SHEDD AQUARIUM

Providing Forever Homes

LESSON ONE: Shedd Habitat Designer

In 1989, when the Abbott Oceanarium was still under construction, no one could have planned that Shedd would become a leader in rehabilitating and raising sea otter infants and in training these frisky, feisty cousins of weasels. No inland aquarium or zoo even had sea otters then. But Shedd was building a massive, immersive re-creation of the rugged coast of the Pacific Northwest, and it wouldn't be authentic without sea otters. Instead of adult otters, however, Shedd received four orphaned pups from the Exxon Valdez oil spill, beginning a permanent commitment to rescuing, rehabilitating and providing forever homes to the most vulnerable members of this species.

Since then, Shedd has provided a home to many sea otter pups, including one of the most recent rescues, Luna. Luna's odyssey began on Sept. 30, 2015, when her insistent high-pitched cries caught the attention of someone taking an evening walk along central California's Coastways Beach. Awareness about stranding networks runs high on the coasts, and it only took two phone calls to arrange to get rescuers from Monterey Bay Aquarium to the remote site early the next morning. The 2-pound pup, estimated to be 5 days old, was admitted to the aquarium's sea otter rehabilitation program, where she received intensive care for the next four weeks. Monterey Bay Aquarium contacted Shedd, one of the few other U.S. zoological facilities with the appropriate space and expert staff to care for infant sea otters. Members of our sea otter and animal health teams joined their Monterey Bay colleagues to care for the pup. On Oct. 28, they arrived back in Chicago with the now 5-week-old, 5½-pound otter.

LESSON ONE: Shedd Habitat Designer

CONNECTION TO UNIT: Why this matters for your students

Our students are going to be navigating a changing world. Shedd Aquarium's mission is to connect our guests to the natural world. It is critical that all people have an understanding of basic ecology: the vital roles living and nonliving factors play in the environment. This lesson will also focus on students developing skills to justify or refute claims while supporting their opinions with evidence they have collected during their investigations. They will also have practice using the engineering design cycle: creating a scientific model, conducting a scientific investigation and then editing their initial model.

NGSS DISCIPLINARY CORE IDEAS

LS2.A: Interdependent Relationships in Ecosystems

> Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
  • Difference between living things and nonliving factors.

> In any ecosystem, organisms and populations with similar requirements for food, water, oxygen and other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.

> Growth of organisms and population increases are limited by access to resources.

NGSS SCIENCE AND ENGINEERING PRACTICES

Developing and using models

> Modeling in 6-8 builds on K-5 experiences and progresses to developing, using and revising models to describe, test and predict more abstract phenomena and design systems.

Analyzing and interpreting data

> Analyze and interpret data to provide evidence for phenomena.

Constructing explanations and designing solutions

> Construct an explanation that includes qualitative or quantitative relations between variables that predict phenomena.

Engaging in argument from evidence

> Construct a written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

> Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

KEY POINTS

> Organisms need both living and nonliving things in their environment to survive.

> Students will be able to create a proper habitat for an organism by considering the same information as Shedd's habitat designers: food, water, air, space and other factors.

> Students will be able to define and identify examples of mutually beneficial interactions, competition and predator/prey relationships.

> Population sizes and reproduction are limited by access to resources.

MATERIALS/SETUP

> Student handout (one per student)

> Habitat research articles (can print a few copies of each article and place at stations or have one per student). These articles are the last three pages of the document.

Recommended that at least one copy of each handout is provided to students during the Elaborate section as well.

AGENDA

OPTION 1: TWO DAYS *(recommended)*

Day 1

1. Engage (10 min)
2. Explore (40 min)

Day 2

1. Explain (15 min)
2. Elaborate (30 min)
3. Evaluate (5 min)

OPTION 2: ONE DAY

1. Engage (5 min)
2. Explore (15 min)
3. Explain (10 min)
4. Elaborate (15 min)
5. Evaluate (5 min)

IMPORTANT VOCABULARY

> Ecosystem

> Mutually beneficial interactions

> Competition

> Predator/prey

> Populations

> Resources:
water, food, habitat, oxygen

ENGAGE: Key points previewed

Grab students' attention, recall prior knowledge and set framework for today's lesson.

Students will have a quick intro to Shedd Aquarium's work with sea otter pups off the coast of California. Students will then be asked to create an initial model of a habitat for the sea otter pup Luna.

Student framing and worksheet questions:

Today we are going learn all about the work that happens at Shedd Aquarium when a new exhibit is designed. A lot of work has to go into designing a forever home at Shedd Aquarium. This extremely important job is done by habitat designers. Today you are going to be habitat designers!

Shedd Aquarium has rescued an abandoned sea otter pup. Her name is Luna, and she needs a new home at Shedd Aquarium. Based on what you know about animals from both nature and pets at home, what would need to go into Luna's new home?

> *Students are given 3 minutes to brainstorm.*

> *Have students label these items as either living or nonliving factors.*

Ask: Will _____ need living or nonliving factors in her new home?

EXPLORE: Key points discovered

Students conduct a mini investigation to challenge or confirm initial model. They should make observations, collect/record data and interpret their results.

Students use scientific articles (last three pages of PDF) to complete questions.

OPTION 1 *(recommended)*:
Students will be divided into groups to complete each Shedd habitat designer topic at a station (this will allow students to gain a more in-depth understanding, but will take more time). Corresponding to sections on the worksheet, there is a box for each category: environment, water quality and diet. Students will be responsible for answering each question as they work through the stations.

OPTION 2:
Students will be split into three large groups or six smaller groups with two groups per topic (this option will save time but will not allow all students to have a personal experience with each topic). Corresponding to sections on the worksheet, there is a box for each category: environment, water quality and diet. Students answer questions for one section and then share the information with peers.

The groups will be:

> **Environment**: What goes into a sea otter habitat at Shedd Aquarium? These students will plan and develop the general things that must go into the foundational habitat: rocks, plants, size, etc.
***Main question for students*:** Someone on your team does not want to place any kelp or kelp-like features in the habitat. He claims that kelp is not important. Do you agree or disagree? Make sure to support your claim with evidence.

> **Water quality**: What are considerations when determining the water that goes into Shedd Aquarium's sea otter habitat? These students will make all the major decisions about water in the habitat: temperature, salinity, etc.
***Main question for students*:** Someone on your team thinks sea otters need clean water from Lake Michigan. Will this work? Make sure to support your claim with evidence. How will they get fresh water?

> **Diet**: Design a menu using the data for the sea otters at Shedd Aquarium.
***Main question for students*:** How can you make sure each otter is getting the food that it needs (rather than the bigger otters taking all the food)?

EXPLAIN: Key points formalized

Students are guided toward creating explanations of their results. Here is where they really connect their investigation back to the content. Key vocabulary, scientific principles and theories are introduced. Additional sense-making activities may be used or can be follow-up questions/discussion.

Students are continuing to edit questions from their Explore section. They should be listening to peers and editing the information they have collected thus far.

OPTION 1: Have students share their Shedd Aquarium sea otter information. Because all students have completed each station, the discussion should be focused on the main points below.

OPTION 2: Student groups will take turns sharing the information they were responsible for collecting. Students not in that group should take notes on the key points. A teacher or student volunteer can be recording the full group. Students should present and discuss the claims they received and why they agreed or disagreed.

Main points that need to be addressed and questions to steer these points into conversation:

> **Environment**: Do sea otters need a kelp-like feature in their habitat? Organisms have relationships in which species benefit. Sometimes species can even depend on other species for survival. What did your group discover about the relationship between otters and kelp? Can you think of a different relationship in which this might be the case (bees and flowers, etc.)?

> **Water quality**: All mammals need fresh water to survive. How does this affect the Shedd Aquarium sea otter habitat design? Water is a nonliving factor in the environment that is vital for organisms' survival.

> **Diet**: What types of things do sea otters eat? Are these things living or nonliving? Why do you have to consider special feeding strategies if you have more than one otter in the Shedd Aquarium habitat? Sea otters eat a lot of different animals. Their food is living.

ELABORATE: Key pointsused

Students continue to complete practice problems of skills and/or apply new knowledge to the situation or new scenario. Teacher checks student comprehension and push extension of content.

Students can work though the Elaborate questions (indicated on their handout) either independently or in small groups. The students should learn the definitions of competition and limited resources in this section. They will also continue to apply the idea of living and nonliving features in the environment and at Shedd Aquarium.

EVALUATE: Key points assessed

In this section, both students and teacher check students' acquisition of knowledge. Students should gain a clear understanding of what they have learned. As the teacher, you can use this information to begin to formulate the next day's lesson.

Questions below are meant to be used as a formative assessment. They can be used independently, edited, or used with additional questions. By the end of the lesson, students will be able to answer the following:

1) A scientist claims that living organisms only need other living things to survive. Do you agree or disagree with this claim? Please support your claims with specific evidence or examples.

2) How does limiting or decreasing resources affect the ability of populations to grow and reproduce?

3) Define and compare the three types of species relationships we discussed: mutually beneficial interactions, predator/prey and competition.

In order for Shedd Aquarium to add another organism to a habitat, there is a lot of work and planning required. The needs of the animal limit the number of animals that can find forever homes at Shedd. How does the amount of resources such as food, water and space affect populations in the wild as well?

NOTES/CONSIDERATIONS

This lesson could be done in one class period (50 min) but is recommended over two. The lesson introduces important content and vocabulary, so additional time will allow students to connect deeper and become more invested in the project. If the lesson is split over two days, the goal would be that students have completed their stations or groups with the first class period and complete the rest of the lesson on day two. This lesson could also be given as an introduction to competition and limiting resources.

The final Shedd Aquarium sea otter habitat design could also be done as a more hands-on artistic project. Students could build or draw their final habitats to put on display in the classroom.

We would love to learn from you!

Please take a moment to share your thoughts about the NextGen Animal Responders curriculum. You can complete our brief survey—and boost Shedd learning—at **http://bit.ly/NextGenSurvey**.

SHEDD AQUARIUM

Shedd Habitat Designer

STUDENT HANDOUT

Name _____ Class Period: _____

ENGAGE

Today we are going to learn all about the work that happens at Shedd Aquarium when a new exhibit is designed. A lot of work goes into creating a forever home at Shedd. This extremely important job is done by habitat designers. Today you are going to be habitat designers! Shedd Aquarium has rescued an abandoned sea otter pup. Her name is Luna. She needs a new home at Shedd Aquarium. Based on what you know about animals from both nature and pets at home, what would need to go into Luna's new home? Draw your first habitat design:

> Great job! Now label the different factors or parts in your habitat as living or nonliving.

> Make a hypothesis: Will the sea otter be able to survive if you only put nonliving factors in the habitat? Why or why not?

EXPLORE

We are going to explore three major factors that a Shedd habitat designer must consider when creating the forever home of any rescued animal at the aquarium: environment, water quality and diet. You must use the scientific articles to conduct a research project to create the best home for the new resident.

ENVIRONMENT

1. Based on the information in the article, what would you need to put into the Shedd Aquarium habitat for the sea otter?

2. Why would a sea otter habitat need to have good air flow? What specifically does an otter need from this? Is this a living or nonliving part of the habitat?

3. Someone on your team does not want to place any kelp or kelp-like features in the Shedd Aquarium otter habitat. He claims that kelp is not important. Do you agree or disagree? Make sure to support your claim with evidence.

WATER QUALITY

4. What temperature should the water be inside the Shedd Aquarium sea otter habitat?

5. Is water a living or nonliving factor? Why do you think that?

6. Luna is a sea otter. Based on the information in the article, what special considerations should be made? How does this affect the type of water?

7. Will the water sample taken by a Shedd scientist and measured with the hydrometer be okay to use in the habitat? Why or why not? Make sure to support your claim with specific quantitative (numerical) data from the text.

8. All mammals need fresh water to survive. How does this affect the Shedd Aquarium otter habitat design?

DIET

9. Use the diet data to create the dietary plan for the sea otter. Is there any type of food in Figure 1 that you should give the otter? Why?

10 Based on the diet you have created, would you classify the diet of the otter as living or nonliving? Why?

11. How would you describe the relationship of otters with giant Pacific octopuses?

12. When looking at Figure 2, explain the trend of each species' population over time.

According to Figure 2, the population size of giant Pacific octopuses _____.
The sea otter population _____. Finally, the population of sea lions _____.

13. Why do you think the trend for question 12 occurred? Helpful hint: Look at the data collected in the Dietary Information Table (Figure 1). What do you notice about the relationship of sea otters to giant Pacific octopuses vs. that of sea lions to giant Pacific octopuses?

ELABORATE

Use the information you collected and answer the following analysis questions.

1. Check your original hypothesis. Will the sea otter be able to survive if you only put nonliving factors in her habitat? Why or why not? Did you agree with your original hypothesis? Why or why not? Make sure to give specific examples of what you will need in your final Shedd Aquarium sea otter habitat.

2. In nature, when animals of different species need the same resources like food, water and habitat to survive, it is called competition. Where have you heard this word before?

3. Connection question: Why would scientists call organisms needing the same resources competitors?

4. Scenario: Shedd Aquarium is also home to sea lions. These animals eat a similar diet to the sea otters as well as needing other resources such as fresh water and oxygen. Should you place these two organisms in the same Shedd Aquarium habitat? Explain your answer using scientific vocabulary. How would these two organisms occupying the same habitat possibly affect one another?

5. At Shedd Aquarium the sea otters have access to all the food, water, oxygen and other resources they could possibly need to survive and thrive. But this is not always the case in nature. What do you think would happen to a population of sea otters in the wild if the amount of mussels decreased? Why would this occur?

6. How does competition with other organisms or limiting an organism's access to resources affect a population of animals? Why?

7. During the course of your observation experiment, you uncovered three definitions of different types of relationships. Based on the information you collected, complete the table below:

	MUTUALLY BENEFICIAL	PREDATOR/PREY	COMPETITION
Create your own definition			
Example from otter study and explanation of why it is that relationship			
Create your own example of the relationship			

8. Now you have done your research and considered many different things about creating a forever home for Shedd Aquarium's otter Luna. Use your original habitat and new information to create a final Shedd Aquarium sea otter habitat design. Make sure to label all the living and nonliving parts of your habitat.

SHEDD AQUARIUM

Sea Otter Environment Information

BACKGROUND

Sea otters are able to both swim in the sea and walk on land, so they need places in their habitat where they can do either. They are very active animals and must have things to keep them busy. You may call some of those things toys. Zoos and aquariums call them "enrichment items."

The forelimbs have small, dexterous paws with retractable claws used for grooming and foraging. Tough pads help them grip their prey, like slippery fish and prickly urchins. While foraging, food is often stashed in hidden "pouches," which are actually loose folds of skin located under the forelimbs, until the otter returns to the surface.

In some areas, sea otters are considered a keystone predator because they have a principal influence on the ecosystem they live in by preying upon certain organisms. Specifically, sea otters promote kelp growth by preying on sea urchins and abalone, which feed on young kelp plants. If present in large numbers, urchins and abalone could prevent the growth of kelp forests that, in turn, provide habitat for a wide variety of marine life, including the sea otters.

SIZE

Alaska sea otters tend to be larger, in both length and weight, than California sea otters. Males reach 58 inches and a weight of 100 pounds. Females reach to 55 inches and 72 pounds.

HABITAT

Sea otters usually live along rocky coasts in areas that offer some protection from wind and waves. Sea otters show a preference for kelp beds, which provide camouflage, protection and abundant food sources. Otters will often wrap kelp blades around themselves to keep them from drifting while sleeping. Because both the otters and the kelp need each other to help their species survive, this is called a mutually beneficial relationship.

RANGE

Historically, sea otters were abundant in the North Pacific from the northern coast of Japan up through the Commander Islands, across the Aleutian Islands and down the Pacific coast of North America to Baja, California.

Currently, sea otters have been found along the northern coast of Japan, across the Commander Islands and down the coast of Alaska, Canada and in central California. It is estimated that 90 percent of all sea otters can be found in Alaskan waters.

SHEDD AQUARIUM

Sea Otter Water Quality Information

BACKGROUND

Currently, sea otters have been found along the northern coast of Japan, across the Commander Islands and down the coast of Alaska, Canada and in central California. It is estimated that 90 percent of all sea otters can be found in Alaskan waters. Alaskan water temperatures can range anywhere from 30-55°F.

Sea otters live in the sea, but what does it take to make seawater different than fresh water? The elements and amount of salt in seawater vary around the world and in different parts of the ocean. Otters need certain ranges of salinity (saltiness of their water). There are a variety of techniques to measure salinity and different ways to measure and create a salt mixture. The average salinity in the ocean is approximately 35g for every 1000 mL of water (3.5%).

At Shedd Aquarium we used a hydrometer to collect data on a water sample. We take these steps:

> Pour a little bit of your sample into the top of the hydrometer by the blue tab.

> Stop when you have water leak out the bottom. That is an overflow. You can't put any more water in or it will just run out again.

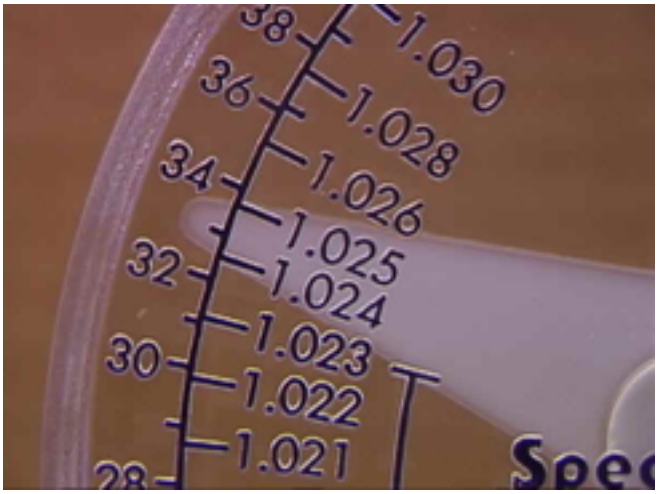
> The float will move to point to the numbers along the side. (You might want to tap it gently on the table to make sure no bubbles are stuck to the float. It will ruin your results.)

> Read the outer scale (the whole numbers), which is in salinity units or 1 gram of salt per 1000 grams of water.

> When you have your results, pour out your water. Make sure you pour toward the side with the numbers; otherwise the water will flow out the overflow.

Shedd water quailty sample measured by a hydrometer:

> Remember to read the outer scale, which is in salinity units or 1 gram of salt per 1000 grams of water.



SHEDD AQUARIUM

Sea Otter Dietary Information

BACKGROUND

Otters have very fast metabolisms and need as varied a diet as Shedd can provide for them. You are creating a yearly food order for one otter. Assume that each otter would eat about the same amount; any that eat more than average would be balanced by those that eat less.

DIET AND FORAGING METHOD

Sea otters are opportunistic and feed on the most available food items, including fish, echinoderms, crustaceans and mollusks. Food preference may vary from otter to otter. Sea otters can dive down to 120 feet in search for food and consume up to 25 percent of their body weight a day. The table below shows some of the different food options that Shedd provides for our marine mammals including otters.

FIGURE 1: DIETARY INFORMATION OF MARINE MAMMALS

	Beluga	Sea otter	Sea lion
Echinoderms			
Red sea urchin		X	
Green sea urchin		X	
Bat sea star		X	
Morning sea star		X	
Mollusks			
Red abalone			
California mussel		X	
Giant Pacific octopus	X	X	
Arthropods			
Shield back kelp crab	X	X	
Spot shrimp	X	X	
Coonstripe shrimp	X	X	
Bony fish			
China rockfish		X	X
Blue rockfish		X	X

Simulation: Population Dynamics of Alaskan Seas

The data collected is a simulation of what scientists predict would occur if populations of three species changed over time.