

A Citizen's Guide to Monitoring Marine Invasive Species



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INTRODUCTION

This Monitoring Guide is meant to provide volunteers and volunteer coordinators with the information needed to initiate or become involved in a marine invasive species monitoring program. Information about current locations, abundance, and characteristics of many marine invasive species varies and is often limited. Land-based invasive plant programs have successfully involved citizen volunteers in data collection and invasive species eradication for many years. However, employing volunteers in marine biological invasion research and detection is relatively new.

Funding in 2004 from a Gulf of Maine Council Action Plan Grant enabled Salem Sound Coastwatch (SSCW) to conduct a regional pilot program enlisting volunteers to gather quantitative information on marine invasive species in a variety of coastal habitats. SSCW's Coastal Habitat Invasives Monitoring Program (CHIMP) trained citizen volunteers to conduct monthly monitoring at permanent floating docks, along rocky shorelines, and in tidepools in five communities within Salem Sound and Cape Ann, Massachusetts. This pilot program generated important information on the training needs of local volunteers and effective survey methods for monitoring marine invasive species. SSCW learned that citizens needed more extensive training than anticipated, better species identification materials, and longer assistance in the field before becoming confident in their monitoring abilities.

However, it also became clear that, with appropriate guidance, volunteers could master the material and conduct productive monitoring in their communities. As a result, SSCW has developed this manual to explain CHIMP's three data collection methods. In addition, a fourth data collection method, a visual survey, has been added to involve a larger range of volunteers and develop better early detection efforts. Massachusetts Office of Coastal Zone Management has provided SSCW with funding to produce marine invasive species identification cards to augment species identification efforts. The techniques and information in this manual are works in progress. As you become involved in collecting data on marine biological invaders, your feedback is welcomed.

MARINE BIOLOGICAL INVASIONS

Biological invasions have emerged as one of the leading environmental threats to our coastal and marine habitats. Marine biological invaders are species that have been moved beyond their natural geographic range by human activities. These nonindigenous marine organisms are being transported to new regions of the world everyday. They travel by ships in ballast water or attached to hulls. They may be mixed in fresh bait or fish packaging. Some escape or are released from aquariums, aquaculture farms, or the pet and live food trade. While human-mediated activities have redistributed organisms around the world for centuries, the number of species being relocated and released by transport methods or vectors continue at an unprecedented rate (Carlton 1989).

Not all nonindigenous species survive their release into a new environment. In their native habitat, most species live in balance with other organisms. Diseases, competition, predators, and ecosystem interactions control their populations. However, the situation often changes when these species are introduced into new parts of the world. When an introduced species has the ability to reproduce in large numbers and to outcompete native species for food and space, they can offset the ecological balance. With nothing to keep nonindigenous species in check, these invaders may have damaging affects on their new environments. Invasive species are considered second only to human development in causing declines in the total number of species in the U.S. and worldwide. This loss in biodiversity takes place when invasive species

1. outcompete native populations for food and space;
2. restructure established food webs;
3. interbreed with native species, resulting in gene pool alterations and/or hybridization;
4. import diseases, pathogens, and parasites.

Besides the ecological affects, marine bioinvasions can have socio-economic and human health consequences, such as

1. reducing available food sources;
2. damaging infrastructure and equipment;
3. fouling beaches;
4. spreading diseases, pathogens, and parasites.

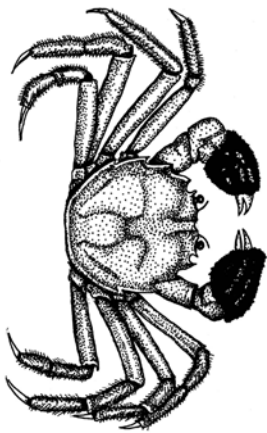
Four Examples of Marine Biological Invasions

The arrival of the club tunicate, *Styela clava*, in Newport Harbor, California in the 1920s resulted in a loss of biodiversity. By 1949, it had become one of the two dominant tunicate species in the bay, having replaced native solitary tunicate species (Lambert and Lambert 1995).



The impact of invading lacy crust bryozoan, *Membranipora membranacea*, on kelp, *Laminaria saccharina*, can lead a restructuring of the food web. When the kelp blades become encrusted with lacy crust, the kelp become stiff and break as wave energy increases. This, in turn, has ramifications for other organisms such as native green sea urchins, *Strongylocentrotus droebachiensis*, which graze in kelp forests.

Aquaculture and shellfish industries are facing serious problems from invasive fouling species such as solitary and colonial tunicates. Invasive tunicates compete for food and space on substrates meant for cultured species. These invaders add immense weight to lines and netting, causing cultured oysters to be pulled off. When they fall to the bottom, they become prey for sea stars and crabs. As colonial tunicates, e.g., *Didemnum* sp., spread across the seafloor and hard surfaces, they cover sedentary bivalves (scallops, mussels, oysters). There is concern that the bivalves' ability to feed and breathe could be hindered.



Experiences with one invasive alone, the Chinese mitten crab (*Eriocheir sinensis*), exemplifies most of the negative impacts of biological invasions. Chinese mitten crabs have damaged infrastructure and equipment by clogging screens and fishing gear and have weakened riverbanks and levees by excavating burrows. They also have the potential to spread a human disease, the Asian lung fluke. Although not yet reported in New England, this recent biological invader to California has the potential to survive in many areas of the northwestern Atlantic Ocean.

DETECTION EFFORTS: How can you help?

Public education regarding the nature of this problem, transport vectors, and species identification is essential for prevention and early detection of new nonindigenous marine species.

Prevention and early eradication of marine biological invaders are the most effective methods of managing these species.

To develop an understanding of the extent of marine biological invasions in a region and to become immediately aware of new invaders requires a substantial commitment of time and effort. No single or combined state, regional or federal agency can mount this effort. Therefore, the people who live, work, and play along the coastline are being called upon **to become the eyes in the field**. First, volunteers need to be trained to identify marine species for specific habitats. Then, they can participate in organized monitoring efforts.

Many marine organisms can be difficult to identify. Some can only be identified by molecular genetic analysis or by complex taxonomic assessments that are impossible for individuals without formal training in marine invertebrate taxonomy. Because of the difficulty in correctly identifying many marine organisms to species level, **volunteers will be asked to identify only species that can be identified without the use of a microscope**. Volunteers will focus their learning on a select list of biological invaders of concern, including several that have not yet become established in the region. When a potential invasive species needs further identification to verify its identity, volunteer monitors will be asked to take careful note of its location and obtain a specimen collection. Then, a taxonomic expert will be asked to verify the species.

Individuals who are in the field on a regular basis may have the opportunity to detect new species or to help document the rapid expansion of a biological invader. Regional organizations, such as Salem Sound Coastwatch, will help volunteers determine where to focus their energies.

You will need to decide:

- Whether to be involved in intensive monitoring or visual surveys; and
- Which area to you would like to monitor.

For a monitor's volunteer time to be well spent, it is critical that the data collected be shared with the appropriate agencies, resource managers, and scientists. This information can then be used to increase effective management policies for prevention, rapid response, and early eradication of marine nonindigenous species. Data collected by volunteers will be entered into the **MarineID** database by

the regional organization that is overseeing the monitoring. This database enables data sharing among governmental and scientific communities.

As a Marine Invasive Species (MIS) monitoring volunteer, you will be assisted in learning:

- Marine species in your chosen marine environment;
- Select marine biological invaders currently in that region;
- Potential marine biological invaders that could arrive in the future;
- Appropriate data collection and recording techniques.

The marine invasive species identification cards developed by SSCW and the Massachusetts Office of Coastal Zone Management are invaluable tools to augment your species identification efforts and are included with this manual. These laminated ID cards can be taken in the field or left on a boat so they are handy when you are monitoring or surveying an area where you work or play. Although they do not cover all nonindigenous marine species, they represent the species of most concern. The ID cards of species with the potential to invade our region in the future have stickers indicating “Potential Invader” status. Early detection efforts are most concerned with the “Potential Invader” species. If you believe you have seen one of these, it is important to notify your monitoring organization immediately (see Section 6: Visual Surveys)

The following marine life field guides are specific to the New England North Atlantic region and will, also, help with the identification process:

SUGGESTED IDENTIFICATION RESOURCES

BOOKS

Eastern Tidepool & Reef: North-central Atlantic Marinelife Guide.

Harvey-Clark, Chris. 1997. Hancock House Publishers. Blaine, WA.

Marine life of the North Atlantic: Canada to New England.

Martinez, Andrew J. 1999. Down East Books. Camden ME.

Peterson Field Guide: A Field Guide to the Atlantic Seashore.

Gosner, Kenneth L. 1978. Houghton Mifflin Co. New York, New York.

ID CARDS

Hitchhikers: Guide to Exotic Species

Waterproof guide with information on 14 invasive marine species, as well as a few species native to New England. Free guides can be ordered using the MITSG number 04-3 from MIT Sea Grant. web.mit.edu/seagrant/pubs

Guide to Marine Invaders in the Gulf of Maine

Laminated ID cards of indigenous species found or threatening invasion in the Gulf of Maine. Developed by Salem Sound Coastwatch . www.salemsound.org

Beachcomber's Companion

A set of 50 marine invertebrate identification cards common along the northwest Atlantic coast. www.beachcomberscompanion.net

MONITORING TECHNIQUES

INTRODUCTION TO MONITORING EFFORTS

This section covers three different sampling techniques, each designed for a particular habitat. It is possible to tailor any of these methods to address a project's specific monitoring goals. A **point-contact transect method** is used at floating docks to record presence or absence of algal and invertebrate species. A **random quadrat method** is employed in the rocky tidal zone to determine abundance of algal and invertebrate species. Species abundance is also measured in the **tidepool monitoring**, but the sampling is not random. Each monitoring session collects data on the biological organisms in the evaluation area at that moment in time. Therefore, conclusions about population and natural community dynamics may only be drawn after long-term data collection.

The intertidal marine environment experiences high variability. Physical, chemical, and biological factors interact to create this complexity; for example, the time of year, air and water temperature, time of day, tidal magnitude, substrate type, and topography. Species distribution and abundance change over horizontal and vertical distances as well as over time. A population may be reduced, isolated, or eradicated in particular areas due to physical and biological disturbances, like the increase of predators, storms, wave exposure, ice scouring, or human disturbances. Therefore, only when repeated, consistent samplings are combined and analyzed can population dynamics and the complex nature of these environments begin to be understood (Murray et al 2002).

GOALS OF MONITORING EFFORTS

- Identify native and nonindigenous species at an evaluation site;
- Document pertinent environmental data;
- Report new marine invasive species;
- Analyze data for extent of biological invasions and range expansions;
- Share data in a regional database;
- Share insights with volunteers.



Volunteer
Activities



Regional
Coordinating
Organization

SAFETY FIRST

Protecting Your Safety

YOUR SAFETY is the FIRST PRIORITY! The tidal zone can be a dangerous place.

Please remember these common sense guidelines:

- DO NOT go out to a dock, the rocky shore, or a tidepool alone – always go out with at least one other team member, and preferably two. That way, if someone is injured, there is someone available to go for help and one person to stay and assist.
- Avoid going out in bad weather. Be aware of the changing weather conditions.
- Be aware of the tide and how fast it returns.
- Wear clothing that will keep you warm and dry.
- Protect your feet from slippery, wet, and sharp surfaces with strong, waterproof footwear with good traction.
- Walk carefully and watch your step – surfaces are often very slippery!

Protecting the Environment

Even though the tidal zones experience regular disturbances from wave exposure, temperature, and human and animal presence, care should be taken to avoid creating additional disturbances or undo stress that may affect settlement and/or life processes of organisms. For example, slipper shells (*Crepidula* spp.) can be injured if pried from their attachment sites. To lessen the environmental impact of monitoring, take care to place overturned rocks back where they were without crushing any organisms. Learn how to handle invertebrates to avoid injury to them and yourself. Leaving organisms, such as sea stars and green sea urchins, exposed may increase the possibility of their predation. Collect only if it seems important and necessary for further taxonomic identification. Take the minimum amount necessary for identification. No one wants foul smelling decaying or desiccated specimens.

Specimen Collection Procedure	
Method One: <ol style="list-style-type: none">1. Place specimen in a container with seawater. Do not overcrowd.2. Provide a means to replace oxygen.3. Store in an ice chest.4. Deliver to the agreed collection center as soon as possible (within 24 hours).	Method Two: <ol style="list-style-type: none">1. Place specimen in spill-proof container with 75 -95% ethyl alcohol.2. Label container with date, location, and collector's name.3. Store at a cool temperature.4. Deliver to the agreed collection center.

POINT-CONTACT TRANSECT METHOD for FLOATING DOCKS

OVERVIEW Many sessile marine organisms (e.g., algae, tunicates, mussels, barnacles, anemones) need to attach to hard substrates or structures. These habitats are often in short supply in ocean waters. Therefore, the submerged floats supporting permanent floating docks, ones that remain in the water year round, provide important areas upon which marine larvae and seed can settle and grow. Mobile organisms, such as sea stars and crabs, also frequent these colonized areas to feed. Repeated samplings at the same location over an extended time are necessary to rule out natural variability in these biological communities.

Monitoring of docks is not tide-dependent. Line transects are laid out along the dock edge above the floats (see Directions #1). Presence or absence of species attached to the edge of the submerged float is recorded on a data sheet. Monitoring conditions and visibility will vary depending, for example, on the angle of the sun, cloud cover, clarity of water, wave action, and the layering of species. Actual counts or abundance estimates are difficult to make, but it is possible to distinguish between none present, 1-10, or greater than 10. This quantitative grouping will allow for more productive data analysis in the future. Twenty-eight species are listed on the Floating Dock Data Sheet with space to add other species. The data sheet is designed and tested to facilitate easy data recording. This data sheet is in MS Excel format and may be adapted to include new bioinvaders and species most commonly found in your monitoring region. Sampling may be conducted year round. However, when docks become cold, icy, or otherwise unsafe, it is best to avoid monitoring. In general, monthly monitoring from late spring to early fall is a realistic target, with the possibility of perhaps one winter sampling.



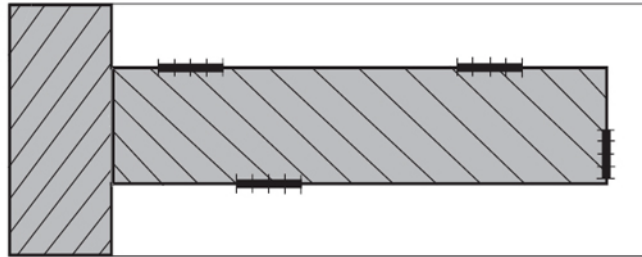
EQUIPMENT

Meter Stick	Marine Invasive ID Cards
Clipboard and pencil	Marine Field Guides
Data sheet	Ziplock bags or watertight containers
Thermometer	70% - 95% ethanol
Refractometer	Net or stick for moving floating organisms
Permanent marker	Camera
Pillow, cushion or towel	

DIRECTIONS - Point-Contact Transect for Floating Docks

How to set-up your monitoring site:

1. Establish a random line transect 80 cm long by placing a meter stick along the edge of the dock. Since sessile organisms need to adhere to submerged surfaces, the line transect must be aligned over a dock float.



Four transects laid out on the dock with each transect above a dock float.

2. With a permanent pen, place a mark at the dock edge at the beginning of the line transect. Then, mark every 20 cm along the length of the line transect (5 marks). Marking the edge of the dock helps in locating the line transects during repeat monitoring.
3. Repeat Steps 1 and 2 three more times at different places on the dock. The four line transects should be selected randomly.

Randomness in Dock Monitoring: where to monitor along a dock

Randomly selecting four locations (one for each line transect) before going to the dock is the best method to assure randomness. However, often the outer or less protected, open water-facing dock edge may lack resident organisms. Areas with high boat traffic may also diminish attachment by organisms.

If the evaluation area has many docks, one could randomly place four line transects, and then place another four transects in selected area. A selected area may be chosen because it is more protected and heavily settled with organisms, e.g., a submerged chain or rope. This would require two sampling areas, which could be monitored by two teams or a second monthly sampling time. Experience sampling docks has shown that trying to complete more than one set of four transects at a time is too taxing.

4. Once the line transects are marked off, draw a map on the back of the data sheet (data sheet is provided) to make a visual record of the monitoring site. Ascertain the site coordinates using a GPS or a topographic map, if you can. This needs to be done only once, after the transects have been established.

How to collect data:

1. Record on the data sheet the names of volunteer monitors present, date, time, site name, time of low tide, weather conditions, air and water temperature, and salinity (using a refractometer). Although it is a good practice to sample the salinity during each sampling session, this is something that could, also, be done once a season or when environmental changes have taken place.
2. Observer: Lying on your stomach, peer over the edge of the dock and name all visible species in the submerged top 8 inches for each 20 cm segment (4 segments each line transect).
3. Data keeper: Records on the checklist the species present as the observer calls them off. A single row on the datasheet is the record of species observed per 20 cm segment. There are sixteen records per dock sampling.
4. Observer should estimate the abundance of each species using three categories: none present (0); 1-10 (X), and more than 10 (Z).
5. Whenever possible, sketch or photograph rare nonindigenous species, i.e. purple anemones (*Sagartia elegans*).
6. Collect samples for verification by a project specialist off site **only** if the species is believed to be one of the future potential invasive species or verification is needed. (Specimen Collection Procedure, pg. 9).
7. Return data sheets to your coordinating organization for data entry.

TIPS for EASIER DOCK MONITORING

1. Bring a boat cushion, foam or towel to lie on while looking over the dock edge.
2. Take turns sharing the task of data keeper and observer.
3. You may put your hands in the water to gently feel the organisms or move them aside for better visibility.
4. Do not damage or dislodge attached organisms.
5. Remove only small specimens for identification purposes to examine with a magnifying lens.

RANDOM QUADRATS METHOD for the ROCKY INTERTIDAL SHORELINE

OVERVIEW Rocky intertidal shoreline sampling should be targeted at a cobble area of the shoreline in between the mid to low tide zones. Two of the targeted invasive species for the rocky intertidal habitats are *Hemigrapsus sanguineus* (Asian shore crab) and *Carcinus maenas* (European green crab). These crabs normally seek shelter between the cobble and rocks of the intertidal zone.

This monitoring must be conducted at or near low tide. A target evaluation area is selected and divided into four equal sections (quadrants). A square-meter quadrat is randomly placed in each of the four quadrants. It is important to understand that the evaluation area is consciously selected to allow for repeatability, but that the quadrat sampling is random. Random sampling means that every area within the evaluation area has an equal chance of being measured and that one quadrat placement does not determine or influence the next quadrat placement. Randomness eliminates bias and ensures that each subset is independent. If the location of the sampling quadrat is chosen in a nonrandom manner, an unrealistic assessment of the evaluation area will result.

It is a fallacy to think a person can go out in the field and place a quadrat randomly in the study area without bias. Unknowingly, the size of the rocks, the amount of water, the glimpse of a crab shell, or something else will influence the decision. This is haphazard sampling and studies have shown that haphazard placements result in non-random distributions with study area edges being underrepresented (Greig-Smith 1983). Data collected in a haphazard manner will be discounted as statistically unusable.



Each quadrat has its own data sheet on which all species present are recorded. Abundance estimates are used for some common and often prolific species such as common periwinkles (*Littorina littorea*). An actual count is taken for other invertebrates, such as the crabs, sea stars and sea urchins. Sessile organisms (seaweeds, mussels, barnacles) are given percent coverage estimates, while mobile invertebrates are either counted or given abundance estimates.

Monthly sampling during spring, summer, and fall is a good target. Monitoring once during the winter months would be a bonus, but weather conditions do not always permit this. Monitoring in teams of two to four people is recommended. The safety of the monitors is always of paramount importance, and people should never put themselves in danger to collect data.

EQUIPMENT

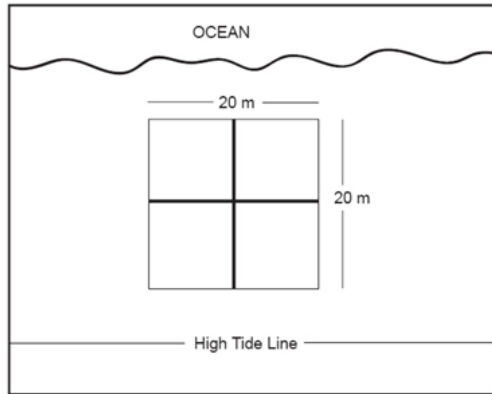
Two 30 meter tape measures or two ropes with meter markings	
One square-meter quadrat made from PVC pipe	
Clipboard and pencil	Marine Invasive ID Cards
Four data sheets	Marine Field Guides
Thermometer	Ziplock bags or watertight containers
Refractometer	70% - 95% ethanol
Camera	Net for capturing mobile organisms
Work/gardening gloves (to protect hands)	
Protective footwear	

DIRECTIONS - Random Quadrat Sampling of Rocky Intertidal Shoreline

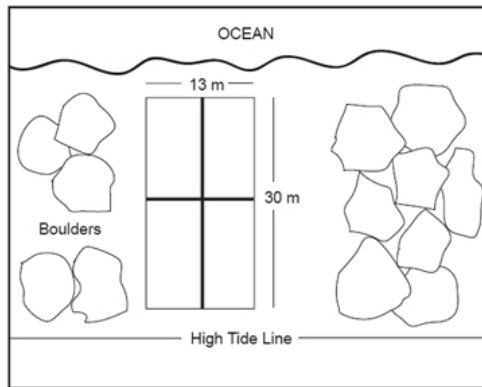
How to set-up your monitoring site:

1. Establish a fixed evaluation area between the mid and low tide lines by locating the largest and best suitable area of rocky or cobble habitat in a particular region.
2. Tide charts are available at www.maineharbors.com/ma/tidemans.htm

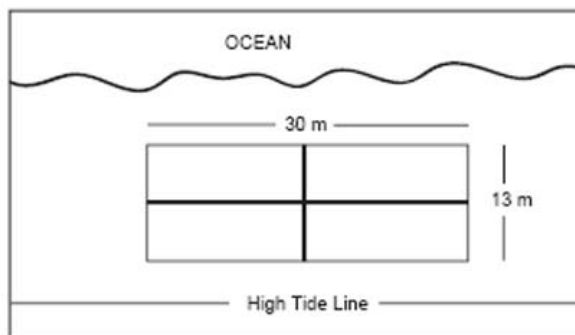
3. Divide the area into four quadrants (sections) by placing a meter tape (knotted rope) parallel to the water's edge for a distance of 20 meters and perpendicular to waterline for 20 meters. The two tapes must cross each other at the mid-intersection, in this case, at 10 meters.



Ideal set-up is 20 meters by 20 meters



If available area is narrower than 20 meters



If area is shallower than 20 meters

4. At the initial setup, map the area and key landmarks for repeatability. Ascertain the site coordinates using a GPS or from a topographic map.

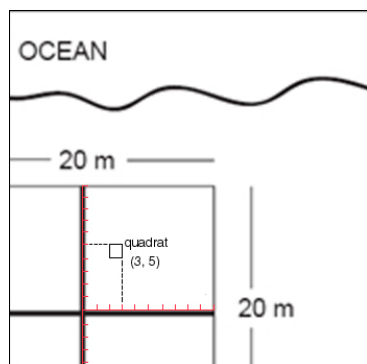
How to collect data:

1. Return to your chosen evaluation site within one to two hours of low tide.
2. Record the names of all monitors present, date, time, site name, time of low tide, weather conditions, air and water temperature, and salinity using a refractometer.
3. Choose a quadrant near the low water edge to begin sampling.
4. Place the quadrat using two random numbers generated from a random number table. A random number table is provided

1. Random placement of all quadrats is strongly recommended. The best way to do this is to select the numbers from a random number table before going out to sample. Random number tables are generated so that the numbers 0 to 9 have equal and independent chances of occurring in the table. A random number table is provided with this manual.

2. How to use a Random Number Table for Quadrat Sampling

3. Chose a direction to move within the table: horizontally, vertically or diagonally;
 4. Select a spot in the table;
 5. Write down the first number;
 6. Move over one digit in the pre-determined direction to obtain the second number;
 7. These two numbers become the first set of coordinates (x, y);
 8. Repeat three more times so that you have four coordinate pairs;
 9. Pair the coordinates with a quadrant (NE, SE, NW, SW);
 10. Write the quadrant direction and the quadrat's set of coordinates on the data sheets before going out to sample.
5. Starting in the center of the plot, walk parallel to the water, marking off on the x-axis the first random number. Then, walk perpendicular to the water, marking off the second random number on the y-axis.
6. Place a 1-meter² quadrat at the intersection of these two random numbers (x, y). The quadrat should be placed on the ground inside (x, y) as shown in the diagram.



Placement of quadrat within a quadrant

7. Using the data sheet, record all organisms in the quadrat.
8. If you want to know more about crabs than their numbers, place crabs in a bucket as you find them.
9. Data keeper: Record percent coverage of sessile organisms (invertebrates like mussels, barnacles, and all types of algae) and abundance (averages and actual counts) for mobile invertebrates (e.g., crabs, snails, sea stars). See page 21 for percent cover comparison charts.

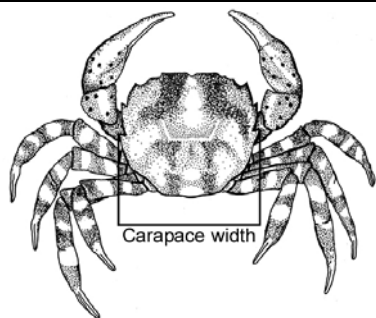
TIPS for Estimating Percent Coverage

Percent cover is a visual estimate of the area occupied by a particular species. The following five standard cover classes are used to reduce individual sampling variability: 1-3% (a trace), 4-10%, 11-25% (less than a quarter), 26-50% (more than a quarter but less than half), and >50% (more than half). The midpoint of each cover class is the actual number recorded in the database for data analysis. Thus, it often helps to think about which midpoint best represents the observed abundance. For example, it might be asked if the abundance of barnacles in the quadrat comes closest to equaling: 1.5%, 7%, 18%, 38%, or 75% of the total area. The total abundance of all species may exceed 100% since species often overlap one another and live in three-dimensional space. See page 20 for chart.

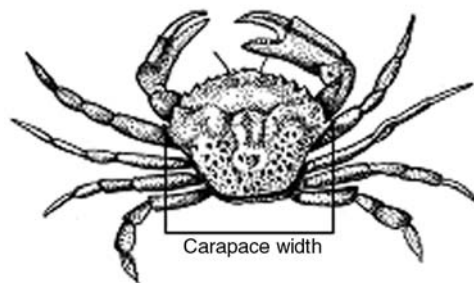
10. After visible organisms have been counted, turn over rocks and pebbles to look for crabs. Tunicates, bryozoans, snails, and mollusks may also be observed on the underside of rocks.
11. Depending on the monitoring goals, one may want to ascertain additional information about the crab population.

Crab Carapace Measurement:

Measure each crab shell at the widest section. Try measuring all crabs but if crabs are too small to measure (less than 5 mm or 0.20 inch), use a “ ? ” to indicate it was too small to accurately measure.



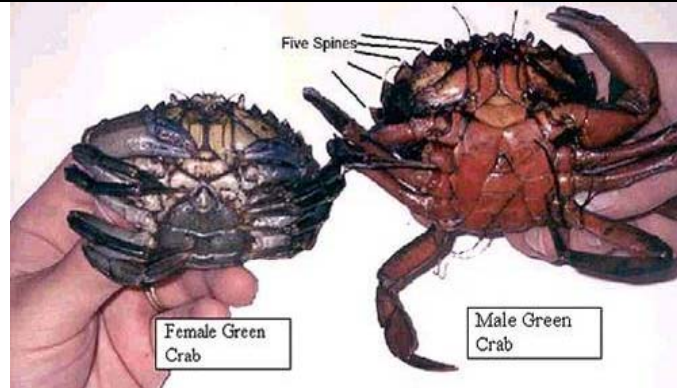
Asian shore crab



European green crab

Determining Sex of Crabs:

Examine the underside of the crab's carapace. Determine the sex by the shape of the abdomen or tail flap. The male has a thin triangular apron, while the female's is larger and rounder. Male Asian shore crabs will have a bulb on the inside of the pincer claws. Sex on very young crabs is difficult to determine visually. Use a "?" to indicate if sex is indecipherable.



12. Sample one quadrat in each quadrant (NE, NW, SE, SW) following the same random number procedure.
13. Even though the intertidal zone experiences regular disturbances from wave exposure, temperature and other human and animal presence, care should be taken to avoid creating disturbances or undo stress that may affect settlement and/or life processes of the organisms.
14. Photograph or sketch rare invaders or unusual observations e.g., *Didemnum* sp.
15. Return data sheets to the coordinating organization for data entry.



MONITORING TIDEPOOLS

OVERVIEW Tidepool monitoring is similar to rocky shoreline monitoring. Abundance of algal and invertebrate species is measured in the tidepool. However, because the tidepool is a contained area, sampling is not random. Quadrats are not used, and every species present in the tidepool is recorded on the data sheet.

A tidepool is selected in the mid to low intertidal zones. **This monitoring must be conducted at or near low tide.** The tidepool environment is highly variable and species presence may fluctuate with the time of year, time of day, and tidal magnitude. Species distributions and abundances may be reduced, isolated, or eradicated in a tidepool from physical and biological disturbances. Tidepool monitors use the intertidal rocky habitat data sheet to record the species' percent coverage and abundance in the entire tidepool. Care should be taken to avoid creating disturbances or undo stress that may affect settlement and/or life processes of the organisms.



EQUIPMENT

Thermometer	Marine Invasive ID Cards
Rule	Marine Field Guides
Clipboard and pencil	Ziplock bags or watertight containers
Data sheet	70% - 95% ethanol
Refractometer	Net for capturing mobile organisms
Camera	Work/gardening gloves
Protective footwear	

DIRECTIONS - Tidepool Sampling

How to set-up your monitoring site:

1. Find a mid to low intertidal tidepool that you will be able to access most of the year. Tide times can be found at www.maineharbors.com/ma/tidemans.htm.
2. Draw a map on the data sheet and take GPS coordinates so you and others will be able to return to the same location for monitoring.

How to collect data:

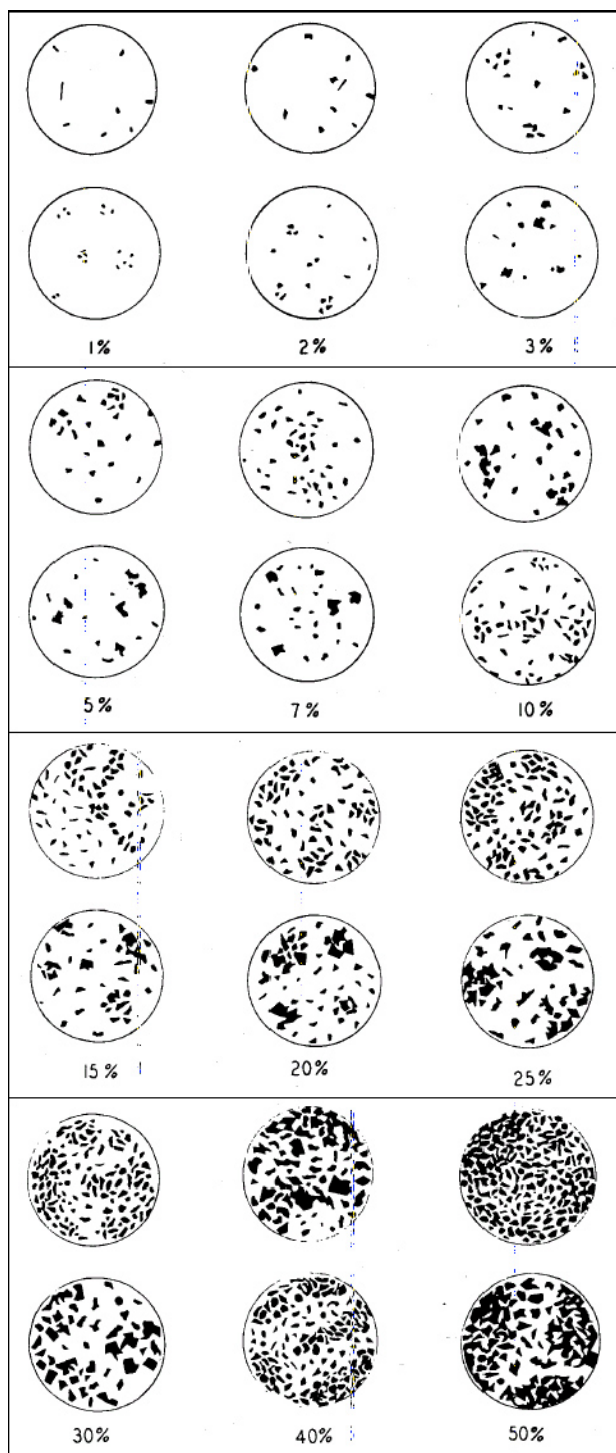
1. Return to your tidepool within one to two hours of low tide.
2. Record the names of all volunteer monitors present, date, time, time of low tide, weather, and site number.
3. Measure and record the water depth in the tidepool.
4. Measure and record salinity, and water and air temperatures.
5. Identify the different seaweed species present and estimate “percent cover”. Examine the entire tidepool area and decide how much space is covered by each species. Circle the one that best approximates what you observe. See page 21 for percent cover comparison charts.

TIPS for Estimating Percent Coverage

Percent cover is a visual estimate of the area occupied by a particular species. The following five standard cover classes are used to reduce individual sampling variability: 1-3% (a trace), 4-10%, 11-25% (less than a quarter), 26-50% (more than a quarter but less than half), and >50% (more than half). The midpoint of each cover class is the actual number recorded in the database for data analysis. Thus, it often helps to think about which midpoint best represents the observed abundance. For example, it might be asked if the abundance of barnacles in the quadrat comes closest to equaling: 1.5%, 7%, 18%, 38%, or 75% of the total area. The total abundance of all species may exceed 100% since species often overlap one another and live in three-dimensional space.

6. Identify each invertebrate species in the tidepool. Follow the data sheet for guidance on how to measure each species. Some will require an estimate of their abundance, while crabs and more mobile invertebrates will need to be counted. Estimate “percent cover” for invertebrates that are sedentary and tend to cover an area, such as barnacles and mussels.
7. Record any important observations in the area of the tidepool including wildlife and human activities, general changes in the tidepool and adjacent land use. Record any information that may be helpful in understanding the tidepool environment.

8. Photograph and record rare invaders or unusual observations, e.g., large numbers of Asian shore crabs (*Hemigrapsus sanguineus*).
9. Return data sheets to the coordinating organization for data entry.



Percent Coverage Comparison Charts.

Developed by R D. Terry and G.V. Chilingar. Published in the Journal of Sedimentary Petrology 24(3):229-234. September 1955

SHARING DATA

Your coordinating organization will share the data you have collected with the Northeast Aquatic Nuisance Species (NEANS) Panel and the Massachusetts Office of Coastal Zone Management (CZM). An online invasive species database (the Marine Invader Database or MarineID) has been developed to serve as a repository for historical, current, and future invasive species data sets collected from the Gulf of Maine, Long Island Sound, and Atlantic Canada. MarineID enables scientists, natural resource managers, and the public to contribute data online and to download relevant information on marine invasive species distributions.

Built in MS Access (versions 1997 or 2000), the MarineID can be downloaded from the website www.marineID.org. A tutorial can also be downloaded from the “contribute data” page. Monitoring coordinating organizations will keep the database on their computers and send updated Access files to marineid@NortheastANS.org at the end of the sampling season. All data will go through a series of quality assurance checks prior to posting to the web site.

Invasive species identification and distribution information submitted through these forms will be available at the MarineID site. Contributors should notify the MarineID project managers if any information included in the submitted database should be kept confidential.

Data needed to make an entry into the MarineID database

Monitoring location:

Latitude and longitude in decimal degrees

City, state, county

Water body (Gloucester Harbor, Salem Sound)

Hydrological unit (bay, estuary, tidal river, open ocean, pond, canal)

Habitat type (bay, pier, floating dock, marina, rocky shore, eelgrass bed)

Observation details:

Date, Time, Surface Salinity, Surface Water Temperature

Species Observations:

Scientific name

Abundance (rare, uncommon, common, abundant)

VISUAL SURVEYS

OVERVIEW The monitoring protocols previously discussed are different from the visual survey, because they obtain quantitative data that can be used to identify population changes. In a visual survey, you are looking for the emergence of a new species or a dramatic change in the species distribution. Individuals who are in the field on a regular basis may have the opportunity to detect new species or to help document the rapid expansion of a nonindigenous species. Contact the local monitoring organization or email marineID@northeastANS.org immediately if a future invader is observed, such as a Chinese mitten crab or rapa whelk. Visual surveys may be conducted in a variety of habitats: beaches, intertidal mudflats, cobble shorelines, oyster reefs, salt marshes, consolidated clay substrates, floating docks and piers, fishing gear, and boat hulls.

GOALS

1. Detect new biological invaders or a noticeable change in species densities.
2. Report findings easily and quickly to marineID@northeastANS.org.

Immediate notification of a suspected new species or an alarming expansion of a nonindigenous species enables the appropriate agencies, resource managers, and/or scientists with information to increase effective management policies for prevention, rapid response, and early eradication of marine nonindigenous species.

OPTIONAL EQUIPMENT

GPS	Maps to mark sighting
Camera	Ziplock bags or watertight containers
Marine Invasive ID Cards	Marine Field Guides

DIRECTIONS - Visual Survey

1. Choose a survey area that you can return to and commonly frequent, such as a beach, dive area, or dock; or choose equipment you use often, such as the bottom of a boat or fishing equipment, lobster traps, submerged ropes, and nets.
2. First, scan the entire area or equipment before moving anything.
3. Then, move into the area, turning over cobbles or equipment, looking for unfamiliar or inconspicuous species that you have not seen before.
4. Consult marine invasive species identification cards and field guides as needed (Resources and Contacts, p. 24)
5. Photograph unidentifiable species or potential biological invaders
6. Photograph any rapid expansion or unusual abundances of marine invasive species
7. Record GPS location if possible, or record on a map as accurately as possible, if you observe a unique species. The location of your observation is critical for verification so GPS coordinates are preferred, but a written location description is acceptable.
8. Collect a sample if you find one of the future biological invaders (Specimen Collection Procedure, page 8)
9. Notify by email marineID@northeastANS.org, and call your local monitoring organization. Please include the name of the suspected nonindigenous species and the number or extent observed, sighting location, and how you can be reached (telephone number and/or email).

RESOURCES and CONTACTS

Marine Life Field Guides

- Gosner, Kenneth L. 1978. A field guide to the Atlantic seashore. The Peterson field guide series. Houghton Mifflin Co. New York, New York.
- Harvey-Clark, Chris. 1997. Eastern tidepool & reef: north-central Atlantic marinelife guide. Hancock House Publishers. Blaine, WA.
- Martinez, Andrew J. 1999. Marine life of the North Atlantic: Canada to New England. Down East Books. Camden ME.
- Pollock, Leland W. 1998. A practical guide to the marine animals of northeastern North America. Rutgers University Press. New Brunswick, New Jersey.
- Weiss, Howard M. 1995. Marine animals of southern New England and New York: identification keys to common nearshore and shallow water macrofauna. State Geological and Natural History Survey of Connecticut. DEP Maps and Publications Office. Hartford CT.
- MIT Sea Grant. 2004. Hitchhikers: guide to exotic species. MITSG number 04-3.web.mit.edu/seagrant/pubs
- Woods Hole Sea Grant. 2004. Beachcomber's companion. www.whoi.edu/seagrant/education/citizen.html

Web Sites

- Global Invasives Species Programme. CAB International <http://www.cabi-ioscience.ch/wwwgisp/gtcsun.htm>
- Gulf of Maine Environmental Information Exchange. Marine Invertebrate Diversity Initiative. July 2003 <http://www.fundyforum.com/MIDI/>
- Invasive Species in Massachusetts. <http://www.northeastans.org/pet/index.html>
- MA Aquatic Invasive Species Working Group. MA aquatic invasive species management plan. December 2002. <http://www.mass.gov/czm/invasivemanagementplan.htm>.
- Maine Sea Grant. <http://www.seagrant.umaine.edu/index.htm>
- Massachusetts Bays Program. <http://www.mass.gov/envir/massbays>
- MIT Sea Grant Center for Coastal Resources. <http://massbay.mit.edu/exoticspecies/index.html>
- National Sea Grant. <http://www.nsgo.seagrant.org/>
- New Hampshire Sea Grant. <http://www.seagrant.unh.edu/index.html>
- Northeast Aquatic Nuisance Species Panel. <http://www.northeastans.org>
- Smithsonian Environmental Research Center. National Exotic marine and Estuarine Species Information <http://invasions.si.edu/nemesis/index.html>

Woods Hole Sea Grant. <http://www.whoi.edu/seagrant/>

World Conservation Union, Invasive Species Specialist Group. <http://www.issg.org/>

Scientific Books and Papers

- Berman, J., L. Harris, W. Lambert, M. Buttrick, M. Dufresne. 1992. Recent invasions of the Gulf of Maine: three contrasting ecological histories. *Conservation Biology* **6**:435-441.
- Brower, J.E., J.H. Zar, C.N. von Ende. 1997. *Field and laboratory methods for general ecology*. 4th ed. WCB McGraw-Hill. Boston.
- Carlton, J. T. 1989. Man's role in changing the face of the ocean: biological invasions and implications for conservation of near-shore environments. *Conservation Biology* **3**:265-273.
- Carlton, J. T. 2001. Introduced species in U.S. coastal waters: environmental impact and management priorities. Pew Oceans Commission, Arlington, Virginia.
- Chase, B.C., J.H. Plouff, W.M. Castonguay. 2002. The marine resources of Salem Sound, 1997. Technical Report TR-6. Mass. Div. Mar. Fisheries.
- Cohen, A.N., H. D. Berry, C.E. Mills, D. Milne, K. Britton-Simmons, M. J. Wonham, D. L. Secord, J. A. Barkas, B. Bingham, B. E. Bookheim, J. E. Byers, J. W. Chapman, J. R. Cordell, B. Dumbauld, A. Fukuyama, L. H. Harris, A. J. Kohn, K. Li, T. F. Mumford Jr., V. Radashevsky, A.T. Sewell, K. Welch. 2001. Washington state exotics expedition 2000: a rapid survey of exotic species in the shallow waters of Elliott Bay, Totten and Eld Inlets, and Willapa Bay. The Nearshore Habitat Program, Washington State Department of Natural Resources. Olympia, WA.
- Greig-Smith, P. 1983. *Quantitative plant ecology*. Third Edition. University of California Press, Berkeley, CA.
- Lambert, G., and C.C. Lambert. 1995. Nonindigenous sea squirts in California Harbors. *Aquatic Nuisance Species Digest* 1(2):17,20.
- Murray, S. N., R. F. Ambrose, and M. N. Dethier. 2002. Methods for performing monitoring, impact, and ecological studies on rocky shores. MMS Cooperative Agreement No. 14-35-0001-30761. U.S. Department of the Interior, Minerals Management Service, Pacific OCS Region. Camarillo, CA.
- Ruiz, G. M., P. W. Fofonoff, J. T. Carlton, M. J. Wonham, and A. H. Hines. 2000. Invasion of coastal marine communities in North America: Apparent patterns, processes, and biases. *Annual Review of Ecological Systematics*. 31: 481-531.

GLOSSARY

Abundance: The number of individuals of a species within a survey area. This can be by count, weight or other measurement for a given group in a given area.

Alga (plural: **Algae**; adj. **Algal**): Simple plants that are either attached in aquatic (marine or freshwater) environments; can be used as a term to describe seaweed.

Alien: Belonging to a different place and differing in nature to the point of incompatibility.

Aquaculture: The controlled cultivation and harvest of aquatic animals and plants.

Aquatic: Relating to fresh and saltwater systems, including both open waters and wetlands.

Ballast water: Any water that is placed in the hold of a ship for the purpose of maintaining stability.

Benthic: Relating to the substrate (bottom) of a lake, pond, ocean, or other water bodies, which often provide habitat for a variety of organisms.

Biodiversity: the variety of life: the different plants, animals and micro-organisms, their genes and the ecosystems of which they are a part.

Biological Invasion: arrival, establishment, and subsequent expansion of species in a natural community in which they previously did not exist.

Community: A group of species inhabiting a given area, where organism interact and influence one another's distribution, abundance, and evolution.

Cryptogenic Species: Those species whose origins are not clear; may be native or nonindigenous.

Dispersal Mechanism: A method by which a species expands its population or range. Natural mechanisms include migration, seed broadcast via wind or water, etc. Unnatural mechanisms are typically human-induced and include many of the pathways involved in invasive species introduction (ballast water, hull fouling, aquatic pet release).

Epiphyte: An organism that grows on another plant or animal upon which it depends for mechanical support but not for nutrients.

Exotic Species: See Nonindigenous Species.

Fouling: Entanglement, clogging, or obstruction by an undesired organism often resulting in diminished functioning of ships, intake pipes, and other submerged equipment or machinery.

Human Disturbance: Activity or state caused, directly or indirectly, by humans that intrudes, interrupts, or perturbs the natural state of ecological relationship and function.

Intertidal Zone: The area between high tide and low tide. Synonym: littoral zone.

Introduced Species: A species transported intentionally or accidentally from another region, allowing it to occur in areas beyond its normal range. Synonym: Nonindigenous Species, Nonnative.

Invasive Species: A nonindigenous species whose introduction does or is likely to cause economic or environmental harm or harm to human health [*taken from Executive Order 13112 on Invasive Species*].

Monitoring: Periodic or continuous survey or sampling to determine the status or condition of various groups or systems.

Native Species: With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem [*taken from Ex Order 13112*].

Nonindigenous Species: A species transported intentionally or accidentally from another region, allowing it to occur in areas beyond its normal range. Synonym: Introduced Species.

Nuisance Species: Animal or plant species that have been introduced into new ecosystems throughout the world and are having harmful impacts on the natural resources in these ecosystems and the human use of these resources (as defined by the federal ANS Task Force).

Opportunistic Species (genus, family): Able to compete advantageously during periods of stress, both natural and human induced, by colonizing new areas or expanding existing habitat.

Parameter: A measurable attribute or property (e.g., salinity, temperature).

Population: A group of interbreeding organisms occupying a particular space or area; all of the organisms that constitute a specific group or occur in a specified habitat.

Predator: An organism that hunts and consumes other animals.

Protocol: A set of rules governing data collection, such as sampling design, collection methods, species used and level of taxonomic analysis.

Quadrat: An area enclosed within the dimensions set by a frame of a standard size (e.g., a one-meter square).

Quadrant: One of four quarters created by two lines intersecting at right angles.

Qualitative: Involving distinctions based on standards, traits, or perceived value.

Quantitative: Expressible as, or relating to, a measurable value.

Substrate: The various materials that collectively make up the exposed or submerged surfaces of wetlands and aquatic environments, which may include sand, silt, peat, algae, logs, wood, debris, bank surface, sediments, leaf packs, mud, rock, and sometimes solid waste such as tires.

Subtidal Zone: the area below the low tide or intertidal zone. Synonym: sublittoral zone.

Taxonomist: An expert in the skills of systematic classification of organisms.

Transect: A method for environmental sample or survey using a straight line to delineate the area of analysis.

Transport Vector: In terms of invasives species, a vector is an identifiable, physical pathway or method of transport resulting in the introduction of a new species.