Monitoring Marine Invasive Species:

Guidance and Protocols for Volunteer Monitoring Groups

April 2011

The Marine Invader Monitoring and Information Collaborative

CZM

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We would also like to acknowledge the extensive work of Barbara Warren of Salem Sound Coastwatch in coordinating the first volunteer marine invasive species monitoring efforts in Massachusetts and helping to lay the groundwork for the methods outlined in this guide.

We also thank those that reviewed and provided comments to improve this document: Barbara Warren (Salem Sound Coastwatch and the Massachusetts Bay National Estuary Program), Sara Grady (North and South Rivers Watershed Association and the Massachusetts Bay National Estuary Program), and Anne Donovan and Arden Miller (Massachusetts Office of Coastal Zone Management).

Finally, thank you to the many volunteers and local groups who dedicate their time to learn, monitor, and spread the word about marine invasive species. Without you the Marine Invader Monitoring and Information Collaborative would not be a success!



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PREFACE

Monitoring Marine Invasive Species: Guidance and Protocols for Volunteer Monitoring Groups is the primary guidance document for the Marine Invader Monitoring and Information Collaborative (MIMIC). MIMIC is a network of trained volunteers, scientists, and state and federal agency workers who monitor marine invasive species throughout the northeast United States. The collaborative provides an opportunity for the general public to actively participate in an invasive species early detection network, identify new invaders before they spread out of control, and help improve our understanding of the behavior of established invaders.

Monitoring marine invasive species is not only a fun and exciting learning opportunity, but a great community activity as well. This document contains guidance and protocols for groups who wish to monitor marinas, cobble shores, and tidepools for marine invasive species as part of the MIMIC program. It features informative sections on MIMIC, including site selection, monitoring considerations, species identification, data entry, and more. The protocols can also be modified to fit the needs of other groups who wish to monitor independently such as K-12 teachers, after school groups, and others. The document is written for a wide audience, with bolded terms defined in the Glossary (page 36).

Monitoring networks are strengthened with the addition of each monitoring location, and there is a real need for more “eyes on the water” to support early detection efforts. As a MIMIC program partner you will learn about our coastal resources and work alongside a team of scientists, managers, and peers to defend our ecosystems against invasive species. The more trained volunteers we have, the more successful our efforts will be to manage the threat of new introductions. We need your help!

If you have any questions regarding MIMIC, this guide, or its contents, please contact:

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INTRODUCTION

Marine **invasive species*** can have major impacts on ecosystems and economic resources where they have been **introduced**. **Estuaries** and coasts are some of the most heavily invaded ecosystems on earth; an estimated 298 species of marine invertebrates, 100 species of fish and 200 species of plants have been identified as invasive in North American bays and coasts alone.[1] In the Northwest Atlantic, numerous invasions have occurred in virtually all coastal habitats. **Non-native** species such as green fleece (*Codium fragile ssp. fragile*), the Asian shore crab (*Hemigrapsus sanguineus*), and green crab (*Carcinus maenas*), have become so well established in some locales that they are often assumed to be **native species**.[2] In addition, a myriad of troublesome colonial and solitary **sea squirts** have been introduced, the most concerning of which may be *Didemnum vexillum*, a colonial species first discovered in the Gulf of Maine in the late 1980s. This species has rapidly colonized both **nearshore** and subtidal habitats, and may now cover significant portions of area on Georges Bank.[3]

Marine invasive species are inadvertently or intentionally introduced to new habitats by humans in many ways. Transport mechanisms, or **vectors**, include shipping, fisheries, aquaculture, the pet trade, intentional introductions for food sources, research, educational supplies, and other accidental introduction methods. If a species is introduced into a habitat with similar environmental conditions to its native range, there is a small chance that the organism may survive and reproduce. With no natural predators to keep the species in check, the organism may be able to overwhelm and invade the ecosystem, possibly leading to negative impacts to native species, impeded navigation and recreation, and loss of economic value.

Because new invaders may arrive at any moment, the first line of defense is to establish an organized **early detection** network to monitor for the presence of newly arriving non-native species. This network strives to detect non-native organisms soon after introduction, before populations become established in the ecosystem. The Massachusetts Office of Coastal Zone Management (CZM) established the Marine Invader Monitoring and Information Collaborative (MIMIC) in 2006 to serve as an early detection network for marine invasive species across New England. MIMIC is a partnership between state and federal agencies, scientific experts, volunteers, and nonprofits that seeks to expand monitoring efforts for marine invasive species by training volunteers to identify 23 established and potential marine invaders. We are an organized team of monitors that share species location and distribution with all who are interested. Through these efforts, we not only inform resource managers but also provide opportunities for the public to learn more about the marine invasive species issue.

***Bolded terms are defined in the Glossary on page 36.**

MIMIC BASICS

The purpose of the Marine Invader Monitoring and Information Collaborative is to detect newly introduced species, as well as changes in the **abundance** and distribution of established non-native species. There are four primary components of the program: (1) coordination, (2) training, (3) monitoring, and (4) information transfer.

Coordination: MIMIC is coordinated by CZM with support from the U.S. Fish and Wildlife Service, the Northeast Aquatic Nuisance Species Panel, and local monitoring organizations that recruit and train volunteer monitors (Table 1).

Table 1: Program Organization

Title	Duties	Staff/Organization
MIMIC Program Coordinator	Coordinate program, organize trainings and workshops, provide identification assistance, monitor overall QA/QC, manage data, analyze data, and develop reports	Adrienne Pappal, CZM
MIMIC Local Coordinator	Attend trainings and workshops, recruit and train volunteers, select monitoring sites, ensure safety of volunteers at all times, distribute supplies, enter data, provide quality control, schedule monitoring events, supervise monitoring, provide general management of volunteers, and complete administrative tasks as necessary	Amy Costa, Provincetown Center for Coastal Studies; Sara Grady, North and South Rivers Watershed Association; Jeremy Miller, Wells National Estuarine Research Reserve; Barbara Warren, Salem Sound Coastwatch; Nat Goddard & Ivan Ace, Team Eastham; Chris McIntyre, University of Massachusetts, Boston; Kevin Cute, Rhode Island Coastal Resources Management Council; Judy Heller, Three Bays Preservation Inc.; Peter Phippen, Eight Towns and the Bay; Jo Ann Muramoto, Association to Preserve Cape Cod; and others
MIMIC Volunteers	Receive training in protocol and species identification, correctly identify marine invasive species, conduct monitoring according to MIMIC protocols, record data accurately on datasheets, report suspected potential invaders or unidentifiable organisms as soon as possible, transfer datasheets to local MIMIC coordinator in a timely fashion	Volunteers assigned as needed through local coordinating group

Each local organization participating in the program will fill out a monitoring agreement (Appendix A) each year. The monitoring agreement includes basic contact information, a list of volunteers, monitoring locations and types, a training schedule, and safety precautions, which will be reviewed by the program coordinator prior to the monitoring season.

Training: Training is the cornerstone of MIMIC. With the proper training, coordinators and volunteers will be able to identify the 23 marine invasive species that are the focus of our program. Trained volunteers must be able to monitor according to the MIMIC protocol, identify with reasonable accuracy 16 invasive species present in the region, be familiar with seven potential invading species, take physical measurements, and collect data about environmental conditions present during monitoring. Trained coordinators must be able to identify the 23 priority species and enter data into the MIMIC online database.

Monitoring: The monitoring protocol used in the MIMIC program is adapted from the visual rapid assessment method used by scientists from San Francisco Bay to coastal New England to monitor for marine invasive species.[4-5] Rapid assessment is a qualitative approach of visual search within a fixed area and/or time frame, and is focused on the identification of organisms within arm's reach.[6]

We focus the majority of our monitoring on locations associated with shipping because of the enhanced risk of species transfer from this vector (it is estimated that 51% of initial marine invasions in North America are associated with shipping vectors).[1] These include major and minor ports, marinas, and areas commonly used for boating and recreation. Since non-native species can easily spread from their introduced locations to other habitats, we also monitor cobble shores and tidepools.

It is up to the discretion of each volunteer group to select sites for monitoring during the course of the year. Sites should be selected so that a team of two or more volunteers can complete the visual survey in about an hour. Each site will be visited at least once a month for a minimum of four months during mild weather (April-November), preferably in a consecutive four-month span to detect trends through time.

Monitoring: MIMIC participants are trained to monitor 16 established introduced species and seven species that have the potential to invade our region (potential invaders). These particular species were selected because they are generally not difficult to identify (you do not need a microscope) and their potential to spread in our region. For identification resources, see the Identification Tips section on page 31 of this guide.

Salem Sound Coastwatch and CZM have developed Marine Bioinvader ID Cards to assist you in the identification of these 23 species. A limited number of laminated sets of the cards are available from the MIMIC coordinator at no charge, and they are available to download at www.mass.gov/czm/invasives/monitor/id.htm. Additional copies may also be ordered through Salem Sound Coastwatch for a fee: www.salemsound.org/CHIMP-inner.html.

The following pages list the 23 non-native species monitored by MIMIC volunteers (established species are indicated by a blue border, and potential invaders have a red border and a symbol).

Figure 1: Established Marine Species Monitored by MIMIC

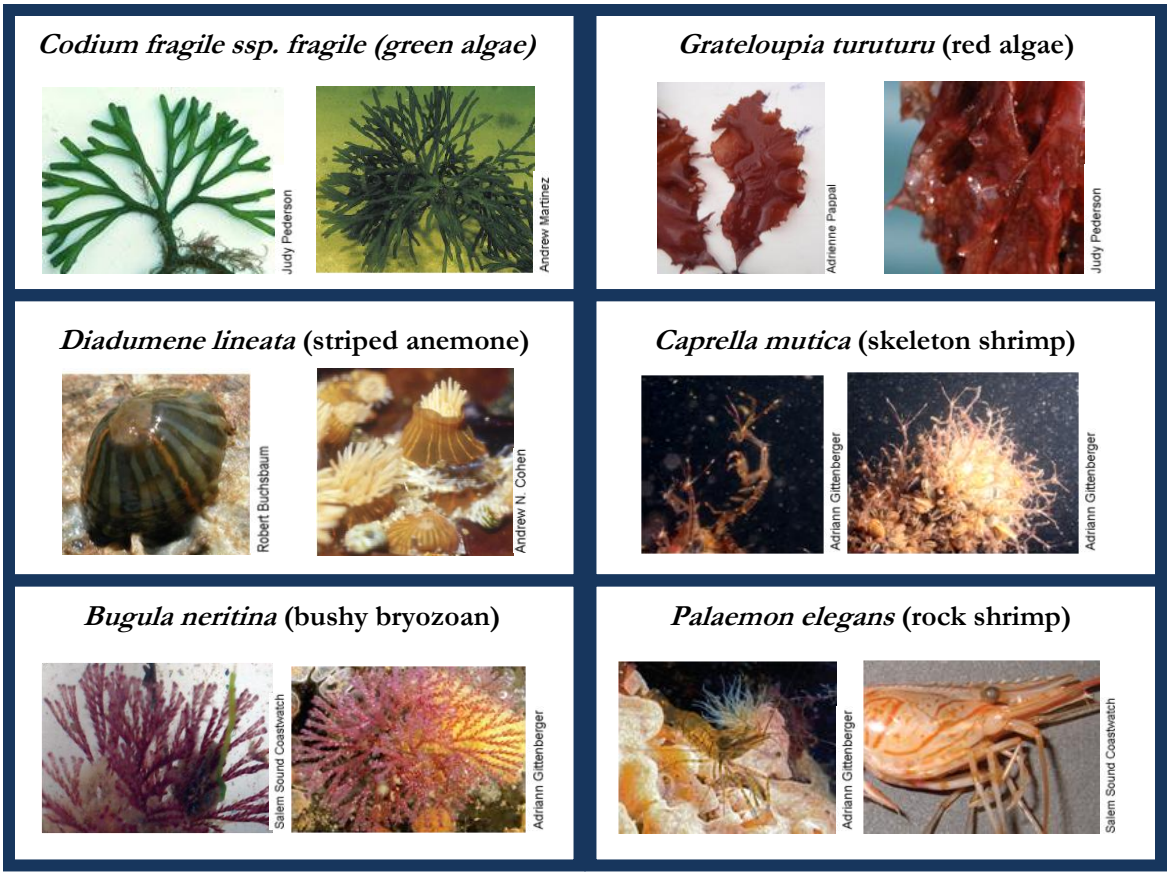


Figure 1 (continued)

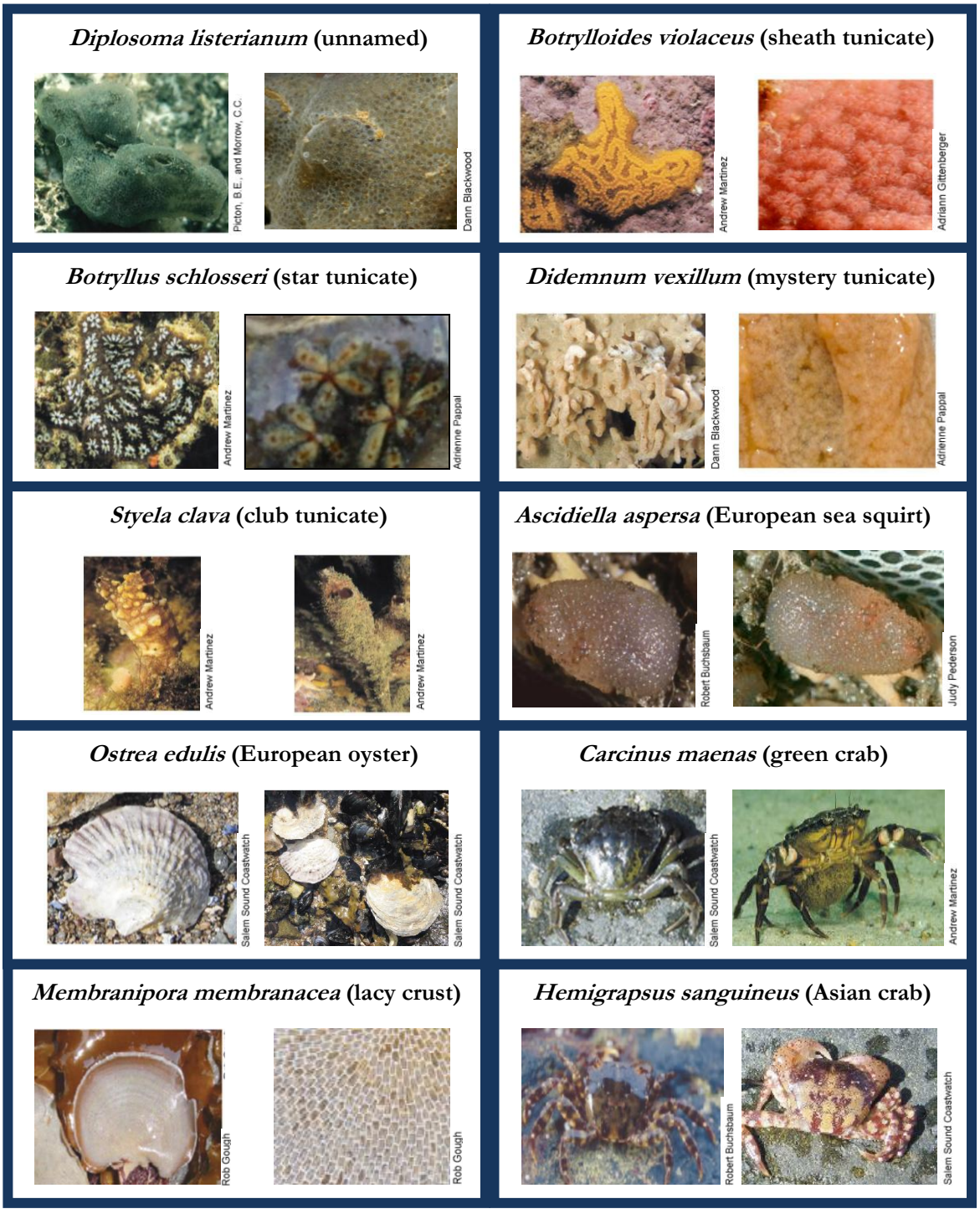
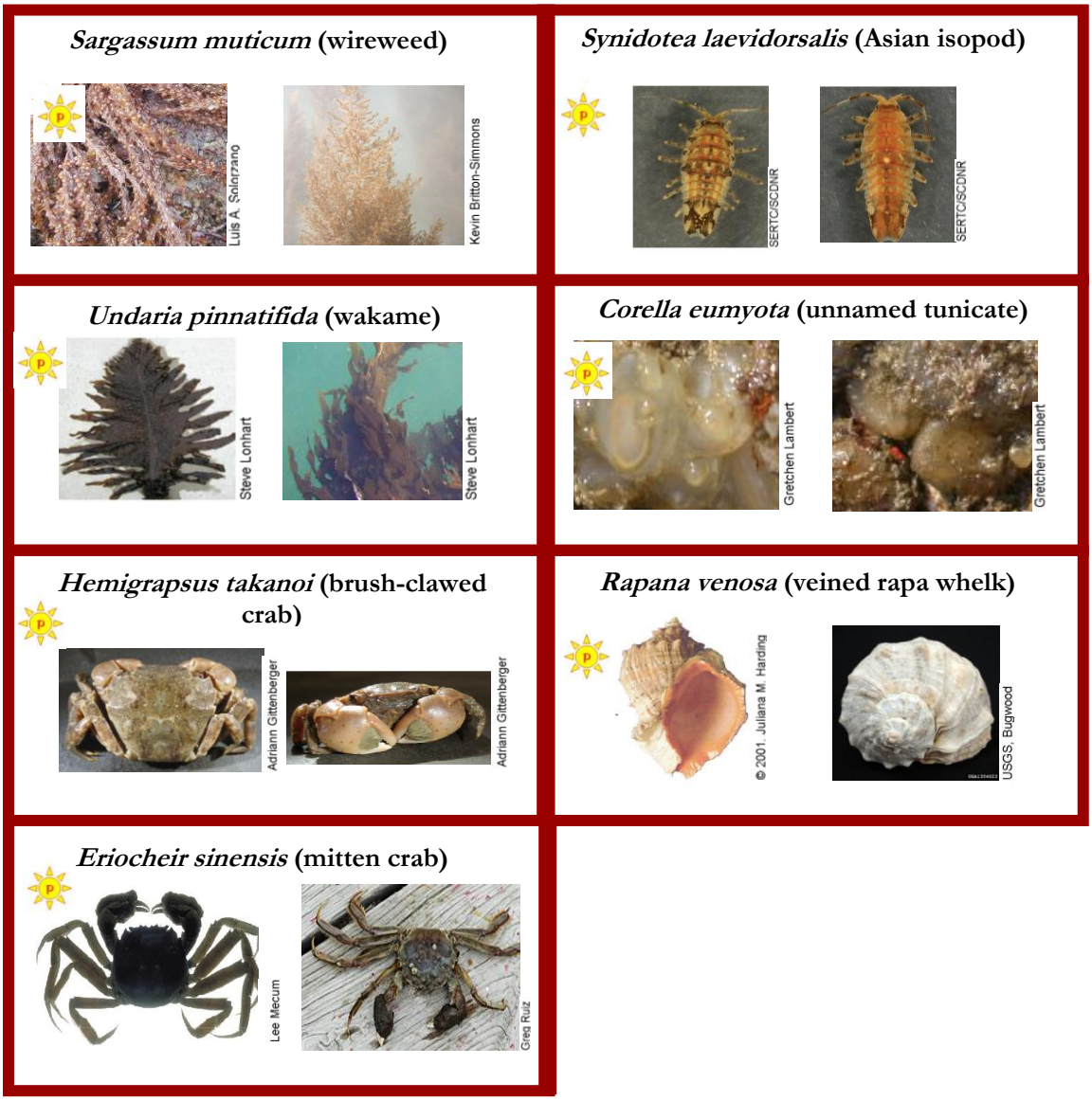


Figure 2: Potential Marine Invaders Monitored by MIMIC



Information Transfer: Monitoring and associated environmental data are collected by volunteers on datasheets (Appendix B) and then entered into the MIMIC online database by local coordinators after every monitoring event. The Marine Invader Tracking and Information System (MITIS) database is a partnership between the Massachusetts Institute of Technology (MIT) Sea Grant College Program (Sea Grant) and CZM, which allows users to both enter data and display information through an interactive mapping system. The website can be accessed at http://massbay.mit.edu/mitis/. MIMIC data can also be viewed through CZM's Massachusetts Online Resource Information System (MORIS): www.mass.gov/czm/mapping/index.htm. MORIS is an online mapping tool that can be used to search and display a wide variety of spatial data pertaining to the Massachusetts coastal zone. With MORIS, users can quickly create and share maps and download the actual data for use in a Geographic Information System (GIS). In addition, participating groups are highly encouraged to share findings and data to the community at large via presentations, newsletters, and other mechanisms.

MARINA AND FLOATING DOCK MONITORING

Artificial structures in marinas and ports are ideal locations to observe introduced marine species because of their proximity to shipping vectors, accessibility, and availability of hard, submerged **substrate** to which marine species can attach. In addition, ropes and other materials that are submerged may be pulled up to get a closer view of several subtidal species. Because of accessibility and relative ease of monitoring compared with other habitats, we suggest that participants focus monitoring efforts on floating docks, particularly if utilizing new and/or inexperienced volunteers.

Pros	Cons
✓ Floating docks are easily accessible. ✓ You can monitor docks at any time of the day (not tide dependant). ✓ Monitors have access to subtidal organisms without having to get wet.	✓ Organisms that attach to hard structure are over-represented and may not reflect other habitat situations. ✓ Mobile species may be under-represented. ✓ Marina owners may be reluctant to allow access.

Monitoring Considerations

Use the information below to guide you in choosing when and where to sample to ensure data quality and volunteer safety.

Site selection

To select a monitoring site, identify several possible marina locations and conduct background research on their use and accessibility. Marinas with permanently installed floating docks are preferred to those that are taken out for the winter (seasonal) because they can host a wider array of marine invasive species. You may monitor seasonal docks, but please note whether docks are seasonal or permanent on your Monitoring Agreement (Appendix A). It is best to avoid sites where the dock floats are cleaned or scraped during the monitoring season by the marina operators.

Whenever possible, the most heavily used marinas and ports in your area should be selected to monitor, as this will increase the chance of detecting a marine invader transported by boating and/or shipping. Keep in mind that it will be best to select locations where your volunteers will be comfortable and where

monitoring will not interfere with marina operation. Avoid monitoring on busy fishing docks or where ships load and unload passengers or cargo.

Obtain permission from the appropriate person/agency prior to any dock monitoring surveys. This is particularly important for privately owned marinas, but the harbormaster or dock superintendent should be notified in advance of monitoring at public marinas as well. If you have difficulty gaining access to a marina, or if marina staff need more information on the purpose of monitoring, contact the MIMIC Coordinator for assistance. A good working relationship between marina owners and volunteers is essential for continued access to survey sites. Try not to disturb normal operations of the marina, staff, and customers during the survey(s). Do not pull up traps or gear unless you have permission to do so from the marina or boat owner.

Once your monitoring sites are selected, take a picture of each site location and record the Global Positioning System (GPS) coordinates if possible. Write a short description of the site and include details such as habitat type, location, and proximity to possible vectors. Keep this and other site descriptions in a centralized location so that you can refer back to them as needed. Assign each site an original site name for data collection purposes. It is best to create a site name that will be specific enough to identify the site and clearly distinguish it from other monitoring locations (particularly as sites are added or dropped between years). Site 1 is a less descriptive name than Beverly Dock, Water Street for instance. With marina staff guidance, identify appropriate parking locations and who should be notified before monitoring begins. Keep a record of each site you will be monitoring, site names, primary contact person for the marina, and volunteers for each location. Include this information on your Monitoring Agreement (Appendix A).

Representative Monitoring

When choosing a dock location, keep in mind that the size of the facility will influence where you monitor and how many volunteers are needed. If the dock you are monitoring is small (below left), a team of two monitors will easily be able to monitor all floats in under an hour. For larger marinas (below right), more than two volunteers can be used to monitor the site. When monitoring at a large marina, it is important to view some floats in all areas rather than focusing on one area of the marina to ensure a representative sample (See Figure 3 on page 11).

Monitoring Protocol for Marinas

The following checklists and steps will help you prepare to monitor and complete your monitoring survey. If you have any questions or concerns regarding the protocol, contact your local coordinator prior to monitoring.

Safety

Safety and comfort of all volunteers is our primary concern. Follow the safety guidelines below every time you monitor.

- Do not monitor alone! Always go out with at least one other person.
- Let someone know where you are going and when you plan to return. Check in with this person when monitoring is complete.
- Be aware of your surroundings and potential hazards: slippery docks, presence of submerged or floating electrical cables, equipment, docking boats, passengers, etc.
- Wear sturdy footwear. Surfaces may be slippery, and there may be ropes, equipment, and sharp objects on the dock.
- Check weather forecasts before traveling to the monitoring site and keep in mind that weather conditions can change quickly. Avoid monitoring in bad weather and never go out if there is a chance of lightning.
- Dress appropriately for weather conditions and bring extra clothing just in case.
- Always carry a well-stocked first aid kit with you, and know how to use it.
- If you feel uncomfortable or feel your safety is at risk for any reason, discontinue monitoring and leave the location. Discuss the issue with your local coordinator.

Supply List

- Datasheets and monitoring instructions
- Clipboard and pen/pencil
- Thermometer
- Refractometer
- Marine species ID guides and/or Marine Bioinvader ID cards
- Pillow, knee cushion, or towel
- Collection containers and baggies
- Dip net
- Magnifying glass
- Labels
- Cooler with ice and/or 75-90% alcohol
- Digital camera
- White collecting tray
- Aquarium net or other fine mesh net

Monitoring Steps

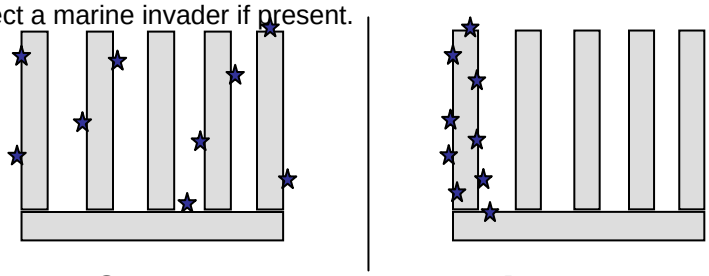
1. Collect site data
   - Take a minute to look around your monitoring location and note any changes that may have impacted species at the site since your last visit, i.e. floats that have been cleaned, docks rearranged, etc. Record these observations on your datasheet (use the back side if necessary).
   - Record weather conditions, time, date, and other associated information on the appropriate sections of your datasheet.

2. Record physical measurements
   - Place a thermometer approximately 6 inches below the water surface for one full minute and record the temperature on your datasheet.
   - If you have a refractometer, collect a small amount of surface water and place several drops on the glass prism. Record salinity value (as indicated by the shadow line) on your datasheet.

3. Monitor for marine invasive species
   - Working in teams of two or more, inspect submerged areas of floats and other surfaces for the 16 current invaders and seven potential invaders you have been trained to identify.
   - For large marinas (more than three docks), you may not be able to monitor the entire location. In this case, monitor a few floats in all areas (some on the outside edges, some on the inside, and some close to shore) instead of focusing on one small area as shown in Figure 3.

Figure 3: Representative Sampling at Marinas

The example below left indicates representative sampling of floats at a large marina (stars indicate monitoring locations). The example below right depicts monitoring focused on one area only. Representative sampling is important because it increases the likelihood that you will detect a marine invader if present.



- Gently move large algae or species that may be blocking your view aside with your hand or dip net. Collect samples from the floats for a closer view with your magnifying glass if needed, and use the Marine Bioinvader ID cards and other field guides to assist you.

4. Conduct shrimp sweeps
   - Fill small tray halfway with seawater.
   - Dip an aquarium or other fine-meshed net down into the water and quickly sweep alongside the dock float surface for 10 seconds, holding net opening at a 90^{o} angle to the float.
   - Sweep as close to the float as possible, brushing against emergent seaweed and other species if present.
   - Upturn the net into the tray and remove any organisms retained in the net.
   - Pause for a few moments then repeat shrimp collection at two other depths: mid-float and bottom of float.
   - Identify any target non-native shrimp, amphipod, or isopod species in the tray, using your hand lens and ID cards as needed, and record on your datasheet.
   - Empty tray and rinse out net.
   - Repeat shrimp sweeps for at least two other locations at the dock.

5. For each of the 23 species note on your datasheet whether it is present or absent at the site and indicate the abundance using the following terms:
   - Abundant: present almost everywhere you look
   - Common: present at most of the monitoring site (present in most locations or over half of the area looked)
   - Few: present, but at low abundance (found less than half of places looked)
   - Rare: one to two specimens present at site
   - Absent: not observed at the site

Keep in mind that not finding a species at a site is just as important as finding one!

Continue to search for marine invasive species for one full hour (if the site is small, or if there are more than two volunteers monitoring at the location, it is possible to complete the survey under an hour-double check with your volunteer coordinator if this is the case for your monitoring location).

6. If you cannot identify a species
    - Take clear photographs of any unusual specimens or organisms you cannot identify using the steps outlined in the Specimen Collection Protocol (page 27).
    - Record on your datasheet whether a photograph was taken and give the label number provided in the photograph.
    - If you do not have a camera, or are having trouble getting a clear photo of the organism, collect a specimen. Either place the organism in a baggie with seawater and a label and place into a cooler of ice for later identification, or preserve in alcohol, whichever is the preferred method for your organization. Talk to your local coordinator about preferred preservation methods.
    - Transfer all photos and/or specimens to your volunteer monitoring coordinator in a timely fashion.

If you suspect a potential invader . . .

1. Take clear photographs of the organism and label
2. Collect a specimen either by freezing or by preserving in alcohol. Labels must accompany any specimen.
3. Transfer specimens and accompanying photographs to your local coordinator ASAP.

5. Wrap up the monitoring day
    - Before you leave the site, make sure you have taken all of your equipment with you and have collected or disposed of specimens properly in accordance with the Specimen Collection Protocol (page 27).
    - Check the completeness and accuracy of your datasheet, initial it, and hand it in to your volunteer coordinator at the designated time/place, along with any collected specimens.

COBBLE SHORE MONITORING

Cobble habitats are a great location to monitor for marine invasive species because they are generally easy to navigate and have an abundance of hard substrate for **sessile** species to attach. Mobile species such as green crabs and Asian shore crabs are also found in cobble habitat.

Pros	Cons
✓ Monitors can look for the presence of marine introduced species in a natural habitat. ✓ Mobile organisms are more accessible compared to floating docks. ✓ Cobble shores are more navigable than rocky shores, mudflats and marshes.	✓ Shore monitoring is tide dependant (must visit site at or near low tide). ✓ Rough terrain may be difficult to sample. ✓ Availability of access points may limit monitoring sites.

Monitoring Considerations

Use the information below to guide you in choosing when and where to sample to ensure data quality and volunteer safety.

Site Selection

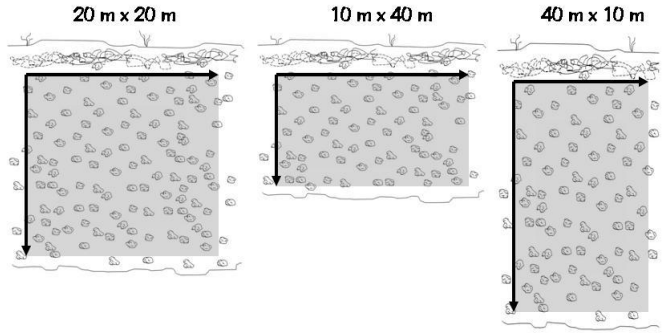
Cobble shores can be distinguished from rocky shores based on the size of the substrate. A cobble shore is made up of baseball to basketball-sized rocks with some muddy or sandy substrate in between. Rocky shores tend to have larger, more stable substrate such as boulders and bedrock, and are generally more difficult to navigate.

When choosing monitoring locations, it is best to select a site with public access down to the water and adequate parking. If you choose a site without a public access way, you will need to obtain permission from the landowner to cross their property. Property rights of the intertidal zone vary and can be complicated. When in doubt, ask permission from your town clerk or property abutters before accessing a site that is not posted for public access. In Massachusetts a list of public access points can be located through the CZM coastal access site: www.mass.gov/czm/access/products/access_locator.htm.

Defining the Search Area

You will be monitoring a 400 square meter section of shoreline (the search area) during every monitoring event. The configuration of the search area will vary based upon the distance between the low tide line and the wrack line, see examples in Figure 4.

Figure 4: Configuration of search area examples



To determine the configuration of the search area at your site, measure the distance between the wrack line and water line at low tide in meters. This is your vertical monitoring distance. Divide 400 by the vertical monitoring distance to determine your horizontal monitoring distance. For example, the vertical monitoring distance at Site A during a typical low tide is 12 m. By dividing 400 m^2 by 12 m we get a horizontal length of 33 m (rounded). Thus volunteers at Site A are directed to measure out a horizontal length of 33 m at the wrack line, and mark the ends of the search area at the water line with a rope or other object.

Since the monitoring protocol focuses on a specific search area, local coordinators will also have to identify a permanent location where the visual survey will begin (the point on the wrack line where you measure out your search area). For example you may be asked to either:

- Access the location, and then walk X steps (to the left or right), or measure out X meters (distance) along the wrack line.
- Start at the “X” (recognizable landmark).
- Start at X,Y coordinates on your GPS (keep in mind that GPS have varying degrees of accuracy).

Once sites are selected, take a photograph and detailed notes on how to access the site, where to park, and who to notify when accessing the location (if needed). Keep this information on file in a centralized location so that you may refer to it as necessary.

Monitoring With the Tides

Unlike marinas where monitoring can be conducted regardless of tidal cycles, cobble shore monitoring will have to be conducted during low tide when most of the intertidal zone is exposed. See http://tbone.biol.sc.edu/tide/sites_useastupper.html or local tide charts to estimate tide times for your area. Tidal cycles differ markedly from one site to the next; use the closest tide estimate to your area that you can find. When setting up monitoring dates/times, be sure to provide adequate time to arrive at the site, walk to the sample area, and set up equipment *before* low tide. A half an hour to set up the search area and take physical measurements (temperature and salinity) should suffice, depending on the accessibility of your site and distance traveled to the monitoring location. Having one or two "rain dates" prescheduled is also a good idea in case of inclement weather.

Monitoring Protocol for Cobble Shores

The following information and steps will help you prepare to monitor and complete your monitoring survey. If you have any questions or concerns regarding the protocol, contact your local coordinator prior to monitoring.

Safety

Safety and comfort of all volunteers is our primary concern. Follow the safety guidelines below every time you monitor.

- Do not monitor alone. Always go out with at least one other person.
- Let someone know where you are going and when you plan to return. Check in with this person when monitoring is complete.
- Be aware of your surroundings and potential hazards: incoming tides, wet slippery rocks, etc.
- Wear sturdy, waterproof footwear; you may be traveling over rough terrain and rocks can be slippery!
- Check weather forecasts before traveling to the monitoring site, and keep in mind that weather conditions can change quickly. Avoid monitoring in bad weather and never go out if there is a chance of lightning.
- Dress appropriately for weather conditions, and bring extra clothing just in case.
- Always carry a well-stocked first aid kit with you, and know how to use it.
- If you feel uncomfortable or feel your safety is at risk for any reason, discontinue monitoring and leave the location. Discuss the issue with your local coordinator.

Supply List

- Datasheets and monitoring instructions
- Clipboard and pencil
- Thermometer
- Refractometer
- Marine Invasive ID guides and/or Marine Bioinvader ID cards
- 50 m Measuring tape
- Bucket(s)
- Small collection containers and baggies
- Wading shoes/boots
- Dip net
- Magnifying glass
- Labels
- Cooler with ice and/or 75-90% alcohol
- Digital camera

Monitoring Steps

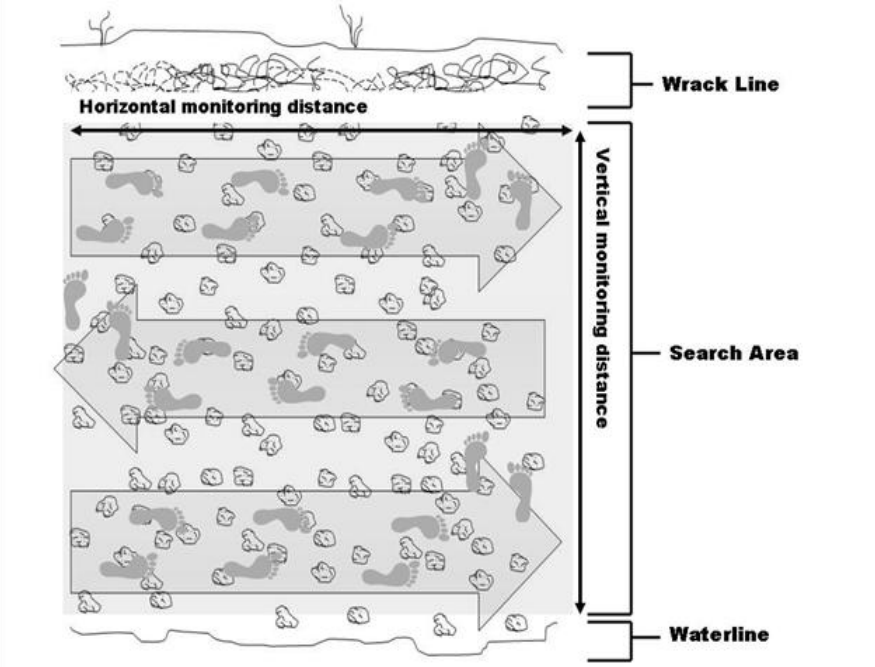
1. Collect site data
    - Take a minute to look around your monitoring location and note any changes that may have impacted species at the site since your last visit, i.e. scour from storms, intense recreational use, etc. Record these observations on your datasheet.
    - Proceed to your designated monitoring location and record weather conditions, time, date, and other associated information on the appropriate sections of your datasheet.

2. Record physical measurements
    - Wade out into the water a short distance to about 1 foot depth. Submerge the thermometer about 6 inches below the water surface for one full minute and record the temperature value on your datasheet.
    - If you have a refractometer, collect a small amount of surface water and place several drops on the glass prism. Record salinity value (as indicated by the shadow line) on your datasheet.

3. Prepare the search area for monitoring
    - Beginning at the reference point or coordinates identified by your volunteer coordinator, measure out the search area length with your measuring tape horizontally along the wrack line as shown in Figure 5.
    - With a rope or other object, mark the beginning and end of the search area at each corner to make a square with the receding water line as the border.

Figure 5: Cobble shore monitoring

Search-area setup and visual scan pattern. Shaded area indicates search area.



4. Monitor for marine invasive species
    - Begin walking along the water line as shown in Figure 5 at low tide or a few minutes prior, noting the presence of the 16 current invaders or seven potential invaders.
    - Turn over rocks every few steps to look for crabs and other species (be sure to return rocks to the position you found them).
    - For each of the 23 species on your ID cards, note on your datasheet whether it is present or absent at the site and indicate the abundance using the following terms:
        - Abundant: present almost everywhere in the search area, or under all rocks
        - Common: present at most of the monitoring site (present in over half of the search area, or under most rocks)
        - Few: present, but at low abundance (found in less than half of the search area, or under less than half rocks)
        - Rare: one to two specimens present at site
        - Absent: not observed at the site
    - Gently move large algae or species that may be blocking your view with your hand or dip net. Collect samples of organisms for a closer view with your magnifying glass if needed. Use the Marine Bioinvader ID cards and other field guides to assist you.

- When you reach the end of the search area length, take one step toward the wrack line and begin to search parallel to the shoreline again for the length of the search area as shown in Figure 5. Continue to turn over rocks every few steps.

Keep in mind that not finding a species at a site is just as important as finding one!

5. Conduct parallel sweeps of the area for marine invasive species in this fashion until you reach the wrack line and the entire area has been examined (the survey will take about an hour to complete). Note the start time and end time of the survey on your datasheet.

6. If you cannot identify a species
   - Take clear photographs of any unusual specimens or organisms you cannot identify using the steps outlined in the Specimen Collection Protocol (page 27).
   - Record on your datasheet whether a photograph was taken and give the label number provided in the photograph.
   - If you do not have a camera, or are having trouble getting a clear photo of the organism, collect a specimen. Either place the organism in a baggie with seawater and a label and place into a cooler of ice for later identification, or preserve in alcohol, whichever is the preferred method for your organization. Talk to your local coordinator about preferred preservation methods.
   - Transfer all photos and/or specimens to your volunteer monitoring coordinator in a timely fashion.

If you suspect a potential invader . . .

1. Take clear photographs of the organism and label
2. Collect a specimen either by freezing or by preserving in alcohol. Labels must accompany any specimen.
3. Transfer specimens and accompanying photographs to your local coordinator ASAP.

7. Wrap up the monitoring day
    - Before you leave the site, make sure you have taken all of your equipment with you and have collected or disposed of specimens properly in accordance with the Specimen Collection Protocol (page 27).
    - Check the completeness and accuracy of your datasheet, initial it, and hand it in to your volunteer coordinator at the designated time/place along with any collected specimens.

TIDEPOOL MONITORING

Tidepools are an excellent location to observe non-native species. Since tidepools can hold water throughout the tidal cycle and are less exposed than the open shore, many organisms are concentrated within them. A single large tidepool or a number of smaller tidepools can be monitored, depending on the location and topography of your site.

Pros	Cons
✓ Monitors can look for the presence of marine introduced species in a natural habitat ✓ Tidepools can host a wide variety of organisms.	✓ Monitoring is tide dependant, although more flexible than cobble shores. ✓ Rough terrain may be difficult to navigate. ✓ Availability of access points may limit monitoring sites.

Monitoring Considerations

Use the information below to guide you in choosing when and where to sample to ensure data quality and volunteer safety.

Site Selection

Select one large tidepool (> 3 feet across) or a few smaller tidepools to monitor. Tidepools should retain water during most low tides, be easy to access, and be located in the mid-to lower-tidal range. Rocky shores vary in their navigability; rocks may be jagged with slippery blue-green algae or larger seaweeds, and tides can be unpredictable with strong currents. Thus, it is best to select a site where you will not have to climb long distances to access a tidepool.

If you can, select a site with public access down to the shore and adequate parking. If you choose a site without a public access way, you will need to obtain permission from the landowner to cross their property. Property rights of the intertidal zone vary and can be complicated. When in doubt, ask permission from your town clerk or property abutters before accessing a site that is not posted for public access. In Massachusetts, a list of public access points can be located through the CZM coastal access site:

www.mass.gov/czm/access/products/access_locator.htm. Once sites are selected, take a photograph and GPS coordinates if possible. Take detailed notes on how to access the site, where to park, and who to notify when accessing the site (if needed).

Monitoring With the Tides

Unlike cobble shores, where monitoring occurs during low tide, tidepool monitoring can be more flexible depending on the location of the pool. For tidepools in the lower intertidal, monitoring at or around low tide will be necessary. For mid-shore pools, monitoring can occur whenever the tidepool is exposed. See http://tbone.biol.sc.edu/tide/sites_useastupper.html or local tide charts to estimate tide times for your area. Tidal cycles differ markedly from one site to the next; use the closest tide estimate to your area that you can find. When setting up monitoring dates/times, be sure to provide enough time for volunteers to arrive at the site, walk to the tidepool, and set up equipment *before* monitoring begins. Having one or two "rain dates" prescheduled is also a good idea in case of inclement weather.

Monitoring Protocol for Tidepools

The following checklists and steps will help you prepare to monitor and complete your monitoring survey. If you have any questions or concerns regarding the protocol, contact your local coordinator prior to monitoring.

Safety

Safety and comfort of all volunteers is our primary concern. Follow the safety guidelines below every time you monitor.

- Do not monitor alone, always go out with at least one other person.
- Let someone know where you are going and when you plan to return. Check in with this person when monitoring is complete.
- Be aware of your surroundings and potential hazards; incoming tides, wet slippery rocks, etc.
- Wear sturdy, waterproof footwear; you may be traveling over rough terrain and rocks can be slippery!
- Check weather forecasts before traveling to the monitoring site, and keep in mind that weather conditions can change quickly. Avoid monitoring in bad weather and never go out if there is a chance of lightning.
- Dress appropriately for weather conditions and bring extra clothing just in case
- Always carry a well-stocked first aid kit with you and know how to use it.
- If you feel uncomfortable or feel your safety is at risk for any reason, discontinue monitoring and leave the location. Discuss the issue with your local coordinator.

Supply List

- Datasheets and monitoring instructions
- Clipboard and pencil
- Thermometer
- Refractometer
- Marine invertebrate ID guides and/or Marine BioInvader ID cards
- Measuring tape
- Bucket(s)
- Wading shoes/boots
- Small collection containers and/or baggies
- Dip net
- Magnifying glass
- Labels
- Cooler with ice and/or 75%-90% alcohol
- Digital camera
- Polarized sunglasses

Monitoring Steps

If you have a number of small tidepools, repeat the steps for each tidepool. Use a separate datasheet for each tidepool you monitor.

1. Collect site data
    - Take a minute to look around your monitoring location and note any changes that may have impacted species at the site since your last visit i.e. scour from storms, intense recreational use, etc. Record these observations on your datasheet.
    - Proceed to your designated monitoring location and record weather conditions, time, date, and other associated information on the appropriate sections of your datasheet.

2. Record physical measurements
    - Submerge the thermometer about 6 inches below the water surface for one full minute and record the temperature value on your datasheet.
    - If you have a refractometer, collect a small amount of surface water and place several drops on the glass prism. Record salinity value (as indicated by the shadow line) on your datasheet.

3. Monitor for marine invasive species
    - Visually scan the entire tide pool area for the 16 established invaders and seven potential invaders featured on the Marine Bioinvader ID cards.
    - Quietly sit at the edge of the pool for a few minutes to observe mobile species or others you may have missed with the visual scan.

- Turn over rocks to look for crabs and other mobile species (be sure to return rocks to the position you found them).
- Gently move large algae or species that may be blocking your view aside with your hand or dip net (return algae to their original position when you are done).
- Collect samples of organisms for a closer view with your magnifying glass if needed. Use the Marine Bioinvader ID cards and other field guides to assist you.
- For each of the 23 species, note whether it is present or absent in the tidepool on your datasheet, and indicate the abundance using the following terms:
    - Abundant: present almost everywhere in the tidepool
    - Common: present in over half of the tidepool area
    - Few: present, but at low abundance (found in less than half of the tidepool area)
    - Rare: one to two specimens in the tidepool
    - Absent: not observed in the tidepool

Keep in mind that not finding a species at a site is just as important as finding one!

4. If you cannot identify a species
    - Take clear photographs of any unusual specimens or organisms you cannot identify using the steps outlined in the Specimen Collection Protocol (page 27).
    - Record on your datasheet whether a photograph was taken and give the label number provided in the photograph.
    - If you do not have a camera, or are having trouble getting a clear photo of the organism, collect a specimen. Either place the organism in a baggie with seawater and a label and place into a cooler of ice for later identification, or preserve in alcohol, whichever is the preferred method for your organization. Talk to your local coordinator about preferred preservation methods.
    - Transfer all photos and/or specimens to your volunteer monitoring coordinator in a timely fashion.

If you suspect a potential invader . . .

4. Take clear photographs of the organism and label.
5. Collect a specimen either by freezing or by preserving in alcohol. Labels must accompany any specimen.
6. Transfer specimens and accompanying photographs to your local coordinator ASAP.

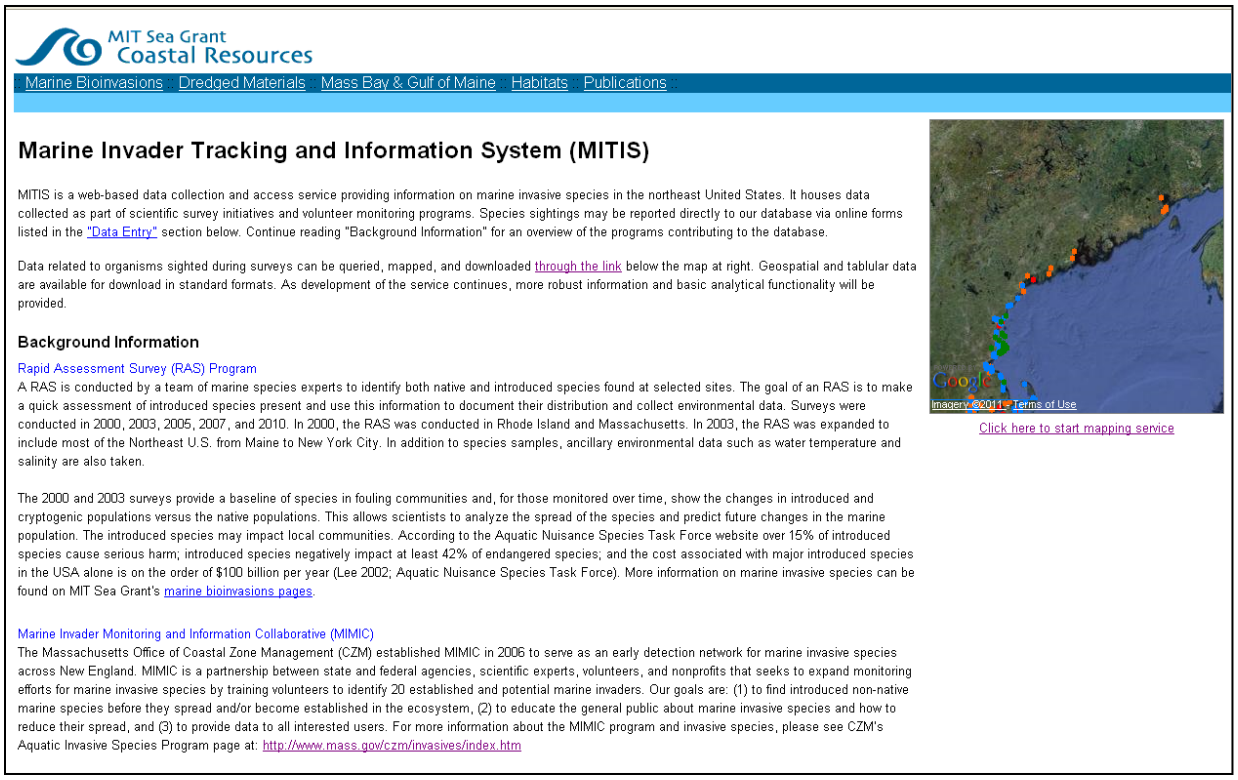
5. Wrap up the monitoring day
    - Before you leave the site, make sure you have taken all of your equipment with you and have collected or disposed of specimens properly and in accordance with the Specimen Collection Protocol (page 27).
    - Check the completeness and accuracy of your datasheet, initial it, and hand it in to your volunteer coordinator at the designated time/place along with any collected specimens.

DATA ENTRY

Data are entered by the local coordinators. After all datasheets are handed in for the day, the coordinator will look them over for completeness and address any questions regarding entries with the volunteer recorder. The data then will be entered into the Marine Invader Tracking and Information System: http://massbay.mit.edu/mitis/.

After data are entered and proofread, make a copy of all datasheets and mail them to the program coordinator for record-keeping.

Figure 6: Screen shot of the MITIS database



SPECIMEN COLLECTION

The MIMC visual survey method is non-destructive, thus specimens do not need to be collected under most circumstances. If you cannot identify a species, suspect a potential invader, or are training to identify organisms, you may need to collect a specimen. This protocol describes three ways to collect specimens: photography (preferred in most circumstances), temporary collection (specimen is returned alive), and collection of an organism for short-term identification purposes (either by freezing or chemical preservative).

Collection Considerations

Keep the following considerations in mind before and after you have collected a specimen.

Permitting

For Massachusetts, volunteer groups participating in the program are covered under an overarching collection permit for MIMIC. For groups in locations other than Massachusetts, appropriate collecting permits must be procured by each volunteer group per local regulations. When in doubt, please contact the MIMIC coordinator to ensure that you are covered under the appropriate permit(s) for your location. For any collection (removing an organism from its original habitat), a record must be kept for annual reporting purposes. The record must include: date, name of species, location, and disposal method.

Labeling

A clear label is required whenever you collect or photograph an organism. Having an original label with site ID, location, time, date, collector, organism name, and other pertinent information is critical to ensure that the data are reported accurately and that specimens are not lost in the shuffle. Below are the two examples of labels to be used:

- Internal Labels - A label of waterproof paper and pencil should be placed in each specimen collection container. The label will have a number, date, and site name (Figure 7). The number written on the label should correspond to a description of the organism on your datasheet or a separate sheet that details the location, collection notes, collector, date, and how the organism is preserved. This is critically important as external labels can fall off, and it is difficult to determine what specimens are and where they came from after the fact.

- External Labels - An external label shall be placed on the outside of any collecting container. The label should include date, location, collector, preservative, and specimen name (if known), and reference the internal label # (Figure 7). The label can be written in waterproof pen, marker, or pencil.

Figure 7: Internal and external label examples for a specimen of *Didemnum vexillum* collected at the Beverly Pier in Massachusetts.

Internal label

#5
5/16/2011
Beverly
Pier

External label

5/16/2011
Beverly Pier, MA
Didemnum vexillum,
#5 95% Ethyl
alcohol

Specimen Collection Protocol

Follow the steps below to ensure collection of quality specimens for identification and training purposes.

Photographing Specimens

1. Place the animal in a tray or shallow container with seawater, or against a flat surface.
2. For algae, place on a white or neutral background (the dock surface will suffice).
3. Place a piece of paper in the frame with a photo number and the location for labeling (see Figure 8).
4. Take one picture of the whole organism, with an object in the frame for reference (i.e. a penny, ruler, etc.), and the label.
5. If possible, take a close up picture of the specimen. This works best if the camera has a macro function (look for the flower symbol on your digital

camera). For the best photos, you may need to take the specimen out of the seawater.

6. Keep track of the number of photos you take and list label numbers on the datasheet with a brief description of the object.
7. Return specimens where you found them, unless you have collected *Didemnum vexillum.* Transfer potential invaders to your volunteer coordinator as directed in the procedure on page 30. Place any collected *D. vexillum* in a plastic bag and discard in the trash. Keep a record of each *D. vexillum* collection and disposal for permitting purposes.
8. Transfer photos promptly to your local monitoring coordinator.

Figure 8: Specimen Photographs
From top left, *Grateloupia turuturu* photographed with label and pencil for size reference, periwinkle photographed with label and penny for size reference, *Didemnum vexillum* photographed on dock with label, and *D. vexillum* close up view.

Temporary Collection of Live Specimens for On-Site Identification

1. Carry a plastic tray or bucket out to the site where training will be conducted.
2. Fill the container partway with seawater and keep it cool (out of the sun).
3. When a species of interest is found, place it in the tray for examination on site.
4. Return specimens where you found them, unless you have collected *Didemnum vexillum*. Transfer potential invaders to your volunteer coordinator as directed on page 30. Place any collected *Didemnum vexillum* in a plastic bag and discard in the trash. Keep a record of each *Didemnum vexillum* collection and disposal for permitting purposes.

Collecting Specimens for Identification Purposes

1. If you wish to examine specimens away from the monitoring location, place the organism in a small plastic bag with a label and place in a cooler of ice.

2. Alternatively, you can temporarily store organisms in 70-95% alcohol by volume. It is best to use a glass or plastic vial when using alcohol.
3. For alga species, lay specimen in between two damp paper towels and place in a plastic bag with a label, or in a small container with seawater and a label.
4. For short-term storage, organisms can be placed in the refrigerator for up to 24 hours and in the freezer for longer periods of time.
5. Keep a collection record on each specimen for permitting purposes.
6. Do not return organisms back to the field. Dispose of specimens in the trash when identification is complete.

Specimen Transfer

Photographs can be emailed to the recipient or mailed in hard-copy form. Specimens to be sent to the MIMIC program coordinator or scientific experts for confirmation should be prepared in the following fashion:

1. Frozen specimens can be transferred in a cooler of ice if the drop-off time is <1 hour. If transfer time is greater than this, or the specimen is to be mailed, preserve the organism in 70-95% alcohol (or vodka in a pinch) in a glass vial or container.
2. Place a label of waterproof paper in the container and affix a descriptive label on the outside that includes date, location collected, collector, and how the specimen was preserved (see Figure 7 on page 28).
3. Include a description of the specimen with the mailing.
4. Mail the specimen to the recipient. Be sure to follow your mailer's rules and guidelines for transporting chemicals (some carriers will not mail items in alcohol).
5. Notify the recipient that you have mailed the specimen.

Potential Invaders

One of the most critical pieces of information shared in the MIMIC program is the discovery of a potential invader or new species by a volunteer or local coordinator. If a potential invader is suspected the following *must* occur:

1. Take clear photograph(s) of the organism and the label. Record date, time, location, and observer on the datasheet.
2. Collect a specimen, either by freezing or by preserving in alcohol. Labels must accompany any specimen.
3. Transfer specimens and accompanying photographs to the local coordinator as soon as possible.
4. The local coordinator will notify the MIMIC program coordinator right away of the suspected potential invader.
5. Arrangements will be made to transfer specimens and/or photographs to the MIMIC program coordinator or designated scientific expert in a timely fashion.

IDENTIFICATION TIPS

How many species can you identify?

Marine communities can be a tangled web of many species, some crowding and even overgrowing each other (see examples above). This can make identification of single individual difficult. Use these four general rules, in addition to field guides, trainings, and resources from your MIMIC coordinators, to make identifying organisms easier.

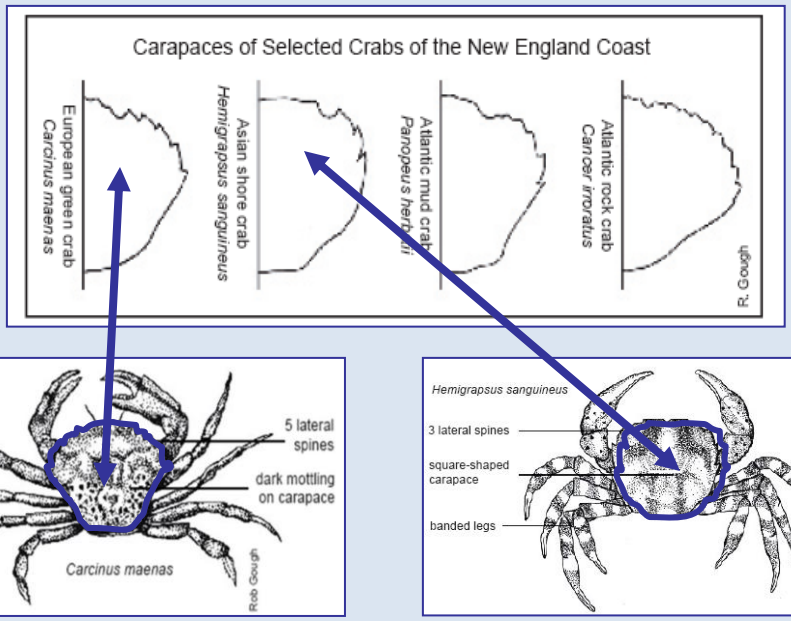
> **Rule #1:** Let the **morphology** (shape and texture) of the organism primarily guide your identification instead of color. Many species have various color morphs, and although individuals can have different growth forms, shape is generally less variable than color.

Figure 9: *Botrylloides violaceus* color variants

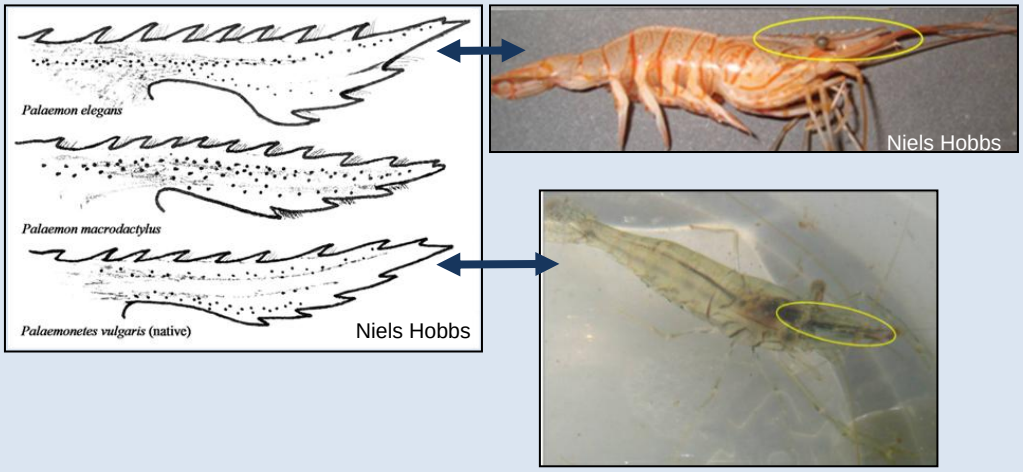
Although the common name of this tunicate is “orange sheath tunicate,” it can be a virtual rainbow of colors. Even colonies growing side-by-side can vary widely in color!

Figure 10: Crustacean morphology

While colors can vary within the species, both native and non-native crabs in our region can be distinguished from each other by the shape of their carapace, see below:



Similarly, native and non-native shrimp can be distinguished from each other by the shape of their rostrum (beak):



Rule #2: Be aware of species that look similar to each other, including both native and non-native species. Your MIMIC coordinator will identify these in trainings. Field guides and other resources listed at the end of this section can also assist you.

Figure 11: Red beard sponge, *Clathria prolifera* (A), can appear similar to orange sheath tunicate, *Botrylloides violaceus* (B), particularly from far away. On closer inspection, the spongy texture and appearance of red beard sponge distinguish it from the firmer and more organized structure of the tunicate.

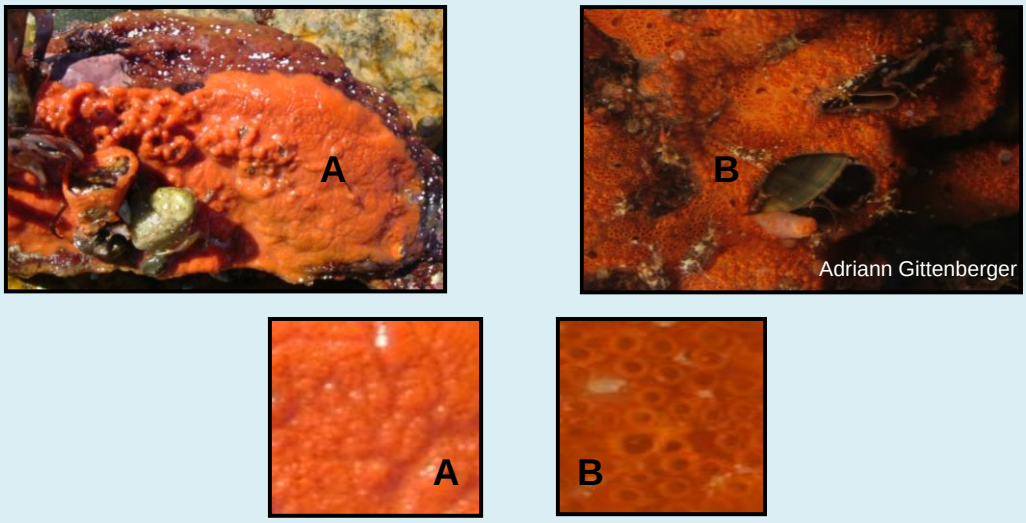


Figure 12: The non-native tunicates, *Botrylloides violaceus* (A) and *Didemnum vexillum* (B), can appear similar to the native species, *Aplidium glabrum* (C). A careful examination of colony structure with a hand lens may be necessary to distinguish these species.

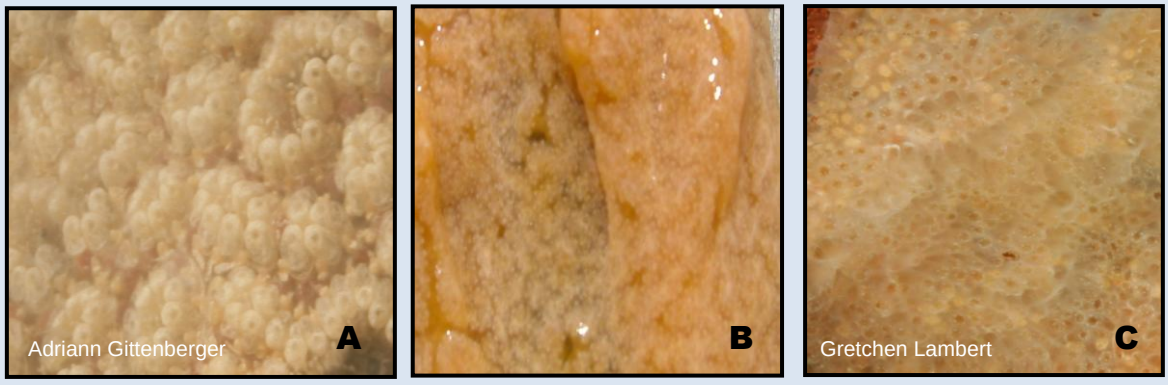


Figure 13: The native tunicate *Molgula spp*., (A) can look similar to the potential invader *Corella eumyota*, (B). *Molgula spp.* have a more spherical body shape than *C. eumyota* which is generally ovoid or egg-shaped. *Molgula* typically attaches at the bottom while *C. eumyota*'s attachment point is often on the side of the animal. *Molgula* spp. also have both siphons positioned at the top of the body versus separated by approx. one third of the body length as in *C. eumyota.* While the tunics of both *Molgula spp.* and *C. eumyota* have a smooth surface, *Ascidiella aspersa,* (C) has a rough surface due to tiny surface bumps (papillae).

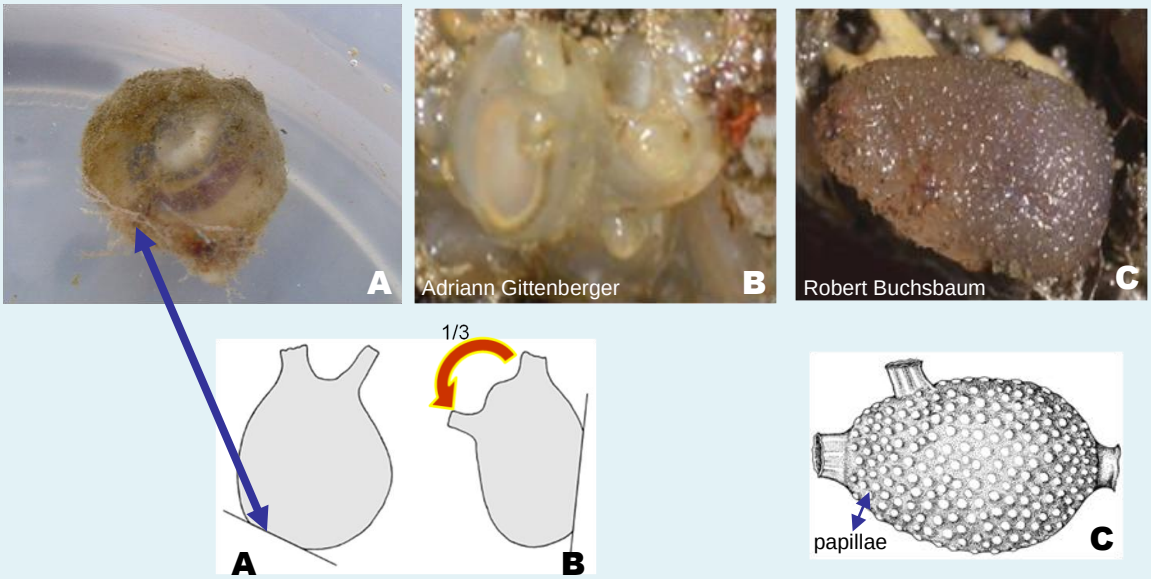
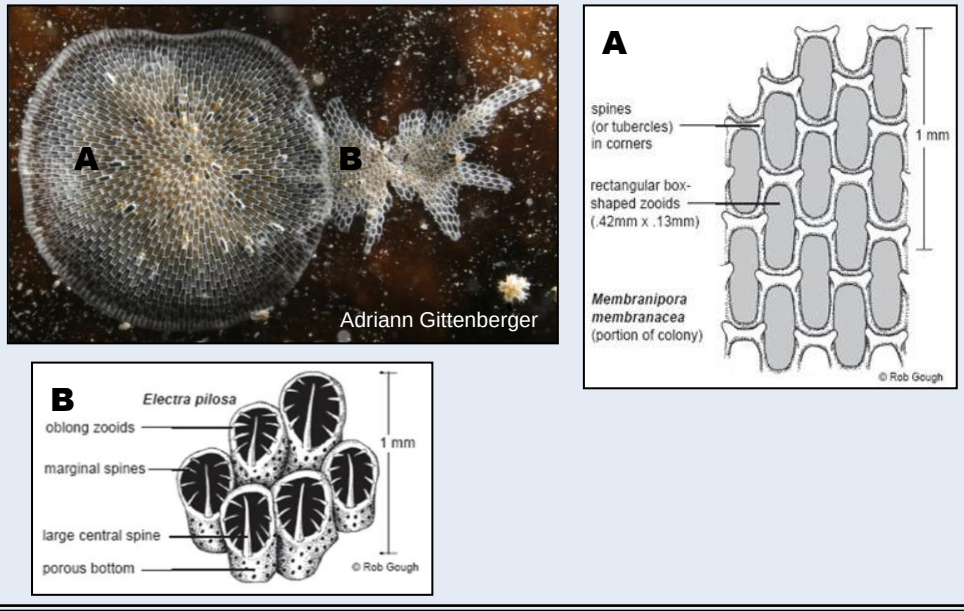


Figure 14: Lacy crust bryozoan, *Membranipora membranacea* (A), can be mistaken for *Electra pilosa* (B). The shape and pattern of zooids (individual animals) and overall colony shape distinguish the two species as shown below:



Rule #3: Learn the scientific names of species and use them. Your pronunciation does not have to be perfect (try saying *Synidotea laevidorsalis*, scientific name for the potential invader, Asian isopod, three times fast!). While common names can vary for the same organism, no two species will have the same scientific name. Using the scientific name (in addition to the common name if you prefer) will lessen confusion about the identity of an organism.

A rose by any other name… Oyster thief, dead man's fingers, and green fleece are all common names for the non-native algae, *Codium fragile ssp. fragile*.

Rule #4: Don't be afraid to ask for help! Although MIMIC focuses on species that can be identified without the use of a microscope, many organisms can look the same and it can be difficult to tell them apart. Even taxonomic experts have difficulty identifying species at times. When in doubt, never guess what the species is. Take a quality photograph or a specimen and get help!

Identification Resources

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Martinez, A.J. 1999. Marine life of the North Atlantic: Canada to New England. Down East Books. Camden, ME.

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Pollock, L.W. 1998. A practical guide to the marine animals of northeastern North America. Rutgers University Press. New Brunswick, NJ.

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GLOSSARY

Abundance: A measure of the number or relative quantity of organisms per unit area.[9]

Cryptogenic: A species that cannot be determined to be native or introduced.[8]

Early Detection: A process to detect **non-native** organisms soon after they are introduced to a location, before they become established in the ecosystem.

Estuaries or Estuary: A body of water along the coast where freshwater meets and mixes with ocean water.

Invasive Species: non-native or **cryptogenic** species that are introduced by humans to a new location and cause harm to the ecosystem or economic resources of the invaded area.[8]

Introduced (as in introduced species): Species that have been dispersed outside of their native range by human activity.[7]

Morphology: The form and structure of organisms.

Native Species: Species that naturally inhabit a given area or region (not introduced by humans).

Nearshore: The general area from the low water line to shallow subtidal waters along the coast.

Non-native Species: A species found outside of its natural range.

Sea Squirt: Sac-like marine filter feeders in the Tunicata subphylum.

Sessile: Organisms that are attached to a **substrate** for the duration of their adult life.

Substrate: Substance on or in which an organism lives or to which it is attached.

Tidepool: A pool of salt water present on the shore as a result of an ebbing tide.

Vectors: Transport mechanisms that introduce species to new locations and/or habitats outside of their native range.

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APPENDIX A: MONITORING AGREEMENT

This form is to be filled out by participating watershed programs and/or volunteer coordinators of the MIMIC program. Please complete all fields to the best of your knowledge (attach additional sheets if more space is needed) and submit to the MIMIC program coordinator no later than four weeks prior to first monitoring date. If you have any questions regarding this form or its contents, please contact Adrienne Pappal at 617-626-1218, or adrienne.pappal@state.ma.us.

1. Organization Name and Address:		
2. MIMIC Volunteer Coordinator Name and Contact Information:		
3. Person(s) responsible for data entry:		
4. Volunteers:		
5. **Trainings attended (or scheduled):**	**If yes, list who attended (volunteer or coordinator) and date(s)**	
MIMIC Coordinator training	Y N	
MIMIC Volunteer training	Y N	
Other *(briefly describe below)*	Y N	

6. Monitoring Locations (list site name and ID # as applicable):	**Type: marina w/permanent dock (MP), marina w/seasonal dock (MT), cobble shore (CS), tidepool (TP).**
1.	MP MT CS TP
2.	MP MT CS TP
3.	MP MT CS TP
4.	MP MT CS TP
5.	MP MT CS TP
Other *(please list)*:	

7. Dates of monitoring visits (estimate or range ok). Example: Site 1, 6/20/11, 6/30/11 or 7/2/11, 7/12/11, 8/19/11-8/23/11	
Site 1	Site 4
Site 2	Site 5
Site 3	
Other *(please list)*:	

8. Please describe the safety measures employed by your program:

Additional Information:

MIMIC Volunteer Coordinator Signature	**Date**
MIMIC Program Coordinator Signature	**Date**

APPENDIX B: DATASHEET

Marine Invader Monitoring and Information Collaborative Datasheet*

Date:

Site ID:

Observers:

Location Type (circle one): dock cobble shore tidepool other:

Location Description:

Begin Time:	**Salinity**	**Water Temp**	**Weather**	**Time of Low Tide**
End Time:				

Established Invaders

Scientific Name	**Common name**	**Present (X)**	**Absent (X)**	**Quantity**	**Photo#**	**Comments**
Ascidiella aspersa	Sea Squirt	[ ]	[ ]			
Botrylloides violaceus	Sheath Tunicate	[ ]	[ ]			
Botryllus schlosseri	Golden Star Tunicate	[ ]	[ ]			
Bugula neritina	Purple Bushy Bryozoan	[ ]	[ ]			
Caprella mutica	Skeleton Shrimp	[ ]	[ ]			
Carcinus maenas	Green Crab	[ ]	[ ]			
Codium fragile	Green Fleece	[ ]	[ ]			
Diadumene lineata	Striped Anemone	[ ]	[ ]			
Didemnum vexillum	"Mystery" Colonial Tunicate	[ ]	[ ]			
Diplosoma listerianum	Diplosoma Tunicate	[ ]	[ ]			
Grateloupia turuturu	Red Alga	[ ]	[ ]			
Hemigrapsus sanguineus	Asian Shore Crab	[ ]	[ ]			
Membranipora sp.	Lacy Crust Bryozoan	[ ]	[ ]			
Ostrea edulis	European Oyster	[ ]	[ ]			
Palaemon elegans	European Rock Shrimp	[ ]	[ ]			
Styela clava	Club Tunicate	[ ]	[ ]			

Potential Invaders- If found, notify MIMIC program coordinator immediately at (617)626-1218.

Scientific Name	**Common name**	**Present (X)**	**Absent (X)**	**Quantity**	**Photo#**	**Comments**
Corella eumyota	Tunicate	[ ]	[ ]			
Eriocheir sinensis	Chinese Mitten Crab	[ ]	[ ]			
Hemigrapsus takanoi	Brush-Clawed Shore Crab	[ ]	[ ]			
Rapana venosa	Veined Rapa Whelk	[ ]	[ ]			
Sargassum muticum	Japanese Seaweed	[ ]	[ ]			
Synidotea laevidorsalis	Asian Isopod	[ ]	[ ]			
Undaria pinnatifida	Undaria Kelp	[ ]	[ ]			
Other Species:						

Notes:

Quantity Key:

Abundant (A) = present almost everywhere you look

Common (C) = present in most of the location (over half of the areas looked)

Few (F) = present, but at low abundance (less than half of the areas looked)

Rare (R) = only one to two specimens present at site

Absent (N)= not present, not observed at the site

*Adapted from Salem Sound Coastwatch.

APPENDIX C: MIMIC FACTSHEET

Use this factsheet as a guide or conversation starter with the interested public when monitoring for marine invasive species.

What is MIMIC?

- MIMIC (the Marine Invader Monitoring and Information Collaborative) is a partnership between state and federal agencies, scientific experts, volunteers, and nonprofits that seeks to expand monitoring efforts and early detection of marine invasive species by training volunteers to identify 23 established and potential marine invaders.
- Our goals are to:
    - Find introduced non-native marine species before they spread and/or become established.
    - Educate the general public about marine invasive species and how to reduce their spread.
    - Provide data to all interested users.

What does MIMIC look for?

- Invasive species are non-native species that are introduced by humans to a new location and cause harm to the ecosystem or economic resources of the area that they invade.
- MIMIC monitors 16 established introduced species and seven species that have the potential to invade our region (potential invaders).
- We focus the majority of monitoring at ports, marinas, and areas commonly used for boating and recreation because of the enhanced risk of species being introduced to these areas. Since non-native species can easily spread from their introduced locations to other habitats, we also monitor cobble shores and tidepools.

Why are invasive species so bad?

- There are three broad categories of impacts from introduced marine species: ecosystem impacts, economic impacts, and human health impacts.
- Ecosystem examples:
    - Community shifts - The non-native bryozoan *Membranipora membranacea* colonizes native kelps, leading to blade breakage and removal during winter storms. The resulting bare patches are colonized by another invader, *Codium fragile* ssp. *fragile*, changing the community structure.
    - Predation - Juvenile blue mussels comprise up to 30% and 45% of the diet of the non native crabs *Hemigrapsus sanguineus* and *Carcinus maenas*, respectively.
    - Competition - The native periwinkle *Littorina saxatilis* has a reduced growth rate when it is forced to compete with the non-native periwinkle *Littorina littorea* for food; smaller snails are more susceptible to predation by *C. maenas*.
    - Habitat alteration - The tunicate *Didemnum vexillum* has colonized areas on Georges Bank, potentially smothering critical habitat and competing with native species.
    - Extinction - Invasive species are thought to be a leading factor in species extinctions, seconded only by habitat destruction.
- Economic examples:
    - Fouling by tunicates on gear and harvested product is a major issue for the mussel farming industry and commercial fisheries.
    - Non-native microorganisms such as Infectious Salmon Anemia (ISA), MSX Oyster disease, Dermo Oyster disease, and Bonamia oyster disease impact commercially important species.
    - The non-native green algae *C. fragile fragile* washes ashore frequently on beaches, leading to noxious odors and unsightly deposits that are costly to clean up.
- Public health examples:
    - Introduced pathogens, such as the bacteria responsible for cholera in humans, have been found in ballast water and could potentially be discharged to local waters.
    - Non-native dinoflagellates may contribute to red tide outbreaks.

How did they get here?

- Marine invasive species are inadvertently or intentionally introduced to new habitats by humans.
- Transport mechanisms, or vectors, include shipping (ballast water and hull fouling), fisheries, aquaculture, the pet trade, intentional introductions for food sources, research, educational supplies, and other accidental introduction methods.

What can we do about marine invasive species?

- Inspect your hull and remove any attached organisms from your boat when you take it out of the water and dispose of them in the trash.
- Never release unused bait or bait packaging materials into the water - Put unused bait into a plastic bag or container and place it in the trash.
- Be careful not to let your bait escape unintentionally!
- Clean your equipment between visits to different water bodies.
- Eat your seafood, do not release it.
- Put seafood waste in the trash (including shells).
- Buy local seafood.
- Choose native species as pets and for water gardens.
- Do not release aquarium species into local waterbodies or storm drains.
- Contact your state and federal legislators about the importance of strong measures for prevention of non-native species.

How do I find out more?

- Go to the Massachusetts Office of Coastal Zone Management's Aquatic Invasive Species Program Page: www.mass.gov/czm/invasives/index.htm or contact your local MIMIC monitoring group.

Information for this factsheet was sourced from Pappal 2010 and references therein and the Massachusetts Office of Coastal Zone Management's Aquatic Invasive Species Program.

Massachusetts Office of Coastal Zone Management's Aquatic Invasive Species Program: www.mass.gov/czm/invasives/index.htm

Pappal, AL. 2010. State of the Gulf of Maine Report: Marine Invasive Species. Gulf of Maine Council on the Marine Environment. 21 p. Available: www.gulfofmaine.org/state-of-the-gulf/docs/marine-invasive-species.pdf

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