Ecosystem Design
Education Resources: 9th-12th grade

Students will design an aquarium habitat based on knowledge of the requirements of a balanced ecosystem and animal needs. Acting as animal biologists, students will create a habitat plan that includes the size, cost, and educational value of their proposed exhibit. They will then pitch their proposed plan to the rest of their class, who play the role of potential investors considering to fund the project.

Standards Alignment

MLS:

9-12.LS4.C.2 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.

9-12.ETS1.B.1 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

9-12.LS2.C.1 Evaluate the claims, evidence, and reasoning that the interactions in ecosystems maintain relatively consistent populations of species while conditions remain stable, but changing conditions may result in new ecosystem dynamics.

9-12.LS2.C.2 Design, evaluate, and/or refine solutions that positively impact the environment and biodiversity.

NGSS/ILS:

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.

HS-LS4-6.Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Ecosystem Design, 9th-12th

Pre-Visit Lesson

45 minutes

Objectives:

- Students will think critically about animal behavior and animal needs to design a habitat where an animal can thrive under human care
- Students will do reasearch to guide the design of their habitat , and be able to support their design choices with evidence
- Students will think critically about the educational value of zoos and aquariums

Materials:

- Research materials for each animal assigned, or access to computers/books for students to do their own research
- Drawing paper
- Colored pencils or markers

Lesson Plan

Engage

Ask students to write their response to the following prompt: Have you ever visited a zoo or aquarium? What animals were you most excited to see? Why were you excited to see these animals? What do you wish you could see? How much would you pay to see it? If you've never been to a zoo/aquarium before, why might you be interested in going to one? What would you expect to see? Why are aquariums/zoos important?

Students may share their responses with a partner or small group. Allow students 3-5 minutes to discuss, then ask a few students to share their responses with the class.

Explore

We are going to be acting as animal biologists, tasked with designing a habitat for an animal under human care. First we must understand an animals' needs and how they live in the wild.

Review the definition of *ecosystem: a biological community of interacting organisms and their physical environment.*

Ask students to create a list of different types of ecosystems. Possible answers include: desert, ocean, prairie, wetland, forest, arctic, etc. Discuss the following questions:

- What makes a successful ecosystem?
- What is needed for an organism to survive in an ecosystem?
- How could we measure the success of an ecosystem?
- What impact do humans have on ecosystems?

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Pre-Visit Lesson *(continued)*

You may choose to discuss: space, food, predator/prey relationships, abiotic and biotic factors, health, and ease of survival.

Explain

Assign each student (or group of students) one of the following animals: shark, octopus, sting ray, sea urchin, sea horse, sea star (or aquatic animal of their choice). Students should research their animal and find answers to the following questions:

In what type of ecosystem does this animal live?

What does this animal need in order to survive? (what do they eat, what do they use for shelter, what strategies do they use to protect themselves, etc.)

Elaborate

Based upon your research of this animal, describe what a typical day for this animal in the wild might be like. What do they spend most of their time doing?

How might you design the habitat so that the animal could practice these same behaviors while under human care?

What factors would you consider to keep the animal safe and healthy if they were under human care? How would you address these issues?

Possible Resource: Association of Zoos and Aquariums about animal needs in captivity https://www.aza.org/animals-and-conservation

Evaluate

Students will begin to design a habitat for their animal. Designs can be sketches and/or written descriptions. Students should address the animal's needs and behaviors in the design of their habitat.

Ask students to consider the following factors in their design:

Description of the exhibit

- What ecosystem are you highlighting?
- What species will be housed in the ecosystem?
- Why is this ecosystem important to humans?
- The size of the habitat needed for the animal to live comfortably
- Other plants and animals that will be present in the habitat
- Will your habitat need salt water or fresh water?
- What items in the habitat will allow the animal to feel safe or provide shelter?
- What items in the habitat will allow the animal to practice natural behaviors they exhibit in the wild?

- What items in the habitat will provide enrichment for the animal (activities to keep their brains and bodies active and healthy)?
- What design elements did you include so that the animal feels safe but also can be viewed by guests?

Logistics

- What are the dimensions of the exhibit?
- What does the exhibit look like?
- Where will the exhibit be located?
- What animals will be in the exhibit, and what will you include in the exhibit to meet their needs (both physical and psychological)?

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Field Trip Guide

The following discussion points for each gallery of the St. Louis Aquarium and Conservation & Education Center will help make the most of your field trip by engaging your students and asking them to recall information discussed in the pre-visit lesson.

Conservation & Education Center

What's your Watershed?

- Discover where your water comes from and where it flows to, while learning facts about your watershed

Plastic Bottle Sculpture

- Learn about humanity's excessive use of single use plastics and how this impacts our planet while viewing our bottle plastic sculpture

Species Discovery

- Explore some local species and research being done to protect them
- View the animals and take note of what items are included in their habitats

Digital River Clean-up Game

- This multi-player touch screen game teaches gamers about conservation topics and our collective responsibility to keep waterways healthy
- Explore the features of a river ecosystem and what can be done to keep these ecosystems healthy

St. Louis Aquarium at Union Station

Confluence Gallery

- Explain that this is an example of our local habitat, and the animals you see here live in our area
- Discuss the features of this exhibit that allow animals to live there comfortably (size of tank, hiding places/rocks, choice of animals included in exhibit together)

Global Rivers

- Rivers all over the world provide fresh water to humans, animals, and plants, making life possible
- Discuss similarities and differences between local river habitats and other river habitats throughout the world

Changing Rivers

- Discuss how human actions like farming, cutting down of trees, levees/dams, pollution, or construction projects can change the river ecosystem

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Field Trip Guide

Ocean Shore

- See and touch some amazing ocean animals!
- Take note of the animals' behavior in these touch tanks: are there places the animals can go if they don't want to be touched? Do the animals have to interact with people?

Shark Canyon

- Estimate the number of different species in this habitat (answer: over 60)
- Ask students to estimate the amount of water in this tank (answer: 250,000 gallons)
- Take note of the features included in this ecosystem – places for animals to hide, space to move around, water type (fresh or salt water) and general temperature
- Take note of what is on the surface floor and walls of the habitat
- Observe animals and discuss what behaviors you notice

The Deep

- View some very unique animals that live in the depths of the ocean
- Do these exhibits mimic the areas these animals would live in the wild? How are they similar? How are they different?
- Discuss what animals you haven't seen at the Aquarium and potential reasons those animals are not here

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Post-Visit Lesson

45 minutes

Objectives:

- Students will practice presentation and public speaking skills
- Students will think critically about the role of zoos and aquariums and evaluate potential benefits they bring to the community
- Students will use data to form an argument and present their ideas to their class
- Students will practice managing multiple aspects of a project including design, animal research, budgeting, and marketing

Materials:

- Internet access for research or pre-printed reference materials
- Paper for drawing plans and outlining exhibit proposal

Lesson Plan

Engage

Ask students to recall their field trip to the Aquarium. What were their favorite animals they saw? What do they remember about the animals' habitats? Were there any features of the exhibits they noticed during the field trip that they can incorporate into their habitat designs from the pre-lesson? Working with their groups, give students time to finish their habitat drawings from the pre-lesson, adding in any additional features based on ideas they got during their field trip to the Aquarium.

Explore

Tell students they are playing the role of a biologist who specializes in studying the animal they researched in the previous lesson. They are being tasked with designing a new exhibit to feature at a local aquarium. Working as a group of experts on their particular animal (working in the same groups that they did research with in the pre-visit lesson) students will create a habitat design and present it as a proposal to potenial investors.

An important part of getting their habitat built will be communicating to investors the educational value of this new exhibit and how it benefits the community. Ask students to read the research article titled, "Why Zoos and Aquariums Matter Handbook", a study by John Fraser and Jessica Sickler for the Association of Zoos and Aquariums and the Wildlife Conservation Society, found at the link below (especially pages 12-15):

https://documentcloud.adobe.com/link/track?uri=urn%3Aaaid%3Ascds%3AUS%3Aca8d4054-f71b-49e6-aecd-f289e134cdc4

As students read this, ask them to look for data that supports the idea that the addition of this animal habitat is valuable to the community.

Explain

Students continue to prepare their habitat proposals, by estimating the costs and benefits of building the habitat. As a approximation, students should plan to provide one gallon of tank space for every inch of animal being placed in the tank.

Here is a cost guide (approximation) that you may share with your students:

- Tank: $35/square foot
- Filtration system: $5,000 for tanks up to 500 gallons, $7,500 for tanks larger than 500 gallons
- Salt water: $1/gallon
- Sand: $1.50/pound
- Animals from reputable sources: $25/pound of average adult weight of the animal
- Coral or other habitat structures: $75/square foot

Encourage students to consider the following:

<u>Budget</u>

- How much will the exhibit cost to build?
- How will you care for the animals and what will this cost?
- What daily and long-term care/upkeep is needed?
- Will it be free or will it cost to see?
    - If there will be an admission fee, how much do you propose charging?

<u>Benefit to the community</u>

- What is the educational value of your proposed exhibit?
- If charging a fee, provide an explanation of why this exhibit is worth the price of admission
- What accompanying educational materials will be available with the exhibit?

Elaborate

Students prepare a presentation to potential investors (role played by their classmates) that describes their proposed new exhibit, how it benefits the community, and how much it would cost to build and maintain. They should also include a marketing plan to ensure the exhibit is successful. Students should be prepared to answer the following questions:

<u>The Exhibit</u>

- What animal(s) are you featuring in your proposed exhibit?

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Post-Visit Lesson (continued)

- What habitat does this animal live in, and how will you recreate that for this exhibit?
- How large will the exhibit be?
- What type of care, enrichment, and feeding is needed for the animals?

Benefits to the Community

- Why will this exhibit be interesting to the public?
- What experience or education should guests expect when visiting?
- How else will it benefit the community?

Costs

- How much will it cost to build this exhibit?
- What will it cost to maintain the exhibit?

Marketing Plan

- Who is your target audience for this exhibit, and what can you do to make sure all guests have a meaningful experience?
- How will you advertise to let the community know about this new exhibit?

Evaluate

Students present their exhibit proposals to the class. You might choose to have students evaluate each other's presentations.

What great ideas did your students come up with? Teachers are encouraged to share their students' work with the Education Curator of the St. Louis Aquarium by emailing them to: arodgers@stlaquariumfoundation.org with the subject "Ecosystem Design".

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