BACK BAY SCIENCE CENTER

Fouling Organisms and Invasive Species

ACTIVITY: INVADER ID- CONNECTING CITIZEN SCIENCE WITH REALTIME RESEARCH
TIME: 60 minutes
GRADE LEVEL: 8th-12th

OBJECTIVES:
Learners will be able to:

1. Utilize the online platform "Zooniverse" to become Citizen Scientists and assist Smithsonian Environmental Research Center with their research.
2. Explain how the presence and abundance of aquatic invasive species (AIS) can affect native species and entire ecosystems.

MATERIALS:

- Background Information section
- Computer with internet access
- Introduction video: https://www.youtube.com/watch?time_continue=125&v=BCtEjzd9zog&feature=emb_logo
- Zooniverse online research platform: https://www.zooniverse.org/projects/serc/invader-id

KEY TERMS:
Aquatic invasive species
Invasive
Native
Fouling organisms
Hull Fouling
Ballast

INSTRUCTIONS:

1. Begin by reading the Background Information. The online activity will follow.
2. Follow the instructions and links to participate in the online Citizen Science project called **Invader ID** *(created by Smithsonian Education Research Center (SERC) partnering with the Zooniverse online research platform).*

BACKGROUND INFORMATION:

A **fouling organism** is an animal or plant species that exists in water and attaches itself 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 can be vulnerable to changes in salinity and water temperature.

Fouling organisms can be native to an area or introduced. If a species is introduced to an area and begins to thrive and take over, we call that species **invasive**.

Invasive fouling aquatic species were introduced to the West Coast of the United States throughout the last century. Boats, ballast water, and other aquaculture can transport and introduce invertebrates to new places. Their presence and spread could impact native marine ecosystems. They increase fouling **(the buildup of organisms)** on surfaces. This happens a lot on boats and underwater cables where organisms grow and can damage the structures

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.

What is hull fouling and how does it relate to aquatic invasive species (AIS)?:

Aquatic invasive species 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. These organisms then colonize the hull and "hitch a ride" from one port 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 region.

The full effects of all AIS species is unknown but their presence means that they can cover large areas. This buildup on surfaces can therefore smother native species or 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.

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, include many forms of viruses, bacteria, plankton, plants and animals. When ships take on ballast water, these things 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.

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.

Who cares if AIS 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 research platform called Zooniverse.***

The goal of this research project is to find 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 number of organisms present on vessel hulls through regular cleaning and maintenance.

ONLINE ACTIVITY INSTRUCTIONS:

Currently, scientists are conducting identifications by collecting and looking for fouling organisms on the actual PVC tiles they have submerged in bays. This is a time-consuming process, but with the help of digital photography, citizen scientists (like you!), and online platforms scientists can increase the amount of data that they are able to work with. Having a community of citizen scientists who are interested in marine animals can greatly aid in the research process by; identifying fouling communities in more places, finding new species, or watching as these communities change. Citizen scientists, along with advancements in technology have created a new advancement in the scientific community – something that may become more important as human impacts affect our coastlines.

1. **Watch the introductory Smithsonian Environmental Research Center's Citizen Scientist "Plate Watch" video at**:
   https://www.youtube.com/watch?time_continue=125&v=BCtEjzd9zog&feature=emb_logo

2. **Visit the Zooniverse webpage: Invader ID**
   https://www.zooniverse.org/projects/serc/invader-id
   To help identify fouling organisms from pictures taken by Scientists click the **"Get Started"** button to begin the identification process.
   - If the Welcome Tutorial does not automatically load, you can click the "TUTURIAL" tab on the right of the screen.

3. Challenge your understanding by answering the optional analysis questions below.

4. To learn how California's Department of Fish and Wildlife is preventing the spread of invasive species click here:
   https://wildlife.ca.gov/Conservation/Invasives/Species

ANALYSIS QUESTIONS: CHECK YOUR UNDERSTANDING (OPTIONAL)

How do AIS (aquatic invasive species) affect the native species and the ecosystem?

Were you able to identify any AIS through the online Invader ID activity? If so, what were they?

How has technology helped us to understand and/or investigate invasive species?

How could humans change their actions or develop technologies to help prevent the transfer of species into bays and harbors?

Besides humans, what other things can affect fouling communities?

NEXT GENERATION SCIENCE STANDARDS:

PERFORMANCE EXPECTATIONS
MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics **Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.** **MS-ESS3-2 Earth and Human Activity** **Analyze and interpret data on natural hazards 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 • Evaluate the claims, evidence, and reasoning behind currently accepted explanations or solutions to determine the merits of arguments (HS-LS2-6) Connections to Nature of Science ----------	**ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it (MS-ETS1-4) • Models of all kinds are important for testing solutions (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • 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) **ESS3.C: Human Impacts on Earth Systems** • 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	**Stability and Change** • Much of science deals with constructing explanations of how things change and how they remain stable (HS-LS2-6)

Scientific Knowledge is Open to Revision in Light of New Evidence • 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)	impacts (negative and positive) for different living things (MS-ESS3-3) **LS2.C: Ecosystem Dynamics, Functioning, and Resilience** 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)	

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.