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Quality Assurance Project Plan
Intertidal Biota Monitoring in the Cherry Point and Fidalgo Bay Aquatic Reserves

Washington Department of Natural Resources

Ensuring regulatory effectiveness in
Puget Sound's most special places

Grant #: PC-00J29801-0

Prepared for:

Cherry Point Aquatic Reserve Citizen Stewardship Committee

Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee

Prepared by:

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June 2013

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EPA requires a Quality Assurance Project Plan (QAPP) for studies, such as this one, that generate environmental data. This QAPP describes monitoring of environmental conditions that will be conducted in 2013 at two of Washington's aquatic reserves. However, the contents of the QAPP 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.

Copies of this QAPP and final project publications will be available from the Washington State Department of Natural Resources
http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_rsve_aquatic_reserves_program.aspx

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Quality Assurance Project Plan

Intertidal Biota Monitoring in the Cherry Point and Fidalgo Bay Washington Department of Natural Resources Aquatic Reserves

June 2013

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Abstract

As steward of 2.6 million acres of state-owned aquatic lands, the Washington Department of Natural Resources established aquatic reserves throughout Puget Sound to protect important native ecosystems. These reserves are an effort to promote the preservation, restoration, and enhancement of state-owned aquatic lands that are of special educational, scientific, or environmental interest. One of the tools used for managing aquatic reserves and protecting their resources is measuring and monitoring the diversity, distribution, and abundance of intertidal species within an aquatic reserve. This project is monitoring intertidal shorelines and biota within two aquatic reserves, Cherry Point and Fidalgo Bay. Assessment and monitoring methods will be based on those established by the Washington State University Beach Watcher Intertidal Monitoring Program, with modifications to enhance the compatibility with other studies. The monitoring is intended to provide baselines for detection of changes and determination whether these changes are due to natural variation or anthropogenic causes, and if they are harmful, beneficial, or neutral. Acquired baseline information can be used for natural resource damage assessment, reserve management, and protection of critical habitats, and protected species.

Background

The Washington State Department of Natural Resources (WDNR) is steward of more than 2.6 million acres of aquatic lands. As steward, WDNR established aquatic reserves throughout Puget Sound to protect important native ecosystems. The Aquatic Reserves Program focus is to conserve high-quality native ecosystems in both freshwater and marine environments. It is an effort to promote the preservation, restoration, and enhancement of state-owned aquatic lands that are of special educational, scientific, or environmental interest.

A benefit of the Aquatic Reserves Program is the partnerships WDNR establishes to aid in development and implementation of site-specific aquatic reserve management plans. WDNR works with federal, state, local, tribal and non-governmental organizations and private citizens in an effort to identify and manage important resources for conservation at each reserve. An additional benefit of Aquatic Reserve designations is that management plans can be designed to compliment other protective measures within or adjacent to the site.

The types of Aquatic Reserves include:

- Environmental— promote conservation and restoration.
- Scientific—provide unique aquatic habitats for research.
- Educational—promote opportunities for field-based environmental education.

Some of the anticipated benefits of these aquatic reserves include:

- Ensuring environmental protection through site-based preservation, restoration, and enhancement.
- Ensuring environmental protection through site-based preservation, restoration, and enhancement.
- Enhance the health of native marine and freshwater aquatic habitats, and the fish and wildlife that depend on them.
- Encouraging public use and access.
- Providing for greater public input into conservation management.
- Working with stakeholders, including citizens and state, local and federal governments, to develop and implement site-specific management plans.

The two aquatic reserves (AR) established and managed by WDNR in which intertidal monitoring is planned are Cherry Point in SE Georgia Straits and Whatcom County, and Fidalgo Bay near Anacortes in Skagit County. The location of these reserves is shown in Figure 1. For each of these reserves, specific Management Plans were written. These plans include the requirement and recommendation for research and monitoring with the following four components:

A. Identify data gaps, baseline inventory to fill gaps and establish standards for trend monitoring.
B. Establish baseline conditions.
C. Trend monitoring to determine the effectiveness of management activities and document natural variation.
D. Research, to better understand observed changes and the interactions between management activities and natural resource conditions.

Descriptions of each aquatic reserve and their management plans are available from WDNR at the Aquatic Reserves Program internet site http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_rsve_aquatic_reserves_program.aspx (accessed on January 17, 2013).

Figure 1: Location of Cherry Point and Fidalgo Bay Aquatic Reserves (circled) in Puget Sound, WA.

Source of base map: WDNR (2011).

Cherry Point Aquatic Reserve

The Cherry Point AR, according to its management plan (WDNR, 2010) is an important biological area as "Aquatic diversity along this reach is very high with cobble intertidal habitat, large rocks and boulders, sandy beaches, eelgrass beds, and kelp. Additionally, the deep area close to shore and the steep intertidal gradient along this reach may be important to marine diversity." Additionally, the management report characterizes the upland areas and access as "The bulk of the uplands adjacent to the Reserve are privately owned, primarily by five entities: BP, Pacific International Terminals, Alcoa-Intalco, Phillips 66, and Cherry Point Industrial Park. North of the industrial area, private residential lots exist with a small county-owned public access area just southeast of Point Whitehorn. Birch Bay State Park is located to the northeast of the residential lots and the aquatic reserve. The Lummi Indian Reservation is located to the south of the Aquatic Reserve." The geography of this area is shown in Figure 2.

The management plan also notes that many of the nearshore and intertidal areas have had declines in the number of many of the native species and an increase in the number of invasive species.

Figure 2: Map of Cherry Point Aquatic Reserve.

Source: WDNR (2010)

Fidalgo Bay Aquatic Reserve

Fidalgo Bay AR is a very different environment than the Cherry Point AR in that it has extensive mud and sand flats with limited areas of bedrock and has artificial hard substrates such as pilings and riprap. However, similar to Cherry Point, the uplands include refineries and other industrial facilities, as well as residential areas (WDNR, 2008). Unlike Cherry Point, there are no industrial facilities (i.e., marine terminals) present as "in holdings" within the reserve boundaries.

The characteristics of the Fidalgo Bay AR are shown in Figure 3.

Figure 3: Map of the Fidalgo Bay Aquatic Reserve.

Source: WDNR (2008)

Project Description

The goals and objectives of the intertidal monitoring in the two reserves are to collect baseline data over time at specific monitoring sites and to document changes over time in beach slope, substrate, and biodiversity, using scientifically and statistically sound methods that will provide data comparable across reserves and monitoring years. Monitoring is essential to determine if or how AR beaches are changing. In addition, the impact on reserve beaches of natural and human-induced events cannot be measured without such data. Moreover, environmental questions posed by governmental agencies and interested groups cannot be scientifically answered without such data.

Efforts will be made to establish continuity with data from previous monitoring for defining trends and an understanding of the conditions and processes affecting the study areas over time. The Cherry Point AR has an extensive history of intertidal monitoring since 1954. Much of this monitoring was conducted using a variety of quantitative methods. The methodology implemented in this study is consistent with recent studies and should allow comparison with recent data sets. In addition, some other studies are being conducted concurrently with this study and efforts will be made to coordinate activities between the studies to maximize comparability.

In contrast, little historical intertidal information is available from the Fidalgo Bay AR. As the planned monitoring program is implemented over succeeding years, it will generate data that can be used to address this data gap, establish baseline conditions, define trends, and document changes.

Monitoring within each reserve will be constrained by two primary factors; the first will be human resources to conduct the monitoring. In both reserves, interested citizens will be recruited and trained to conduct the monitoring. In most cases, these citizens may be members of the Beach Watchers (BW) program[1]. Monitoring in the ARs will be organized and managed by the Cherry Point AR Citizen Stewardship Committee (CPARCSC) and the Fidalgo Bay AR Citizen Stewardship Committee (FBARCSC), which will recruit members of the BW Program and other interested citizens.

The second constraint will be access. As shown by the BW Program, intertidal monitoring by volunteer citizens is only practical where the target beaches are easily accessible from land. Access by boat or means that are used by government or academic researchers would not be feasible because of the cost limitations. Thus, in each reserve, beaches at or near public access points will be used for intertidal monitoring.

In response to the Management Plan for each reserve, planning has been conducted by WDNR and associated Citizen Stewardship Committees. Members of the committees have compiled appropriate goals, objectives, approaches, and methods for monitoring. The methodology is standardized between the two reserves, with two exceptions. Infaunal sampling will be conducted in the Fidalgo Bay AR. Additional different tidal elevations may also be surveyed in either reserve.

[1] The Beach Waters Program is supported by the Washington State University County Extension program http://www.beachwatchers.wsu.edu/regional/index.php, accessed January 17, 2013.

Organization and Schedule

Washington Environmental Council (WEC) is the coordinator for this program. This monitoring is being conducted in two aquatic reserves, each with its own stewardship committee and associated organizations. The Statement of Work (SOW, 2013) describes the structure as "Washington Environmental Council, with the project partners, will train the citizen committee members using established protocols and will work with the resource agencies to add value to their existing research and monitoring programs…" Table 1 shows the partners involved in this project and Table 2 shows the primary individuals of assigned responsibilities in these programs.

Table 1: Partner organizations

Reserve	Lead Partner	Partner
Cherry Point Aquatic Reserve	Cherry Point Citizen Stewardship Committee (CPARCSC)	Re Sources for Sustainable Communities
Fidalgo Bay Aquatic Reserve	Fidalgo Bay Citizen Stewardship Committee (FBARCSC)	Re Sources for Sustainable Communities

Table 2: Key individuals and their responsibilities

Individual	Responsibilities
Wendy Steffensen RE Sources	Coordinate planning and operations for both reserves. Data management
John Stockman, CPARCSC	Cherry Point planning and organization
Bob Cecile, CPARCSC	Cherry Point planning and organization
Mira Lutz, FBARCSC	Fidalgo Bay planning and organization
Sylvia Yang, FBARCSC	Fidalgo Bay planning and organization
Pete Haase, FBARCSC	Fidalgo Bay recruitment
Maddie Foutch, WEC	Coordinate programs
Jerry Joyce, WEC	Science advisor

A full list of those involved in the program is shown in Appendix B.

Project schedule

The intent of this project is to create an ongoing, self-supporting monitoring program at both reserves. The portion of the program supported by this grant and covered in this QAPP ends on December 31, 2013. The schedule for this project in 2013, by reserve, is shown in Table 3.

Table 3: Project Schedule

Activity	Cherry Point	Fidalgo Bay
Recruit volunteers	Feb-March, 2013	Feb-March, 2013
Training	Classroom Training: April 10, 17, 24 Field Training: April 27th	Classroom Training: April 21 Field Training: April 28th
Surveys	May 25, 26, 27 July 20, 21, 22	May 10, May 24 Possible (June 22, 23 or24)
Draft project report	Nov 19, 2013	Nov 19, 2013
Project summary	Dec 31, 2013	Dec 31, 2013

Budget and funding

This program is primarily a volunteer-run project and therefore does not incur costs for personnel. Only minor equipment and supply costs of $2,000 are anticipated and funding for these purchases is available through this grant, as stated in the SOW (SOW, 2013). Volunteer hours are used as indirect matching to grant funding.

Staff support, including coordinating activities between reserves and preparation of reports, are provided through this grant, including general activities such as development of the stewardship committees and evaluating the implementation of the management plans funded by this grant are beyond the scope of this QAPP.

Sampling Design and Procedures

The Intertidal Biotic Monitoring citizen science program will be conducted in two marine reserves: Cherry Point and Fidalgo Bay. The studies are conducted annually and use a transect/quadrat model using a transect line from high water mark to mean low water. The methodology is based on protocols developed by the WSU BW Intertidal Monitoring program (Beach Watchers, 2003). This protocol for selection of sampling locations has been modified from this methodology to improve the statistical robustness of the study. Additionally, infaunal sampling will also be conducted in the Fidalgo Bay AR. Substantial sampling will be conducted utilizing students. Since the high school groups are quite large (~30-50 students), survey sites resilient to high impact will be sampled during student surveying days. Sites with sensitive areas, such as eelgrass beds will be reserved for small teams, such as BW. Because eelgrass beds tend to be in muddier sediments and require more physically, these areas will be sampled only by fit individuals with appropriate footwear.

Sampling location

Within each Aquatic Reserve one or more areas considered to represent regimes of substrate, salinity, and/or wave exposure will be identified. When human resources and access permit, more than one location may be identified within the boundaries of a reserve.

Sampling frequency

Each area will be examined at least annually and during the same month as originally sampled. The field day events were set with the following criteria:

- On a weekend and one weekday,
- During an extreme low tide event so that one transect can be completed during a low tide cycle, and
- Volunteer availability.

The sampling date ranges for the 2013 are shown in Table 3. Not all days in each date range listed may be used for sampling if the work can be completed in less time.

Parameters to be determined

The parameters that will be determined are the following:

- Beach profile and elevation
- Substrates
- Species composition
- Species abundance

Sampling Methods

Figure 4 shows a typical layout for the sampling, as shown in the Beach Watchers manual (Beach Watchers, 2003). In this sketch, the quadrats are placed at uniform distances apart along the transect line. In this updated procedure, as shown in Figure 5, four quadrats will be used in each transect and will be spaced randomly, using a random start point, which are then spaced equally to represent the entire transect. The transects do not need to be to the left of the profile line as shown, but should be placed to intersect the profile line and to provide a transect across uniform geomorphology.

Figure 4: Diagram of a typical sampling regime used in Beach Watcher sampling.

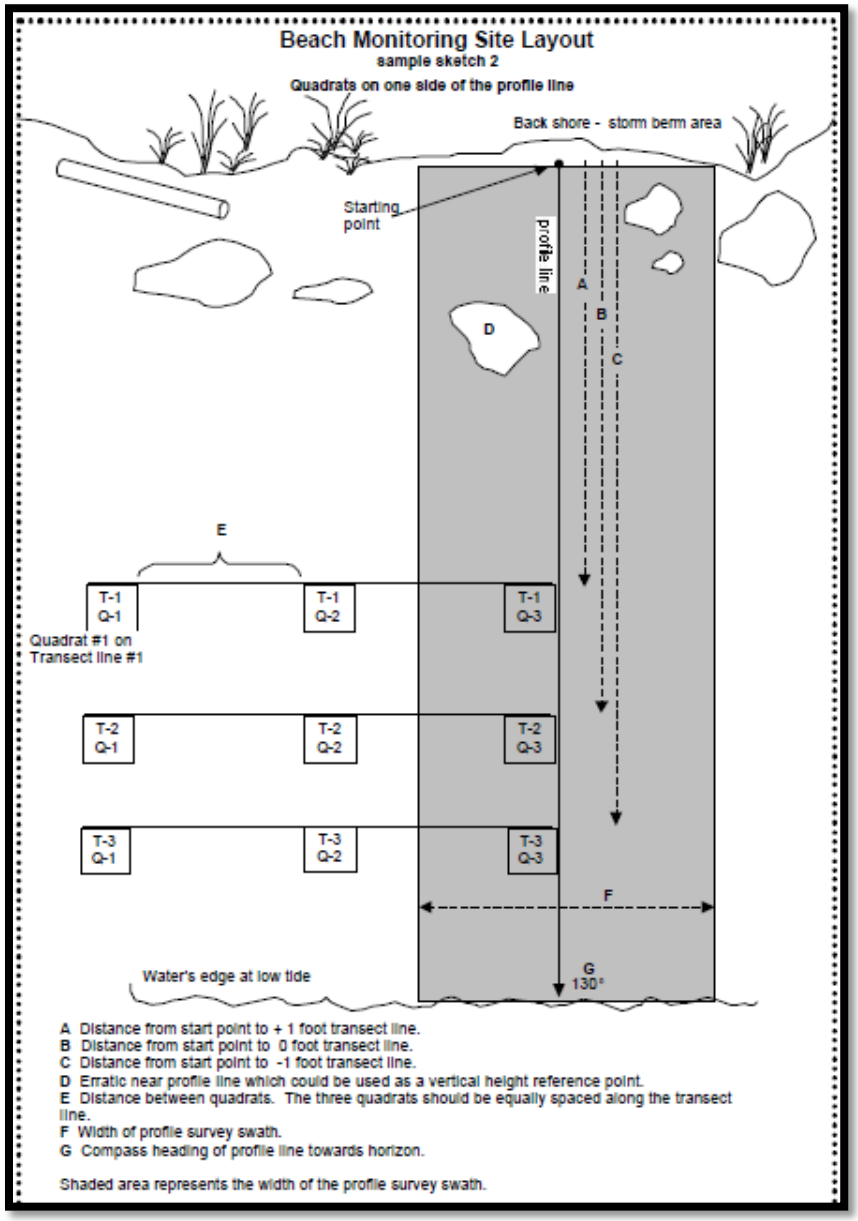
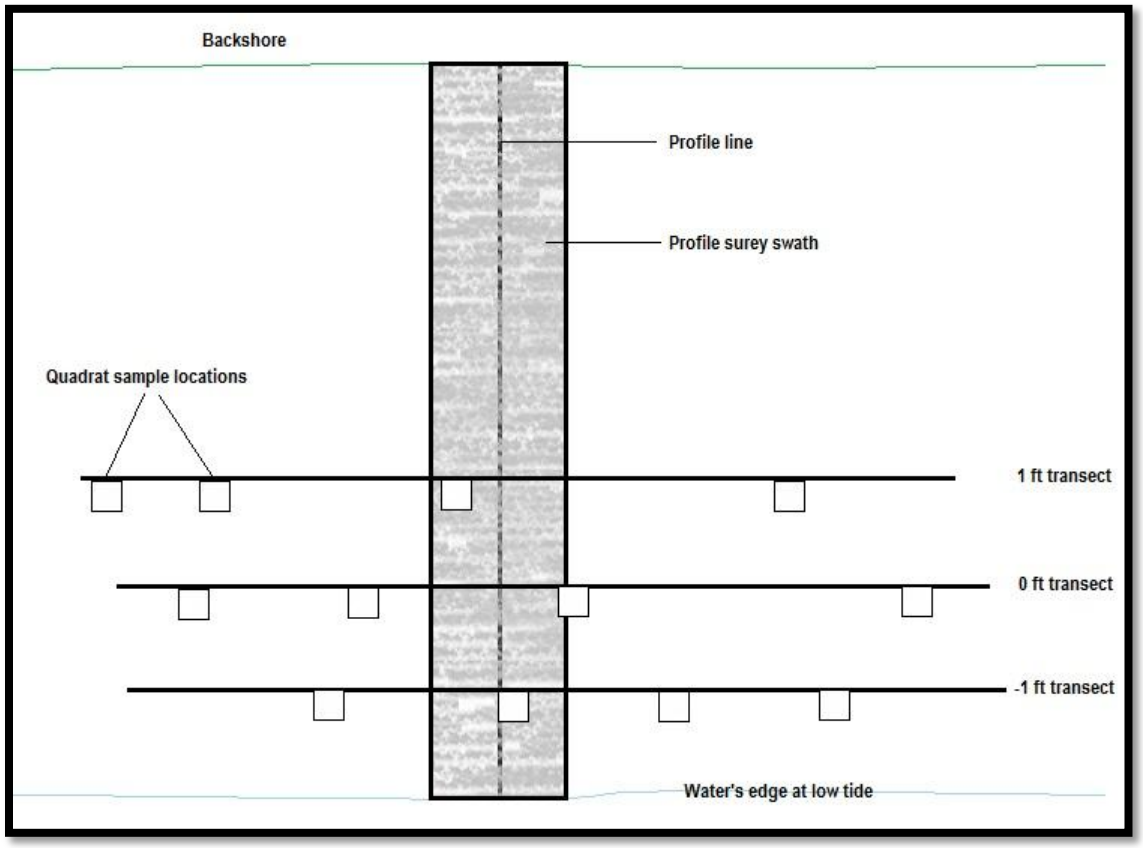


Figure 5: Diagram of revised sampling scheme using –randomized locations for sample quadrats.



Standard Sampling

The following protocol is based on the Beach Monitoring Procedures manual prepared by the Island County/WSU BW (Beach Watchers, 2003). Modifications from this source protocol are noted in the procedure.

- **Profile Station Locations:** Place stations to represent typical conditions of salinity, substrate, and wave exposure that are easily and safely accessible. Use a Geographic Positioning System (GPS) receiver, written description, 3 compass bearings, and photography to document the station location. The station zero or starting point will be on the ordinary high water line (edge of the upland vegetation). Notation about the profile start location will be made using Beach Watcher Forms D1, D2 and D3 as listed in Appendix A. Details of requirements for the GPS are discussed in the Quality Control Objectives and Procedures section, item 2, on page 14.
- **Habitat Classification:** use WDNR habitat classification system by Dethier (1990) and Bailey et al.'s (1993) guide for applying Dethier's classification.
- **Sediment Classification**: Use the standard geological Wentworth Scale in metric with field guides.

- **Monitoring Schedule:** Each station will be examined annually and in the same month as the original survey. Monitoring in the same week or on the same day each year is not feasible because of tidal variation.
- **Beach Profiles:** Starting points will be at the Ordinary High Water line with tide height, as determined by geomorphologic and vegetation characteristics. Profile elevations will be determined using water level determined by a tidal graph generated from NOAA tidal predictions and/or Nobeltec Tides and Currents computer program. Each half-foot elevation will be marked during an outgoing (ebbing) tide and flagged with survey flag stakes, as close as possible to the scheduled survey time. Measurements from each stake to the high tide line will be made using a tape measure or laser range finder. The elevations will be determined each time the profile is examined. Substrate, seaweed, and invertebrate profile information will be taken for each 10 foot by 20 meter (65.6 feet) areal section about the profile line for each profile increment of 10 feet. During this phase of monitoring, rocks may be turned over to examine what is underneath them, but must be returned to their original position. (When this occurs, an effort will be made to record the species under the rock using the species ID list)
- **Transect Levels for Quadrats**: Transects should be placed +1, 0, -1 feet (Figure 5). Additional transect levels may be selected by the group if there is time and interest.
- **Transect Locations:** The location should ensure that each survey transect should be in an area of consistent geomorphology. This is primarily identifying a type, such as mud, sand, cobble, that has the same amount of wave and sea action and excludes localized effects, such as streams and discharges. These transects should be located as close as possible to the profile line established from the profile station. The location of the start of each transect should be recorded using GPS as should the bearing of the transect line. Details of requirements for the GPS are discussed in the Quality Control Objectives and Procedures section, item 2, on page 14.
- **Quadrat Size, Number, and Placement:** Randomization of the location of the four quadrats along each transect. Transect length = 20 m. Measure quadrats by using a prepared computer-generated randomization chart for the numbers 0-4. Add 5, 10, and 15 to the numbers to get your measure. (When materials are only in English units, transect length will be 66 ft, and random numbers will be from 1-16.)

  Quadrats will be placed below the transect line at the following positions:

  - Transect +1 quadrats at: 4 m, 9m, 14m, 19m
  - Transect 0 quadrats at: 0 m, 5m, 10 m, 15m
  - Transect -1 quadrats at: 2m, 7m, 12m, 17m
- **Quadrat Analysis (Epibenthos)**: Number quadrats 1-4, left to right. Within each quadrat plants (on top of the substrate only) and animals living on the beach surface and greater than 5 mm in size are classified as epibenthos. The biota may be attached to boulders or cobble (algae and invertebrates), or live on the surface of substrate (invertebrates and small fish). Estimates will be made of percentage coverage for algae and colonial animals. In accord with Beach Watchers protocol, only debris, shells, and unattached

algae will be removed from the quadrat. Algae and organisms will not be touched in the quadrat thereafter; survey of the quadrat will take an aerial view only.

Estimation technique will vary with the individual and site. All estimates will be made using 2 -4 people. These include simple visual assessment, or using an estimation aid such as a square equivalent to 1% or an estimation worksheet. (attached) To use the estimation worksheet, estimators assign a value of 1 to each 1% grid section where coverage is greater than one-half for a specified organism, and 0 where coverage is less than one-half for that organism. The values are totaled to arrive at percentage coverage. Latin names are recorded on the data sheets

Photographs and keys will be used to identify unknown species. Organisms in the quadrats and field will be identified using the laminated identification cards, Common Intertidal Seaweeds and Seagrasses of the Salish Sea, 2011 Periwinkle Press, and Common Intertidal Invertebrates of the Salish Sea, 2009 Periwinkle Press. These are the same cards that citizen scientists and students have been trained on prior to the surveys. For further expert identification, surveys always include a number of "expert identifiers" or citizens who have been identifying organisms for a period of years and have become proficient. These identifiers rely on the following sources:

- Coastal Fishes of Pacific N.W., by Andy Lamb and Phil Edgell, 2010;
- Guide to Common Seaweeds of British Columbia by R. F. Scagel. Illus. by Ernani G. Meñez. [Victoria] K. M. MacDonald, Printer to the Queen, 1972 [reprinted 1973]
- Marine Invertebrates of the Pacific N. W., by Eugene N Kozloff, 1996.
- Marine Life of Pacific N. W., by Andy Lamb and Bernard P. Hanby, 2005
- North Pacific Seaweed by Rita M. O'Clair and Sandra C. Lindstrom. Illustrations by Katherine M. Hocker and Patricia s. Holley. Auke Bay, Alaska:Plant Press, c2000.
- Pacific seaweeds, Louis Druehl, 2001.
- Phycological Contribution #8, by Paul W. Gabrielson, Sandra Lindstrom and Charles O'Kelly, May 2012;

When any of our resident experts are unsure about a species, a "preliminary" species ID is recorded with photos in the field, and in the QA/QC process the ID is checked again using photos, the above taxonomic sites, and web references, such as:

- Integrated Taxonomic Information System site; www.itis.gov/
- World Register of Marine Species; www.marinespecies.org/index.php
- Invertebrates of the Salish Sea; http://www.wallawalla.edu/academics/departments/biology/rosario/inverts/index.html

- **Mega-Macrofauna** (e.g., large seastars [*Pisaster sp.*], anemones [*Urticina* sp.]) associated with selected large boulders or other fixed objects (e.g., piling, pipelines, concrete blocks) within 20 m of the profile line will be identified and enumerated. The same objects will be used each time the profile is examined. These species are excellent indicators of changes in environmental conditions. These species will be added to the species list generated by the point intercept and quadrat sampling.
- **Infaunal Sampling**: Core for each quadrat using standard schedule 80 PVC. The corer has a nominal diameter of 6 in with outside diameter of 6.625 in and inside diameter of 5.709 in. The core will be up to 30 cm deep, only where eelgrass is not present. Place in 1

large sieve (could be made from 1 cm (~0.5") hardware cloth). Wet sieve at the quadrat site, if time allows. If time does not allow, transport the core upland for sieving and identification. Record which and how many organisms are retained in each sieve. Return all animals following enumeration. This will be conducted in Fidalgo Bay Aquatic Reserve only.

- **Invasive Species Evaluation**: Any invasive or alien species encountered within the quadrats or profile swath will be recorded, photographed, and reported to the appropriate agency
- **Data Recording and Field Log**: Photos of each quadrat will be taken to accompany the data forms. Use Beach Watcher forms modified as needed; completed forms scanned to PDF for archiving. Data forms will be submitted to WDNR for data base entry. A Rite-in-the-Rain pen will be used for recording data on Rite-in-the-Rain or plastic DuraRite paper. Additional details for data recording will follow the Beach Watcher Manual. A field log or journal should be maintained for each reserve with information on monitoring planning, implementation, equipment construction and procurement, and other relevant details that will guide new personnel. All forms are described in Appendix A.

Student Sampling

The following procedure is used on high school student field survey days:

- Set up the 'profile swath' and have students line up on both sides of the swath.
- Allow the students time to explore the space in their section of the swath to record presence/absence of organisms along the swath.
- In the meanwhile, BW and FBARCSC personnel will assess the stage of the water's level using prepared tide graph and set up the 4 transects and quadrat placement.
- Once the students start their quadrat measurements, BWs will spread out amongst each transect to answer student queries.
- As students are working in their quadrats, FBAR person(s) will take one student quadrat group at a time to teach and conduct beach profile measurements, so that all students will get a chance to take beach profile measurements.

Invasive species transport prevention

No specimens will be removed from 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 through washing clothing in hot water and thorough drying. No one in the program should wear boots or shoes with felt-covered soles as these can't be properly decontaminated. Details and options for decontamination are given at http://www.ecy.wa.gov/programs/eap/InvasiveSpecies/AIS-PublicVersion.html .

Data Management and Analysis

Data forms, data logs, and photos will be archived by Wendy Steffensen of RE Sources. Data will be entered into an Excel spreadsheet within 48 hours of collection. Major categories will include amphipods, anemones, barnacles, chitons, clams, crabs, fish, insects, isopods, limpets, mussels, nudibranchs, sand dollars, sea cucumbers, sea stars, snails, urchins, flatworms, nemerteans, polychaetes, arachnids, shrimp, green seaweed, brown seaweed, red seaweed, and sea grasses. All organisms identified for the quadrat analysis or species list will be identified to species, if at all possible. Organisms identified as part of the general profile will be identified to the broader categories as listed above, and may be further identified to species if time and expertise allows. Final, verified infauna data, in electronic or printed form, will be made available upon request.

Raw data publication will be done within 1 month after last field day. Analysis will include descriptive statistics (mean density or percent cover with a measure of variation), diversity, species richness (number of species), and species lists will be generated from the data logs.

Results will be compared to historical data if available for the specific reserve, to other reserves conducting intertidal monitoring, and across years of monitoring. Comparisons will be carefully interpreted to account for geographic, substrate, and exposure regimes.

Training

Citizen scientists will receive training in both fauna identification and sampling methods. Training will occur prior to any sampling. Training will be similar to that of the BW program, as detailed in their training manual (Beach Watchers. 2003).

All participants will receive safety training to keep all participants safe while working in the intertidal and supralittoral zones. They will also receive training on avoiding transport of invasive species.

Table 3 shows the schedule for both training and sampling.

Quality Control Objectives and Procedures

The established procedures were developed to address representativeness through the selection of the profile line and the randomization of sample sites along each transect and precision by conducting replicate samples along each transect. The procedures address accuracy and bias concerns through using experts to supervise sampling and verify sampling results. Completeness is considered achieved if at least one profile line with three transects, is completed with at least 75% the planned samples collected on each transect.

The following items will be implemented to provide the best QC throughout the program:

1. Follow the standard procedures as described in the previous section among sites and among monitors.
2. Use a GPS system that has an expected accuracy of at least ± 3 m and compass bearings. The make and model of the GPS will be recorded along with the design specifications for accuracy. The GPS system will be calibrated by taking a reading of a know location and comparing the positions. Ensure that the location of each starting point is adequately

photographed and described, so the starting point location can be relocated and verified through the use of all four data sources.

3. Monitoring teams will be accompanied by at least one person experienced at identifying marine biota and conducting quantitative intertidal sampling. These leaders will confirm species identification and double check counts on-site.
4. Intertidal species identification classes will be held each spring to provide monitoring team members an opportunity to review species characteristics.
5. Training will be enhanced through use of local public aquaria (if available), internet resources, quadrat training on beaches, and local Beach Watchers or other personnel with species identification expertise.

Data Verification and Usability

Before leaving the field, field data forms will be reviewed by team leaders to ensure data completeness and thoroughness, to the extent possible, on-site. Any questions on species identification will be resolved with the week by team leaders in consultation with on the ground experts, photographs, and the use of published and internet resources. The project manager will review all field data records (Appendix A) to ensure that questions about missing and unusual data had been addressed and corrected, if needed.

Data entry and accompanying graphs will be completed by intertidal volunteers or RE Sources interns. Date entry and graphic displays will be verified by RE Sources Lead Scientist/ staff to the CPARCS and FBARCS project, ensuring correct data entry.

All electronic records will be compared to the original observations recorded on field data forms to confirm accuracy of data entry / transcription. Data usability will be assessed relative to the project objectives (page 4). For example, the database contents (e.g., species locations, identifications, and abundance), will be verified to represent an initial baseline that can be replicated over time and used to assess trends.

Audits and Reports

No Audits of this project are anticipated.

A scientific report will be produced by WDNR with the help of monitoring personnel with statistics and interpretations. Results will be correlated with tidal height and substrate. Reports and data bases will be placed into the public domain by providing report with all data and analyses to WDNR to be placed on the Aquatic Reserve internet site at (http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_rsve_aquatic_reserves_program.aspx).

A final monitoring report for each reserve will be completed by December 31, 2013. Production of the reports will be created in collaboration between the WEC, the partner organizations, and WDNR. Drafts of the reports will be subject to peer review and review by the NEP Quality Coordinator prior to submission.

The report will include for each reserve:

- A narrative of the field research
- A summary of observations
- Analysis of effort
- Analysis of observations
- An assessment of the feasibility of this study
- Recommendations for any modification of the procedures and the overall program

The final report will be available from the WDNR AR website at http://www.dnr.wa.gov/ResearchScience/Topics/AquaticHabitats/Pages/aqr_rsve_aquatic_reserves_program.aspx

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We also thank our partners at WDNR and especially Betty Bookheim for her assistance in refining the procedures. Finally, we thank Dr. Megan Dethier of University of Washington for her assistance in helping us resolve some of the theoretical issues in the sampling protocol.

Appendix A: Data Forms and Reference Materials

Data forms

The following data forms will be used in this project:

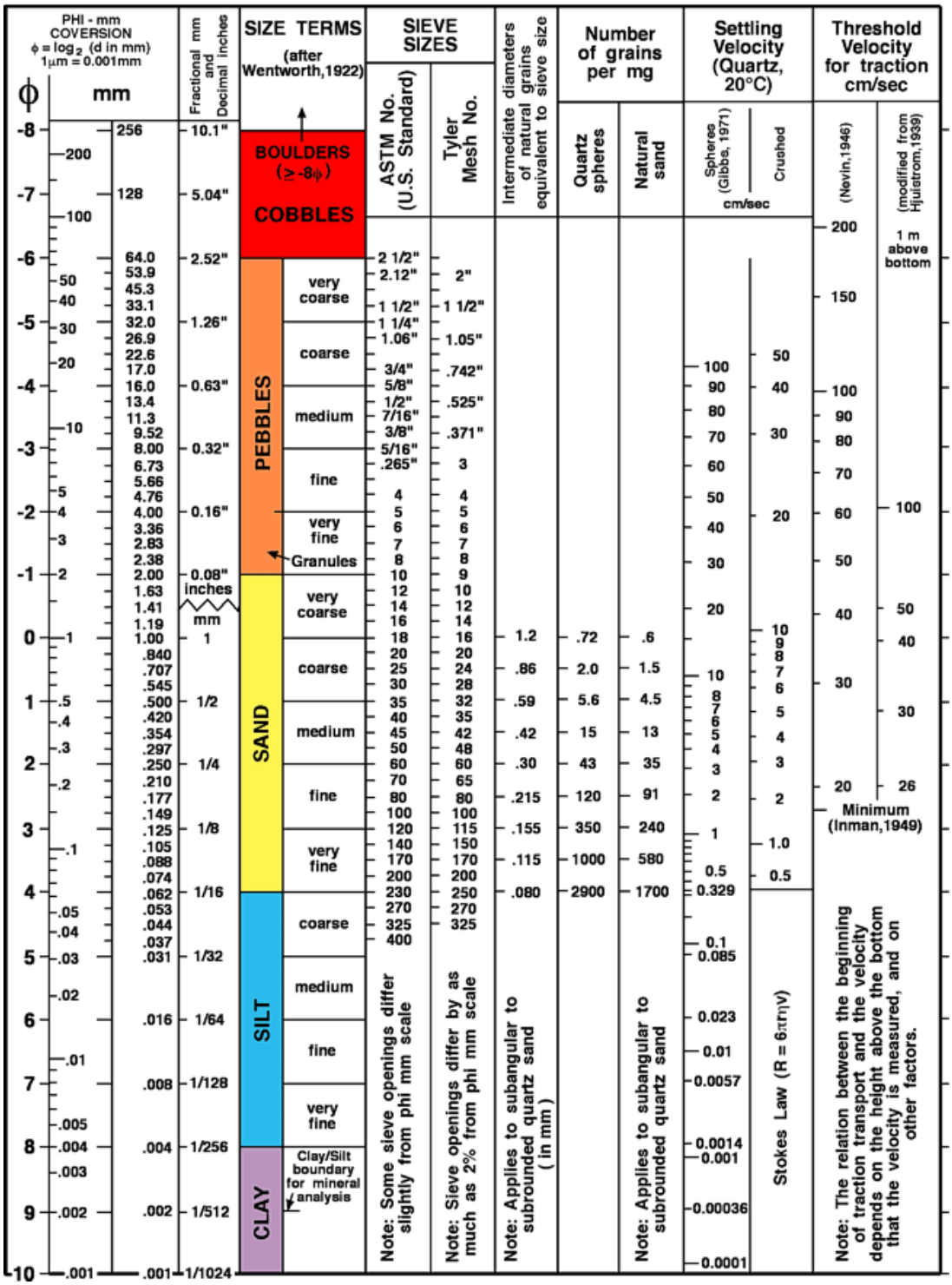
Form	Purpose
Binary method wksht	Assess percentage coverage
Fidalgo Quadrat Sheet	Quadrat analysis, Fidalgo Bay AR
Profile data_A	Profile elevation (Beach Watchers form D4, side A)
Quadrat Estimation	Assess percentage coverage
Species Checklist_latin	Species identification
Whatcom Quadrat	Quadrat analysis, Cherry Point AR
BW D1	Record start point with multiple readings
BW D2	Record presence and dimensions of structure on or near the profile line
BW D3	Identifies general location of beach and then provides specific information to locate start point

These forms are included as supplemental documents.

Reference materials

Figure 6: Wentworth Scale Source: USGS Open-File Report 2006-1195.

Available at http://pubs.usgs.gov/of/2006/1195/htmldocs/nomenclature.htm (April 8, 2013)



Appendix B: List of Additional Personnel Involved in the Program

Fidalgo Bay Aquatic Reserve Team

FBAR Biotic Monitoring Subcommittee members

Mira Lutz and Sylvia Yang-Subcommittee Co-leads:

Plan and lead subcommittee meetings, draft protocol specific to Fidalgo Bay Aquatic Reserve, delegate tasks related to training and data collection among subcommittee members and experts as needed, coordinate and help to lead volunteer training sessions, organize and direct intertidal biota data collection, organize data for presentation to WDNR, act as liaisons to Education and Outreach subcommittee for project sharing.

Shawn Arellano	project support
Pete Haase	project support
Morty Cohen	project support
Wayne Huseby	project support

Pattie Hutchins, Pete Haase -Skagit County Beach Watchers. Will recruit and coordinate Beachwatcher volunteers to attend trainings and gather data on monitoring days.

Project Volunteers

Skagit County Beach Watchers -attend biotic monitoring training sessions to learn protocol and practice organism ID; apply training to gather data on scheduled monitoring days.

Victor Garcia, Environmental Science Teacher, Anacortes High School (AHS) - coordinate training sessions and field trip for students to participate as volunteers.

Laurelynn Brooks, Marine Biology Teacher, Mount Vernon High School (MVHS)- coordinate training sessions and field trip for students to participate as volunteers.

AHS AP Environmental Science class and MVHS Marine Biology class -attend biotic monitoring training sessions to learn protocol and practice organism ID; apply training to gather data on scheduled monitoring days.

Cherry Point Aquatic Reserve Team

Project Team:
AR Subcommittee Members: John Stockman, Bob Cecile, Gaythia Weiss, Bill Beers, Kathy Orlich, Marie Hitchman
Other involved persons: Doug Stark (MRC), Atina Casas (MRC), Chris Brown (MRC), Michael Kyte (Technical Advisor), Bob Lemon, Matt (Mateo) Schwartz (RE Sources intern)
Staff: Wendy Steffensen, Maddie Foutch, Jerry Joyce

Project Team

Project co-leads: John Stockman, Bob Cecile
Instructors: Doug Stark, John Stockman, Wendy Steffensen
Expert Identifiers for field training and surveys: Doug Stark, Bob Lemon, Michael Kyte, Marie Hitchman (algae)
Volunteer Coordinator: Mateo Schwartz
Field Day Leads: John Stockman (June, July), Doug Stark (May), Bob Lemon (May, June),
Advertising/Recruitment: Mateo Schwartz, Wendy Steffensen
Technical Advisor- Michael Kyte
Purchasing: WEC, RE Sources, Whatcom County MRC
Equipment Manager: Bob Cecile

Appendix C: Glossary, Acronyms, and Abbreviations

Glossary – General Terms

Dataset - A grouping of samples, usually organized by date, time and/or analyte. (Kammin, 2010)

Data verification - Examination of a dataset for errors or omissions, and assessment of the Data Quality Indicators related to that dataset for compliance with acceptance criteria (MQO's). Verification is a detailed quality review of a dataset. (Ecology, 2004)

Parameter - A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene, nitrate+nitrite, and anions are all "parameters". (Kammin, 2010; Ecology, 2004)

Population - The hypothetical set of all possible observations of the type being investigated. (Ecology, 2004)

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)

Representativeness - The degree to which a sample reflects the population from which it is taken; a data quality indicator. (USGS, 1998)

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

Sample (statistical) – A finite part or subset of a statistical population. (USEPA, 1997)

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

References

USEPA, 1997. Glossary of Quality Assurance Terms and Related Acronyms. http://www.ecy.wa.gov/programs/eap/qa.html

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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

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

AR	Aquatic Reserve
BW	Beach Watchers
CPAR	Cherry Point Aquatic Reserve
CPARCSC	Cherry Point Aquatic Reserve Citizen Stewardship Committee
e.g.	For example
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
et al.	And others
FBAR	Fidalgo Bay Aquatic Reserve
FBARCSC	Fidalgo Bay Aquatic Reserve Citizen Stewardship Committee
GPS	Global Positioning System
i.e.	In other words
NOAA	National Oceanographic and Atmospheric Administration
PI	Principal Investigator
QA	Quality assurance
SOP	Standard operating procedures
SOW	Statement of work
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

Units of Measurement

Cm	centimenter
ft	feet
in	inch
km	kilometer, a unit of length equal to 1,000 meters.
m	meter
mm	millimeter