Make sure to write ‘0’ if no eggs were seen. Do not leave any fields blank or WDFW will assume that you forgot to enter the data here. Sign your name on the back of the sheet and write volunteer names under ‘Samplers.’ Write ‘Whatcom MRC’ under ‘Organization.’

Processing

1. Meet volunteers in the garden on Kulshan St. behind the RE Store
2. Empty one blue tote bin and set up for blue bowl processing. Do this on a flat surface.
    a. Place plywood board on top of tote bin
    b. Place pump (with nylon stocking cover) into the small hole. Try to put as much tubing as you can into the bin to help speed up the pumping process.
    c. Place the smallest sieve over the larger hole on the board
    d. Set the blue bowl on top of the small sieve. Attach end of pump tubing to the blue bowl.
    e. Place battery on top of the board, but do not connect it yet

3. Hook up your hose to the fitting behind the recycled rain water totes. You may need to disconnect an existing hose first.
4. Go inside the RE Store warehouse and turn on the spigot in the employee bathroom
5. Once the water is on, fill the tote bin about ⅓ of the way full
6. Set up green bucket on flat surface, and place all three sieves (the smallest mesh on the bottom and the largest on top) on top of the bucket
7. Open the plastic sample bag and place the sample tag in a sample jar. Keep this tag and jar with the sample so as not to mix up any samples!
8. Dump all contents on to the top sieve. If there is too much sediment to fit in the sieve, only do half the bag at a time.
9. With one person shaking the sieve/bucket and another using the shower function on the hose nozzle, wash the sediment for a minute or two (until most of the smaller sediment has been washed into the lower sieves)
10. Repeat this process on the middle sieve
11. When you get to the lower sieve, do not shake. Simply rinse the sediment with the hose for about 20 seconds.
12. Transfer the contents of the lower sieve to the white, rectangular bin. If there are eggs in the sample, they will be in this sediment, so it is very important to be careful here. Use the hose to gently wash all sediment from lower sieve into white bin.
13. Connect the battery to the pump. Red to red and black to black.
14. Wait for the water to reach an appropriate velocity. The water should be swirling enough to spill over the top of the center hole but not so fast that the bowl is almost overflowing with water. Use the black knob on the blue bowl/pump connection to control the speed of the water.
15. Pour the water in the white bin directly into the center of the blue bowl
16. Pour the sediment around the edges of the blue bowl
17. Sift and stir the sediment by moving the white spatula from the middle of the bowl out to the edges (see Figure 2). Continue to move around the bowl in the direction of the water flow. Do this for 2-3 minutes.
18. Disconnect one battery connection (red or black, doesn't matter) and close the valve on the blue bowl
19. Disconnect the bowl from the pump tubing and dump sediment on the gravel path. The eggs, if present, will now be in the small sieve that was underneath the blue bowl.
20. Use the mist function on the hose to GENTLY move sediment in small sieve to one edge of the sieve. Spray the sediment from behind/underneath the screen in a downwards motion. Be careful to not lose any sediment or possible eggs!
21. Use the spoon to scoop all sediment into a sample jar. Ensure that everything that was in the small sieve is now in the sample jar. You can use the mist function to help facilitate this, but make sure to limit

the amount of water going into the jar. Try not to fill the jar with more than a ¼ cup of water.

Cleaning Equipment

1. You must clean and rinse all equipment between each sample to prevent cross contaminating your samples!
2. Use the hose to rinse the white bin and blue bowl. Make sure to spray some water into the hole where water enters the blue bowl as sediment frequently gets stuck in there.
3. Rinse the spoon and white spatula
4. Dump all excess sediment from sieves into gravel path
5. Use plastic brush and hose to remove rocks and sand from each of the four sieves

Preparing Sample Jar

1. On the lid of the sample jar, use a pencil to write the date, the sample location, 'Whatcom MRC,' and an 'x.' The 'x' indicates that there is stockard in the jar and should therefore be stored and handled appropriately.
2. Ensure that the sample tag is in the jar
3. Place the jar on the ground and CAREFULLY add equal parts of the stockard as there is water in the jar. This chemical contains formaldehyde and should be handled with extreme care. Rinse eyes and skin thoroughly if contact occurs.
4. Cut a piece of Parafilm and stretch it to fit over the mouth of the jar
5. Place the lid on the jar
6. Place the jar and the accompanying field sheet into a plastic Ziploc bag. Little Squalicum and Marine Park samples can be placed in the same bag. Place all Aiston Preserve samples in their own bag.
7. A NOTE ABOUT AISTON SAMPLES: Much of the Aiston samples will yield a lot of shell fragments. The calcium carbonate in the shells reacts with the stockard and creates gas bubbles. You will need to leave the lid of each jar open a half turn so that this gas can escape and not cause the jar to explode. Store these samples in a place where they will be undisturbed. Make sure to screw the lids on tightly when transporting.

Figure 1. Starting points

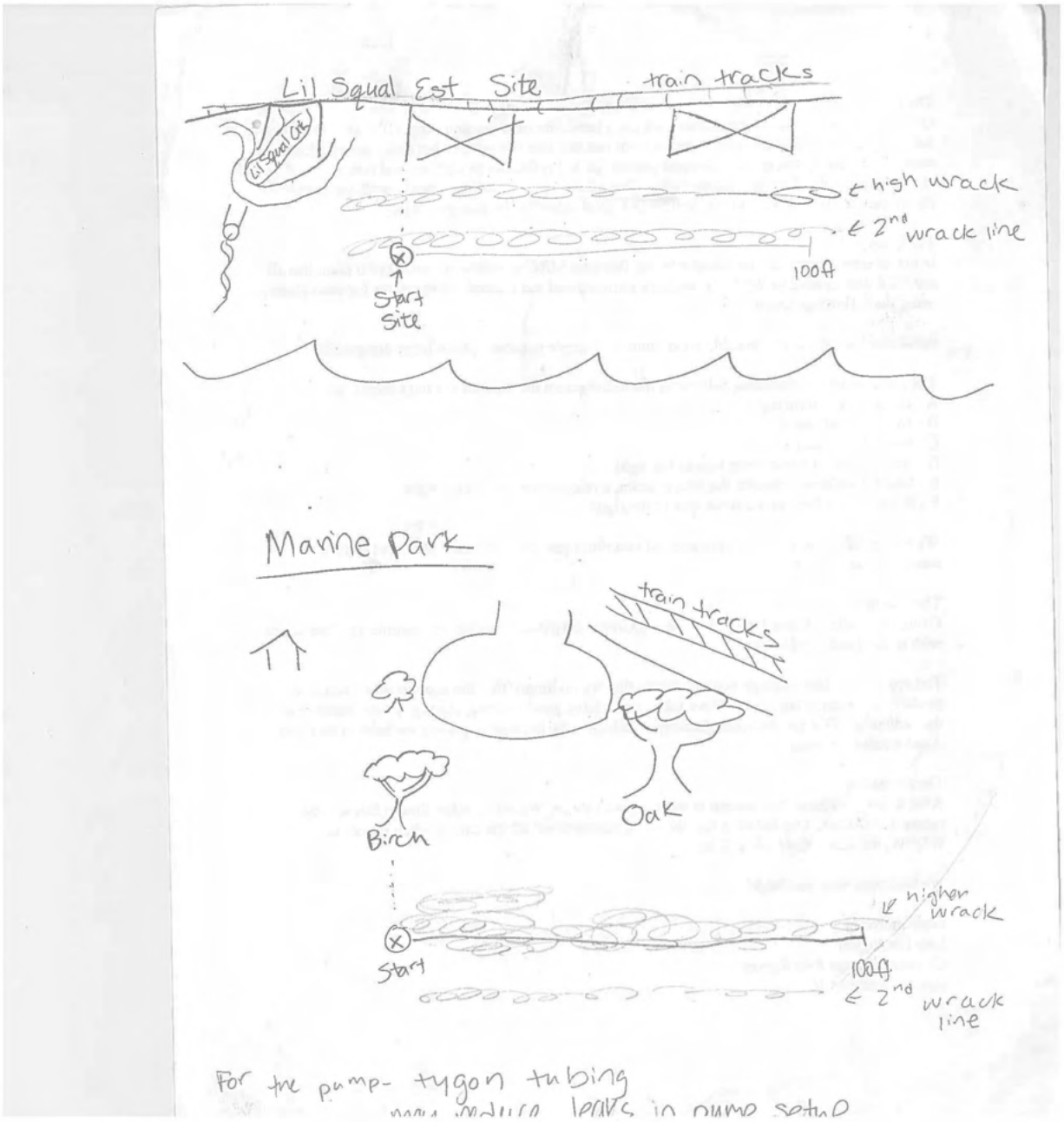
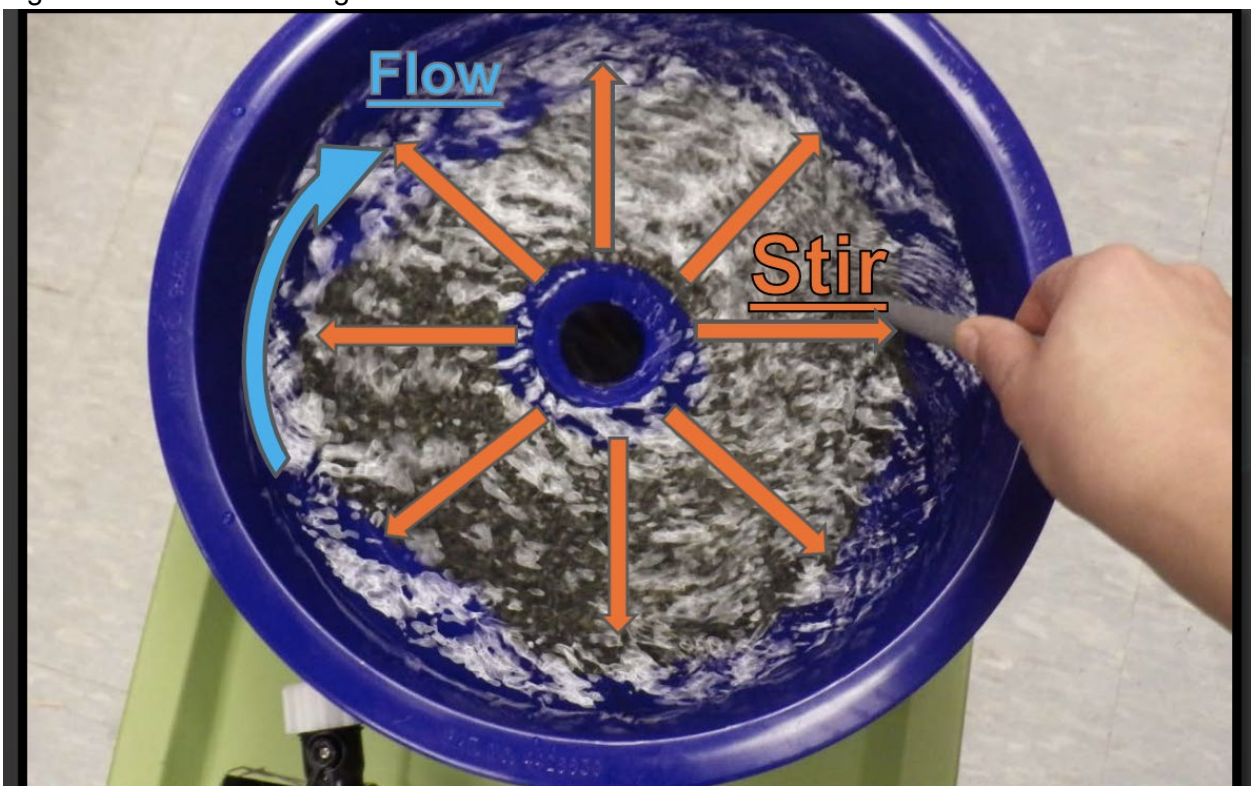


Figure 2. Blue bowl stirring method



Appendix D:
Raw Forage Fish Data from WDFW

This excel sheet is used to report egg counts of surf smelt and sand lance from beach surveys. The samples are collected through partnerships organizations and sent to WDFW's lab to confirm species IDs and report counts. This data is typically reported on a monthly basis, and the larger data from these surveys is publiched on the WDFW's Marine Beach Spawning map.	
Marine Beach Spawning Map Link:	https://wdfw.maps.arcgis.com/home/webmap/viewer.html?webmap=19b8f74e2d41470cbd80b1af8dedd6b3&extent=-126.1368,45.6684,-119.6494,49.0781

Cell	Header	Description
A1	SurveyDate	Date of survey
B1	Location	Location of survey
C1	BeachStation	Beach Station #
D1	Sample	Sample #
E1	FieldSheet	WDFW has possession of the survey field sheet (Y/N)
F1	LabSheet_Sample	WDFW has possession of either the sample or the lab sheet (Y/N)
G1	Photos	WDFW has possession of the survey photos (Y/N)
H1	DFW_QAQC	WDFW has QAQC'd the sample (Y [Yes]/N [No]/P [Pending])
I1	SurfSmelt	# of surf smelt eggs found in the sample
J1	SandLance	# of sand lance eggs found in the sample
K1	RockSole	# of rock sole eggs found in the sample
L1	x_factor	Mulitplication factor. Only for very large samples where only a portion of the sample was processed. Default = 1 (i.e., entire sample was processed)
M1	DFWdatabase	Field and lab data have been entered into the WDFW database (Y [Yes]/N [No]/P [Pending])
N1	Comments	Additional comments where needed

SurveyDate	Location	BeachStation	Sample	DFW_QAQC	SurfSmelt	SandLance	RockSole	x_factor	DFWda	SS Spav	SL Sp	Comments	Entered by	Barcode assigned?
1/30/2024	Little Squalicum	1	1	Y	17	0	0	1	Y	1	0		SS	23_1528
1/30/2024	Little Squalicum	2	1	Y	1	0	0	1	Y	0	0		SS	23_1530
1/30/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		SS	23_1532
1/30/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		SS	23_1534
2/29/2024	Little Squalicum	1	1	Y	1	0	0	1	Y	0	0		EF	23_1536
2/29/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		EF	23_1538
2/29/2024	Little Squalicum	3	1	Y	1	0	0	1	Y	0	0		EF	23_1540
2/29/2024	Little Squalicum	4	1	Y	0	0	2	1	Y	0	0		EF	23_1526
3/15/2024	Little Squalicum	1	1	Y	0	0	0	1	Y	0	0		EF	23_1541
3/15/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		EF	23_1543
3/15/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		EF	23_1545
3/15/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		EF	23_1547
4/24/2024	Little Squalicum	1	1	Y	15	0	0	1	Y	1	0		EF	23_1549
4/24/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		EF	23_1551
4/24/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		EF	23_1553
4/24/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		EF	23_1555
5/21/2024	Little Squalicum	1	1	Y	0	0	0	1	Y	0	0		SS	23_1557
5/21/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		SS	23_1559
5/21/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		SS	23_1548
5/21/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		SS	23_1546
6/27/2024	Little Squalicum	1	1	Y	0	0	0	1	Y	0	0		MS	23_1544
6/27/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1542
6/27/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1561
6/27/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1552
7/26/2024	Little Squalicum	1	1	Y	1	0	0	1	Y	0	0		MS	23_1561
7/26/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1563
7/26/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1565
7/26/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1567
8/7/2024	Little Squalicum	1	1	Y	0	0	0	1	Y	0	0		MS	23_1569
8/7/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1571
8/7/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1579
8/7/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1564
9/17/2024	Little Squalicum	1	1	Y	111	0	0	1	Y	1	0		MS	23_1577
9/17/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1573
9/17/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1575
9/17/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1556
10/15/2024	Little Squalicum	1	1	Y	115	0	0	2	Y	1	0		MS	23_1566
10/15/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1568
10/15/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1570
10/15/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1572
11/13/2024	Little Squalicum	1	1	Y	5	0	0	1	Y	1	0		KO	23_1578
11/13/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		KO	23_1580
11/13/2024	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0	Site 4 was in	KO	23_1581
12/9/2024	Little Squalicum	1	1	Y	64	0	0	1	Y	1	0		MS	23_1585
12/9/2024	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1587
12/9/2024	Little Squalicum	3	1	Y	2	0	0	1	Y	1	0		MS	23_1589
12/9/2024	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1591
1/23/2025	Little Squalicum	1	1	Y	5	0	0	1	Y	1	0		MS	23_1593
1/23/2025	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1595
1/23/2025	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1597
1/23/2025	Little Squalicum	4	1	Y	4	0	0	1	Y	1	0		MS	23_1599
2/21/2025	Little Squalicum	1	1	Y	5	0	0	1	Y	1	0		HMD	23_1586
2/21/2025	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		HMD	23_1588
2/21/2025	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		AOR	23_1590
2/21/2025	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		AOR	23_1592
3/14/2025	Little Squalicum	1	1	Y	2	0	0	1	Y	1	0		HMD	23_1598
3/14/2025	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		HMD	23_1600
3/14/2025	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		HMD	23_1609
3/14/2025	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		HMD	23_1615
4/10/2025	Little Squalicum	1	1	Y	2	0	0	1	Y	1	0		SMS	23_1613
4/10/2025	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		SMS	23_1601
4/10/2025	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		SMS	23_1603
4/10/2025	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		SMS	23_1611
5/13/2025	Little Squalicum	1	1	Y	12	0	0	1	Y	1	0		MS	23_1602
5/13/2025	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1604
5/13/2025	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1606
5/13/2025	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1608
6/17/2025	Little Squalicum	1	1	Y	18	0	0	1	Y	1	0		MS	23_1614
6/17/2025	Little Squalicum	2	1	Y	0	0	0	1	Y	0	0		MS	23_1616
6/17/2025	Little Squalicum	3	1	Y	0	0	0	1	Y	0	0		MS	23_1618
6/17/2025	Little Squalicum	4	1	Y	0	0	0	1	Y	0	0		MS	23_1605
7/15/2025	Little Squalicum	1	1	digital data received, pending physical sample						0	0		KO	23_1619
7/15/2025	Little Squalicum	2	1							0	0		KO	23_1620
7/15/2025	Little Squalicum	3	1							0	0		KO	23_1661
7/15/2025	Little Squalicum	4	1							0	0		KO	23_1663
8/25/2025	Little Squalicum	1	1							0	0		KO	23_1665
8/25/2025	Little Squalicum	2	1							0	0		KO	23_1667
8/25/2025	Little Squalicum	3	1							0	0		KO	23_1669
8/25/2025	Little Squalicum	4	1							0	0		KO	23_1671
9/19/2025	Little Squalicum	1	1							0	0		KO	23_1677
9/19/2025	Little Squalicum	2	1							0	0		KO	23_1679
9/19/2025	Little Squalicum	3	1							0	0		KO	23_1662
9/19/2025	Little Squalicum	4	1							0	0		KO	23_1680

SurveyDate	Location	BeachStatior	Sample		FieldSh	LabSheet	Photos	DFV SurfSmelt	SandLance	RockSole	x_factor	DFWda	SS Spav	SL Spav	Comments	Entered by	Barcode assigned?
10/11/2023	Clayton Beach	1	1	Y	Y	N		digital data received, pending samples					0	0		KO	barcode not assigned yet
10/11/2023	Clayton Beach	2	1	Y	Y	N							0	0		KO	barcode not assigned yet
11/10/2023	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		SS	23_1501
11/10/2023	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		SS	23_1503
12/21/2023	Clayton Beach	1	1	Y	Y	N	Y	0	0	0	1	Y	0	0		SS	22_1057
12/21/2023	Clayton Beach	2	1	Y	Y	N	Y	1	0	0	1	Y	0	0		SS	22_1119
1/31/2024	Clayton Beach	2	1	Y	Y	N	Y	0	0	0	1	Y	0	0		SS	22_1062
1/31/2024	Clayton Beach	1	1	Y	Y	N	Y	0	0	0	1	Y	0	0		SS	22_1104
2/24/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		EF	22_1055
2/24/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		EF	22_1054
3/14/2024	Clayton Beach	1	1		Y	Y	Y	0	0	0	1	Y	0	0		EF	23_1524
3/14/2024	Clayton Beach	2	1		Y	Y	Y	0	0	0	1	Y	0	0		EF	23_1522
4/18/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		EF	22_1050
4/18/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		EF	22_1064
5/10/2024	Clayton Beach	1	1	Y	Y	Y							0	0	Samples discarded by Skagit, (	EF	22_1106
5/10/2024	Clayton Beach	2	1	Y	Y	Y							0	0	Samples discarded by Skagit, (	EF	22_1049
6/14/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		KO	22_1048
6/14/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		KO	22_1066
7/25/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		KO	23_1554
7/25/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		KO	23_1556
8/3/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	22_1047
8/3/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	22_1068
9/16/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	23_1558
9/16/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	23_1562
10/13/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	22_1088
10/13/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	22_1110
11/12/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	23_1574
11/12/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	23_1576
12/23/2024	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		SMS	22_1075
12/23/2024	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		SMS	22_1117
1/22/2025	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	23_1582
1/22/2025	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		MS	23_1584
2/25/2025	Clayton Beach	1	1	Y	Y	Y							0	0		MS	22_1092
2/25/2025	Clayton Beach	2	1	Y	Y	Y	Y	1	0	0	1	Y	0	0		MS	22_1109
3/13/2025	Clayton Beach	1	1	Y	Y	Y							0	0		AOR	23_1594
3/13/2025	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		AOR	23_1596
4/16/2025	Clayton Beach	1	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		HMD	22_1087
4/16/2025	Clayton Beach	2	1	Y	Y	Y	Y	0	0	0	1	Y	0	0		HMD	22_1107
5/14/2025	Clayton Beach	1	1	Y	Y	Y							0	0	collected by Whatcom MRC	MS	23_1610
5/14/2025	Clayton Beach	2	1	Y	Y	Y							0	0	collected by Whatcom MRC	MS	23_1612
6/3/2025	Clayton Beach	1	1	Y	Y	Y	Y	Digital data received, awaiting physical samples					0	0		KO	22_1085
6/3/2025	Clayton Beach	2	1	Y	Y	Y	Y						0	0		KO	22_1114
7/10/2025	Clayton Beach	1	1	Y	Y	Y	Y	Digital data received, awaiting physical samples					0	0	collected by Whatcom MRC	KO	23_1617
7/10/2025	Clayton Beach	2	1	Y	Y	Y	Y						0	0	collected by Whatcom MRC	KO	23_1607
8/17/2025	Clayton Beach	1	1	Y	Y	Y	Y						0	0		KO	22_1101
8/17/2025	Clayton Beach	2	1	Y	Y	Y	Y						0	0		KO	22_1063
9/18/2025	Clayton Beach	1	1	Y	Y	Y	Y						0	0		KO	23_1673
9/18/2025	Clayton Beach	2	1	Y	Y	Y	Y						0	0		KO	23_1675