QUALITY ASSURANCE PROJECT PLAN:

Marine Resources Committee Intertidal Forage Fish Spawning Survey

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Prepared for:

Washington Department of Ecology

March 2020

Based on EPA guidance CIO 2106-G-05 (2012)

This project has been funded wholly or in part by the United States Environmental Protection Agency. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency under Assistance Agreement [CE-01J65401]. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Publication Information

This study has been funded in part by the United States Environmental Protection Agency (EPA) through the Puget Sound Partnership National Estuary Program, via Interagency Agreement Number 2020-19 with the Department of Ecology/Northwest Straits Initiative, of which the Marine Resources Committees are a member. The Northwest Straits Commission is comprised of 7 Marine Resources Committees in Northwest Washington. The Marine Resources Committees were established by county governments in 1999, as an advisory body to county government, and are part of the regional coordinating organization, the Northwest Straits Initiative.

Each study conducted for the EPA using National Estuary Program funds must have an approved Quality Assurance Project Plan (QAPP) describing the objectives of the study and the procedures to be followed to achieve those objectives. The plan and final reports for this program will be available on the Northwest Straits Commission website in the resource library for different counties and in the annual report. Neither document necessarily reflects the views and policies of the EPA, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. This QAPP is valid through March 2025 / five years from the date of approval].

Data for this project will be available on the SoundIQ website at
https://www.iqmap.org/geviewer/Html5Viewer/?viewer=soundiq
And Washington Department of Fish and Wildlife's forage fish spawning map:
https://www.arcgis.com/home/webmap/viewer.html?webmap=19b8f74e2d41470cbd80b1af8dedd6b3

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Quality Assurance Project Plan
Marine Resources Committee Intertidal Forage Fish Spawning Survey

March 2020

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1.0 Table of Contents

Acronyms

DO – Dissolved Oxygen

ESA – Endangered Species Act

GPS – Global Positioning Satellites

MRC – Marine Resources Committee

NWSC – Northwest Straits Commission

QAPP – Quality Assurance Project Plan

SRSC – Skagit River System Cooperative

WDFW – Washington Department of Fish and Wildlife

WDNR – Washington Department of Natural Resources

WSU – Washington State University

2.0 Abstract

Forage fish are a vital part of the Puget Sound ecosystem, and the monitoring of their status is an important component to the recovery of Puget Sound and the Salish Sea. Sampling to identify forage fish spawning will be conducted by citizen-science volunteers who have received training from Washington Department of Fish and Wildlife (WDFW) and Project Managers, and will use sampling and processing protocols established by WDFW. This survey is designed to establish continuity with existing WDFW data in an effort to measure seasonal and temporal trends of spawning and develop an understanding of the conditions and processes affecting the study areas over time. MRC volunteers conduct presence/absence forage fish spawning surveys at select index and restoration sites on a monthly basis in the Northwest Straits Counties as part of the WDFW/NWSC Forage Fish Index Sites monitoring program. The volunteers make an initial determination of presence of forage fish eggs. Samples are then sent to WDFW for confirmation and quality checks using laboratory methods to identify and count eggs if present. The scope of work for this QAPP is limited to field sampling of bulk beach substrate samples and condensing bulk samples (known as the "blue bowl vortex method") at program sites for the ongoing index sampling period (Currently 2020-2021). Subsequent quality assurance and lab based analysis is conducted by WDFW and considered outside the scope of this QAPP.

3.0 Background

3.1 Introduction and Problem Statement

Forage fish are a vital part of the Puget Sound ecosystem, and the monitoring of their status is an important component to the recovery of Puget Sound and the Salish Sea. They are intermediaries in the food chain, passing energy from primary producers (phytoplankton) and primary consumers like invertebrate larvae and shrimp to higher trophic levels, including marine birds, mammals and fish. The latter include salmon, some of which are listed as endangered under the Endangered Species Act (ESA). The sampling will be conducted by citizen-science volunteers who have received training from Washington Department of Fish and Wildlife (WDFW) and Project Managers, and will use sampling and processing protocols established by WDFW.

There are seven Marine Resources Committees (MRCs) in the counties of northern Puget Sound created in 1998 when Congress authorized the Northwest Straits Marine Conservation Initiative. This initiative resulted from the 1998 Murray-Metcalf Northwest Straits Citizens Advisory Commission Report The MRCs were created to provide local, broad-based, bottom-up input to the Northwest Straits Commission (NWSC) and affiliated county governments.

In 1998, WDFW established a policy (POL-C3012) on the management of forage fish that requires management policies based on monitoring data (WDFW 1998). A Northwest Straits Commission symposium on forage fish was held in September 2012 (Liedtke et al., 2013) that both summarized current work and presented new research. One of the conclusions of the symposium was that:

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

Forage fish beach spawning surveys have been recognized as a reliable way of monitoring forage fish spawning abundance and determining critical spawning habitat sites. (Moulton and Penttila, 2001).

The MRCs and NWSC run a forage fish spawning survey program by conducting monthly sampling at select index sides in the seven counties year round to track spatial and temporal patterns of forage fish spawning. This work is done in partnership with WDFW. WDFW staff coordinate with MRCs and the WDFW to receive and process samples, analyze data, and provide quality assurance checks.

3.2 Study Area

The index survey sites and select restoration sites sampled for this program span the seven counties in the NWSC area. Survey sites may occasionally change as directed by Washington Department of Fish and Wildlife (WDFW), data results, or restoration site needs. If sites change, a QAPP addendum will be submitted to include site changes. Survey sites include (Figure 1):

Island County:

- Ala Spit, Cornet Bay, Hidden Beach, Seahorse Siesta, Sunlight Shores, Glendale and Maple Grove

Clallam County:

- Cline Spit, Lower Elwha restoration site on Ediz Hook, Elwha Beach east of river mouth

Jefferson County:

- Adelma Beach, Fort Townsend State Park

Whatcom County:

- Marine Park, Little Squalicum Beach

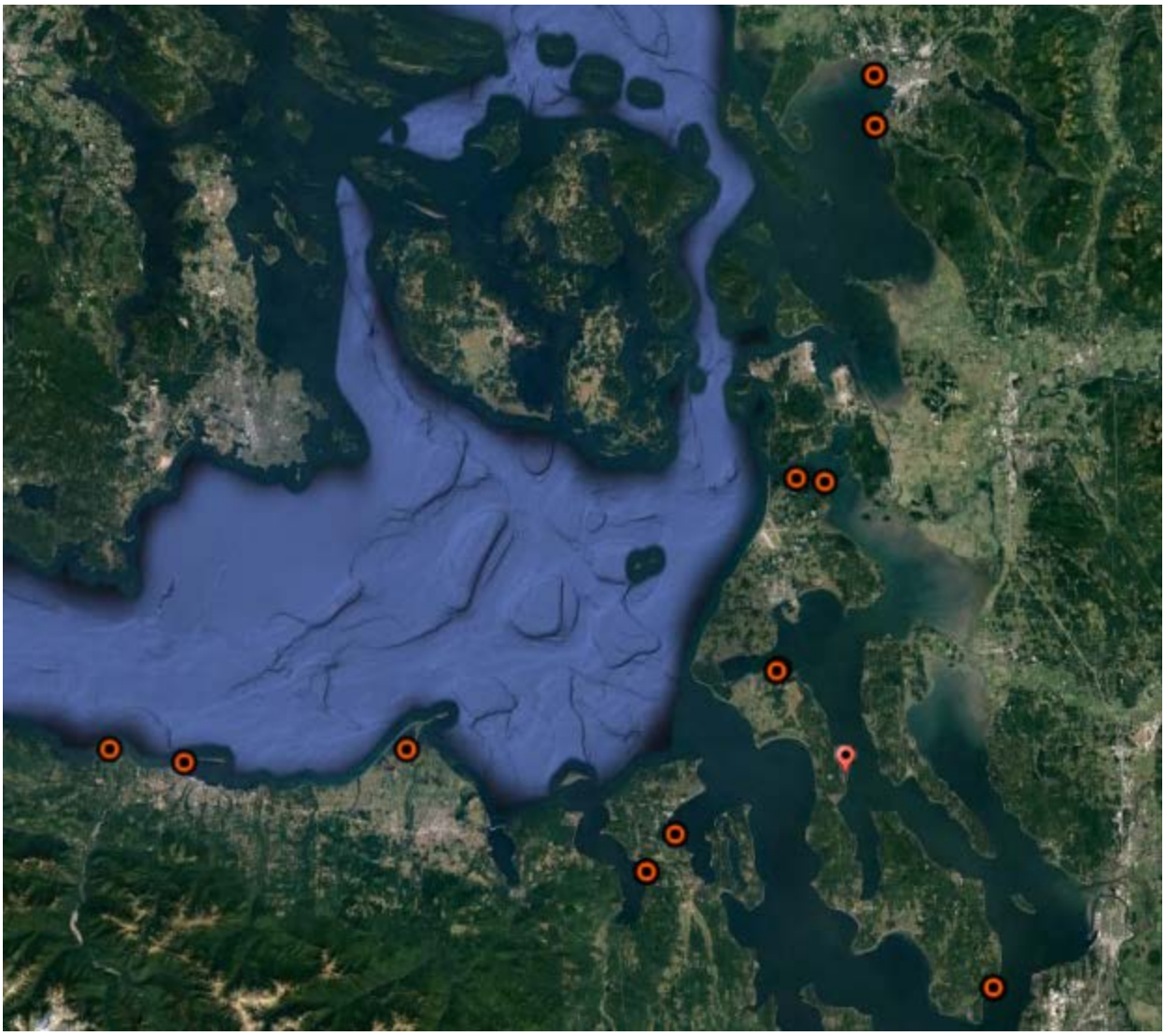

Figure 1: Google Earth map of forage fish sampling sites.

3.2.1 History of study area

The study site spans a large region representing the Northwest Straits and Marine Resources Committees (MRCs) areas of interest. Monitoring sites include both index sites and restoration sites. Index sites are publically accessible or privately owned lands the MRCs have permission to access to monitor monthly for seasonal and yearly trends in forage fish spawning. The index sites were established in 2016 and have been routinely monitored since the start of the Index program in partnership with WDFW. The sites are meant to be considered good habitat for forage fish spawning to occur and therefore have less armor and development in the nearshore environment. Restoration monitoring sites take place at locations selected for restoration or where restoration has already occurred to document changes to forage fish spawning activities as a result of nearshore habitat restoration. All the selected monitoring sites in the Northwest Straits region represent important habitat for forage fish spawning, and better understanding forage fish distribution and spawning trends.

Sampling of forage fish spawning is considered a high priority and part of the Puget Sound Partnership Action Agenda (Puget Sound Action Agenda, 2018-2022).

3.2.2 Summary of previous studies and existing data

This project is part of a long term study being conducted and analyzed by WDFW and began in 2016. WDFW is leading the review and analysis and results have not been released. The study is to document long term seasonal and spatial trends and distributions of forage fish spawning in Puget Sound and includes MRC collected data, as well as WDFW data. Prior to the Index site monitoring, WDFW sampled at most annually at the index sites.

Beach spawning data is viewable on the WDFW spawning location map:
https://www.arcgis.com/home/webmap/viewer.html?webmap=19b8f74e2d41470cbd80b1af8dedd6b3

Another spatiotemporal study was done by Pierce et al. in 2012. Results indicated spawning mostly occurred in the fall, winter, and spring, but could occur year-round at sites.

3.2.3 Parameters of Interest

Parameters of interest for this project include:

- Presence and absence of forage fish spawn eggs
- Visual observations of beach characteristics

3.2.4 Regulatory criteria or standards

Not applicable. Does not assess compliance or regulatory criteria.

3.3 Water quality impairment studies

Not applicable

3.4 Effectiveness monitoring studies

Not applicable

4.0 Project Description

4.1 Project Goals

The goals of the intertidal forage fish spawning surveys are to:

- Enhance baseline data
- Document changes over time in forage fish usage of beaches using established methods that will provide data comparable across monitoring years.

4.2 Project Objectives

The objectives of this project are to:

- Train and empower citizen scientists to conduct surveys using a standardized protocol

- Implement the surveys on a regular and consistent basis which can contribute to the time series from previous monitoring studies, and supplement the Sound-wide survey led by WDFW

4.3 Information needed and sources

This survey is designed to establish continuity with existing WDNR and WDFW data in an effort to define trends and develop an understanding of the conditions and processes affecting the study areas over time. To achieve this, all surveys will use established standards and sampling methodologies developed and made available by WDFW. As the planned monitoring program is implemented over succeeding years, it will generate data that can be used to establish baseline conditions, define trends, document changes, and identify potential shoreline protection and restoration opportunities. No existing data sources are being assembled for this project.

4.4 Project Tasks

Project tasks include:

- Schedule and carry out volunteer training course for new volunteers.
- Provide quarterly feedback to volunteers on status of data collection.
- Each MRC project lead schedules monthly sampling events and communicates schedule to local volunteer team.
- Each MRC project manager receives samples and sends them to WDFW.

4.5 Systematic planning process

Not applicable.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Each MRC is responsible for coordinating monthly sampling at select sites in their county. The samples collected are transferred to WDFW staff who carry out laboratory analysis and quality assurance steps. The NWSC coordinate with WDFW and MRCs to ensure volunteers have enough materials and training to conduct routine sampling. Key staff with WDFW, NWSC, and MRCs are identified below in Table 1.

Table 1: Organization of project staff

Role	**Position Who is Responsible**	**As of 1/1/2020**
Coordinates with MRC PMs and WDFW staff to provide supplies/materials and training to volunteers.	NWSC Marine Program Manager	Dana Oster
Coordinates data analysis, supplies for volunteers, training,	Washington Department of Fish and Wildlife	Lisa Hillier

and on the beach sampling practice/refreshers.		
Island MRC		
Manages Island County sampling needs, coordinates with MRC project lead, manages volunteer coordination, receives samples and transfers to WDFW, and tracks training needs and coordinates with NWSC and WDFW. Creates county reports and manages data.	MRC PM	Anna Toledo
Sets sampling dates, manages volunteer coordination, leads sampling collection following protocols and QAPP.	MRC project lead	Matt Kukuk
Assist MRC project lead with sampling.	Island County volunteers	MRC volunteers
Clallam MRC		
Manages Clallam County sampling needs, coordinates with MRC project lead, manages volunteer coordination, receives samples and transfers to WDFW, and tracks training needs and coordinates with NWSC and WDFW. Creates county reports and manages data.	MRC PM	Helle Andersen
Sets sampling dates, manages volunteer coordination, leads sampling collection following protocols and QAPP.	MRC project lead	Ed Bowlby
Assist MRC project lead with sampling.	Clallam County volunteers and project intern	MRC volunteers
Whatcom MRC		
Manages Whatcom County sampling needs, coordinates with MRC project lead, manages volunteer coordination, receives samples and transfers to WDFW, and tracks training needs and coordinates with NWSC and	MRC PM	Austin Rose

WDFW. Creates county reports and manages data.		
Sets sampling dates, manages volunteer coordination, leads sampling collection following protocols and QAPP.	MRC project lead	Rachel Arnold
Assist MRC project lead with sampling.	Whatcom County volunteers and program intern	MRC volunteers
Jefferson MRC		
Manages Jefferson County sampling needs, coordinates with MRC project lead, manages volunteer coordination, receives samples and transfers to WDFW, and tracks training needs and coordinates with NWSC and WDFW. Creates county reports and manages data.	MRC PM	Monica Montgomery
Sets sampling dates, manages volunteer coordination, leads sampling collection following protocols and QAPP.	MRC project lead	Jeff Taylor
Assist MRC project lead with sampling.	Jefferson County volunteers	MRC volunteers

MRC: Marine Resources Committee
NWSC: Northwest Straits Commission
WDFW: Washington Department of Fish and Wildlife
PM: Project manager

5.2 Special training and certifications

The sampling program requires adequate training of the participating citizen scientists. Each sampling event will be led by a volunteer who has completed the WDFW one day training. This is typically the project site lead, or someone familiar with each site. Additional volunteers are all encouraged to take the WDFW training or a shortened training from the County Project Manager or MRC project lead. Survey protocols are attached in Appendices A and B. The NWSC and WDFW coordinate trainings approximately once a year for new and existing volunteers to take. In addition to the official training, WDFW staff attend sampling events when possible to provide refreshers and guidance for that specific site.

5.3 Organization Chart

Not applicable, see Table 1 for roles and responsibilities.

5.4 Project Schedule

All MRCs follow the same schedule for the 2019-2021 project cycle. Once collection has started, it will be performed at each selected site monthly year-round. Site locations and sampling frequency will be reviewed at least once annually and more frequently as needed due to changes in site accessibility, volunteer constraints, or other factors.

Table 1: Project Schedule

Date	**Event**
Ongoing	Recruit and train citizen scientists
March 2020 – Sep 2021	Data recording, analysis, storage
Sep 2020, Sep 2021	Report findings

5.5 Budget and funding

Sample collection for this program is primarily volunteer-run. NEP-funded staff support for the program is provided by local county staff (MRC Project Managers) and regionally by the Northwest Straits Commission. This may include coordination of volunteer training (provided in-kind by WDFW), sampling support as needed, management of samples collected and transport to WDFW, coordination and purchase of supplies and materials, communications with WDFW for site selection and other project management tasks. The estimated budget for staff support of this project in each county varies. Table 2 provides a summary of approximate Northwest Straits staff support and average MRC Project Manager staff support.

Table 2: Estimated Project Budget

Staff Support	**Estimated Cost**
MRC Project Managers (all four counties)	$17,670 annually
Northwest Straits Commission Staff	$ 5,700 annually
TOTAL	$23,370 annually

6.0 Quality Objectives

6.1 Data Quality Objectives

The overall quality objective for this project is to provide high quality data on forage fish usage of select Northwest Straits region beaches and restoration projects. This QAPP describes how physical samples and ancillary data on beach conditions will be collected.

The sampling locations and tidal elevations where sampling will occur will be chosen to be representative of where various species of forage fish are expected to spawn, based on information from Dan Penttila and WDFW staff from the Fish Management division during training sessions regarding optimal spawning conditions and locations. Sampling will occur at two types of sites: restoration and index. Restoration sites will be selected based on recommendations from the MRC and project partners at sites where shoreline restoration is planned, in progress, or has been completed. Index sites are selected in

collaboration with WDFW as an extension of their Puget Sound forage fish surveys. Index sites have had documented spawn presence in the past, and are publically accessible.

6.2 Measurement quality objectives

To achieve comparability over time, samples will be collected, handled, stored, and transported following standard protocols approved and disseminated by WDFW as described in Appendix A and B. Because this sampling follows protocols tested and established by WDFW's Fish Management division, quality objectives are consistent across Puget Sound and followed by multiple organizations along with local, state, federal, and Tribal entities. The use of these protocols (appendix A and B) provide comparability and minimize bias between different volunteers. The target for completeness is to successfully collect beach samples for 90% of the planned monthly sampling events.

6.2.1-6.2.2

Not applicable. There are no quantitative criteria for sample collection, beyond adherence to the WDFW protocols.

6.3 Acceptance criteria for quality of existing data

Not applicable. This QAPP does not address any analysis of data generated from the samples.

6.4 Model quality objectives

Not applicable.

7.0 Study Design

7.1 Study Boundaries

The boundaries for this regional survey effort includes all seven counties of the Northwest Straits region (Clallam, Jefferson, Island, San Juan, Snohomish, Skagit, and Whatcom counties). However, this QAPP only includes four counties (Clallam, Jefferson, Island, and Whatcom).

7.2 Field data collection

See section 3.2 Study area for field locations.

7.3 Modeling and analysis design

Not applicable

7.4 Assumptions of study design

Study design assumes collection methods occur at representative elevation and locations on the beach. Environmental conditions of beach are subject to interpretation of individual volunteers and are considered qualitative.

7.5 Possible challenges and contingencies

Monitoring at each site will be constrained by two primary factors: Human resources to conduct the monitoring and public access. In addition to regular sampling at fixed sites, there is the potential need for variability in sampling time and/or location. In the case of restoration projects, it may be necessary to

conduct surveys on set sampling dates or at randomized sites based on the project needs. The same survey protocol will be utilized for obtaining these samples.

8.0 Field Procedures

8.1 Invasive species evaluation

All sample jars will be sealed prior to leaving the beach. All sampling equipment will be inspected for any substrate, fauna, or flora. Potentially contaminated equipment will be rinsed in seawater and wiped down until all potential contaminants are removed. Paper or cloth towels used will be bagged and either properly disposed of or decontaminated. Training will also include instructions for participants to inspect their clothing for any possible contamination and the need to decontaminate the clothing before returning to any marine area. All clothing and equipment should be thoroughly dry prior to returning to a beach. Observers should not wear felt-soled boots or shoes as these can't be effectively decontaminated. Details and options for decontamination are given at http://www.ecy.wa.gov/programs//eap/InvasiveSpecies/AIS-PublicVersion.html. Standard laboratory precautions will be used to prevent any release of invasive species from the samples.

8.2 Measurement and sampling procedures

The sampling design follows the WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols, Procedures for Obtaining Bulk Beach Substrate Samples (Philip Dionne, 2015) based on earlier protocols developed by Dan Penttila (Penttila, 2011) with the San Juan MRC. Complete protocols are included in Appendices A and B.

8.3 Containers, preservation methods, holding times

Bulk sediment samples collected are placed in a polyethylene bag before being condensed (Following Appendix B, Dionne 2015). Once samples have been condensed, they are placed in a 400 ml plastic sample jar (provided by WDFW). Stockards solution is added to preserve the sample. Volunteers wear gloves and eye protection when adding Stockards to the sample and do this outdoors. The jars do not need to be refrigerated and do not have a timeframe to be sent to WDFW. MRCs generally transfer samples once a month or once every two months. Volunteers should have very limited contact with the chemical and they do not require disposal training for volunteers, but chemical safety sheets are available to volunteers and kept where the chemical is stored.

8.4 Equipment decontamination

Not applicable.

8.5 Sample ID

An identifying label will be placed inside the sample jar. This label will include: location name, date and beach number/sample number (B#S#) in pencil.

8.6 Chain of Custody

The samples will be fully documented and sent to WDFW for laboratory analysis. An appropriate chain of custody will be maintained and documented throughout this process. All samples will include an identification tag referencing data sheets completed on site. Samples will be concentrated under the guidance of the MRC project manager or MRC project lead. This step is done at the sampling site, or

nearby facility shortly after sample collection (within 1-2 hours) following the Blue Bowl Vortex Method protocols described in Appendix B (Dionne, 2015) and transported to WDFW in coordination with Northwest Straits Commission when needed. In addition, data sheets, photos and sample accounting forms will be provided to WDFW and the Northwest Straits Commission via email.

8.7 Field log requirements

Each sample collection includes the completion of the Forage Fish Spawning Surveys form included in Appendix A.

8.8 Other activities

Not applicable.

9.0 Laboratory Procedures

Not applicable.

10.0 Quality control procedures

The following procedures will be used to maintain quality of the samples and data in this program.

1. Follow the standard procedures as described in the previous sections among sites and among monitors. This includes filling out the field form completely.

2. Only individuals who successfully complete training in the collection protocols are allowed to collect samples. Other individuals may participate in other non-collection activities, such as assisting with the establishment of a transect line, but only if they are accompanied and supervised by a trained individual.

3. Project Manager or a single individual who has been successfully trained in the protocol will serve as Field Lead, and be responsible for the integrity of the sampling. This individual will be identified on the data collection form by being the first name entered under “Samplers.”

4. Sampling locations will be recorded from a hand-held GPS unit or phone. The make and model of the units will be recorded. The datum for each unit will be set to NAD 83 and positions recorded in decimal degrees. The unit will be calibrated vs. a known reference point at the start of each sampling event. Sampling coordinates are expected to be accurate and repeatable to within 3 meters. The readings from the GPS units and iPhones have been compared for consistency.

5. An identifying label will be placed inside the sample jar. This label will include: location name, date and beach number/sample number (B#S#) in pencil.

6. Prior to leaving each sampling area, the Field Lead will review field logs and other field notes to identify any unusual or anomalous results. If any are found, they will be resolved (e.g., repeat GPS measurements or sample collections, if necessary) before leaving the field.

7. Raw datasheets will be provided to WDFW with the necessary oversight/error checking to ensure accuracy of transcription

10.1 Table of field and laboratory quality control
Not applicable.

10.2 Corrective action processes
Sample collection is done with multiple volunteers. This often provides multiple sets of eyes and experience that can identify a potential issue with field sampling or data. If there are concerns about field samples while the team is sampling, they will start again and use clean equipment. If there are concerns during processing the team will notify WDFW staff of their concern for confirmation or to dismiss the data point.

11.0 Data management procedures
Project Managers for each county track the number of volunteer hours, volunteer participants, sampling dates, photos, copies of datasheets, and data results sent by WDFW for reporting to the NWSC. Data are stored electronically on the county servers and reported on annually.

12.0 Audits and Reports
12.1 Audits
Audits are not anticipated for this project. Progress reports and volunteer hours will be submitted quarterly.

12.2 Responsible personnel
County MRC Project Managers are responsible for reporting quarterly to the NWSC on sampling activity.

12.3 Frequency and distribution of reports
A copy of protocols and QAPP will be developed and reviewed annually.

Raw data and a report on survey activities will be submitted annually. The report will include:

- A narrative of the field research
- A summary of sampling effort
- Results of the presence or absence of eggs by zone for those samples where laboratory analysis is complete.
- Recommendations for any modification of the procedures and the overall program

12.4 Responsibility for reports
The project manager for each participating MRC (see Table 1) are responsible for annual report submission to the Northwest Straits Commission.

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

For field data verification, the MRC project lead prior to leaving each sampling area, will review field logs and other field notes to identify any unusual or anomalous results. If any are found, they will be resolved (e.g., repeat GPS measurements or sample collections, if necessary) before leaving the field.

13.2 Laboratory data verification

Not applicable.

13.3 Validation requirements, if necessary

Not applicable.

13.4 Model quality assessment

Not applicable.

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

The sampling objectives were met if all samples are submitted to WDFW. The objective is to successfully collect beach samples for 90% of the planned monthly sampling events?

14.2 Treatment of non-detects

Not applicable.

14.3 Data analysis and presentation methods

Not applicable.

14.4 Sampling design evaluation

Sampling design is established by WDFW and used across the state of Washington.

15.0 References

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WDFW, 1998. Forage Fish Management Policy, Goals and Plan. https://wdfw.wa.gov/about/commission/policies/forage-fish-management-policy-goals-and-plan

WDFW, 2011. Protocol FF-04 Intertidal Forage Fish Spawning Habitat Survey Protocols Laboratory procedure for determining forage fish egg presence/absence from preserved "winnowed light fraction" beach substrate samples. Available at https://wdfw.wa.gov/sites/default/files/2019-02/protocol-lab_spawn_enumeration.pdf

WDFW Intertidal Forage Fish Spawning Habitat Survey Protocols

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 Ziploc)
Handheld GPS device
Tide table
Digital camera (optional)
Hypsometer (if available)
Data sheet (preprint on Write-in-the-Rain paper if possible)

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

Procedure:

1. Upon arriving on the beach, fill out the header information on the attached data sheet. *Do not* fill in "Reviewed by." Before conducting the first sample, describe the character of the upland and beach environment using the codes provided on the back of the data sheet. For additional details on sample codes see Moulton and Penttila (2001)*.

2. Identify a landmark from which you will measure the distance to the bulk substrate sample tidal elevation. Typical landmarks include the upland toe of the beach, the last high tide mark or wrack line, and the edge of the water.

3. Measure the distance from the landmark to the tidal elevation to be surveyed. 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" and that the tape should remain a consistent distance from the landmark.

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 Ziploc. You may need to take two scoops to get sufficient sediment, depending on the coarseness of the beach.

7. Walk ten paces (single steps) along the measuring tape, repeat the sediment scooping action, and place the sediment in the bag. Move an additional ten paces and repeat. Move an additional ten paces, approximately to the end of the tape, and repeat. The bag should now have sediment from four locations along the tape and be at least 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 the sample as described in the companion protocol "Procedures for recovering "winnowed light fractions" subsamples of forage fish egg-sized material from bulk beach substrate samples."

9. 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. Version 1.0, July 2011

Forage Fish Spawning Surveys

Reviewed by_____

Last high tide

Time (24-hr) | Elevation

Location

Day | Month | Year

SEE CODES ON BACK OF DATA SHEET

Beach Number	Sample Number	Time (24-hr)	Latitude (decimal degrees)	Longitude (decimal degrees)	Beach	Uplands	Landmark	Sample zone	Tidal elevation	Smelt	Sand lance	Rock sole	Herring	Width	Length	Shading	Comments

Samplers:_____

Field Observation Sampling Codes

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

Uplands: Character of the uplands (up to 1,000 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

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.

Smelt, Sand Lance, Rock Sole, Herring: subjective field assessment of spawn intensity apparent to the naked eye:
0 = no eggs visible
1 = very light, sparse
2 = light, but apparent
3 = light medium, visible
4 = medium, readily visible
5 = medium heavy, abundant
6 = heavy, broadly abundant
7 = very heavy, widespread
8 = eggs observed in the winnow

Width: Width of the potential spawning substrate band to the nearest foot. Judged by character of sediment and presence of spawn, when possible.

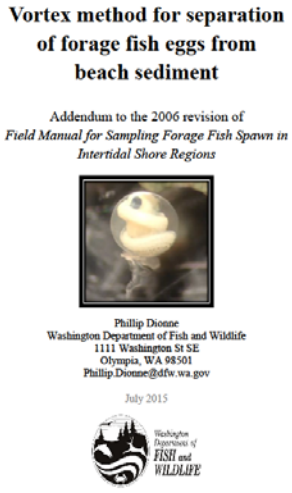
Length: Length of the beach up to 1,000 feet (500 feet on either side of the station). The value "C" may be assigned if surveyed beach is continuous with other potential sample sites.

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

Version 2.0, July 2011

Appendix B: Protocols and Data Forms: Condensing Bulk Samples Protocol

Samples will be concentrated according to the “blue-bowl” vortex method developed by Philip Dionne and others at WDFW.



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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July 2015

Washington Department of FISH and WILDLIFE

The following protocol for the older “winnowing” method for concentrating eggs in the samples is derived from Moulton and Penttila, (2000).

Equipment

- Nested set of sediment screens, size 4, 2, and 0.5 mm, Nalgene or stainless steel preferred over brass screens, for durability
- 2 - 5 gallon buckets modified to act as drain for screen rack
- Wash bucket
- Plastic dishpan
- 400 ml wide-mouth sample jar
- Bristle brush for cleaning screens between samples
- Stockard’s solution

Procedure

The bulk egg samples can be processed in the field to remove most of the sand and reduce the volume of the sample. This is done by washing the eggs from the sand and discarding the barren sediment. The eggs are lighter than the sand and gravel and will move upward during the washing process, allowing them to be skimmed from the surface of the material. The washing is conducted as follows:

- Assemble the screens on top of the drain bucket, with the largest mesh on top, grading to the smallest mesh on the bottom.
- Remove the sample label and place it in a 16 ounce sample jar.
- Add the sample to the top screen; thoroughly wash the sediment through the screen set with either salt or fresh water, whichever is readily available. If the sample is large you may have to split in and repeat the following steps with the remaining half.
- Discard the sediment in the top screens; retain only the material in the bottom (0.5 mm) screen.
- Dump the material retained in the 0.5 mm screen into the dishpan.
- Add water until the material is covered by 1-2 inches of water.
- Swirl the water around the pan, adding rocking and bouncing motions to allow the eggs to migrate to the top of the sediment. The idea is similar to gold panning, try to winnow the eggs to the surface of the material.
- After swirling for 1-2 minutes, work the lighter fraction of material to one corner of the pan.
- Carefully dry up the lighter fraction by tipping the pan so that the water drains away, and skim the lighter fraction from the surface of the sand with the sample jar.
- Repeat the winnowing process 2-3 more times, each time adding the retained lighter fraction to the sample jar, until you are left with a sample jar 1⁄2 to 2/3 full.
- Gently rinse the threads of the jar with the sample water to ensure a tight seal.

Appendix C: Glossary

Accuracy - The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms precision and bias be used to convey the information associated with the term accuracy. (USGS, 1998)

Bias - The difference between the population mean and the true value. Bias usually describes a systematic difference reproducible over time, and is characteristic of both the measurement system, and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI). (Kammin, 2010; Ecology, 2004)

Calibration - The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured. (Ecology, 2004)

Comparability - The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator. (USEPA, 1997)

Completeness - The amount of valid data obtained from a data collection project compared to the planned amount. Completeness is usually expressed as a percentage. A data quality indicator. (USEPA, 1997)

Precision - The extent of random variability among replicate measurements of the same property; a data quality indicator. (USGS, 1998)

Quality Assurance (QA) - A set of activities designed to establish and document the reliability and usability of measurement data. (Kammin, 2010)

Quality Assurance Project Plan (QAPP) - A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives. (Kammin, 2010; Ecology, 2004)

Sample (field) - A portion of a population (environmental entity) that is measured and assumed to represent the entire population. (USGS, 1998)

Sensitivity - In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit. (Ecology, 2004)

Standard Operating Procedure (SOP) - A document which describes in detail a reproducible and repeatable organized activity. (Kammin, 2010)

Stockard's Solution - A formalin-based preservative that also includes acetic acid, glycerin, and water (Moulton and Penttila, 2001)

Glossary References

Ecology, 2004. Guidance for the Preparation of Quality Assurance Project Plans for Environmental Studies. http://www.ecy.wa.gov/biblio/0403030.html

USEPA, 1997. Glossary of Quality Assurance Terms and Related Acronyms.

http://www.ecy.wa.gov/programs/eap/qa.html

Kammin, 2010. Definition developed or extensively edited by William Kammin, 2010.

USGS, 1998. Principles and Practices for Quality Assurance and Quality Control. Open-File Report 98-636. http://ma.water.usgs.gov/fhwa/products/ofr98-636.pdf