NATIONAL STATUS AND TRENDS
Mussel Watch Program:
Sampling Methods
2012 Update

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National Centers for Coastal Ocean Science
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Citation for the Full Report
Apeti, D.A., W.E. Johnson, K.L. Kimbrough, and G.G. Lauenstein. 2012. National Status and Trends Mussel Watch Proram: Sampling Methods 2012 Update. NOAA Technical Memorandum 134. NOAA National Centers for Coastal Ocean Science, Center for Coastal Monitoring and Asssessment. Silver Spring, MD. 39 pp.

National Status and Trends Mussel Watch Program:
Sampling Methods 2012 Update

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Silver Spring, MD

2012

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INTRODUCTION

Since 1986, the National Oceanic and Atmospheric Administration (NOAA), through its National Status and Trends (NS&T) Mussel Watch Program, has monitored our coastal waters for chemical contaminants and biological indicators of water quality. The Mussel Watch Program (MWP) is based on the collection and analysis of indigenous bivalve mollusks (oysters and mussels) and sediment. Mussels and oysters are sessile organisms that filter and accumulate particles from water; thus, measuring contaminant levels in their tissue is a good indicator of local chemical contamination. Currently, there are approximately 300 core MWP sites along the nation's coast, including the Great Lakes, Hawaii and Puerto Rico. Detailed descriptions of MWP monitoring sites are available elsewhere (Lauenstein et al., 1997) and a revised version is in preparation. Initially, the MWP sites established in areas intended to represent general conditions of broad coastal areas, thus sites are not located near specific pollution outfalls such as water treatment plants or industry. In recent years however the MWP has expanded to meet a broader mission and has included sites in areas known to be directly impacted by outfalls and/or known pollution sources. These new sites provide our partners and stakeholders data that permit direct measurement of management action or remediation effectiveness.

Currently, the MWP collects bivalve samples biennially (with half of the sites collected each year), while sediment collection occurs once every decade. Special events such as accidental oil spills and hurricanes may warrant a unique sampling mission with a rapid response and modified procedure to meet an urgent need. Examples include NOAA's MWP response to: hurricanes (e.g. Rita & Katrina), oil spills (e.g. Deepwater Horizon), or other environmental events. In these instances the timing and nature of sampling may differ from regular MWP sampling discussed herein. In general, the biennial monitoring of bivalves for contaminants, occurrence of pathogens, diseases and reproductive stage, and sediment contaminant monitoring on a decadal frequency provide a meaningful measure of contaminant status and trends in our coastal environments. Parameters monitored by the MWP include about 150 chemical contaminants, ancillary measurements such as sediment grain size and tissue lipids, and more than 40 biological indicators. The MWP data provide the status and temporal trends of coastal contaminant conditions at the national and regional scale. A national assessment of program data was summarized in a recent report (Kimbrough et al. 2009) and is available online (http://NSandT.noaa.gov).

This document describes in detail the procedures used by MWP for bivalve and sediment collection. It is intended for use by NOAA staff and its partners who do the planning and execution of field collection activities or provide oversight of the staff and resources required. The NS&T Program is committed to providing the highest quality data to meet its statutory and scientific responsibilities. To assure good data quality, the MWP's sampling methodologies are based on quality assured practices described in Environmental Monitoring and Assessment Program's (EMAP), coastal assessment quality assurance project plan (EPA, 2001).

Information in the document is presented in chronological order, so as to be of practical use to the field crews. Procedures for bivalve collection and sediment sampling are described in separate sections. Field crews may be tasked with collecting sediment only, bivalves only or both sediment and bivalves depending on the predetermined mission goals.

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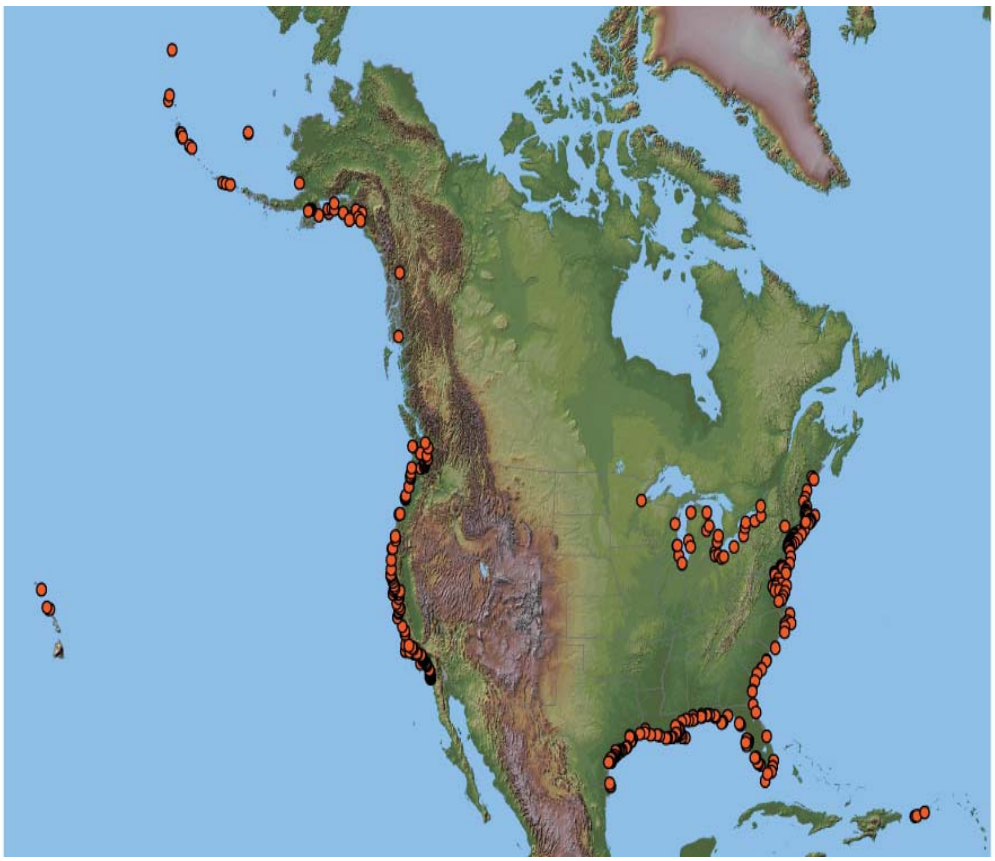
Mussel Watch Sites



PLANNINNG AND PREPARATION

The level of advanced planning will vary with sites, experience, and training of personnel, resource requirements, and who has jurisdictional authority over where the sites are located. Once MWP managers, in coordination with their partners, have agreed upon mission goals, a list of sites to be visited, and the type and quantity of samples to be collected, then the following guidelines are suggested:

1) Submit applications for sampling permits early as this process may take several months;
2) Identify transportation required to navigate to the sites, and any institutional policies for their use (cars, ferries, boats, light planes);
3) Identify field crew personnel, skills required (e.g., SCUBA), and training needs (safety and equipment use);
4) Identify sampling equipment and supply needs – including their sources, procurement, and shipment;
5) Identify and procure chemicals (if needed) and arrange for their proper storage, transportation, use, and disposal;
6) Prepare a logistics plan that takes into account unique site visit requirements: permissions, access and navigation, equipment, tides and currents.

Mussel Watch sites vary in regards to their accessibility, and mode of sampling. Therefore, knowledge of site description and accessibility is essential prior to conducting field operations (Lauenstein et al., 1997). Mussel Watch sites are assigned nominal latitude and longitude coordinates. Field crews should use GPS to locate the nominal coordinates and report the actual sampling coordinates with each site visit. Collection date and time should be based upon the site-specific target date (Appendix C), tide criteria, and sample shipping and receiving constraints. For sites located in the intertidal zone, the time must correspond to low tide when bivalves are easily accessible. Height of collection (above the water level at the time of collection) and height of the highest bivalve distribution is information to be recorded at the time of collection.

Sampling Permits

See appendix A for a list of permitting agencies by state. Permission to collect living resources and in some instances permission to collect sediment is required from authorities within the appropriate jurisdiction. The United States Territorial Sea extends from the mean low-water mark to12 nautical miles from shore, with the state government having sovereignty over resources in this area. In general, all Mussel Watch sites in coastal waters lie within three nautical miles of shore; hence, they fall within the authority of the coastal states. the US Exclusive Economic Zone (EEZ) extends from 12 to 200 nautical miles offshore. In the EEZ, the federal government has authority over the seabed resources as well as living marine resources. For special events sampling that may involve removing environmental samples in the EEZ, Federal permits will be required.

Permit applications are not standardized across Federal or state agencies and may have pre- and post- reporting requirements. Some sampling sites may fall within multiple jurisdictions and hence multiple permits may be required. Some information often requested on permit applications includes:
-Purpose of sampling;
-Name of the organization conducting the sampling;
-Names of individuals who will be collecting samples;
-Coordinates (latitude/longitude) of sites to be sampled and target date of collection;
-Living and/or non-living resources being collected by site;
-Species collected, size, number of individuals;
-Method of sample collection (dredge, tongs, SCUBA, hand).

Field crew sampling at Mussel Watch sites can attract curious people leading to questions from the general public, recreational and commercial fishermen and resource authorities. Possession of proper permits is required. Permit holders are usually requested to notify local resource managers of the intent to sample (where and when). This helps to minimize unnecessary investigation by the authorities in response to calls or complaints. Field crews who encounter a curious public are encouraged to engage their questions and refer them to NOAA's Mussel Watch Program web site (http:NSandT.noaa.gov) or the MWP manager (address above). The MWP can also provide fact sheets to interested parties.

Timing of Site Visits

Each Mussel Watch site has a target collection date (see appendix F). Field crews should plan accordingly to visit sites within three weeks of the target date. In planning the crews should take into consideration tides and currents. Some sites must be sampled at low tide, which may occur at night, while other sites may be accessible by boat only at high tide.

PERSONNEL TRAINING AND SAFETY

The Mussel Watch Program has sites located in every coastal region of the country and in some U.S. Territories and Protectorates. Each region, and in fact, each site, has unique conditions that require consideration when preparing for their visitation and collection. It is beyond the scope of this document to describe every consideration. It is the responsibility of the field team to acquire the local knowledge required for a safe and successful mission. Here is a brief list of some issues to consider in training personnel and planning field activities:
-Situational awareness of weather and the environment;
-Local knowledge of surf, tides and currents;
-Local knowledge of dangerous animals (e.g., bears, alligators, poisonous snakes, etc);
-Navigation skills with GPS, nautical charts and land maps;
-Field crew of two or more each with knowledge and stamina to complete the work;

-Appropriate form of electronic communication (cell phone, VHF radio, satellite phone);
-Ability to respond to first aid emergencies;
-Wear appropriate clothing for thermal and water protection. “Cold Water Kills.” Review coldwater safety prior to entering the field. Extreme heat can be harmful; take necessary precautions to prevent sunburn and heat exhaustion
-Appropriate safety equipment and knowledge of how to use it;
-Appropriate sampling equipment and knowledge to use it (sediment grabs, oyster dredge, water quality meter);
-Sample contamination avoidance e.g. not exposing samples to boat bilge water or exhaust fumes;
-Understanding of the sample collection and shipping procedures.

Coastal environments can be dangerous and unpredictable; exercise due caution at all times. Field teams should use good judgment and not risk their personal safety when conditions pose undue risk. Abandon the site if necessary and return when conditions improve. When sampling begins the field team should communicate with the Mussel Watch Program staff on a daily basis or other previously agreed upon schedule. Clear and timely communication with Mussel Watch staff and laboratories receiving the samples are critical. Deviations from the SOP are sometimes necessary but approval from the Program Manager should be obtained prior to sampling. If prior approval is not possible, notification of Program staff should be done as soon as possible after sampling. In every case, changes in sampling procedures or location must be clearly documented by the field crew. The following section lists tasks that should be completed prior to entering the field.

MATERIALS AND RESOURCES

Field Equipment and Materials

A comprehensive list of field equipment and materials are provided in Appendix B. While the list includes personal safety gear, equipment required for bivalve and sediment collection, not all items are to be transported into the field at the same time. Field gear, sampling equipment and materials should be selected and packed based on the environmental sample to be collected and knowledge of the sites to be visited.

Instrument Calibration

All field equipment must be checked and calibrated daily or as required by the manufacturer. For high quality environmental data collection, the MWP follows the USEPA guidelines recommended for its Environmental Monitoring and Assessment Program (EMAP). All equipment must be routinely subjected to a field quality control checks (EPA, 2001). A detailed account of field quality (QC) control and the calibration of instruments customarily utilized during Mussel Watch field work (e.g. pH meter, GPS, Hydro lab multirole meter etc.) can be found in the EMAP Quality Assurance Plan (EPA, 2001). It’s important to take photo documentation at each site. Before entering the field, the camera to be used must be properly checked and date and time must be set to the local time. All field-

QC procedures must be appropriately documented including dates and the name of the person conducting the procedures.

Planning Resources

Information about Mussel Watch site description and access, tide, current prediction and weather are important and should be assessed during the field work planning process. The following resources provide helpful information:

-NOAA MWP - Site descriptions document (Lauenstein et al. 1997 - http://ccma.nos.noaa.gov/publications/TechMemo112.pdf)
-NOAA Tides and Current Predictions (NOAA http://tidesandcurrents.noaa.gov/)
-NOAA Weather (http://weather.gov)
-NOAA Marine Weather (http://www.nws.noaa.gov/om/marine/home.htm)
-Google Earth file (KMZ) of NOAA Mussel Watch Site; supplied by MWP contact, pg. 2.
-NOAA Dive Program (http://www.ndc.noaa.gov/)

ENTERING THE FIELD

Prior to entering the field the field teams should do the following:

-Review and maintain a copy of the site descriptions and access considerations found in NOAA Technical Memorandum NOS ORCA 112 (Lauenstein et al. 1997);
-Prepare a site visit schedule (date and time of day) for intertidal based on tide prediction tables;
-Check travel time between sites and mode of transportation (ferry schedules, or boat support); Communicate your tentative site visit schedule with NOAA staff (Appendix A) and your home office;
-Inform the laboratories of your tentative schedule for sample shipping; alert them to pending shipments;
-Alert local resource managers of your planned field activities as advised in you permit(s).

LOCATING EXISTING SITES

Use a GPS (NAD83 datum) to navigate to the sampling site (if another Datum is used, a detailed documentation should be provided in the field notes). Knowledge of existing site description and site accessibility is essential prior to conducting sampling at Mussel Watch sites. The NOAA Technical Memorandum NOS ORCA 112 gives extensive descriptive accounts of the majority of the Mussel Watch sites. Collection day should fall within three-weeks of the target sampling date (Appendix F). The time of sampling may require close monitoring of tidal conditions. Sites that lie in the intertidal zone must be sampled at low tide. Sub-tidal sites and sites that lie in shallow waters should be accessed by boat at high-tide or by snorkeling.

ESTABLISHING A NEW MUSSEL WATCH SITE

The project manager may direct a field team to establish new monitoring sites based upon prior knowledge before the field crews enter the field. However, upon visiting a pre-existing site the field crew may determine that no live bivalves are present and the site is dead. At the direction of the Mussel Watch Program manager, the field crew may be instructed to evaluate relocating the site nearby where bivalves are available. The following section describes general procedures for establishing a new Mussel Watch site under these conditions.

Specific Criteria for New Bivalve Site

-New sites should integrate contaminant accumulation from nearby or surrounding areas and should be outside any obvious effluent discharge zone-based upon visual inspection unless advised otherwise.

-Substrates are limited to rock or concrete (including rip-rap and jetties), and sand or mud. Structures such as wooden pilings and metallic navigation aids are to be avoided in order to eliminate potential point contamination; indigenous populations of bivalves must exist.

-New sites must have sufficient population of bivalves for repeated future sampling.

-Newly established sites are assigned a new site name and unique four letter site code to be approved by NOAA staff. A clear, concise description should be included in the field documentation that describes the site, how to access the site, precise coordinates of each sampling station sampled, water depth, substrate, and digital photographs documenting the surrounding area.

Specific Criteria for New Sediment Site

Bivalve and sediment sites are generally co-located or within 2 km of each other. Because fine grained sediments are preferred, in certain instances it may be necessary to locate a sediment site beyond the 2 km radius. When sediment sites are not closely associated with the bivalve site, the sediment site receives its own unique site acronym. The specific criteria for sediment sites are:

-The site should be a sub-tidal (never exposed at lowest tides), a low energy depositional area, as evidenced by providing surficial sediments that are fine grained (low sand content), and 20% fine grained material (≤64 microns) on a dry weight basis is preferred and determined in the laboratory. The field team should be able to visually differentiate between sediments high in sand and sediments predominately silt or clay.

-The site should be exposed to the same water mass as the corresponding bivalve site.

-The site should be located near and preferably not more than 2 km from, the bivalve site.

-The site should integrate contaminants from in the surrounding area and not reflect inputs from an individual point source of contamination unless advised otherwise by the Mussel Watch Program manager providing oversight to the field crew.

ORDER OF SAMPLE COLLECTION

It is preferable to collect water chemistry data first to avoid introducing bottom sediment or other material into the water column. Water data includes on-site measurements (temperature, salinity, and dissolved oxygen) as well as water sample collection for laboratory analyses. Bivalve collection should be conducted prior to sediment collection if the sites are collocated.

BIVALVE COLLECTION

Description

The Mussel Watch Program collects a number of different species of mussels and oysters depending on the location. Except in the Great Lakes, bivalve sampling occurs during winter months to minimize the influence of reproduction on contaminant body burden as bivalves' physiological changes during spawning may affect their contaminant body burdens (Jovanovich and Marion, 1987; Ellis et al., 1993). In the Great Lakes, zebra mussels are collected in late August through September; winter sampling in the Great Lakes is difficult because the lakes are frequently frozen. Bivalves are dredged

Figure 1. National Mussel Watch sites for bivalves. Color coding: ● = *M. edulis sites*;
● = *C. virginica*; ● = *M sp.*; ● = D. *sp.*; ● = *O. sandvicensis*; ● = *Chama sinuosa*;

using epibenthic dredge, handpicked by walking along shallow sites or diving (SCUBA, snorkeling). Bivalve samples are immediately place in Ziploc bags, preserved on ice and shipped overnight, within 48 hours of sampling, to analytical laboratories.

Field Equipment and Materials

Prior to the start of field work the team lead must develop a check list of sampling equipment and materials needed. The field team must also assure that all field equipment is in good working condition and if possible have back up equipment to assure that proper sample materials are accounted for. A comprehensive list of materials is provided in Appendix B, however specific to bivalve collection, the following materials should be included in the check list:

Logistics material: GPS, roadmaps and charts, transportation (boat, automobile), YSI or multimeter, gloves (unpowdered latex), water ice, buckets, coolers, paper towels, notebooks, datasheets, chain of custody forms, pens, permanent markers, and camera (cameras should be set to local date/time and used for photo documentation at each site).

Bivalve equipment: Stainless steel knives oyster knives, Ziploc freezer bags and heavy duty plastic large storage container with lid.

Shipping equipment: Overnight shipping labels, and tapes (strapping, labeling and duct).

Bivalve Species

Different geographic regions of the country are dominated by different bivalve species. Hence the Mussel Watch Program has identified a target species for each site (Figure 1). The species collected include the blue mussel (Mytilus edulis, Linnaeus 1758) from Maine to Delaware Bay. Mytilus species (Mytilus sp.=M. galloprovinciallis & M. trossulus) alternate with the California mussel M. californianus, Conrad 1837) for West Coast collections. From Delaware Bay south and throughout the Gulf of Mexico, the American oyster (Crassostrea virginica, Gmelin, 1791) is sampled. Areas distant from the conterminous United States and those specimens collected in fresh water require the collection of alternate species. The Hawaiian oyster (Ostrea sandvicensis, Sowerby, 1871) is taken at Hawaiian Islands sites. The species collected in Puerto Rico is the mangrove oyster (Crassostrea rhizophorae, Guilding, 1828). At a site in southern Florida, the smooth edged jewel box (Chama sinuosa, Broderip, 1835) is collected. In the Great Lakes, the zebra mussel (Dreissena polymorpha, Pallas 1771) and quagga mussel (D. bugensis Andrusov, 1897), both which are invasive species (Hebert et al. 1989; Mills et al. 1993), are collected.

Bivalve Sampling

Bivalves collected from established sites should be composited in the field from a representative sample. This could be at least three stations or alternatively bivalves collected along a 100 – 400m transect of a rock breakwater or jetty. However, when new sites are established, samples from the 3 unique stations

should not be composited as they will be analyzed separately. Field data sheets should be recorded for each unique bivalve collection station (see appendix C) for an example.

The following steps are taken at each sampling site:

1. Navigate to the sampling site using GPS navigation and fill in the data sheet with the required site information and take photo documentation of the site. The camera should be properly set to local time/date and the photos taken should have reference points or objects (e.g. shoreline, bridge, buoys).
2. Wear personal protective gear (gloves, PFD, survival suit, as appropriate) and handle specimens with care as bivalves have sharp edges. The Program recommends the use of Kevlar gloves;
3. Take water quality measurement (e.g. temperature, salinity). Record the depth of the water and the estimation of the height of collection on the date sheet
4. Record site condition on the data sheet. This should include weather condition, unusual smell, and presence of any physical environmental disturbances (e.g. oil sheen).
5. Collect the bivalve samples. Specimens can be collected by diving (SCUBA or snorkeling), dredging, tonging or by walking and wading in the intertidal zone. In the latter case bivalves can be collected by hand or rake. Note: collections methods may be limited by sampling permits. In certain areas dredging is not allowed
6. Place specimen into a clean container (Heavy duty large plastic with lid), carefully break apart any bivalve clumps, while being careful not to break open the shells of the target specimens. Thoroughly rinsed the specimens in water at the site to remove mud and debris which are possible sources of contamination of the tissues inside.
7. Quickly sort the animals by selecting the largest size range of sufficient quantity.
8. Label two Ziploc freezer bags per station and per laboratory. Labels should include Site acronym, date, and station number; double bag each sample, being sure to label both bags;
9. Put samples in Ziploc bags and place the bags with samples immediately on ice (even pending collection of a complete sample).
10. Ideally for chemistry, it is recommended to collect about 60 (30 for organics and 30 for metals) oysters or mussels and 300 (150 for organic and 150 for metals) zebra mussels per site. This is roughly 20 oysters or mussels and 100 zebra mussels per station. It is also recommended to err on the side of collecting more sample than less because a portion of the sample is also kept for possible retrospective analysis in the Mussel Watch contract laboratory specimen bank.
11. An additional 8 oysters or mussels and 15 zebra mussels per station are to be collected for gonadal index and histopathology analyses.
12. It may not be possible or practical to delimit three separate stations at each site. In such a case, the collection could be made without distinction, but the “picking” should be separated into three based on relative spatial distance. The purpose of this is to avoid sampling a single non-representative “clump” of bivalves.

Precaution for Bivalve Sampling:

1. Avoid contamination of samples from oil, fuel, exhaust fumes, flaking or rusty metal or other potential form of chemical contamination. When using a boat for sample collection, make sure that the bilge pump is off when on station.
2. Avoid collection of samples on anything other than natural substrates. Untreated concrete and natural rock used for breakwaters are acceptable.
3. Sample bags (Ziploc bags) should be properly labeled to indicate site code, collection date, and station number (when appropriate).
4. Periodically examine the bags of bivalves to ensure that any entrained water has not leaked into the bags. Any standing water in the Ziploc bags should be drained immediately.
5. In the field 48 qt. cooler with drain port should be used for sample storage (Appenix B). Bivalves are capable of surviving for several days if the quantity of water ice is maintained and water is not allowed to accumulate. Hence, the storage cooler should be drained frequently to remove melt water.

BIVALVE SAMPLE HOLDING

Bivalves can be kept alive for days when appropriately held on ice (0 - 5 ºC) with sample bags properly sealed and free of freshwater contact. However, proper holding and shipping within 48 hours of collection will ensure organisms arrive alive. DO NOT allow bivalves to freeze. Use extra caution when ambient air temperatures drop below freezing; ensure iced samples do not get too cold. This is especially important for samples that will be analyzed for histopathology/gonadal index. Try to ship samples within 48 hours of collection. However, experience has shown that it is better to hold bivalve samples as described above over weekends or holidays rather than risk shipping on a Friday with a Monday morning or later delivery.

ANCILLARY MEASUREMENTS

Water Quality

Use a water quality meter (e.g., YSI or Hydro lab) to measure and record physical parameters of the water (salinity, depth and water temperature). For salinity determination, it is recommended to use a temperature compensated refractometer measurement (Appendix G). All field equipment should be tested and calibrated as required by the manufacturer prior to beginning field work. A detailed account of field-QC check and calibration of instruments customarily utilized during Mussel Watch field work (e.g. YSI, Hydrolab or similar meter) is described in the EMAP Quality Assurance Plan (EPA, 2001).

Depth

Record the water depth for the bivalve collections. Mussel Watch water depths are most frequently based on actual measurements at the time of the field collections. Depths are relative to Mean Lower

Low Water, unless otherwise noted. For the Great Lakes the minimal tide need not be considered. Depth to bottom should be determined by depth sounder, or weighted line. Depth measurements are to be reported in increments of meters.

Height of Collection

Height of collection refers to the height above the water level at the time of collection. This should not be confused with distance from the water's edge. Estimate the "height of collection" as being the height above the water level at which mussels are available for collection. For example if samples are collected three feet above the water level sample height is indicated as 3 or if samples are collected at water level, the height of collection is 0. The other value is height of highest access. For example, if bivalves are at current water level, but you note that they are available up the intertidal zone (the vertical extent which is washed by the tides) all the way to approximately 6 feet above the current water level, then the Highest Access is 6 feet. On the other hand if collection was conducted at water level of 0 feet, but there were no other bivalve beds, the Height of Highest Access in this instance is also 0 feet. By correlation with time of collection and a graphical depiction of the tide, the tide stage can be determined. Reporting time and tide stage of when specimens are expected to be accessible is very helpful for future collections.

SAMPLE PACKING AND SHIPPING PROCEDURES

"Sample shipping conditions" are NOT the same as "sample holding conditions." The water ice MUST be protected from leaking out of the cooler. An alert courier is likely to hold your shipment for safety/security reasons if they observe liquid leaking from the cooler. The shipper – YOU – may be contacted by the courier and TOLD to come retrieve your "hazardous" shipment. To ensure water does not leak from the cooler double bag the water ice in Ziploc bags (Figure 2). If the shipping cooler has a drain port tape it shut.

Packing Samples

Samples going to separate laboratories generally should be packed into separate coolers. Determined this before field activities begin. For example, bivalves for chemical analysis are not usually packed in the same cooler as bivalves for histopathology analysis. It is best to ship multiple small coolers (28 qt. size or smaller) then one large cooler.

The packing process is easier and faster when done with two people; one recording the Chain of Custody (COC) and the other calling out the sample information as it is placed into the cooler. The following steps should be taken for packing bivalve samples:

1. Purchase enough ice. While gel packs may be used, water ice has proven to be more reliable. Water ice should account for at least one-third of the cooler's volume (about two 10 lbs. of ice for a 28 qt. cooler). If gel packs are used they should fill at least ½ the cooler volume. Gel packs are

not to be used with histopathology samples.

2.Double bag the water ice and place these bags in an empty cooler until they are ready to use.

3.All bivalve samples should be double bagged to ensure that ice meltwater will not leaked into the bags. Any standing water in the Ziploc bags should be drained completely before packing.

4.Make sure that site acronyms, collection date and station number (if appropriate) are clearly visible (readable) on the Ziploc bags. If they are not you may write this information on a piece of paper and place the paper between the inner and outer double bagged samples.

5.Select a cooler for shipping (28 qt. for chemistry samples and 16qt. for histopathology samples)

6.While noting the sample site acronym, and collection date, place the samples to be shipped with zipper side up into the cooler in alternating fashion with bags of ice. Try to place the bags of ice

Figure 2. Illustration showing packaging and labeling for sample shipment

against the cooler internal walls.
7.Add another layer of alternating bags of sample and ice if possible.
8.Place a layer of bags of ice on top of the sample. Completely fill the entire volume of the cooler with extra bags of ice to minimize sample movement.
9.Fill in the COC forms (Appendix D) and use it to inventory the samples as they are placed into a shipping cooler.
10.Make copies of the COC forms and all the field data sheets for your records.
11.Put the original COC forms and copies of field data sheets into double Ziploc bags and place them on top of the bags of ice. Each shipping cooler should have separate COC form(s).

Shipping

On the day of shipping – preferably immediately before dropping off the coolers with the overnight courier, do the following:

1.Before taping the cooler shut, make sure COC form and copies of field data sheets are placed in the cooler and are protected from moisture inside a Ziploc bag.
2.Use nylon reinforced strapping tape to securely fasten the cooler lids shut (Figure 2). Use at least two bands of (3 wraps each).
3.Attach the courier's air bill to the top of the cooler. Include phone numbers of the field crew (shipper) and the lab (receiver).
4.Use sharpies to write both shipper and recipient's addresses and phone numbers directly on the coolers.
5.Deliver shipping coolers to an overnight courier, an authorized agent, or call for a pickup from a secure location. Do not leave the shipping coolers at a drop box.
6.Once samples are shipped, email a complete list of all samples shipped, the shipment tracking numbers and if possible scanned copies of COCs and data sheets to the MWP manager.
7.Inform the laboratories of the shipment and provide them the tracking numbers.

Precautions for Packing Shipping samples:

1. Do NOT put ice in the bags containing the bivalves. Bivalves and water ice should be in separate bags and double bagged.
2. Do NOT allow samples to freeze (this is a caution peculiar to the Alaska and few East coast sites almost exclusively, in winter).

SEDIMENT COLLECTION DESCRIPTION

The NS&T Mussel Watch Program collects fine grained surficial sediment (> 20% fine material) from non-exposed sub-tidal sites. A site sample is based on the composite of samples from three different stations which may be located within a 100 to 400m radius of the main site. Sediments are collected using a cleaned van Veen, PONAR-grab or hand held box-core, which are to be cleaned with acetone

Small Van Veen grab
Lightweight with 2 stainless steel lids
Self-releasing pinch-pinTM for safety
0.1 to 0.025 m2 sample area
Lids allow removal of undisturbed top sediment

after each use and between sites. Once retrieved, the grab sediments are inspected for disturbance then a stainless steel scoop is used to carefully scoop the top 2 to 3 cm sediment materials. These sediment materials are placed into pre-cleaned metal grade IChem glass jars and kept chilled on ice. At each station, additional grabs are taken for ancillary measurements such as grain size and total organic carbon (TOC) characterization; these samples may be collected into HDPE or glass containers. Samples from each station are to be properly labeled and preserved on ice until shipped. The following data and information are collected at each station: latitude, longitude, temperature, salinity, and a written description of each sampling site including digital color photographs of the sites. Additionally, upon collecting the sediment samples, all information in the field data sheet should be recorded including color, odor and presence of infauna.

FIELD EQUIPMENT AND MATERIALS

The field team lead must develop a check list (Appendix B) of sampling equipment and materials prior to the start of the day of the field trip. Assure that proper sample containers and labeling materials are accounted for. The list must include field measurement equipment and the materials listed below. The field team must also assure that all field equipment is in good working condition and if possible have back up equipment.

Logistics: GPS, roadmaps and charts, transportation (boat, automobile), YSI or multimeter, gloves (unpowdered latex), methanol ice, buckets, coolers, paper towel, notebooks, datasheets, chain of custody forms, pens, permanent markers, and camera (cameras should be set to local date/time and used for photo documentation at each site).

Sediment equipment: PONAR, Van Veen sampler or box corer, Teflon coated titanium or stainless steel scoop, glass jars (250 ml), whirlpack bags, and heavy duty plastic storage container with lid, labels, electrical tape, and bubble wrap.

Shipping equipment: Overnight shipping labels, and tape (strapping, labeling and duct).

COLLECTION PERIOD

Sedimentation rate along United States' continental shelf was evaluated to vary generally between 0.1 - 0.5 cm yr-1 (Valette-Silver, 1992 and Olsen et al., 1993). Therefore, to collect newly settled sediment materials, Mussel Watch conducts sediment collection once every 10 years. When taken, sediment samples are collected concurrently with bivalve samples.

SITE INACCESSIBILITY

On occasion a set of site coordinates cannot be sampled. Reasons may include: the site is too shallow, location has no depositional sediments, or there is no dredging or anchoring allowed in the area. If this occurs, an alternate sediment site in the vicinity of the bivalve site should be selected. Sediment sites should contain at least 20 percent fines (silt and clay) and the field team should use their best judgment to visually determine if this criterion has been met. Sediment high in sand has lower relative surface area onto which contaminants can adsorb. These samples may result in lower contaminant concentrations which are then an artifact of the composition of the sampling matrix.

FIELD DOCUMENTATION

In cases where sediment sites are different from bivalve sites, collection information should include site, date, time, temperature and salinity. Sediment sites must be described with the following information: latitude, longitude, written descriptions of how to reach each site, plotted locations on National Ocean Service charts, and photographs.

SEDIMENT SAMPLE COLLECTION

The MWP primarily uses a Young-modified Van Veen grab sampler that minimizes sediment folding when the sampler jaws close. The PONAR grab and hand held box corer are used for relatively shallow environments in order to minimize sediment folding. The MWP collects fine grained surficial sediment, which is defined as the top 1 to 3 cm that is likely to represent newly deposited material. Exposed sediments should never be collected. Hence, sediments are to be collected in subtidal zones only and within 400 to 500 m of the bivalve sites. If depositional sediments cannot be found closer to the intertidal sites where bivalves are collected, sediment samples may be collected within 2 km radius of the bivalve site center. In those cases, the sediment site receives a different site acronym.

The grab sampler and scoop should be cleaned after each use and between each site:
Before the first use of between sites, the grab samplers and scoops should be scrubbed clean with nylon brush, ambient water and detergent (e.g. Dawn). Methanol spray should then be used to rinse the samplers before a final rinse with deionized water (DI water). Between replicate collections at

a site, all the cleaning steps are applied without the use of soap. Methanol wastes are collected in specially designated waste containers and returned to the laboratory for proper disposal.

Grab sampling might be impossible or very difficult at some sites due to sediment or ocean conditions. Sediment type (high percent sand) tends to be a significant determinant of achieving proper sampler penetration depth. Some sediment types (e.g., cobble, gravel, coarse sands) and localities (e.g., canyons, slopes, and rocky areas) could be difficult to sample. Sediments containing rocks and large/intermediate shell debris often prevent complete closure of the grab such that sediment washes out during retrieval. Each grab sample must be inspected upon retrieval and determined to meet acceptability criteria before it can be used to provide sediment for analyses. The acceptability of a sample must be determined by inspection of the grab contents (Figure 3). For example, the surface sediment flocculation layer must still be evident, infaunal tubes must be intact, the sampler is not to be buried by overlying sediments, and sampler jaws must be closed such that the sediment sample is not lost while being retrieved. Sampling gear and collection methods must minimize sample contamination e.g., by personnel, boat, exhaust emissions and sampling devices. Position-fixing techniques must permit the field team to be able to return within 1 meter of an existing site center. The use of the Global Positioning System (GPS) is required to compliment other navigational methods. Water measurements should include salinity and temperature.

The following protocol should be followed at each site:

Sampling:
1.At the beginning of each day thoroughly clean (see step above) the sampling equipment (grab sampler and scoops).

2.Using a GPS navigate to the sampling site and fill in the data sheet with the required station information and take photo documentation of the site. Photos should have reference points or objects (e.g. shoreline, bridge, buoys).

3.Take water quality measurements.

4.Rinse the equipment again with methanol and DI water just before the start of the sampling.

5.Place pre-labeled sample jars and label one whirlpak bag for grain size and TOC. Jars should be labeled separately for each parameter to be analyzed.

6.Make sure the sampler is secured to the cable with a shackle.

7.Secure and check weights if necessary (if frame is used).

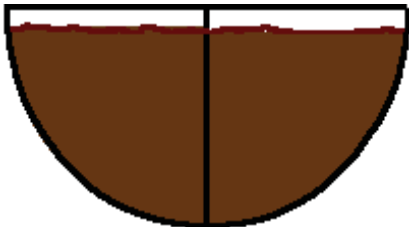
8.Set the grab mechanism.

9.Lower sampler through the water column at speeds appropriate to minimize disturbance of surficial sediments.

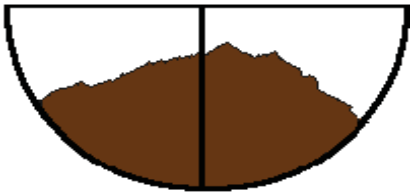
10.Retrieve sampler and place the grab inside a large plastic container that was rinsed with ambient water.

11. Evaluate whether the grab sampler has closed properly and has sufficient sediment for sampling. Acceptable sample condition is characterized by a relatively even surface with minimal disturbance and little or no leakage of the overlying water. Heavily canted samples are unacceptable (Figure 3). Samples with a large amount of “humping” along the midline of the grab, which indicates washing of the sample during retrieval, are also unacceptable (Figure 3).

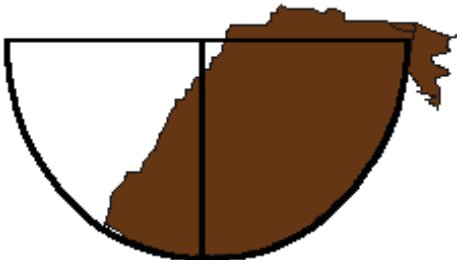
Acceptable - Level, intact sediment; center depth is > 5 cm



Unacceptable - Partially filled, sample extending through top



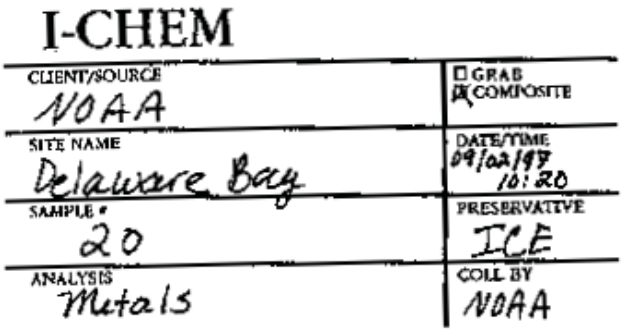
Unacceptable - Washed out



Unacceptable - Rock, shell, or other debris caught in jaws

Figure 3. Criteria for acceptability vs. unacceptability of sediment samples

Example of label for a chemistry jar (also see Appendix D)


I-CHEM

CLIENT/SOURCE	☐ GRAB ☒ COMPOSITE
NOAA	
SITE NAME	DATE/TIME
Delaware Bay	09/02/97 10:20
SAMPLE #	PRESERVATIVE
20	ICE
ANALYSIS	COLL BY
Metals	NOAA

12. A minimum of three good grabs should be taken at each site. For contaminant analyses, the standard Mussel Watch sediment sampling requires triple collections at each site in order to have a better representation of actual larger area sediment conditions. Collect an additional grab for grain size and TOC.

Processing a Grab:

1. Drain off any surface water using a syringe and plastic tygon tubing, being careful to leave as much of the surface flocculent layer as possible.
2. Using a cleaned stainless steel scoop place a small amount (approximately 20 ml) of the surface sediment (2-3 cm depth) into a pre-labeled 250 ml jar with Teflon liners. Immediately place the lid on the jar to minimize exposure to the ambient air and store on ice. One jar each should be filled for trace element and organic contaminant analyses.
3. Use care when sampling to avoid having the sediment scoop touch the side of the grab sampler.
4. Dump the remaining sediments in the grab over the side and rinse the grab thoroughly with site water.
5. Continue the above steps until the jars are nearly full. This may require collecting additional sediment grabs. Three grabs are ideal because multiple sediment grabs will integrate the local sediment contaminant signature.
6. Take surface sediments for grain size analyses and place into a Whirlpak bag.
7. The metals (250 ml) and organics (250 ml) jars should have adequate space from the rim to allow for expansion during freezing.
8. Seal the sample jars with electrical tape and place in coolers containing ice chips.

9. Clean and rinse the grab and scoop with ambient water, then methanol, in preparation for the next site. Place scoop in a Ziploc bag to avoid exposure to boat fumes. The grab sampler should also be rinsed with acetone before the start of the next site's sampling.

ANCILLARY MEASUREMENTS

Salinity and Temperature

At all Mussel Watch sites, temperature and salinity measurements (exception, no salinity measures are taken in the Great Lakes) must be taken. At sediment sites measurements should be taken at the bottom using a calibrated water quality meter (e.g. YSI or multimeters). If salinity values are to be determined in a laboratory setting, undisturbed water samples should be collected in a sealed container (The lid should be securely taped) and conserved on ice together with the bivalve samples. Salinity measurements must be temperature compensated. Frequently, for Mussel Watch sampling activities, salinity measurements have been taken in field using either a calibrated YSI or a temperature compensated refractometer. Water temperature measurements can also be made directly using a portable digital thermometer.

Depth

At all sediment collection location, water depth should be recorded. Mussel Watch water depths are most frequently based on actual measurements at the time of the field collections. Depths are relative to Mean Lower Low Water, unless otherwise noted. For the Great Lakes the minimal tide need not be considered. Depth to bottom should be determined by depth sounder, weighted line, or, for shallow sites, a ruler. Depth measurements are to be reported in increments of meters or centimeters.

Sample Labeling

Sample jars should be properly labeled to indicate among other things site specific information, the type of analysis e.g. Metals, Organics, Grain size (see below). Place the labels on the sides of the jars and cover with wide clear plastic tape. Also write the site number, time, and date on the lid of each container with a permanent marker.

NOTE: If new site is established, the first sampling location represents the site center and two additional locations within 200 m should be sampled following the steps above. However, the water quality measurement should be taken at the site center only.

SAMPLE HOLDING & SHIPPING CONDITIONS

Sample Type	Holding Conditions in the Field	
Holding Conditions on ship/ Laboratory	Shipping	
Sediment Grain Size	Cooler with water ice	Cooler with water ice
Metals/Organics	Cooler with water ice	Freeze or on ice
Cooler with ice. If frozen, ship with dry-ice		
Total Organic Carbon	Cooler with water ice	Freeze or on ice
Cooler with ice. If frozen, ship with dry-ice		

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APPENDIX A - IMPORTANT CONTACTS

NOAA Contacts

General inquires should be addressed to the "Mussel Watch Program Manager" at

NOAA, N/SCI1
1305 East West Highway
Silver Spring, MD 20910
Phone: 301-713-3028
Monday – Friday 7AM to 4:30PM

Field crews activitely involved in sampling should follow pre arranged instructions for 24/7 communication.

Current Mussel Watch Contacts include:

Dennis Apeti, PhD. dennis.apeti@noaa.gov

Ed Johnson, PhD. ed.johnson@noaa.gov

Kimani Kimbrough, PhD. kimani.kimbrough@noaa.gov

List of permitting agencies by state (Contacts and office names change over time. Mussel Watch manager should be informed of any changes):

State	Agency	Address	Contact #	Web address
New Jersey	Department of Environmental Protection Division of Science and Research	P.O. Box 405 - Stoney Hill Road, Leeds Point, New Jersy 08220	Tel. 609-292-3093 or 609-748-2000 Fax. 609-748-2014	http://www.state.nj.us/dep/fgw/scicolperm.htm
New York	New York State Department of Envonmental Conservation, Divison of Fish and Wildlife. Special Licensee Unit	50 wolf Road, Albany, New York, 12233	Tel. 518-457-0689 Fax. 518-457-0884	http://www.dec.ny.gov/63.html
North Carolina	Dapartment of Environmental Health and Natural Resources, Division of Marine Fisheries	P.O. Box 769, Morehead City, North Carolina 28557	Tel. 919-726-7021 or 800-682-2632 Fax. 919-726-6062 or 919-726-1675	http://portal.ncdenr.org/web/deao/permit-directory/
Oregon	Department of Fish and Wildlife, Shellfish Investigations	2040 Southeast Marine Science Drive, Newport, Oregon 97365	Tel. 503-947-6000	http://www.dfw.state.or.us/fish/license_permits_apps/index.asp
Rhode Island	Department of Environmental Management, Division of Fish and Wildlife	4808 Tower Hill Road, Wakefield , Rhode Island 02879	Tel. 401-789-3094	http://www.dem.ri.gov/topics/permits.htm
South Carolina	Department of Natural Resoures, Office of Fisheries Mangement, Marine Resources Division	P.O. Box 12559, Charlestoin, South Carolina 29422	Tel. 843-953-9300 or 803-795-6350	http://www.dnr.sc.gov/licensing.html.

Texas	Parks and Wildlife Department, Permits section	4200 Smith School Road, Austin, Texas 78744	Tel. 512-389-4491 or 800-792-1112	http://www.tpwd.state.tx.us/business/permits/land/wildlife/
Virginia	Department of Planning and Natural Resources, Division of Fish and Wildlife, Marine Resources Commission	2600 Washington Avenue, Newport News, Virginia 23607	Tel. 575-247-2200 or 866-721-6911	http://www.dgif.virginia.gov/licenses/
Alabama	Department of Conservation, Division of Game and Fish	64 North Union Street, Montgomery, Alabama 36130 or P.O. Box 301456, Montgomery, Alabama 36130	Tel. 888-848-6887	http://www.dcnr.state.al.us/licenses/
Alaska	Department of Fish and Game, Commercial Fisheries Management and Development	P.O. Box 25526, Juneau, Alaska 99802	Tel. 907-465-6118	http://www.adfg.alaska.gov/index.cfm?adfg=license.main
	Department of Fish and Game, Lincense ad Revenue Branch	1740 N. Market Blvd, Sacramento, California 95834	Tel. 916-928-5805	http://www.dfg.ca.gov/licensing/
	Department of Agriculture, Acquaculture Division	P.O. Box 97, Mildford, Connecticut 06460	Tel. 203-874-0696 Fax 203-783-9976	http://www.ct.gov/doag/cwp/view.asp?a=1369&q=259170
Delaware	Department of Natural Resources and Environmental Control. Division of Fish and Wildlife	P.O. Box 1401, Dover, Delaware 19903	Tel. 302-739-4782 or 302-739-9918	http://www.dnrec.delaware.gov/fw/Services/Pages/Licenses.aspx.
Florida	Department of Environmental Protection, Division of Marine Resources	3900 Commonwealth Boulevard, MS 200, Tallahassee, Florida 32299	Tel. 850-245-2118 Fax. 850-245-2128	http://www.dep.state.fl.us/secretary/info/permitting.htm.
Georgia	Department of Natural Resources, Wildlife Resource Division	2070 U.S. Highway 278, S.E. Social Circle, Georgia 30279	Tel. 800-366-2661	http://www.georgiawildlife.org/.
Hawaii	Department of Land and Natural Resources, Division of Aquatic Resources	1151 Punchbowl Street, Room 330, Honolulu, Hawaii 96813	Tel. 808-587-0100 or 808-243-5294 Fax. 808-587-0115	http://hawaii.gov/dlnr/dar/licenses_permits.html.
Louisiana	Department of Wildlife and Fisheries	P.O. Box 98000. 2000 Quail Dr. Baton Rouge, Louisiana 70898	Tel. 225-765-2800	http://www.wlf.louisiana.gov/licenses.
Maryland	department of Natural Resources, Tidewater Administration	580 Taylor Avenue, Annapolis, Maryland 21401	Tel. 410-260-8261	http://www.dnr.state.md.us/wildlife/Licenses/index.asp.
	Division of Marine Fisheries	251 Causeway Street, Suite 400, Boston, Massachusetts 02114-2152	Tel. 617-626-1520 or 617-626-1633	http://www.mass.gov/dfwele/dmf/commercialfishing/permit_index.htm.
	Department of Fish and Wildlife, Division of Fisheries	1111 Washington Stree Southeast or P.O. Box 43115, Olympia, WA 98504	Tel. 360-902-2464 Fax. 360-902-2945	http://wdfw.wa.gov/licensing/.
Maine	Department of Marine Resources	21 State House Station, Augusta, maine 04333	Tel. 207-524-6550 Fax. 207-624-6024	http://www.maine.gov/dmr/license/index.htm.

Table 1. List of sampling equipment and supplies.

APPENDIX B - MUSSEL WATCH SAMPLING SUPPLY CHECK LIST

ITEM	QUANTITY	DESCRIPTION AND USE
ELECTRONICS & GENERAL ITEM		
Handheld GPS	1 plus backup	Set datum to NAD83; Become familiar with the GPS unit
Water Quality Meter	1 plus backup	Measure water salinity, temperature and dissolved oxygen
Digital Camera	1 plus backup	Site documentation. Set to local time and date
28 Qt Crate	1 or 2	For packing field supplies
Road Maps	As needed	
NOAA Charts	As needed	
Field manual		
First aid kit		
SAMPLING & SHIPPING SUPPLIES		
Gloves, Kevlar	2 pairs/person	For protection when removing bivalves from substrate
Gloves, latex	1 pair/person/site, plus extras	To protect sample from contamination when sorting
Data Sheets	1 per site, plus extras	For field documentation
Chain of Custody Forms	1 per cooler, plus extras	
Clipboard (with paper storage)	1/team	
Pencils	1 box	Filling forms
Sharpies	2 boxes	Regular tip for labeling samples bags and fine tip for data sheets
Ball Point Pens	1 box	For filling out shipping forms (air bills)
Shipping Labels	As needed	One air bill label per shipping cooler

APPENDIX B - MUSSEL WATCH SAMPLING SUPPLY CHECK LIST

Paper Towels	As needed	
Wet Ice	As needed	Used in the field and for packing samples
Blue Ice	As needed	Can be substituted for wet ice if necessary
1 inch wide Strapping Tape	1 roll / 5 sites	Nylon reinforced tape to keep cooler lids from opening during shipping
48 QT Cooler (with drain port)	1 or 2	Used for storing samples on ice (drain port open to allow melt water to drain) pending transfer to shipping coolers
BIVALVE SAMPLING GEARS		
Clam rake, epibenthic dredge, or other appropriate bivalve collecting equipment	1 plus backup	Some site may require a rake to sample bivalves
SCUBA or snorkLing gear		Some site may require diving to sample bivalves
Bucket	1 or 2	Used with ambient water to wash the bivalves
Stainless steel Knives	1 / person	Used to safely detach bivalves
Brush	1 or 2	Used to remove debris from bivalves
1 gallon Ziploc bags	1 box /5 sites	Samples are to be double bagged
28 Qt Cooler (no drain port)	1 / 5 sites	Used for shipping samples to chemistry laboratory
16 QT Cooler (no drain port)	1 / 5 sites	Used for shipping samples to histopathology laboratory
SEDIMENT SAMPLING GEARS		
Sediment grab (Young Van veen or Ponar)	2/team	For sediment sampling
Teflon coated titanium or Kynar-coated scoop or Stainless steel scoop	2/team	Sediment collection
Glass jars (250 ml)	3/site	Sediment samples

APPENDIX B - MUSSEL WATCH SAMPLING SUPPLY CHECK LIST

Whirlpack bag	3/site	Sediment grain size samples
Salinity bottles	1/site	Measurement of salinity in the lab.
Di water	2 gallons/team	Cleaning and Rinsing
1 l spray bottles	3/team	Grab sampler rinse
Acetone	1 gal/team	Grab sampler rinse
Electrical tape		Seal leads of the sediment jars
Bubble wrap or bubble bags		Serve as cushion for sediment jars
Bucket and liner		
Anchor with line and float		
Bailing bucket		
Personal Flotation Device (PFDs)		
Required USCG equipment (lights, air horn, signal flares – day and night)		
Oars		
Spare trailer tire		
Trailer straps		
Transom plug		
Bow and stern lights		
Bow line		
Fuel tank		

Mussel Watch Collection Data Sheet

Date	11/30/09	Local Time	14:17
Field Personnel	DARIO DIEHL AND DAVID TSUKADA		
Site name (acronym)	SBSB		
General Location	SANTA Barbara	Specific Location	Santa Barbara Pt.
Datum (e.g. NAD 83)	NAD 83		
B Latitude (DD)	34° 23.741' N	Longitude (DD)	119° 43.699' W
Weather conditions	Clear, sunny, 3.1 m/s from 250° (West-Wind), air Temp 22.2°C		
Chain of custody included?	(Y/N)		
Water Conditions (e.g. depth, turbidity, current, etc.,)	Clear with some turbidity due to crashing waves		
Site Observations; conditions (e.g. runoff, construction, etc.,)	No runoff, people on the beach, low low tide @ 14:29 (-0.7 ft)		

	Surface	Bottom
DO (mg/L)	—	
Salinity (psu)	33.0 psu	
Water Temperature (°C)	16.1 °C	

Tidal Horizon	80 cm		
Species collected	Mytilus californianus		
Population (e.g. plentiful or sparse)	SPARSE		
Evidence of local contamination: If yes describe	NO		
Sediment chemistry collection?	Y/(N)	*Clostridium perfringens* collection	Y/(N)
Grain size collection?	Y/(N)		
Access; was local permission required? From whom? Contact info:	Public access.		
Collection Methods (e.g. hand, dredge, etc.,)	HAND		

Other Notes: (e.g., sediment observations, instrument problems etc.,)

STATION A: 34° 23.752' N - 119° 43.726' W

STATION B: 34° 23.740' N - 119° 43.627' W

Clean beach sand. Replaced batteries in YSI SALINITY METER.

APPENDIX C (CONTINUED)- SAMPLE DATA SHEET

Target Species	Site Code	Alternate	Date (mm/dd/yyyy)	Time (local)

SITE DESCRIPTION	Photographic verification Y/N:
(bivalve abundance; collection method; access; permits; safety issues; tide & current; sea state; weather; sources; etc)	

STATION LOCATION			
GPS:	Station 1	Station 2	Station 3
Latitude (decimal degrees)			
Longitude (decimal degrees)			
Water Depth (meters)			
Tidal Horizon (meters)			

WATER QUALITY				
Instrument:		Station 1	Station 2	Station 3
Temperature (C)	Surface			
	Bottom-0.5m			
Salinity (ppt)	Surface			
	Bottom-0.5m			
Specific Conductance (mS/cm^3)	Surface			
	Bottom-0.5m			
Dissolved Oxygen (mg/L)	Surface			
	Bottom-0.5m			
Secchi Depth (ft or m)				

Other Comments:

Southern California Coastal Water Research Project
3535 Harbor Blvd. Suite 110
Costa Mesa, CA 92626-1437
(714) 755-3200 Fax (714) 755-3299

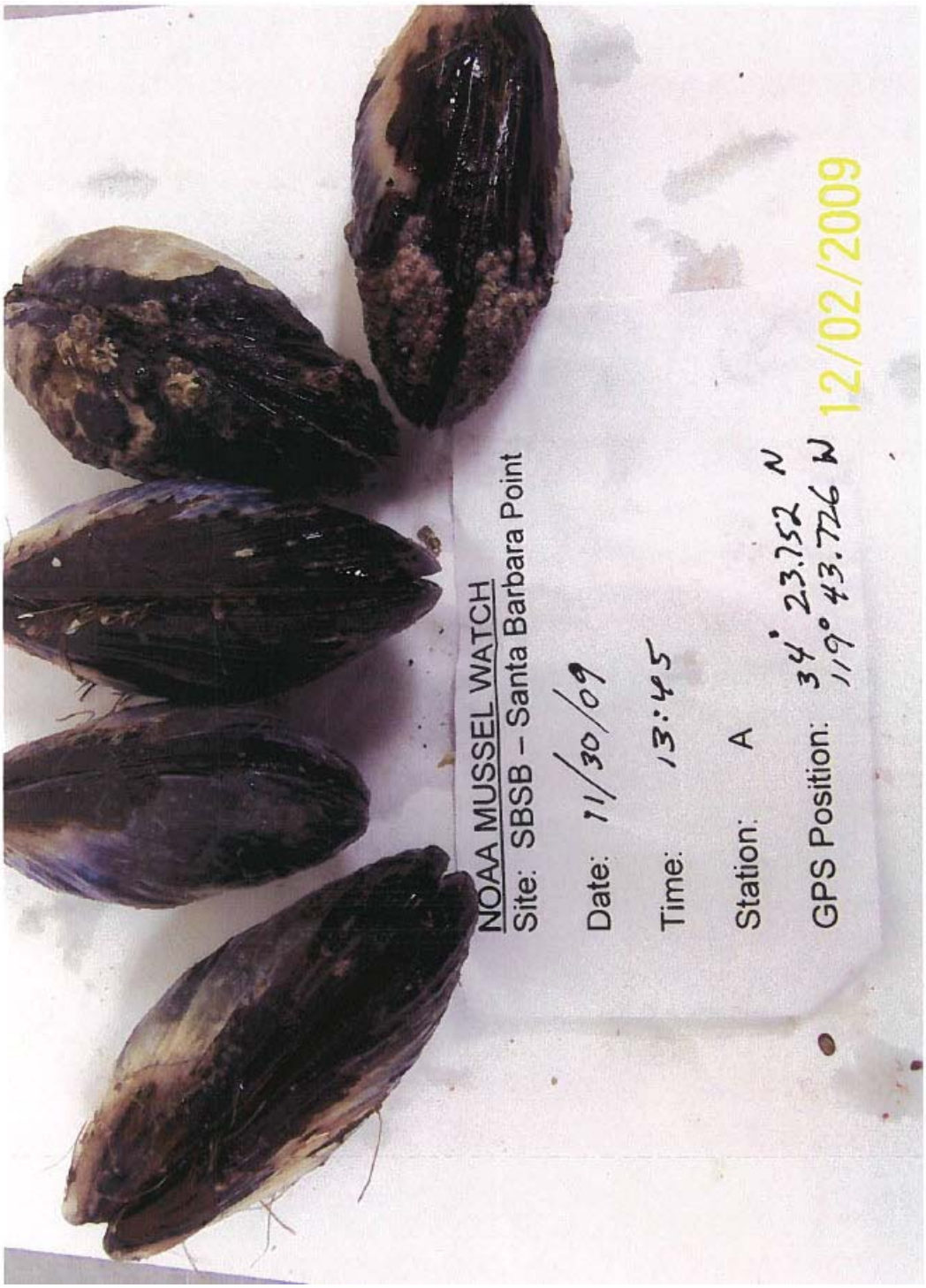
Chain of Custody

Date 11/30/09 Page 1 of 1

Sample Collection By: DARIO DIEHL & DAVID TSUKADA Project Name: NOAA MUSSEL WATCH Project Number: D3239

Sample ID	Date	Time	Matrix	Container Type	Number of Containers	Comments	Analysis
✓ SBSB - #A	11/30/09	14:00	MUSSELS	PLASTIC BAG	1	ARCHIVE	CHEMISTRY
✓ SBSB - #B	"	13:45	"	"	1	"	"
✓ SBSB - #C	"	14:15	"	"	1	"	"
✓ SBSB - #H	"	13:45 to 14:15	"	"	1	"	"
✓ SBSB - EXTRA	"	1345→1415	"	"	1	"	"
✓ SBSB - SALINITY	"	14:35	SEA WATER	PLASTIC BOTTLE	1	"	SALINITY

Relinquished By		Relinquished By		Relinquished By	
(Signature) Dario Diehl	(Date) 12/1/09	(Signature)	(Date)	(Signature)	(Date)
(Printed Name) DARIO DIEHL	(Time) 1200	(Printed Name)	(Time)	(Printed Name)	(Time)
(Company) SCCWRP		(Company)		(Company)	
Received By		**Received By**		**Received By**	
(Signature) Amanda Fryer	(Date) 12/02/09	(Signature)	(Date)	(Signature)	(Date)
(Printed Name) Amanda Fryer	(Time) 900	(Printed Name)	(Time)	(Printed Name)	(Time)
(Company) B:B Laboratories		(Company)		(Company)	



APPENDIX F **Table of target dates**

Site	General Location	Specific Location	Target	Target Latitude (deg.)	Target	State name	
CIHS	Cook Inlet	Homer Spit	13-Mar	59.614500	-151.444167	Alaska	AK
GASH	Gulf of Alaska	Shuyak Harbor	19-Mar	58.501000	-152.621833	Alaska	AK
GASL	Prince William Sound	Sleepy Bay	28-Mar	60.067330	-147.826000	Alaska	AK
GAWB	Gulf of Alaska	Windy Bay	20-Mar	59.218667	-151.517000	Alaska	AK
KTMP	Ketchikan	Mountain Point	16-Apr	55.293833	-131.548000	Alaska	AK
NBES	Nahku Bay	East Side	7-May	59.453333	-135.336500	Alaska	AK
PVMC	Port Valdez	Mineral Creek Flats	27-Mar	61.132833	-146.461000	Alaska	AK
PWDI	Prince William Sound	Disk Island	28-Mar	60.493000	-147.655833	Alaska	AK
PWKH	Prince William Sound	Knowles Head	29-Mar	60.688000	-146.584000	Alaska	AK
PWSH	Prince William Sound	Sheep Bay	30-Mar	60.640670	-145.990000	Alaska	AK
UISB	Unakwit Inlet	Siwash Bay	26-Mar	60.960833	-147.646000	Alaska	AK
ABLR	Aransas Bay	Long Reef	15-Dec	28.054833	-96.951167	Texas	G
ABOB	Atchafalaya Bay	Oyster Bayou	7-Jan	29.255500	-91.136167		G
AESP	Apalachee Bay	Spring Creek	29-Jan	30.063333	-84.322000	Florida	G
APCP	Apalachicola Bay	Cat Point Bar	28-Jan	29.724167	-84.884167	Florida	G
APDB	Apalachicola Bay	Dry Bar	27-Jan	29.672500	-85.065667	Florida	G
BBMB	Barataria Bay	Middle Bank	7-Jan	29.276667	-89.942000		G
BBSD	Barataria Bay	Bayou Saint Denis	6-Jan	29.404833	-89.998833		G
BBTB	Barataria Bay	Turtle Bay	6-Jan	29.511167	-90.083333		G
BRCL	Brazos River	Cedar Lakes	4-Dec	28.858000	-95.464667	Texas	G
BRFS	Brazos River	Freeport Surfside	4-Dec	28.921167	-95.339500	Texas	G
BSBG	Breton Sound	Bay Gardene	8-Jan	29.598000	-89.620833		G
BSSI	Breton Sound	Sable Island	9-Jan	29.405667	-89.483833		G
CBBB	Choctawhatchee Bay	Boggy Bayou	23-Jan	30.504000	-86.494000	Florida	G
CBBI	Charlotte Harbor	Bird Island	31-Jan	26.514333	-82.034500	Florida	G
CBBL	Choctawhatchee Bay	Ben's Lake	23-Jan	30.453167	-86.541000	Florida	G
CBCR	Copano Bay	Copano Reef	13-Dec	28.142000	-97.128000	Texas	G
CBFM	Charlotte Harbor	Fort Meyers	31-Jan	26.558333	-81.922833	Florida	G
CBJB	Choctawhatchee Bay	Joe's Bayou	27-Jan	30.410833	-86.490833	Florida	G
CBPP	Choctawhatchee Bay	Postil Point	23-Jan	30.482333	-86.479333	Florida	G
CBSR	Choctawhatchee Bay	Off Santa Rosa	27-Jan	30.412000	-86.203667	Florida	G
CCBH	Corpus Christi	Boat Harbor	16-Dec	27.836167	-97.380167	Texas	G
CCIC	Corpus Christi	Ingleside Cove	14-Dec	27.838000	-97.238000	Texas	G
CCNB	Corpus Christi	Nueces Bay	14-Dec	27.852167	-97.359833	Texas	G
CKBP	Cedar Key	Black Point	29-Jan	29.206667	-83.069500	Florida	G
CLCL	Caillou Lake	Caillou Lake	7-Jan	29.253167	-90.926667		G
CLLC	Calcasieu Lake	Lake Charles	7-Dec	30.058667	-93.307500		G
CLSJ	Calcasieu Lake	St. Johns Island	7-Dec	29.829000	-93.384000		G
ESBD	Espiritu Santo	Bill Days Reef	15-Dec	28.411833	-96.449000	Texas	G
ESSP	Espiritu Santo	South Pass Reef	15-Dec	28.298167	-96.622000	Texas	G
EVFU	Everglades	Faka Union Bay	30-Jan	25.902333	-81.512333	Florida	G
FBFO	Florida Bay	Flamingo	25-Jan	25.141167	-80.923667	Florida	G

APPENDIX F Table of target dates (Continued)

Site	General Location	Specific Location	Target	Target	Target	State name	
FBJB	Florida Bay	Joe Bay	25-Jan	25.212167	-80.534000	Florida	G
GBCR	Galveston Bay	Confederate Reef	5-Dec	29.263333	-94.916333	Texas	G
GBHR	Galveston Bay	Hanna Reef	6-Dec	29.480333	-94.741833	Texas	G
GBOB	Galveston Bay	Offatts Bayou	5-Dec	29.284000	-94.836333	Texas	G
GBSC	Galveston Bay	Ship Channel	5-Dec	29.704500	-94.993000	Texas	G
GBTD	Galveston Bay	Todd's Dump	6-Dec	29.503000	-94.896000	Texas	G
GBYC	Galveston Bay	Yacht Club	5-Dec	29.622000	-94.995833	Texas	G
JHJH	Joseph Harbor Bayou	Joseph Harbor Bayou	6-Jan	29.636833	-92.766833	Louisiana	G
LBMP	Lake Borgne	Malheureux Point	8-Jan	29.867000	-89.678500	Louisiana	G
LMAC	Lower Laguna Madre	Arroyo Colorado	14-Dec	26.282500	-97.285333	Texas	G
LMPI	Lower Laguna Madre	Port Isabel	13-Dec	26.074833	-97.199500	Texas	G
LMSB	Lower Laguna Madre	South Bay	13-Dec	26.043167	-97.176000	Texas	G
MBAR	Mesquite Bay	Ayres Reef	15-Dec	28.173000	-96.835000	Texas	G
MBCB	Matagorda Bay	Carancahua Bay	16-Dec	28.665000	-96.383000	Texas	G
MBCP	Mobile Bay	Cedar Point Reef	9-Jan	30.315500	-88.133833	Alabama	G
MBDI	Matagorda Bay	Dog Island	14-Dec	28.640333	-96.007833	Texas	G
MBDR	Mobile Bay	Dog River	10-Jan	30.591667	-88.039833	Alabama	G
MBEM	Matagorda Bay	East Matagorda	14-Dec	28.711167	-95.883333	Texas	G
MBGP	Matagorda Bay	Gallinipper Point	15-Dec	28.578833	-96.563000	Texas	G
MBHI	Mobile Bay	Hollingers Is. Chan.	10-Jan	30.563333	-88.075000	Alabama	G
MBLR	Matagorda Bay	Lavaca River Mouth	15-Dec	28.660333	-96.584500	Texas	G
MBTP	Matagorda Bay	Tres Palacios Bay	14-Dec	28.666333	-96.233500	Texas	G
MRPL	Mississippi River	Pass A Loutre	9-Jan	29.089500	-89.074833	Louisiana	G
MRTP	Mississippi River	Tiger Pass	8-Jan	29.145000	-89.427333	Louisiana	G
MSBB	Mississippi Sound	Biloxi Bay	11-Jan	30.392500	-88.857500		G
MSPB	Mississippi Sound	Pascagoula Bay	12-Jan	30.336000	-88.589167		G
MSPC	Mississippi Sound	Pass Christian	10-Jan	30.302333	-89.327167		G
NBNB	Naples Bay	Naples Bay	29-Jan	26.111833	-81.785167	Florida	G
PBIB	Pensacola Bay	Indian Bayou	26-Jan	30.516667	-87.111667	Florida	G
PBPH	Pensacola Bay	Public Harbor	26-Jan	30.413667	-87.191333	Florida	G
PBSP	Pensacola Bay	Sabine Point	26-Jan	30.349833	-87.154667	Florida	G
PCLO	Panama City	Little Oyster Bar	28-Jan	30.251333	-85.681000	Florida	G
PCMP	Panama City	Municipal Pier	27-Jan	30.151167	-85.663000	Florida	G
RBHC	Rookery Bay	Henderson Creek	30-Jan	26.027000	-81.738833	Florida	G
SAMP	San Antonio Bay	Mosquito Point	15-Dec	28.344000	-96.712333	Texas	G
SAPP	San Antonio Bay	Panther Point Reef	15-Dec	28.232333	-96.708167	Texas	G
SAWB	St. Andrew Bay	Watson Bayou	28-Jan	30.142500	-85.632167	Florida	G
SLBB	Sabine Lake	Blue Buck Point	6-Dec	29.790833	-93.906333	Louisiana	G
SRWP	Suwannee River	West Pass	29-Jan	29.329167	-83.174167	Florida	G
TBCB	Tampa Bay	Cockroach Bay	1-Feb	27.681000	-82.517667	Florida	G
TBHB	Tampa Bay	Hillsborough Bay	31-Jan	27.854833	-82.394667	Florida	G
TBKA	Tampa Bay	Peter O. Knight Airport	31-Jan	27.909667	-82.453833	Florida	G
TBLB	Terrebonne Bay	Lake Barre	6-Jan	29.259500	-90.594333	Louisiana	G
TBLF	Terrebonne Bay	Lake Felicity	7-Jan	29.264167	-90.398167	Louisiana	G
TBMK	Tampa Bay	Mullet Key Bayou	31-Jan	27.620833	-82.726500	Florida	G
TBNP	Tampa Bay	Navarez Park	1-Feb	27.787167	-82.754000	Florida	G
TBOT	Tampa Bay	Old Tampa Bay	30-Jan	28.023667	-82.632833	Florida	G

APPENDIX F Table of target dates (Continued)

Site	General Location	Specific Location	Target	Target Latitude (deg.)	Target	State name	
TBPB	Tampa Bay	Papys Bayou	31-Jan	27.844333	-82.611500	Florida	G
VBSP	Vermilion Bay	Southwest Pass	8-Jan	29.579500	-92.051000	Louisiana	G
BPBP	Barber's Point	Barber's Pt. Harbor	26-Mar	21.320333	-158.119667	Hawaii	HI
HHKB	Hawaii	Kaneohe Bay	6-Apr	21.411833	-157.778833	Hawaii	HI
HHKL	Honolulu Harbor	Keehi Lagoon	27-Mar	21.316667	-157.885833	Hawaii	HI
GBBS	Green Bay	Bayshore Park	22-Aug	44.637000	-87.808167	Wisconsin	L
LEAB	Lake Erie	Ashtabula	20-Aug	41.924667	-80.718333	Ohio	L
LEDK	Lake Erie	Dunkirk	26-Aug	42.529167	-79.277667	New York	L
LELR	Lake Erie	Lorain	19-Aug	41.461167	-82.207000	Ohio	L
LEOW	Lake Erie	Old Woman Creek	18-Aug	41.385000	-82.518667	Ohio	L
LERB	Lake Erie	Reno Beach	22-Aug	41.674500	-83.226167	Ohio	L
LESP	Lake Erie	Stony Point	22-Aug	41.958667	-83.233000	Michigan	L
LHBR	Lake Huron	Black River Canal	20-Aug	43.044333	-82.438667	Michigan	L
LHTB	Lake Huron	Thunder Bay	25-Aug	44.922167	-83.413500	Michigan	L
LMCB	Lake Michigan	Calumet Breakwater	25-Aug	41.727167	-87.495000	Indiana	L
LMHB	Lake Michigan	Holland Breakwater	26-Aug	42.773167	-86.215000	Michigan	L
LMMB	Lake Michigan	Milwaukee Bay	23-Aug	43.032167	-87.895167	Wisconsin	L
LMMU	Lake Michigan	Muskegon	27-Aug	43.228241	-86.346884	Michigan	L
LMNC	Lake Michigan	North Chicago	24-Aug	42.304667	-87.827333	Illinois	L
LOCV	Lake Ontario	Cape Vincent	25-Aug	44.144167	-76.324667	New York	L
LOOC	Lake Ontario	Olcott	23-Aug	43.355333	-78.686667	New York	L
LOOS	Lake Ontario	Oswego	24-Aug	43.452833	-76.550833	New York	L
LORC	Lake Ontario	Rochester	24-Aug	43.257833	-77.495333	New York	L
NRNF	Niagara River	Niagara Falls	22-Aug	43.046833	-78.892000	New York	L
SBPP	Lake Erie	Peach Orchard Pt.	22-Aug	41.659667	-82.825000	Ohio	L
SBSP	Saginaw Bay	Sandpoint	18-Aug	43.909833	-83.400167	Michigan	L
SBSR	Saginaw Bay	Saginaw River	19-Aug	43.673500	-83.836667	Michigan	L
TBLL	Traverse Bay	Leelanau State Park	26-Aug	45.205667	-85.536833	Michigan	L
AIAC	Absecon Inlet	Atlantic City	8-Dec	39.367167	-74.411167	New Jersey	M
BIBI	Block Island Sound	Block Island	26-Mar	41.198167	-71.592167	Rhode Island	M
BIBL	Barnegat Inlet	Barnegat Light	8-Dec	39.761667	-74.095000	New Jersey	M
CBBO	Chesapeake Bay	Bodkin Point	7-Jan	39.157333	-76.404833	Maryland	M
CBCC	Chesapeake Bay	Cape Charles	17-Dec	37.284500	-76.015333	Virginia	M
CBCI	Chincoteague Bay	Chincoteague Inlet	17-Dec	37.938500	-75.375833	Virginia	M
CBCP	Chesapeake Bay	Choptank River	5-Jan	38.607333	-76.120000	Maryland	M
CBDP	Chesapeake Bay	Dandy Point	20-Jan	37.098333	-76.294833	Virginia	M
CBHG	Chesapeake Bay	Hog Point	11-Jan	38.312333	-76.397833	Maryland	M
CBHP	Chesapeake Bay	Hackett Point Bar	9-Jan	38.969500	-76.414667	Maryland	M
CBJR	Chesapeake Bay	James River	22-Jan	37.065333	-76.632167	Virginia	M
CBMP	Chesapeake Bay	Mountain Point Bar	7-Jan	39.072000	-76.412667	Maryland	M
DBAP	Delaware Bay	Arnolds Point Shoal	14-Dec	39.383333	-75.450000	New Jersey	M
DBBD	Delaware Bay	Ben Davis Pt. Shoal	12-Dec	39.252333	-75.302833	New Jersey	M
DBCH	Delaware Bay	Cape Henlopen	10-Dec	38.783500	-75.120500	Delaware	M
DBCM	Delaware Bay	Cape May	9-Dec	38.982167	-74.961333	New Jersey	M

APPENDIX F Table of target dates (Continued)

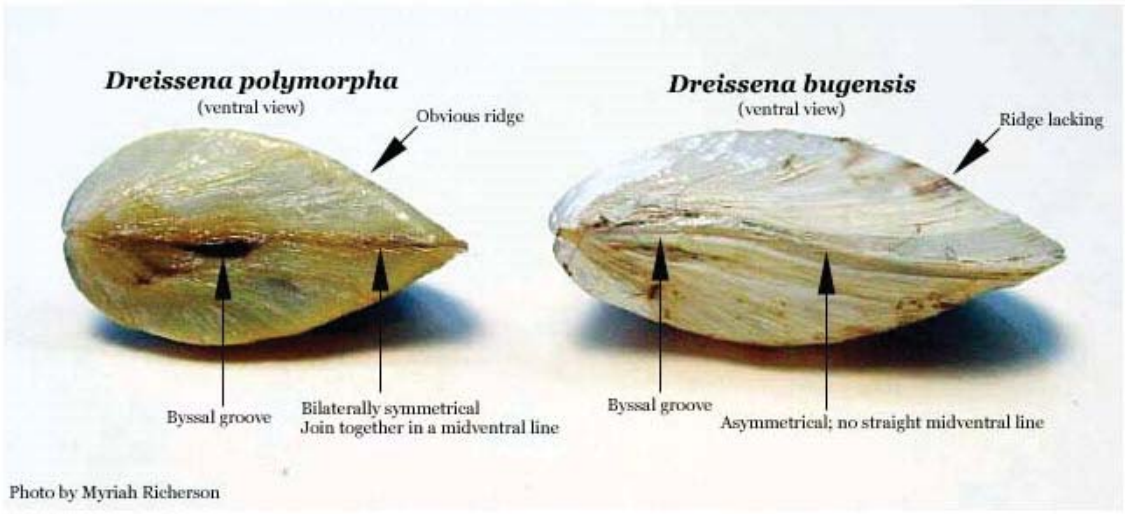
Site	General Location	Specific Location	Target	Target	Target	State name	
DBFE	Delaware Bay	False Egg Island Point	11-Dec	39.211667	-75.191667	New Jersey	M
DBKI	Delaware Bay	Kelly Island	15-Dec	39.203167	-75.359000	Delaware	M
HRJB	Hudson/Raritan Estuary	Jamaica Bay	3-Dec	40.566667	-73.895333	New York	M
HRLB	Hudson/Raritan Estuary	Lower Bay	8-Dec	40.566000	-74.050833	New York	M
HRRB	Hudson/Raritan Estuary	Raritan Bay	9-Dec	40.519000	-74.184500	New York	M
HRUB	Hudson/Raritan Estuary	Upper Bay	6-Dec	40.689333	-74.043167	New York	M
ARWI	Altamaha River	Wolfe Island	12-Feb	31.324167	-81.310833	Georgia	S
BBGC	Biscayne Bay	Gould's Canal	24-Feb	25.533333	-80.323167	Florida	S
BHKF	Florida Keys	Bahia Honda	22-Jan	24.661167	-81.273000	Florida	S
BIPI	Beaufort Inlet	Pivers Island	2-Feb	34.718333	-76.675500	North Carolina	S
CFBI	Cape Fear	Battery Island	3-Feb	33.915833	-78.003500	North Carolina	S
CHFJ	Charleston Harbor	Fort Johnson	8-Feb	32.750500	-79.900333	South Carolina	S
CHSF	Charleston Harbor	Shutes Folly Island	7-Feb	32.773500	-79.912167	South Carolina	S
IRSR	Indian River	Sebastian River	18-Feb	27.829500	-80.474333	Florida	S
MRCB	Matanzas River	Crescent Beach	18-Feb	29.764000	-81.261833	Florida	S
NMML	North Miami	Maule Lake	21-Feb	25.937667	-80.149667	Florida	S
PSCH	Pamlico Sound	Cape Hatteras	28-Jan	35.202833	-75.716167	North Carolina	S
PSNR	Pamlico Sound	Neuse River	1-Feb	35.089667	-76.529000	North Carolina	S
PSPR	Pamlico Sound	Pungo River	31-Jan	35.296000	-76.439167	North Carolina	S
PSWB	Pamlico Sound	Wysocking Bay	30-Jan	35.412333	-76.039667	North Carolina	S
RSJC	Roanoke Sound	John Creek	26-Jan	35.889833	-75.633667	North Carolina	S
SJCB	St. Johns River	Chicopit Bay	17-Feb	30.381000	-81.440000	Florida	S
SRNB	Santee River	North Bay	5-Feb	33.168333	-79.241667	South Carolina	S
SRTI	Savannah River Estuary	Tybee Island	9-Feb	32.016500	-80.882500	Georgia	S
SSSI	Sapelo Sound	Sapelo Island	11-Feb	31.392833	-81.288000	Georgia	S
WBLB	Winyah Bay	Lower Bay	6-Feb	33.243333	-79.197167	South Carolina	S
ABWJ	Anaheim Bay	West Jetty	8-Dec	33.733500	-118.101000	California	W
BBBE	Bodega Bay	Bodega Bay Entrance	8-Jan	38.305000		California	W
BBSM	Bellingham Bay	Squalicum Marina Jet.	9-Jan	48.752167			W
CBCH	Coos Bay	Coos Head	12-Dec	43.350000		Oregon	W
CBRP	Coos Bay	Russell Point	12-Dec	43.431333	-124.221167	Oregon	W
CBTP	Commencement Bay	Tahlequah Point	11-Dec	47.331167			W
CRSJ	Columbia River	South Jetty	15-Feb	46.228667		Oregon	W
EBDH	Elliott Bay	Duwamish Head	9-Jan	47.595833			W
EBFR	Elliott Bay	Four-Mile Rock	11-Dec	47.638833			W
EUSB	Eureka	Samoa Bridge	15-Jan	40.821500		California	W
FIEL	Farallon Islands	East Landing	15-Jan	37.696167		California	W
GHWJ	Gray's Harbor	Westport Jetty	21-Feb	46.909667	-124.117667		W
HMBJ	Eureka	Humboldt Bay Jetty	11-Jan	40.764167		California	W
IBNJ	Imperial Beach	North Jetty	10-Dec	32.587667	-117.133500	California	W
JFCF	Strait of Juan de Fuca	Cape Flattery	3-Mar	48.382500			W
KRFR	Klamath River	Flint Rock Head	8-Jan	41.527167		California	W
LBBW	Long Beach	Breakwater	7-Mar	33.723167	-118.173500	California	W
LJLJ	La Jolla	Point La Jolla	28-Jan	32.851500	-117.273833	California	W
MBES	Monterey Bay	Elkhorn Slough	10-Feb	36.809833		California	W

APPENDIX F Table of target dates (Continued)

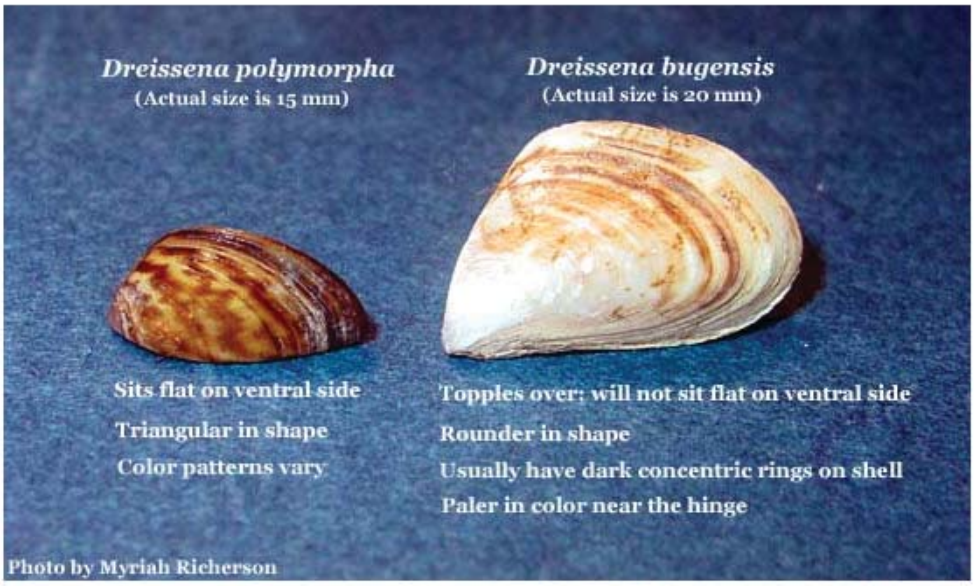
***Mytilus galloprovincialis* (West coast)**
Shell dark blue or brown to almost black. The outside is black-violet colored
The two shells are equal and nearly quadrangular, on one side the rim of the shell ends with a pointed and slightly bent while the other side is rounded.
Variable size, typically 5-8cm, but grows larger than its cousins, up to 15cm.
Exposed rocky outer coasts to sandy bottoms in bays

***M. trossulus* (bay mussel)**
smooth shell with smooth growth lines, little erosion, and no major radiating ridges
Shell color vary from brown (juvenile) dark blue in adults

M. Californianus
Thick shells reach 80-130 mm in length
Shell color is blue with brown periostracum
Shell with coarse radial ribs and irregular growth lines
Shell is thicker than in *M. edulis*
Eroded beak in adult
Rocky shores attached to hard substratum with strong and elastic abyssal threads
California coast in high salinity waters high energy



USGS



U.S Geological Survey

National Status and Trends Mussel Watch Program:
Sampling Methods
2012 Update

Dennis A. Apeti, W. Edward Johnson, Kimani L. Kimbrough
and Gunnar G. Lauenstein
National Oceanic and Atmospheric Administration