Globe Toss

(modified from COSEE West teacher resources)

Standards Correlations

National Science Education Standards A, C, F, G
California State Science Education Standards 3rd grade 3b, 5a, d, 5th grade 3a
Ocean Literacy Principles and Fundamental Concepts: 1a

Key concept

Most of the Earth is covered by water.

Background

The ocean occupies more than 70% of the earth's surface and has a large impact on the earth and its inhabitants. Ocean-weather-climate interactions, transportation, fisheries, and recreation are just a few of the many things that are influenced by the ocean. In this introductory exercise, participants will determine the percent of the surface area of the Earth covered by water.

Materials

16" inflatable globe

Engage

- Ask students if they have been to the ocean and if they could see across the ocean to the next land mass.
- Ask if they know or can guess how much of the earth is covered by sea water? *If they don't know ask them to make a prediction.*
- How would we measure this amount?

Explore

1. We are going use an inflatable globe to see if we contact the ocean or the land more frequently as we catch the globe.

2. Draw a chart on the board to track catches that touch land vs. catches that touch water.

3. Have students get into a circle and toss the globe to one another. (*The results tend to be more reflective of actual percentage land/water if globe spins when tossed.)*

4. After each toss have students report whether their left thumb landed on land or water when they caught the globe, mark a tally to show the correct location.

5. Repeat until you reach 25 catches and multiply by 4 to get percentage of land vs. water **or** continue to 50 and multiply by 2 to get percentage of land vs. water. *Results should be about 70-75% water.*

6. Ask students to propose how else they might determine how much of the Earth is covered with water? *Answers will vary. Calculating the area of land vs. sea is one option.*

Understanding Fish Invaders at Gypsy Point
3rd – 6th grade

Standards Alignment

National Science Standards A, B, C and F
Ocean Literacy Principles and Concepts 5, 6e, g
Education in the Environment Initiative Principles and Concepts IIb-d, Vc

3rd grade
- CA Science Content Standards 2a, 3a - e
- CA Reading Comprehension Content Standards 1.0, 2.0, 3.3, 3.4
- CA Listening and Speaking Standards 1.1, 1.3, 1.7
- CA History - Social Studies Content Standards 3.1.1, 3.1.2, 3.4.2

4th grade
- CA Science Standards 2b, 3a – c
- CA Reading Comprehension Standards 1.1, 1.4, 1.6, 2.1, 2.3
- CA Listening and Speaking Standards 1.1
- CA Social Science - History Content Standards 4.1.1, 4.1.4, 4.1.5

5th grade
- CA Science Standards 6a
- CA Reading Comprehension Standards 1.1, 2.1
- CA Listening and Speaking Standards 1.1
- CA Social Science - History Content Standards 5.9

6th grade
- CA Science Standards 5b - e
- CA Reading Comprehension Standards 1.1, 1.2, 1.5
- CA Social Science - History Content Standards Chronological and Spatial Thinking and Historical Interpretation

Key Concepts

- Students will identify responsible pet care.
- Students will identify the steps of what to do when they can't keep a pet.
- Students will understand why lionfish, *Caulerpa sp.,* and other introduced species can be a problem for a natural environment.
- Students will explain how humans can affect natural systems by the decisions they make.

Prerequisite Knowledge

- knowledge of basic needs of living things, resources used by organisms to meet their basic needs
- ability to follow a story and interpret pictures
- ability to use descriptive words to share observations

- recognize patterns found in nature

Background

When living organisms are introduced into a new environment it is extremely stressful for those organisms and many do not survive. Those that are introduced may survive and even impact the environment where they are introduced. Invasive species include any living organism that is introduced into a environment where it is not found historically and once introduced it is able to out compete native species or significantly impact the environment. Non-native plants are frequently put into gardens because people like how they look or they remind them of another place. Invasive species often include weeds that we pull from our gardens. Introduced species of grasses in mudflats can trap sediment to such a degree the mudflat is transformed into a different type of habitat, a high marsh.

Invasive species often don't have a predator in their new habitat to keep the population in balance, so they can often out compete the native species, reducing or even eliminating the organisms naturally found there. While some introduced species provide food and habitat for animals others may not provide the same resources as the species they are replacing. For example, reducing the necessary habitat for nesting birds in an ecosystem may result in fewer chicks and a decline in the bird population.

Wildlife managers continue to deal with the challenge of domesticated pets that are released into the wild. This has been a tremendous problem internationally, as these animals are not prepared to survive in nature and their behaviors impact native animals found in the area. Cats are a worldwide example. When released cats can prey upon nesting and migratory birds, yet the cats still have a tough time surviving in nature on their own. Their wastes increase the levels of bacteria in the watershed and can spread diseases impacting human health. Wild parrots are another example of introduced species that are able to thrive in a new environment.

Laws prohibit the release of domesticated animals (including pets) into nature. Ships in port are prohibited from releasing ballast water (the water a ship takes in to balance the load) so as to not introduce new species of plankton. Recreational anglers and hikers are urged to check and clean their equipment, boats, fishing gear, and boots to avoid spreading species to new locations.

Pouring aquariums into the sewage treatment system allows the water to be cleaned as chlorine is added to kill living organisms. Pouring aquarium water into a stormdrain or directly into the ocean prevents it from being cleaned and can result in introducing species into the environment. Any algae large enough to be caught with a net should be frozen before being disposed of to ensure that the algae won't spread.

Lionfish natural history Lionfish are top predators in their native coral reef habitats in warm, tropical waters of the South Pacific and Indian Oceans including the Red Sea where they feed upon shrimp and crabs. These fish have few predators and tend to live solitarily. The males especially are fierce in defending their territory. They lay eggs in mucus-encapsulated clusters of up to 15,000 eggs that are fertilized within 12 hours and then hatch 36 hours following fertilization. They can swim within two to three days and at 20 – 40 days they are no longer considered larva and are 10 – 12 mm in size. They move slowly and protect themselves with their venomous spines that contain a neuromuscular toxin. They are very popular in aquarium trade.

Lionfish adapt well to a broad range of temperatures and salinity making them very successful as they are introduced to new areas. Lionfish have been reported along the southeastern United States since the early 1990's. They are found in large numbers from Florida to North Carolina. Young have also been found in New York and the Bahamas. More recently they are being found at greater depths replacing some of the herbivorous fish. Two concerns for this increase of a non-native species is the success of these top predators out competing the native grouper and other fish and the health risk for recreational swimmers and anglers being stung by their toxin. *(see lionfish info page)*

Caulerpa taxifolia is a marine alga that is native to the Caribbean, Australia, Brazil, Philippines, Vietnam, and other tropical seas where it grows in small patches and does not present problems. In the early 1980's it became a popular decoration in home aquaria. When it was introduced to the Mediterranean it grew much more robustly spreading into thousands of hectares. It has a toxin that protects it from sea urchins, fish, and other herbivores. While a native non-invasive *Caulerpa taxifolia* is found in the Florida waters, the invasive species from the Mediterranean has also been observed. *Caulerpa* t*axifolia* was also introduced into California waters by a home aquarist and has been eradicated. It reproduces by fragmentation so even a small piece can cover an area as it grows. Because of its adaptability to grow rapidly, even with diverse substrate, nutrient limitations, wide temperature ranges, low light, and lack of predators in the introduced habitats, it out competes the native seaweeds. *(see Caulerpa info)*

Materials

- Copy(ies) of Fish Invaders at Gypsy Point: Katie and George Learn About Alternatives to Aquarium Dumping
- *Caulerpa* presentation and necessary AV equipment to share
- Magnifying lenses
- Samples of *Caulerpa* images
- World map to show where Lionfish and *Caulerpa* are found and where they have become invasive species

Instruction time one 30 - 40 minute period. This lesson can be spread over several days depending upon the time available so that students have a chance to ask questions and to explore their ideas and interpretations of the story. Reviewing responsible choices and the impacts of invasives can happen throughout the year.

Differentiated instruction Use a big book or powerpoint to focus students attention as a group. Have students create a puppet show or act out the story.

Procedures

1. Engage the students' interest by asking if any of them have gone snorkeling, visited the beach or an aquarium? Did they see what they were looking for or were they surprised? (*Answers will vary. Prompt students to explain why they saw something that was different.)*

2. We are going to read about two students who are going snorkeling and how they use what they have learned when confronted with a surprise. *Show the students the cover of the book and ask what do you think this story will include?*

3. Read the story. As you read encourage students to make predictions about the story using the illustrations. Ask the students to share what feeling the illustrator is conveying by selecting the style he did.

4. Ask questions that connect them to the story with their own life experiences. (*Have you ever seen an animal up close that could be dangerous? Have you ever needed to get rid of a pet?*)

5. Comprehension check
   - What was the problem that Katie and George faced? *Seeing the environment had changed and being confronted by a lionfish.*
   - Who helped solve the problem? *a scientist, Dr. Linda*
   - What did they do when confronted with the situation? *They took a picture to get the fish identified. They posted a sign to warn others.*
   - Can you define a well-balanced food web, using the illustrations in the book on page 4? *The well-balanced food web includes seagrass, many kinds of small fish eating microscopic organisms, a little bit larger fish eating sea grass, and larger fish eating invertebrates and smaller fish. Some very large fish hiding as well.*
   - On page 5 what made Katie and George ask "What happened here?" *They couldn't find any of the fish or invertebrates they had seen before and everything was still.*
   - Why do you think that the lionfish startled and froze with the flash? *Bioluminescence is sometimes used to startle predators to avoid getting eaten and the flash acted like bioluminescence.*

- How are the lionfish causing an imbalance in the reef's food web? *They are eating all the small fish that occur on the reef, reducing biodiversity.*
- What happened when they invited their friend to go snorkeling? *Dave brought his aquarium fish to release it.*
- Why didn't they put the fish in the ocean? *Because introduced species are a problem.*
- How did they solve the problem? *They went to an aquarium store and donated the fish to be someone else's pet.*
- What are other options they could have selected that wouldn't damage the environment? *Give the plants and pets to an aquarium hobbyist, freeze extra plants or seaweeds, contact an aquarium, check with a school or day care center.*
- Why shouldn't you dump your aquarium water in the storm drain? *Most storm drains lead directly to the ocean without filtering or cleaning the water, so you risk introducing seaweeds and/or diseases.*

6. Investigate further by looking at a sample of algae or the image of *Caulerpa* using a magnifying glass. *(Ask students about their observations. What parts do you see? What plantlike parts does Caulerpa have that you recognize? (leaves, stem)*

7. Let's find out why *Caulerpa* can be a problem*. (Share slide presentation*)

8. Where do *Caulerpa* and lionfish live in nature – where are they from? Look on a map and show where in the ocean they are a problem and where they are naturally found.

Assessment

If you have a pet that you can't keep or take with you when you move, what will you do? (B*e a good citizen and be responsible for finding it a home or returning it to a pet store*.)

Extend at home

1. Visit the library to find out where your pet is naturally found.
2. Tell someone you know who has a pet about what you learned today so if they can't keep their pet they would know what to do.
3. Visit an aquarium or aquarium store to learn about the different algae and fish they have at the store.

Student resources

One Less Fish by Kim Michelle Toft and Allan Sheather

Additional resource

Washington Sea Grant "Bio-invasions: Breaching Natural Barriers" p 9, 11, and 15

Staying Alive or Adapt and Thrive

Standards Addressed

National Science Standards A, B, C, E, F, G

California Science Standards 3rd gr. 3a-d; 4th gr. 2b, 3b; 5th gr. 6a; 6th gr. 5e

Education in the Environment Principles and Concepts 1c, IIb, IIIc, IVa-c

Ocean Literacy Principles and Concepts 5c, f, 6e,g

Key Concepts

- Specific behavior or physical characteristics have a purpose.
- Physical structures or behavior enable some organisms to survive better than others.

Prior experience

Knowledge of the features that make a fish a fish. All fish are finned vertebrates that use gills to respire in the water.

Materials

- copy of Fish Invaders at Gypsy Point
- many images of diverse fish

Vocabulary

adaptation – a change in structure or function of an organism that results from natural selection thus the organism becomes better suited to survive and reproduce in a changed environment.

aposematic or warning coloration – bright colors or patterns used to advertise that it is toxic or bad tasting.

bioluminescence – ability of living organism to emit light. A chemical process in which luciferin reacts with oxygen in the presence of the enzyme luciferase; 98% is light energy and 2% heat.

camouflage renders a target indistinguishable from background objects both to avoid predators and to enhance its ability to capture prey.
countershading – silver or white bellies contrasted with dark backs and sides to match the lighting from the surface or dark of the ocean depths.
cryptic coloration – blending in with the environment, disguised to match the background. Colors may be a random sampling of its surroundings.
disruptive coloration – coloration broken up with mottling or prominent lines (stripes and bars), and/or bold contrasting colors.
mimicry – an organism's resemblance to another species or to a feature of its natural surroundings, developed as protection from predators.
spiny – covered with sharp processes or thorn-like structures.
venomous - having a gland or glands for secreting a venom (a poisonous fluid) produced by an animal; able to inflict a poisoned bite or wound

Background

The appearance of an animal often helps an observer know how the animal makes its living. Physical structures and colors help an animal survive in its environment. Through the evolutionary process animals have adapted to their surroundings. Many organisms can't move out of the way of predators so they develop structures or behaviors to survive. When a fish opens its fins at other fish it is typically a display or territoriality.

Some appearances can be a challenge for an observer to understand. While animals need to avoid predators, they also must attract prey and mates. Bioluminescence, for example, can be used by fish to startle a predator, attract prey, or attract a mate. If an animal is introduced into an environment where there aren't predators, the adaptations it has may enable it to not just survive but even thrive, especially if it has all of the resources it needs and it is able to out compete the other animals in that area. It can become the dominant species causing changes to the environment.

Procedures

1. Before reading the story hold up a picture or show an image of a lionfish. Ask students how might this animal protect itself?

2. Read the story and make a list of adaptations that are represented in the story and fact pages about *caulerpa and lionfish*.

3. Have students answer what are adaptations that organisms in the story have to increase their survival? *Tastes bad, ability to grow from tiny fragments, rapid growth, large reproductive rate, spiny fins that are venomous, disruptive coloration, expandable stomach to eat prey up to half the size of the fish.*

4. What structures do the lionfish, *Pterois volitans,* have to prevent them from being caught by predators? *Spiny venomous fins, disruptive coloration, territorial behavior, slow swimming (blends in with surroundings)*

5. Why are the lionfish, *Pterois volitans,* effective at out competing other fish in the area? *Large mouth to eat smaller fish, stomach expands, rapid growth rate, large numbers of young produced that have a planktonic stage allowing them to flow with the gulf stream current.*

6. How is their mouth adapted for survival? *Points up and is large in size*.

7. Show pictures of other fish and introduce the concept of using coloration for survival. Introduce any unfamiliar terms from the vocabulary list. Have students sort the fish by the strategy they are using for protection. For example: which colors disappear first as light moves deeper in the water? Which fish have disruptive coloration with bars or stripes? Which use mimicry or cryptic coloration and blend in well? Etc.

8. Assess understanding by inquiring "Why don't lionfish, *Pterois volitans,* need to be fast swimmers?"

Extend

1. Encourage students to investigate fish that they are curious about.
2. Visit an aquarium and observe the fish. One guide is found at http://www.mauioceancenter.com/downloads/grade_7&8aw.pdf

Location, Location, Location

Standards Correlation

National Science Standards A, C, F
National Social Science Standards
Geography K – 12,1. maps and geographic representations
Geography K - 12, 4. physical characteristics of places
Geography K – 12, 5. regions to interpret Earth's complexity
California Science Standards: 3rd gr. 3b-d; 4th gr. 2b, 3b; 5th gr. 3a;
6th gr 5c, e, 7f
Education in the Environment Initiative P & C: IIIc, IV a-c
Ocean Literacy P & C: 5a, f, 6e, 6g

Key Concepts

- Maps can be used to identify natural ranges of organisms and track how the ranges change.
- Distances can be calculated using a scale.
- Natural boundaries can prevent organisms from extending their range without intervention.

Prior knowledge or experience

- Experience with Google Earth or build in time to explore the program before starting the lesson.
- Understanding of latitude and longitude

Materials

- Page 19 map in Fish Invaders at Gypsy Point
- Google Earth and internet access
- or a globe showing oceanographic features
- ruler
- graph paper and meter tapes to map campus (optional)

Vocabulary

latitude - The angular distance north or south of the earth's equator,
measured in degrees. Latitude is measured from the equator, with positive values going north and negative values going south.

longitude - angular distance east or west on the earth's surface,
measured by the angle contained between the meridian of a particular place, measured as an arc of the equator. Longitude is measured from the Prime Meridian (which is the longitude that runs through Greenwich, England), with positive values going east and negative values going west.

range - the area where an organism spends its time; it is the region that encompasses all the resources the animal requires to survive and reproduce.

Procedures

1. Engage the students by asking if they have ever wanted someone to go to an exact location but they couldn't take them there themselves? *(For example, maybe you needed someone to get you something you left in a classroom or told a friend about a perfect place to visit.)*

2. Exact locations can be specified worldwide using a latitude and longitude coordinates or a GIS (Geographic Information System). Ask students if they have used a gps, been in a car with a navigation system, or seen one used on TV.

3. Review latitude and longitude lines.

4. Explore the map from page 19. Ask the students to share what they observe from looking at the map. The students may mention or you may note that the map in the book does not contain the location lines but it does show the approximate locations of the species ranges.

5. Remind students that Google Earth allows us to explore our planet including oceanographic features. Have the students complete the following questions recording their answers on the data sheet provided.

    1. Identify where you live on the map. *Answers will vary based upon your location.*

    2. Identify the ocean basins on the map. *N. Pacific, S. Pacific, N. Atlantic, S. Atlantic, Indian, Artic, Southern or Antartic Ocean basins combined equal the one ocean of our planet.*

    3. Using Google Earth or a globe find and write the latitude and longitude lines closest to where *Pterois volitans* is found in its natural environment. *Its natural range is approximately between about 41 degrees N and 141 degrees east and 19 degrees south and 152 degrees East.*

    4. What is the latitude and longitude of where *Pterois volitans* has been introduced? *The range where it is found is approximately 41 degrees N and 71 degrees W to 9 degrees N and 80 degrees West.*

5. Use the Google ruler (found in the toolbar at the top of the screen) to measure the distance the lionfish, *Pterois volitans,* would have to travel if it were to reach the area of invasion on its own. Remember it has to stay in the water to survive. *About 14,000 miles around the tip of Africa.*

6. Using the Google ruler to measure the length of *Caulerpa taxifolia* invasion in the Mediterranean Sea. *It is about 1,900 miles.*

7. What seems to be the furthest northern and southern ranges for these two organisms? *Caulerpa taxifolia 44.46 degrees north and the furthest south is 35 degrees south. Pterois volitans can be found 40 degrees north and 23 degrees south.*

8. Why do scientists monitor the range of where an organism can live? *To determine how the ecological systems are working and to better understand how environments are changing.*

9. How would you describe the oceanographic or bathymetric features on where you find *Pterois volitans*? *The water depth is shallower, as there is a continental shelf.*

10. If researchers needed your help in deciding where to set up a new monitoring program for the Lionfish *Pteois volitans,* where else might be a good place*?* Please explain your answer. *Answers will vary – all should explain the reason they chose the location they did.*

Review results with students.

Extend the experience

6. Have the students map coverage of areas on campus such as how much of the campus is covered with desired plantings and how much is covered with "weeds" or undesired plantings. Alternatively students can determine how much of the school area is covered with grass compared to how much is covered with cement. Have students represent their findings using a map or graph.

7. Have the students select one organism on campus and do research to identify its home range or native habitat and then calculate the distance it traveled from its native range.

Cast of Characters

Standards Addressed

National Science Standards A, C, F
California Science Standards 3rd gr. 3b-d, 4th gr. 3a, b, 6c, 6th gr. 5c,e
Education in the Environment Principles and Concepts 1c, IIb, IIIc, IVa-c
Ocean Literacy Principles and Concepts 5c, f, 6e, g

Key Concepts

- Some living organisms in an area or region are considered native as they have occurred historically and have evolved or adapted to the region while others are introduced species.
- Invasive species occur when introduced species have a negative impact on the natural ecosystem.
- Students can become stewards through conducting scientific observations and by sharing their scientific knowledge.

Prior expereince

Prior to lesson read *Fish Invaders at Gypsy Point.*

Materials

- library resources including web access
- regional invasive species listings, i.e. California aquatic invasive species http://www.invasivespeciesinfo.gov/aquatics/main.shtml
- template for wanted poster profile (optional)

Background

Vocabulary

native species - species that normally lives and thrives in a particular Ecosystem within a historic range or distribution.

introduced species – species that have been recently brought into the area or region by humans, other animals, wind, waves or have recently expanded their range.

invasive species – a non-native species whose introduction causes or is likely to cause economic or environmental harm. Those species that cause harm and once established, spread quickly from their point of introduction are often called "invasive."

climate change - changes in long-term averages of daily weather measured over decades or longer. Changes may be natural and/or human caused.

Early Detection and Rapid Response (EDRR) – identifying and reporting the first pioneering organisms and responding rapidly with control measures will prevent damage to natural resources.

biodiversity – natural diversity that includes 1) the number of different native species and individuals in a habitat or geographical area; 2) the variety of different habitats within an area; 3) the variety of interactions that occur between different species in a habitat; and 4) the range of genetic variation among individuals within a species.

citizen science – involvement of citizens (K-Life) as decision-makers in scientific initiatives outside of formal educational initiatives.

Procedures:

1. Engage the students by asking how many of you have learned the names of some of the aquatic plants and animals that live near shore?

2. Explore what you know and can find by making a list of those that students can recall. Sort them by those that have always been in the region, those that are native and those that have been introduced. For example palm trees were introduced to Los Angeles but coastal oaks are native species.

3. Work as small groups or individuals to search for other names to add to the list and to check to see if all the ones listed are native organisms and which are missing from your list.

4. Identify any species which have become endangered, threatened or rare in the region.

5. Share responses and discuss how species may have become endangered, threatened or rare *(habitat loss is one of the biggest causes for changes in biodiversity*).

6. Elaborate by asking students if they have ever seen something in nature that seemed wrong like a squirrel on the beach or a pelican in the middle of the city. What can you do when that happens?

7. Katie and George were out having fun exploring and they noticed something that didn't belong or looked different from what they expected. Whom did they decide to tell about the fish?

8. By taking a picture and passing on their information they participated in something called citizen science. Citizen scientists can be any age (K-Life) and help address environmental issues and research by helping determine questions, collect data, and engaging in decisions that shape laws and

policies. Katie and George helped identify new occurrences of a species of fish.

9. Evaluate understanding by having students work in teams to select one introduced species and create a wanted poster for that species. Find a location to hang the poster in their classroom, at school or in the community. The poster needs to include species name and a picture, identifying characteristics, why it is undesirable or wanted to be identified and who should be contacted if it is found. You may want to work with your natural resources department, department of fish and game or sea grant office to help find a listing of identified undesirable or invasive species in your area.

Get Involved

Katie and George took classes to learn about what is found in their local area. You can build your knowledge of native aquatic species by visiting your local zoo or aquarium to see what is native to the area.

Some changes are further impacted by climate change so citizen scientists can serve a critical role in reporting observations to scientists and to coastal visitors who might be at risk from animal interactions such as with the lionfish.

You can help identify changes occurring regionally by participating in programs that record changes like Project Budburst http://www.budburst.ucar.edu/ and local efforts to observe changes in your area by joining annual backyard bird counts.