# BACK BAY SCIENCE CENTER

## Fouling Organisms and Invasive Species

**ACTIVITY: INVADER ID**
**TIME:** 50 minutes
**GRADE LEVEL:** 9th-College

**NEXT GENERATION SCIENCE STANDARDS:**

### PERFORMANCE EXPECTATIONS

**to forecast future catastrophic events and inform the development of technologies to mitigate their effects.**
**HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.**
**HS-LS4-5. Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.**

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
|---|---|---|
| **Engaging in Argument from Evidence**<br>• Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments (HS-LS2-6)<br>Connections to Nature of Science<br>---<br>**Scientific Knowledge is Open to Revision in Light of New Evidence**<br>• Scientific argumentation is a mode of logical discourse used to clarify the strength of relationships between ideas and evidence that may result in revision of an explanation (HS-LS2-6) | **ETS1.B: Developing Possible Solutions**<br>• A solution needs to be tested, and then modified on the basis of the test results, in order to improve it (MS-ETS1-4)<br>• Models of all kinds are important for testing solutions (MS-ETS1-4)<br>**ETS1.C: Optimizing the Design Solution**<br>• The iterative process of testing the most promising solutions and modifying what is porposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution (MS-ETS1-4)<br>**ESS3.C: Human Impacts on Earth Systems**<br>• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things (MS-ESS3-3)<br>**LS2.C: Ecosystem Dynamics, Functioning, and Resilience**<br>A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e. the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability (HS-LS2-6) | **Stability and Change**<br>• Much of science deals with constructing explanations of how things change and how they remain stable (HS-LS2-6) |

**Ocean Literacy Principle 5: The ocean supports a great diversity of life and ecosystems**
**F-** Ocean ecosystems are defined by environmental factors and the community of organisms living there. Ocean life is not evenly distributed through time or space due to differences in abiotic factors such as oxygen, salinity, temperature, pH, light, nutrients, pressure, substrate, and circulation. A few regions of the ocean support the most abundant life on Earth, while most of the ocean does not support much life
**Ocean Literacy Principle 6: The ocean and humans are inextricably interconnected**

**D-** Humans affect the ocean in a variety of ways. Laws, regulations, and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution), changes to ocean chemistry (ocean acidification), and physical modifications (changes to beaches, shores, and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

**Ocean Literacy Principle 7: The ocean is largely unexplored**

**F-** Ocean exploration is truly interdisciplinary. It requires close collaboration among biologists, chemists, climatologists, computer programmers, engineers, geologists, meteorologists, physicists, animators, and illustrators. And these interactions foster new ideas and new perspectives for inquiries.

## BACKGROUND INFORMATION

# Fouling Organisms and Invasive Species

A **fouling organism** is an animal or plant species that exists in water and attaches to the surface of a material immersed in the water. Fouling communities are composed of many living organisms including invertebrates, algae, and microbes. These organisms live in shallow coastal ecosystems and are vulnerable to changes in salinity and water temperature.

People also can have an impact on fouling communities. Aquatic invasive species were introduced to the West Coast of the United States throughout the last century. Boats, ballast water, and other aquaculture transports and introduces invertebrates to new places. Their presence and spread could impact native marine ecosystems. They increase **fouling (t*he buildup of organisms on surfaces*).** This happens a lot on boats and underwater cables. Fouling organisms grow and can damage the structures.

***What is hull fouling and how does it relate to AIS?:***

Aquatic nuisance species *(AIS)* are carried across the seas, not only inside ships but also attached to the outside. This is known as hull fouling, vessel fouling, or biofouling. Organisms like **barnacles, mussels, sponges, algae and sea squirts** attach themselves to the hulls of ships, fouling these wetted hull surface areas, or live within the matrix of the fouling community and protected nooks and crannies such as sea chests. These organisms then colonize the hull and "hitch a ride" from one port or bioregion to the next. Invasions can occur when these fouling organisms come in contact with structures in a new port or release their larvae into its waters, possibly establishing themselves in the new port and spreading to nearby areas within that bioregion. The full effects of all AIS species is unknown but their presence means that they can cover large areas, buildup on surfaces and can therefore smother native species, damage or clog man-made structures in the oceans such as docks or power plant pipes. One example, the red rust bryozoan, is tolerant of copper and mercury which are ingredients used in antifouling paint to keep ship hulls clean of fouling organisms. This allows the red rust bryozoan to travel from place to place, providing a surface for other non-natives to settle.

Simply cleaning the ship is not enough, as live organisms are often released into the water during this process. In addition, ecological effects abound. Over 234 invasive species have taken root in the Bay-Delta ecosystem. In the bay's benthic community - its sediment dwellers - invasive organisms account for between 40 percent and 100 percent of the common species, up to 97% of the total number of organisms, and up to 99% of the biomass.

**What is *ballast water* and how does it relate to *aquatic invasive species AIS?:***

Carried by ships to provide stability and adjust a vessel's trim for optimal steering and propulsion, ballast water may be the most important mechanism for the introduction and spread of aquatic invasive species (AIS) into the U.S. Ships often take up ballast water in ports and coastal regions, where the ecosystems have a rich diversity of life. These biologically diverse waters, and their underlying sediments, including many forms of viruses, bacteria, plankton, plants and animals, are sucked into vessels' ballast tanks. Ballast water is then released during various stages of the ship's journey, including at sea, along coastlines, and in various ports. As a result, a diverse mix of organisms is transported

and released around the world. Over 3,000 marine species travel around the world in ships' ballast water on a daily basis. Enormous volumes of ballast water enter domestic water: every hour an average of more than 2 million gallons of ballast water (equivalent to three Olympic-sized swimming pools) are released in U.S. waters. That is 555 gallons per second.

When new species are introduced to an area some of those species may die, but some compete with native fouling organisms for resources. Not all foreign species are invasive, and some get along very well with new neighbors. However, invasive species harm the ecology and the economy of their new environments. People living on the coast spend millions of dollars a year to detect and remove invasive fouling species.

By better understanding where and what kinds of fouling organisms live, we can better identify when species are introduced to a new area, and help coastal communities effectively respond.

***Why do we care about these species? Who cares if they take over?:***

Since 1994, the Marine Invasions Lab at Smisthsonian Environmental Research Center (SERC) has conducted surveys of fouling communities from bays throughout the United States. The surveys are usually done by staff scientists, but volunteers and Citizen Scientists also have the opportunity to help!

To see what kinds of fouling organisms live in an area, PVC tiles are deployed as a substrate for organisms to settle on. These are square plastic tiles that are attached to bricks that hang upside down in the water. After several months, the tiles are pulled out of the water and scientists evaluate all of the organisms that have grown on the tiles while they were in the water. ***This is where Citizen Scientists can help!***

***Photos of the tiles are also taken and YOU can help identify species using the online platform Zooniverse.***

The goal is to find these targeted species and to measure changes in their population. By collecting information about the location of these fouling animals we can determine if the populations are growing or shrinking in particular areas. This information can help to determine what the effects invasive species may have on the native species in the environment. By doing surveys of bays through time, there can be a better understanding of how the types and abundances of organisms change, and how different species interact with another. It also allows for an opportunity to detect new invasive species before they become problematic.

The survey data also helps to show whether or not efforts to prevent invasions or limit the impact of invasions are working. Findings are shared with natural resource managers and policy makers so that they can implement the most effective strategies possible to deal with marine species.

Researchers use the data collected through the fouling community surveys to look at how fouling communities change

through time and between one location and another. They combine that information with other data, such as weather data, to try to understand what causes the patterns that they observe. By understanding these patterns, we can better predict which species are likely to invade nearby areas and what kinds of impacts they could have.

***What is being done about this problem?:***

In order to stop an invasion, organisms: (1) must not be discharged from ballast tanks; and (2) must not be carried on hulls. The first action can be achieved by not taking organisms into ballast tanks, killing organisms during the voyage, or not discharging organisms when ballast water is released; the second action can be achieved by reducing the amount of organisms present on vessel hulls through regular cleaning and maintenance.

**TEACHERS GUIDE**

**ACTIVITY: Invader ID**

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## OBJECTIVES:

Learners will be able to:

1. Use quadrat system to quantify the abundance of aquatic invasive species.
2. Use field guides to identify aquatic invasive species.
3. Explain how the presence and abundance of aquatic invasive species can affect entire ecosystems and native species.

## MATERIALS:

- Field guides
- Fouling plates from dock
- Laminated worksheets to document species
- Salt water fish trough with flowing water

- OPTIONAL: For follow up activity: Computer with internet access
  - Introduction video: https://www.youtube.com/watch?time_continue=125&v=BCtEjzd9zog&feature=emb_logo
  - Zooniverse online platform: https://www.zooniverse.org/projects/serc/invader-id

## KEY TERMS:

Aquatic invasive species
Invasive
Native
Fouling organisms
Hull Fouling
Ballast