



LP6 TEACHING PLAN

Environmental Impacts of Animal Use in Science



LEARNING PLAN OVERVIEW

This learning plan will explore how the use of animals in science affects the environment, including how their use contributes to pollution and the disruption of wild populations. The plan will also examine how the implementation of the 3Rs can lead to more sustainable science.

ESTIMATED TOTAL TIME

75 Minutes

PRE-REQUISITE SKILLS

LP2: The 3Rs of Scientific Research

WHAT STUDENTS WILL LEARN

Competency:

- Develop arguments based on the environmental impacts of animal use in research and the ways implementing the 3Rs can help the environment

Learning Objectives:

- Identify the environmental effects of using animals in a lab setting
- Categorize the environmental harms of animal dissection
- Describe how animals escaped from labs pose potential threats as invasive species
- Identify the potential environmental consequences of using genetically modified species in the lab

Assessment:

Written Scenario Response – Argument Against Animal Testing

- Written response clearly identifies a position
- Written response identifies and explains at least two environmental concerns about the proposed animal testing
- Written response includes a recommendation based on one of the 3Rs
- Written response accurately identifies the recommendation as Replacement, Reduction or Refinement
- Written response identifies how applying one of the 3Rs would have a positive environmental impact

Linked External Standards:

NGSS

- HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales
- HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity
- 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

CCSS- ELA

- W.9-10.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence

TEACHING PLAN

#	Learning Activities	Teaching Notes	Materials and Supplies
1	LEARNING PLAN OVERVIEW Review information detailed in the Student Learning Plan.	TIME: 3 minutes ACTIVITY NOTES Provide a brief introduction to the learning plan.	Student Learning Plan
2	MOTIVATION ACTIVITY There are hundreds of animal research facilities across the US. Brainstorm what kinds of waste may be produced by an animal lab.	TIME: 5 minutes ACTIVITY NOTES Ask students to brainstorm a list of the kinds of waste produced by an animal lab. They can write this in their science journal, share an idea online, or discuss ideas in class.	Journal/whiteboard
3	COMPREHENSION ACTIVITY Listen to a presentation on the environmental impact of animal testing.	TIME: 10 minutes ACTIVITY NOTES Use the presentation provided to highlight the environmental considerations involved with using animals in laboratories.	LP6_3_IntroToTheEnvironmentallImpactOfAnimalTesting
4	PRACTICE ACTIVITY One use of animals in science is classroom dissection. Complete a graphic organizer on the potential environmental and health concerns associated with dissection.	TIME: 10 minutes ACTIVITY NOTES Provide students with an informational sheet describing the environmental harms of animal dissection and ask them to identify if the harm is related to resource use, waste, pollution, ecological disruption, or health.	LP6_4_EnvironmentallImpact_Worksheet LP6_4_EnvironmentallImpact_AnswerKey
5	COMPREHENSION ACTIVITY Read the case study, "A Plague of Frogs." This case study explores the effects of historical use of the African clawed frog in science.	TIME: 5 minutes ACTIVITY NOTES Have students read an information sheet about the story of the African clawed frog, a popular scientific model that escaped and caused environmental havoc.	LP6_5_CaseStudy_APlagueOfFrogs
6	PRACTICE ACTIVITY Answer the questions in the case study, "A Plague of Frogs."	TIME: 5 minutes ACTIVITY NOTES As students read about the African clawed frog, they answer accompanying questions. This can be completed individually, in pairs, or as a group.	LP6_6_CaseStudy_APlagueOfFrogs_AnswerKey

#	Learning Activities	Teaching Notes	Materials and Supplies
7	<p>COMPREHENSION ACTIVITY The previous activity introduces the disease chytrid. Watch the chytrid video to learn more about this.</p>	<p>Time: 2 min</p> <p>ACTIVITY NOTES This National Geographic video further explores chytrid, the disease that was introduced in the activity for the case study, "A Plague of Frogs."</p>	<p>Video: https://www.youtube.com/watch?v=t-5XXlqL1O4</p>
8	<p>PRACTICE ACTIVITY Participate in a guided class discussion on the chytrid outbreak and 3Rs solutions.</p>	<p>TIME: 10 mins</p> <p>ACTIVITY NOTES Questions encourage students to reflect on what they have learned about the chytrid outbreak and generate solutions based on the 3Rs.</p>	<p>LP6_8_GuidedClassDiscussion</p>
9	<p>APPLICATION ACTIVITY Read a fictional scenario about a cosmetic company looking to study the anti-aging properties of salamander mucous. Using information from this lesson and other research, develop a written argument against this testing based on the potential environmental impacts and application of the 3Rs. Use the Scenario Response Performance Assessment Task (PAT) to guide your work.</p>	<p>TIME: 15-30 mins</p> <p>ACTIVITY NOTES A fictional species of Asian salamander has been found to produce a mucous that locals claim prevents wrinkles. An American cosmetic company wants to import the salamander and study the viability of the mucous as an anti-aging serum in a lab. Students must use what they learned about the environmental harms of animal testing to explain why this might not be a good idea and come up with a recommendation based on the 3Rs. Provide the Scenario Response PAT to the students so they can use it to guide their work. Modify as needed, then use the scoring guide to assess their argumentative responses.</p>	<p>LP6_9_SalamanderPositionPaper</p>

Name(s): _____

Date: _____

Read the following information about dissection and sort the environmental impacts into one of five categories: Resource Use, Waste, Pollution, Health Hazards, or Ecological Disruption.

1. Approximately 12 million animals are dissected in the U.S. every year. While some specimens, such as fetal pigs are sourced as byproducts of the slaughter industry, others are taken directly from the wild.
2. Dogfish are caught using destructive fishing methods such as trawling, a technique that involves dragging an enormous net along the ocean floor, destroying the habitat, and scooping up every living thing in its path.
3. Frogs—the animals used most frequently for dissection exercises— are caught en masse from ponds, disturbing the health of the ecosystem. Over a three-year period, an estimated 900,000 frogs were captured in Mexico and shipped to the U.S. for use in science classes.
4. Dissection using animals can only be done once, so every year, animals must be bred or caught, killed and preserved, purchased, and shipped. Once the dissection is completed, the specimens must be disposed.
5. The disposed specimens take up space in landfills. Additionally, the chemical preservatives used to prepare the specimens are considered air and water pollutants, so specimens must be disposed of with special consideration as biohazards.
6. Formalin, the chemical used to preserve dissection specimens, is one of six chemicals that receives special attention under the Toxic Substances Control Act. It is classified as a carcinogen, meaning it has the potential to cause cancer, in addition to being a known eye, skin, nose, and throat irritant.



Resource Use	
Waste	
Pollution	
Health Hazards	
Ecological Disruption	



Answer Key

Resource Use	<ul style="list-style-type: none"> • 12 million animals used in dissection each year • animals must be shipped, using fuel
Waste	<ul style="list-style-type: none"> • animal specimens must be disposed of after dissection, adding waste to landfills
Pollution	<ul style="list-style-type: none"> • formalin, the chemical used to preserve dissection specimens, is considered an air and water pollutant
Health Hazards	<ul style="list-style-type: none"> • formalin is a carcinogen • formalin is an eye, skin, and throat irritant
Ecological Disruption	<ul style="list-style-type: none"> • environmentally destructive fishing methods used to catch dogfish • removing frogs from habitat destabilizes the ecosystem



Case Study: A Plague of Frogs

World's Strangest Pregnancy Test

Before the modern-day pregnancy test was invented, scientists had a very different way of identifying early-stage pregnancy. In the 1930s, a zoologist named Lancelot Hogben discovered that when female African clawed frogs (*Xenopus laevis*) were injected with the hormone chorionic gonadotropin, they began to produce eggs. This same hormone is produced by the human body when a person becomes pregnant and is excreted in the urine. Hogben realized that if he exposed a female African clawed frog to human urine and the frog started laying eggs, then he could announce with total confidence that there was a baby on the way. The 'Hogben method' became one of the world's very first commercial pregnancy tests and soon *Xenopus laevis* was being shipped to labs all over the world. Although modern frog-free pregnancy tests developed in the 1960's made the Hogben method obsolete, researchers had become accustomed to raising African clawed frogs in the lab. They are now a popular animal used to study embryology, cellular and molecular biology.

Question:

Which of the 3Rs does the adoption of the modern chemical pregnancy test represent?

Invasion of the *Xenopus*

Once the African clawed frog had been shipped all over the world to be used in labs and sold as pets, the inevitable happened: frogs began to escape captivity. Many species, when released into a habitat that they have not evolved in, will quickly perish, but a few species, such as the African clawed frog, are particularly well equipped to survive and thrive in a variety of habitats. Over the decades, escaped African clawed frogs and their descendants established invasive populations in the United States, Chile, France, Indonesia, Portugal, the UK and Italy. The frogs wreak havoc in these habitats by outcompeting native species for resources, preying on them, and even possibly poisoning predators that try to eat them.



Case Study: A Plague of Frogs

Activity:

Fill out the table below with the specific ways the African clawed frog exhibits common traits of invasive species.

Try these sources:

<http://www.iucngisd.org/gisd/speciesname/Xenopus+laevis>

<https://nationalzoo.si.edu/animals/african-clawed-frog>

Traits of Invasive Species	African Clawed Frog Traits	How can these traits help the African clawed frog outcompete native species?
Fast growth	They sexually mature in less than a year and can live for 20 years.	
Rapid reproduction	They can lay 1,000-27,000 eggs per clutch and have multiple clutches per season.	
Highly adaptable	African clawed frogs are generalists; they eat a wide variety of foods, including insects, birds, fish, and other frogs, so they are able to adapt to food sources in many different habitats.	
Able to tolerate a wide range of conditions	African clawed frogs can tolerate a wide range of salinities, pH, and temperatures. When their pools dry up, they can bury themselves in the mud for up to a year (aestivation).	
High dispersal	They are able to travel overland to reach new aquatic habitats when their pools dry.	
Association with humans	African clawed frogs are a popular laboratory species and are also kept as pets. They have been traded globally since the 1930s.	



Case Study: A Plague of Frogs

Frog Fatale

Perhaps the most ecologically disastrous outcome of the spread of the African clawed frog is its role in the transmission of *Batrachochytrium dendrobatidis*, a deadly fungus which causes a disease called chytridiomycosis or “chytrid”. The fungus attacks the skin of amphibians, and for most species, it is a death sentence. The African clawed frog, however, can carry the fungus but rarely experiences mortalities, making it the perfect vector to spread chytrid to more vulnerable amphibian populations.

Question:

Based on what you know about amphibians, why might a disease that affects their skin be so deadly?

Examine this graph from a 2016 study of African clawed frogs. Draw a line on each graph reflecting how you estimate the diversity of native amphibian populations has changed over time based on what you have learned about the African clawed frog and its impact on the environment. Note how the dotted lines correspond to the left-hand y-axis and the solid line corresponds to the right-hand axis.

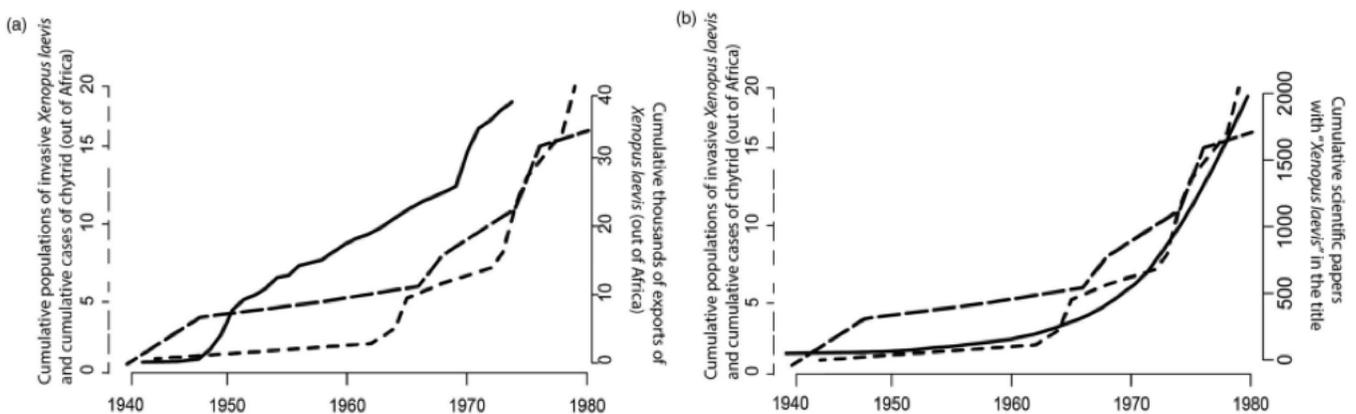


Figure 2. Cumulative numbers of invasive populations of African clawed frogs (*Xenopus laevis*) and outbreaks of chytrid fungus are shown on the left abscissa. (a) shows the cumulative exports of *X. laevis* from the Cape Provincial Authority while (b) shows the cumulative number of scientific papers with '*Xenopus laevis*' in the title.

References:

Jones, N. (2013). Pregnancy test helped to bring frog-killing fungus to the US. *Nature*; Kean, S. (2017). The Birds, the Bees, and the Froggies. Science History Institute; Sittert, Lance & Measey, John. (2016). Historical perspectives on global exports and research of African clawed frogs (*Xenopus laevis*). *Transactions of the Royal Society of South Africa*. 71; Weldon, C., du Preez, L. H., Hyatt, A. D., Muller, R., & Spears, R. (2004). Origin of the amphibian chytrid fungus. *Emerging infectious diseases*, 10(12), 2100–2105.



Case Study: A Plague of Frogs

Answer Key

World's Strangest Pregnancy Test

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Question:

Which of the 3Rs does the adoption of the modern chemical pregnancy test represent?

Replacement

Invasion of the *Xenopus*

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Fast growth	They sexually mature in less than a year and can live for 20 years.	Growing quickly allows animals to reproduce before their competitors have a chance, thus, their offspring receive access to early resources.
Rapid reproduction	They can lay 1,000-27,000 eggs per clutch and have multiple clutches per season.	Fast reproduction and large number of offspring allows the African clawed frog's population to grow quickly and crowd out competitors
Highly adaptable	African clawed frogs are generalists; they eat a wide variety of foods, including insects, birds, fish, and other frogs, so they are able to adapt to food sources in many different habitats.	If any resource or habitat type becomes scarce, they can easily adapt to changed circumstances where their competitors cannot.
Able to tolerate a wide range of conditions	African clawed frogs can tolerate a wide range of salinities, pH, and temperatures. When their pools dry up, they can bury themselves in the mud for up to a year (aestivation).	African clawed frogs are able to survive extreme changes to their habitat that might prove fatal to their competitors.
High dispersal	They are able to travel overland to reach new aquatic habitats when their pools dry.	They can leave if a habitat becomes unsuitable and exploit new habitats that their sedentary competitors cannot.
Association with humans	African clawed frogs are a popular laboratory species and are also kept as pets. They have been traded globally since the 1930s.	Humans are constantly expanding and disrupting new habitats. The African clawed frog can spread with them and thrive in degraded habitats where their native competitors cannot.



Case Study: A Plague of Frogs

Frog Fatale

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Question:

Based on what you know about amphibians, why might a disease that affects their skin be so deadly?

Amphibians exchange gases through their skin, much in the same way that we exchange gases through our lungs. Damaging their skin makes it more difficult for them to ‘breathe.’

Examine this graph from a 2016 study of African clawed frogs. Draw a line on each graph reflecting how you estimate the diversity of native amphibian populations has changed over time based on what you have learned about the African clawed frog and its impact on the environment. Note how the dotted lines correspond to the left-hand y-axis and the solid line corresponds to the right-hand axis.

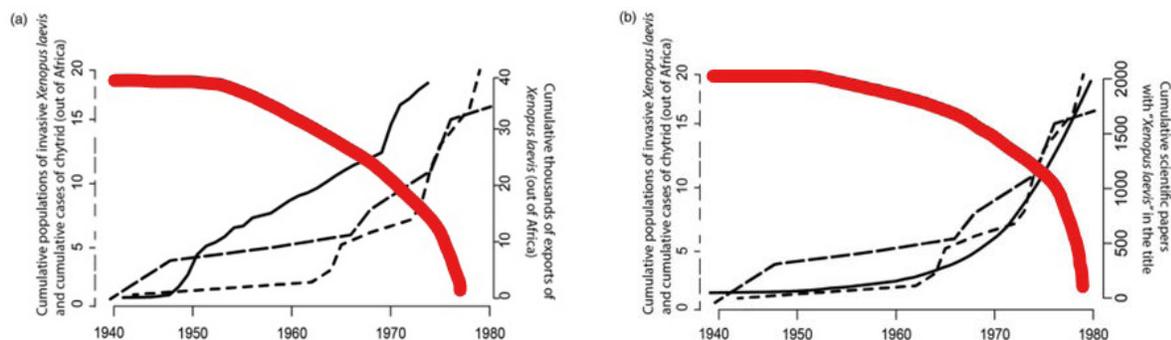


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Slimy Salamanders

Name(s): _____

Date: _____

A fictional species of salamander has been discovered in Vietnam. This salamander produces a mucous that locals claim prevents wrinkles. An American cosmetic company wants to import the salamander and study the viability of the mucous as an anti-aging serum in a lab. Use what you have learned about the environmental harms of animal testing to explain why this might not be a good idea and develop a recommendation based on the 3Rs.



Written Scenario Response – Argument Against Animal Testing

Directions

In this learning plan, you have explored ways in which animal testing can have negative environmental impacts, including waste, pollution, health hazards, ecological disruption, and resource use.

Read the following scenario: A fictional species of Asian salamander has been found to produce a mucous that locals claim prevents wrinkles. An American cosmetic company wants to import the salamander and study the viability of the mucous as an anti-aging serum in a lab.

Use what you have learned about the environmental harms of animal testing to explain, in a written argument, why this might not be a good idea. Identify at least two negative environmental impacts, then make a recommendation suggesting a refined solution for reducing the impacts of this human activity on the environment and biodiversity. Identify which of the 3Rs your solution is based on: Replacement, Reduction, or Refinement.

Use the scoring guide below to guide your work.

Target Course Competencies

Develop arguments based on the environmental impacts of animal use in research and the ways implementing the 3Rs can help the environment

Rating Scale

Value	Description
3	Work fully meets or exceeds criterion; shows depth in insight and grasp of the learning, critical thinking skills, or attention to detail
2	Work meets criterion adequately
1	Work is incorrect or incomplete
0	Work is missing or does not meet criterion



Scoring Standard

You must achieve a rating of at least “2” on each criterion to demonstrate competence.

Scoring Guide

Criteria	Ratings
Written response clearly identifies a position	3 2 1 0
Written response identifies and explains at least two environmental concerns about the proposed animal testing	3 2 1 0
Written response includes a recommendation based on one of the 3Rs	3 2 1 0
Written response accurately identifies the recommendation as Replacement, Reduction or Refinement	3 2 1 0
Written response identifies how applying one of the 3Rs would have a positive environmental impact	3 2 1 0
Written response includes evidence from at least two credible sources	3 2 1 0
Written response includes source citation	3 2 1 0

