Site Naming Convention

Beach Number:
1. The first symbol in the site name is the Nearshore Beach Restoration project segment number (i.e. 2, 5, 9, 13)
2. The second symbol identifies the location of the project relative to the proposed nearshore restoration sites. Transects located in the sediment nourishment/placement polygon are identified with an “S”. Transects not located in the sediment nourishment/placement polygon are identified with an “N”. All N transects are downdrift of the S transects.

Sample Number:
This number is the tidal elevation of the transect (i.e. 7).

Site 2

<table>
<thead>
<tr>
<th>Beach Number: 2S</th>
<th>Sample Number: 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transect:</td>
<td>+7.0’</td>
</tr>
<tr>
<td>Start Point Coordinates:</td>
<td>47.95650618 N, -122.2760342 W</td>
</tr>
<tr>
<td>End Point Coordinates:</td>
<td>47.95656727 N, -122.2756446 W</td>
</tr>
</tbody>
</table>

Perpendicular distance from north embankment marker to start of transect (at chest height): 6.6’. Perpendicular distance from south embankment marker to end of transect (at chest height): 16’

Description:
Located at the western end of the Nearshore Sediment Study Project area and east of the Mount Baker Terminal Beach Restoration Project. Powder Mill Gulch Creek marks the eastern end of the site. The beach at the transect elevation is characterized as large cobbles and boulders with a sand base. The transect is placed within the proposed area for sediment placement. There is a culvert in the rip-rap in the northern end of the transect.

Field Observation Sampling Codes:
- Uplands: 5
- Tidal Elevation: +7.0’
- Shading: 2 (based on coverage provided by bluff)

Figure 1. Site 2S7 viewed from the water
Site 2S7 – south edge of nourishment site looking northeast to Everett. ⭐Stars highlight same features located in sequential photos.

June 7, 2016 – Pre-project sampling

July 22, 2016 – site completion
April 2017

October 2017 – drift has formed delta.

June 2018
October 2018 – note sand delta still present but diminished updrift from Powder Mill Gulch tributary fan. General return to pre-project conditions throughout the nourishment footprint.
Beach Number: 2N  Sample Number: 7  
Transect: +7.0'  
Start Point Coordinates:  47.95688093 N, -122.2730643 W  
End Point Coordinates:  47.95703545 N, -122.2727567 W  

Perpendicular distance from west (south) embankment marker to start of transect (at chest height): 28.8'. Perpendicular distance from east (north) embankment marker to start of transect (at chest height): 50'  

Description:  
Located at the western end of the Nearshore Sediment Study Project area, east of the Mount Baker Terminal Beach Restoration Project. Powder Mill Gulch Creek marks the eastern end of the transect. The beach at the transect elevation is characterized as pea gravel with sand base. The transect is placed outside of the proposed Site 2 sediment placement area. Both end points are marked with a bright orange asterisk.  

Figure 2. Site 2N7 viewed from shoreline.  

Field Observation Sampling Codes:  
Uplands: 5  
Tidal Elevation: +7.0’  
Shading: 2, based on shade provided by vegetation behind rip-rap.
Figure 3: Site 2N7 viewed from south end of transect. Note stump at far end.
Site 5

Beach Number: 5S  Sample Number: 5.9
Transect: +5.9'
Start Point Coordinates: 47.9581181 N, -122.2627703 W
End Point Coordinates: 47.95820111 N, -122.2623893 W

Perpendicular distance from west embankment marker to start of transect (at chest height): 23.8'.
Perpendicular distance from east embankment marker to end of transect: 19’.

Description:
Located west of Narbeck Creek. There are a series of pilings offshore of the site. The beach at the transect elevation is characterized as sand. The transect is placed within the proposed area for sediment placement. The transect is placed at +6.3' within the preferred tidal elevation of Sand lance. At +7.0', the beach is covered by rip-rap.

Figure 4: Site 5S5.9 viewed from southern end of transect.

Field Observation Sampling Codes:
Uplands: 5
Tidal Elevation: +5.9'
Shading: 2, based on shading from vegetation east of rip-rap.
<table>
<thead>
<tr>
<th><strong>Beach Number:</strong> 5N</th>
<th><strong>Sample Number:</strong> 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transect:</td>
<td>+7.0'</td>
</tr>
<tr>
<td>Start Point Coordinates:</td>
<td>47.95832836 N, -122.2318532 W</td>
</tr>
<tr>
<td>End Point Coordinates:</td>
<td>47.95842423 N, -122.2614794 W</td>
</tr>
</tbody>
</table>

Perpendicular distance from west embankment marker to start of transect (at chest height): 24.5'.
Perpendicular distance from east embankment marker to end of transect: 58’.

**Description:**
Located west of Narbeck Creek. The beach at the transect elevation is characterized as medium gravel with sand base. The transect is placed outside the proposed area for sediment placement at Site 5. The Narbeck Creek outfall is at the eastern end of the transect. The transect start and end points are marked with a +7.

**Field Observation Sampling Codes:**
- Uplands: 5
- Tidal Elevation: +7.0’
- Shading: 2, based on shade provided by vegetation east of rip-rap.

*Figure 5: Site 5N7 viewed from water.*
Site 6

Beach Number: 6S  Sample Number: 7

Transect: +7.0’
Start Point Coordinates: 
End Point Coordinates: 

Perpendicular distance from west embankment marker to start of transect (at chest height): 3-4’ to marker on wall. Perpendicular distance from east embankment marker to end of transect (log): 10.10’. New stakes placed at both ends.

Description:
This site begins at northern end of block wall, which marks the southern end of transect. Some vegetation exists between the railroad and the beach. Logs lay parallel and inland from transect. Transect is characterized by sand and cobble.

Figure 7. Site 6 transect from from northwest end, facing southeast.
Figure 8. Site 6 transect viewed from water.
Site 9

Beach Number: 9S  Sample Number: 7

<table>
<thead>
<tr>
<th>Transect:</th>
<th>+7.0’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Point Coordinates:</td>
<td>47.95906 N, -122.25095 W</td>
</tr>
<tr>
<td>End Point Coordinates:</td>
<td>47.95938655 N, -122.2493108 W</td>
</tr>
</tbody>
</table>

Perpendicular distance from west (south) embankment marker to start of transect (at chest height): 33.5’. Perpendicular distance from east (north) embankment marker to start of transect: 42’.

Description:
Located west of Glennwood Creek. The beach at the transect elevation is characterized as cobble with sand base. The transect is placed inside the proposed area for sediment placement at Site 9. There is a side rail on the railroad track above the transect, where trains can pull off to allow other trains to pass.

Field Observation Sampling Codes:
Uplands: 5
Tidal Elevation: +7.0’
Shading: 2

Figure 9. Site 9S7 viewed from southern end of transect.
Beach Number: 9N  Sample Number: 7

Transect:  +7.0'
Start Point Coordinates:  47.95950071 N, -122.2488936 W
End Point Coordinates:  47.95946 N, -122.24979 W

Perpendicular distance from west (south) embankment marker to start of transect (at chest height): 52.9’ Perpendicular distance from east (north) embankment marker to end of transect: 44.1’.

Description:
Located west of Glennwood Creek. The beach at the transect elevation is characterized as cobble with sand base. The transect is placed outside the proposed area for sediment placement at Site 9. There is a side rail on the railroad track above the transect, where trains can pull off to allow other trains to pass.

Field Observation
Sampling Codes:
- Uplands: 5
- Tidal Elevation: +7.0’
- Shading: 1

Figure 10. Site 9N7 viewed from the water.
Site 12 – South of stairs at Howarth Park

Beach Number: 12N  Sample Number: 7

Transect: +7.0'
Start Point Coordinates: 
End Point Coordinates: 

Perpendicular distance from embankment marker to start of (southern end) transect (at chest height) : 46’. Perpendicular distance from northern embankment marker to end of transect: 56’.

Description: The southern portion of the transect is in front of some ecology blocks and the red marker on the railroad. The substrate is course gravel with a sand base.

Field Observation

Sampling Codes:

Uplands: 5
Tidal Elevation: +7.0’
Shading: 2, based on partial shading provided by bluff vegetation.
Beach Number: 12S  
Sample Number: 7

Transect: +7.0'

Start Point Coordinates:
End Point Coordinates:

Perpendicular distance from embankment marker to start of (southern end) transect (at chest height): 67'; 116' from danger sign, measured three feet into northern end of transect.

Description: The southern portion of the transect ends near the root wad of a log. The northern is near the rip rap, a small creek, and perpendicular to a Danger sign. The substrate is course gravel with a sand base. The substrate is mostly sand with some coarse gravel mixed in.

Figure 13. Site 12S7 viewed from southern end of transect.
Figure 14. Southern end of transect 12S7 viewed from the water.

<table>
<thead>
<tr>
<th>Beach Number: 13S</th>
<th>Sample Number: 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transect:</td>
<td>+10.0'</td>
</tr>
<tr>
<td>Start Point Coordinates:</td>
<td>47.96451802 N, -122.2390253 W</td>
</tr>
<tr>
<td>End Point Coordinates:</td>
<td>47.96449 N, -122.2399 W</td>
</tr>
</tbody>
</table>

Perpendicular distance from spray painted mark on tree to start of transect (at chest height): 33'.

Description:
Located on the eastern side of Howarth Park (to the right as you come down stairs to beach). The beach at the transect elevation is characterized as medium gravel with sand base. The transect is placed inside the proposed area for restoration at Site 13. The transect begins 24.5' NE of the toe of the rip-rap.

The +7.0' transect runs parallel to the +10.0' transect.

Field Observation Sampling Codes:
- Uplands: 5
- Tidal Elevation: +10.0'
- Shading: 1
Beach Number: 13S  Sample Number: 7

Transect: +7.0'
Start Point Coordinates: 47.96455821 N, -122.2390962 W
End Point Coordinates: 47.96474169 N, -122.2387621 W

Perpendicular distance from spray painted mark on tree to start (southern end) of transect (at chest height): 81'. Perpendicular distance from embankment marker (northern end) of transect (at chest height): 62'.

Description:
Located on the eastern side of Howarth Park (to the right as you come down stairs to beach). The beach at the transect elevation is characterized as cobble with sand base. The transect is placed inside the proposed area for restoration at Site 13. The transect begins 37.5' NE of the toe of the rip-rap.

The +7.0' transect runs parallel to the +10.0' transect.

Field Observation Sampling Codes:
Uplands: 5
Tidal Elevation: +7.0'
Shading: 1

Figure  Site 13S10 viewed from end of transect.
Beach Number: 13N  Sample Number: 10

Transect: +10.0'  
Start Point Coordinates: 47.96494292 N, -122.2382019 W  
End Point Coordinates: 47.96508673 N, -122.2378621 W  

Perpendicular distance from west embankment marker to start of transect (at chest height): 21'  
Perpendicular distance from east embankment marker to start of transect (at chest height): 8.5'.

Description:  
Located on the eastern side of Howarth Park. The transect start point is 153' east of site 13S10. The beach at the transect elevation is characterized as medium gravel with sand base. The transect is placed outside the proposed area for restoration at Site 13. The transect start point is directly out from the beginning of the concrete block bulkhead. The +7.0' transect runs parallel to the +10.0' transect.

Beach Number: 13N  Sample Number: 7

Transect: +7.0'  
Start Point Coordinates: 47.96478, -122.23943 W  
End Point Coordinates: 47.96512815 N, -122.237895 W  

Perpendicular distance from west embankment marker to start of transect (at chest height): 43.5'  
Perpendicular distance from east embankment marker to start of transect (at chest height): 28.5'.

Description:  
Located on the eastern side of Howarth Park and east of the 13S site. The beach at the transect elevation is characterized as medium gravel with sand base. The transect is placed outside the proposed area for restoration at Site 13. The transect start point is directly out from the beginning of the concrete block bulkhead. The +7.0' transect runs parallel to the +10.0' transect.
Figure  Site13N7 viewed from the end of the transect.

Field Observation Sampling Codes:

- Uplands: 5
- Tidal Elevation: +7.0’
- Shading: 1
Description:
Located on the southwestern side of Howarth Park bridge between sites 12 and 13. The beach at the transect elevation is characterized as medium gravel with sand base. The transects northern edge is 50 feet southwest of the bridge. The transect end point is the base of the large tree trunk.
Beach Number: Meadowdale Unarmored  Sample Number: 7

Transect: +7.0'
Start Point Coordinates: 47.859292 N, -122.335315 W
End Point Coordinates: 47.859157 N, -122.335164 W

Description:
Located on the southern end of Meadowdale approximately 150 feet south of the railroad culvert. The beach at the transect elevation is characterized as medium gravel with sand base. A white marker pole is perpendicular to the start of the transect. The transect runs south from this start point. From the transect start point you can see the red roof of the shelter on the other side of the railroad.

Field Observation Sampling Codes:

- Uplands: 1
- Tidal Elevation: +7.0'
- Shading: 1
**Beach Number: Meadowdale Armored Sample Number: 7**

<table>
<thead>
<tr>
<th>Transect:</th>
<th>+7.0'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Point Coordinates:</td>
<td>47.858203 N, -122.334672 W</td>
</tr>
<tr>
<td>End Point Coordinates:</td>
<td>47.857952 N, -122.334551 W</td>
</tr>
</tbody>
</table>

**Description:**
Located on the southern end of Meadowdale approximately 500 feet south of the southern end of the unarmored site. The beach at the transect elevation is characterized as medium gravel with sand base. The site is located by a metal pole coming straight out of the armoring that has a white sticker on the end of it. This marks the middle (50') of the transect. The southern end of the transect is marked by triangular rocks and large drift wood next to the railroad.

**Field Observation Sampling Codes:**
- Uplands: 4
- Tidal Elevation: +7.0'
- Shading: 1
Beach Number: Picnic Point Unarmored  Sample Number: 7

Transect: +7.0'
Start Point Coordinates: 47.879485 N, -122.333140 W
End Point Coordinates: 47.879208 N, -122.332886 W

Description:
Located on the southern end of Picnic Point beach approximately 200 feet south of the walkway over the railroad tracks. The start and northern end of the transect is perpendicular to a large singular Douglas fir tree which can be seen from the beach. The transect goes south from the Douglas fir tree. The beach at the transect elevation is characterized as medium gravel with sand base.

Field Observation Sampling Codes:

Uplands: 1
Tidal Elevation: +7.0’
Shading: 1
Beach Number: Picnic Point Armored  Sample Number: 7

Transect: +7.0'
Start Point Coordinates: 47.882754 N, -122.332156 W
End Point Coordinates: 47.883020 N, -122.332116 W

Description:
Located on the northern end of Picnic Point beach approximately 850 feet north of the walkway over the railroad tracks. The transect starts approximately 20 feet south of the large bolder sticking out from the rest of the armoring, runs between this bolder and the armoring, all the way north to another large bolder seen at the bottom of the picture. The beach at the transect elevation is characterized as small gravel with sand base.

Field Observation Sampling Codes:

Uplands: 4
Tidal Elevation: +7.0'
Shading: 1
Appendix A:

Appendix B of the transect site descriptions is the bulk collection methods which was created by WDFW and modified for the Snohomish MRC project.
Field materials needed:
Rolatape Wheel and a Measuring tape (100+ feet) 16-ounce plastic jar or large scoop (Crab bait container)
16-ounce scoop attached to measuring rod (for underwater sample collection)
9 inch x 24 inch polyethylene bags
Handheld GPS device (As needed for locating sites)
Measuring card (for photo documentation)
Tide table (5-minute intervals)
Digital camera
Data sheet
Photo documentation sheet
Sample labels
Pencil
Black Sharpie
WDFW Memorandum of Understanding
Site Description (mentioned in procedures)

Personal Field Gear:
Waders
Rain gear
Warm clothing
Life jacket, available at boat launch.
Water and snacks (as necessary)

Note: Sampling will be scheduled to ensure access to the +7-9 (Surf smelt) and +5-8 (Sand lance) tidal height of beach.

Procedure:

1. Upon arriving on the beach, fill out the header information on the data sheet. Do not fill in “Reviewed by.” Before collecting the first sample, describe the size of the beach sediment using the codes provided on the back of the data sheet.

2. Identify the established transect locations by the orange markers painted on the embankment rocks and the stakes in the beach. There are 1 or 2 transects at each sample station, parallel to one another the painted markers identify both the approximate start and end of the transect. The stakes mark the exact beginning and the end of each transect and are capped with yellow, orange, and red tape with colored flagging. All transects start at the western end of the site and progress to the east to the end point.

3. Consult the Site Description to determine what transects should be marked. At beaches where the +10 ft tidal elevation is not accessible (due to rip-rap) only a +7 ft transect was established. The +10 ft tidal elevation transect is higher on the beach than the +7 ft transect and is closer to the rip-rap.
4. If transect stakes cannot be located on the beach, the transect can be located by measuring from the embankment marker the distance reported in the Site Description; measure perpendicular from the embankment marker using a measuring tape (rip-rap prohibits the use of a Rolatape Wheel in many locations). Please note if you had difficulty locating the transect in comments column of the data sheet.

5. Before collecting samples, use a sharpie to label a 9 x 24 inch polyethylene bag with the sample number (and the date). The sample number can be found on the transect description document and the data sheet. Once the sediment is collected, put a Rite-in-the-Rain label in the bag. It is important to ensure that the bag is labeled and the label in inside the bag.

Example label

| Date: __________ |
| Beach Number: _____ Sample Number: ______ |
| Collectors: |
| Sample Description: |
| Snohomish MRC Forage Fish Spawning Surveys |

6. Beginning at the western end of the 100' transect, collect 2 ½ 16-ounce crab bait containers of sediment from the top 5-10 cm (2-4 in) of sediment. Place the sediment in the labeled 9 inch x 24 inch polyethylene bag. Woody debris and large rocks are located in many of the transects, if objects are in the way of collecting a sample collect the sample before or after the object. Large cobbles on the surface layer may be moved aside to collect the finer sediment preferred by forage fish. Note on the data sheet, if any cobbles were moved prior to sample collection.

7. Use the Rolatape Wheel to move to the next sampling station, approximately 1/3 of the transect (~ 33ft), repeat the sediment scooping action, and place the sediment in the labeled bag. Walk an additional 1/3 of the transect and repeat. Continue to the end of the transect, and repeat. The bag should now have sediment from four locations along the tape (0', 33', 66', and 100') and be at least ½ to ⅔ full.

8. Complete the Rite-in-the-Rain label (example above) and under description write: “bulk sediment.” Place the label it in the bag and tie the top of the bag in a knot to seal it.

9. If the transect is slightly underwater, collect the sample using the measuring rod with attached scoop. Using the measuring rod, record the depth of the water at the transect elevation on the data sheet. If the water is too deep to access, record this on the form.
10. Place the sample bag in a bucket and repeat the above procedures for the other transect at the site, if accessible. If no additional samples will be taken, gather all samples and supplies from the beach.

11. Designate a photographer and complete the photo documentation form. Take one photo at the start point (western end) looking toward the end point and a second photo at the end point (eastern end) looking toward the start point. Take a third photo looking down the beach from the backshore, and a fourth in the middle of the transect looking down at the beach sediment with a measuring card in the picture. For each photo, record the cardinal direction (North, South, East, West) you are facing on the data sheet on the photo documentation form.


Original protocol by Dan Penttila, WDFW. Reformatted by Dayv Lowry, WDFW. Modified for the Snohomish County MRC, October 2011.
Appendix B of the transect site descriptions is the winnowing protocol developed by WDFW which was used from sample analysis.
Field materials needed:
2 Nested sets of 4mm, 2-mm and 0.5-mm sieves/screens
2-4 Buckets for discarded material (may have several large holes drilled near lip as rinse water outlets)
6-2 gallon plastic dishpans
400-ml wide-mouthed sample jars (Peanut Butter Jars)
1 Liter Nalgene jars
Freshwater hose work area with sufficient drainage
Stockard’s solution† and MSDS (Material Data Safety Sheet)
4 Kitchen Rubber Spatulas
1 packet of 9 x 24 inch polyethylene bags
Disposable gloves (for use when handling Stockard’s Solution)
Sample labels
Wire brush
Pencils

Procedure:

1. Do one practice run with ‘faux sample’ at the beginning of each day. Do not skip this step.

2. Each team will work with a single sample to avoid cross-contamination. Open the sample bag and empty into a clean bucket and mix the sample. Place the tag and bag in an obvious location to provide a constant reminder about the sample being worked on.

3. We are collecting 1 liter of sediment from each transect for future use. Fill a 1 L Nalgene jar with sediment and pour into a new 9 x 24 Sediment Sample bag. It won’t be a full bag. Complete a sample label with the sample name (site name), date, and describe it as “Sediment Sample.” Place the sample bag inside another clean bag. Place the label in between the two bags so that the label is not touching the sediment sample, then tie the bag in a knot to seal and set it aside. Do this for all 13 transects. Store bags at appropriate location for future sediment size analysis.

4. Stack the sieves as shown on right. Be sure that they remained stacked at all times. Use water and hands (wet screen) to push material through set of 4-mm, 2-mm and 0.5-mm sieves/screens with buckets of water at site or a freshwater hose. Visually look at screens to determine if remaining materials are adequately filtered. Carefully clean each screen between samples.

5. Discard material retained in the 4 mm and 2-mm sieve/screen.

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

7. 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.
8. Tilt/swirl/agitate pan contents to move lighter material accumulated at center down to lower left corner of pan.

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

10. Holding pan in the tilted position, carefully use a spatula to skim the surface 1 inch of material from the lower left corner of the deposit and place in the labeled sample jar (peanut butter jar).

11. Repeat steps 6-9 approximately three more times, or until the sample jar is ~⅔ full of material.

12. Top-off sample jar with Stockard’s solution† and shake well to distribute fluid. Note that long-term storage is also possible with these preservatives.

13. Complete a sample label with the sample name, date, and the description: “winnowed sample”. Place sample label into the jar and 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).

14. Place winnowed samples in a bucket to be delivered to Dan Penttila.

15. 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 will escape.

16. Collect the remaining material from 0.5-mm sieve/screen in a 1 L Nalgene jar. Preserve sample with Stockard’s solution. Complete a sample label with the sample name (site name), date, and the description: “0.5 mm material”. Place the label in the jar and put the jar in a bucket to be delivered to Dan Penttila.

17. Thoroughly rinse and clean all sieves with a wire brush to remove any remaining material after each winnowing session before storing the materials.

† 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. Modified for the Snohomish MRC, September 2013.
Appendix C:

Appendix C of the transect site descriptions is the blue vortex protocol developed by WDFW which was used from sample analysis for sample comparison and QA/QC from 2016-2020.
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

Phillip Dionne
Washington Department of Fish and Wildlife
1111 Washington St SE
Olympia, WA 98501
Phillip.Dionne@dfw.wa.gov

July 2015
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.
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:

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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.


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

A 1/50 inch fine mesh sieve is an alternative: [http://www.goldfeverprospecting.com/keclsc.html](http://www.goldfeverprospecting.com/keclsc.html)

Shims: [http://www.homedepot.com/p/Unbranded-8-in-Composite-Shim-Bundle-of-12-SHM1-12-TW/202807695](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](http://www.amazon.com/Farberware-Color-Silicone-Spoon-Spatula/dp/B005GT01KE)