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Bring home the Biome

Systems Require Interdependence



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GRADE LEVEL: 5TH GRADE



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Introduction

The following unit gives students the opportunity to examine different ecosystems. They will utilize the essential understanding that “Systems require interdependence” to make cross-curricular connections, and personal connections. Students will have the opportunity to explore this concept through four different teaching models. The content students will master during these four lessons, will help build their vocabulary in the subject matter, and allow students to notice patterns across the ecosystems. All content explores the impact that humans can have on ecosystems, which engages students in the content; because it examines the power students themselves hold on the world around them. Several of the skills reinforced in these lessons include collaboration, problem solving, analyzing, inferencing, explaining their thought processes, comparing and contrasting, and presenting. Many of the skills that students learn are transferable in the real world.

This unit will require critical thinking, and is designed to meet the needs of gifted learners. The content is leveled according to readiness in reading, complex vocabulary is added to help build students’ knowledge in the content, and the information is given through a variety of formats. Processes include open-ended questions that require higher-level thinking, student led discussions, grouping based on interest, and students are able to support their findings with evidence. Some of the products included, allow for choices, express the information through synthesis, require self-evaluation, and the performance task includes a rubric. The learning environment are varied, many discussions are student-led, and there are a variety of grouping measures in each lesson including whole groups, small groups, and individual work.

The lessons utilize the nine continuums to support gifted student's needs. Some examples include the VTS model where students will utilize the abstract thinking skill when analyzing the images. The product of the first lesson requires transformation thinking as students predict how the future effects of their solution. While exploring the Kohlberg model students are utilizing complex thinking skills and analyzing a fuzzy problem learning the complexity of decision-making. In the PBL lesson, students will examine the problem through multiple facets of thinking. All lesson include open-ended questions, which help explore concepts in a greater depth. Students are also able to make connections across the lessons, establishing patterns and trends that occur across the different ecosystems. Many of the products require creativity, and as students design, it allows them to display creativity with a purpose.

This unit will be beneficial for gifted students in the fifth grade who have an interest in science, and come from lower socioeconomic backgrounds. Many of these students will often underachieve in the classroom, because they do not have the same support at home, and may test lower than expected. Their families oftentimes do not use academic language at home, so they may be unfamiliar with the vocabulary. Two of these lessons begin with vocabulary building activities, and utilize a variety of sources to display content. This is important, because if reading is not encouraged they can learn through visuals, and discussion. All lessons are relevant to the real world. Many students from lower socioeconomic backgrounds are unmotivated in typical classroom settings, and need to see the relevance of the lessons, and measure its value through personal connections. By displaying how humans interact with the environment, having the students solve real world problems, it helps them form a more personal connection to the

learning. By utilizing an essential concept, it allows students to expand their learning beyond the subject matter, and explore how this idea influences their life. Many of the questions are open-ended, and give students more freedom to explore different thoughts rather than regurgitating facts. Students like to express their point of view, and by valuing the different ideas, it can be a source of engagement. Through discussions and problem solving, these lessons will empower students, and encourage them to express different perspectives. Teachers will have to be encouraging, and make sure students understand the relevancy of these lessons. Allow extra time if necessary for students to make personal connections, and encourage them to see how some of the bigger ideas can relate back to their personal culture, and life at home.

Goals and Outcomes

Unit Topic:	Ecosystems
Unit Concept:	Systems
Essential Understanding:	Systems require interdependence
CONTENT Goal and Objectives: (standards)	GOAL: To understand the interdependence of plants and animals within their ecosystem. OBJECTIVES: <i>The students will know that...</i> • Ecosystems have different characteristics • organisms can be classified according to the function they serve • plants and animals in an ecosystem are interconnected and changes may occur because of this relationship
PROCESS Goal and Objectives: (skills) broad	GOAL: To develop critical thinking skills with application in science OBJECTIVES: <i>The students will be able to...</i> • infer based on visual images • determine cause and effect • identify and classify
CONCEPT Goal and Objectives:	GOAL: To understand the concept of systems OBJECTIVES: • Systems rely on interdependence to increase the efficiency of the system. • All ecosystems have a variety of organisms that are interdependent.

Assessment Plan

As this unit is designed towards gifted students from lower socioeconomic backgrounds, many of the products include visuals, and hands on activities.

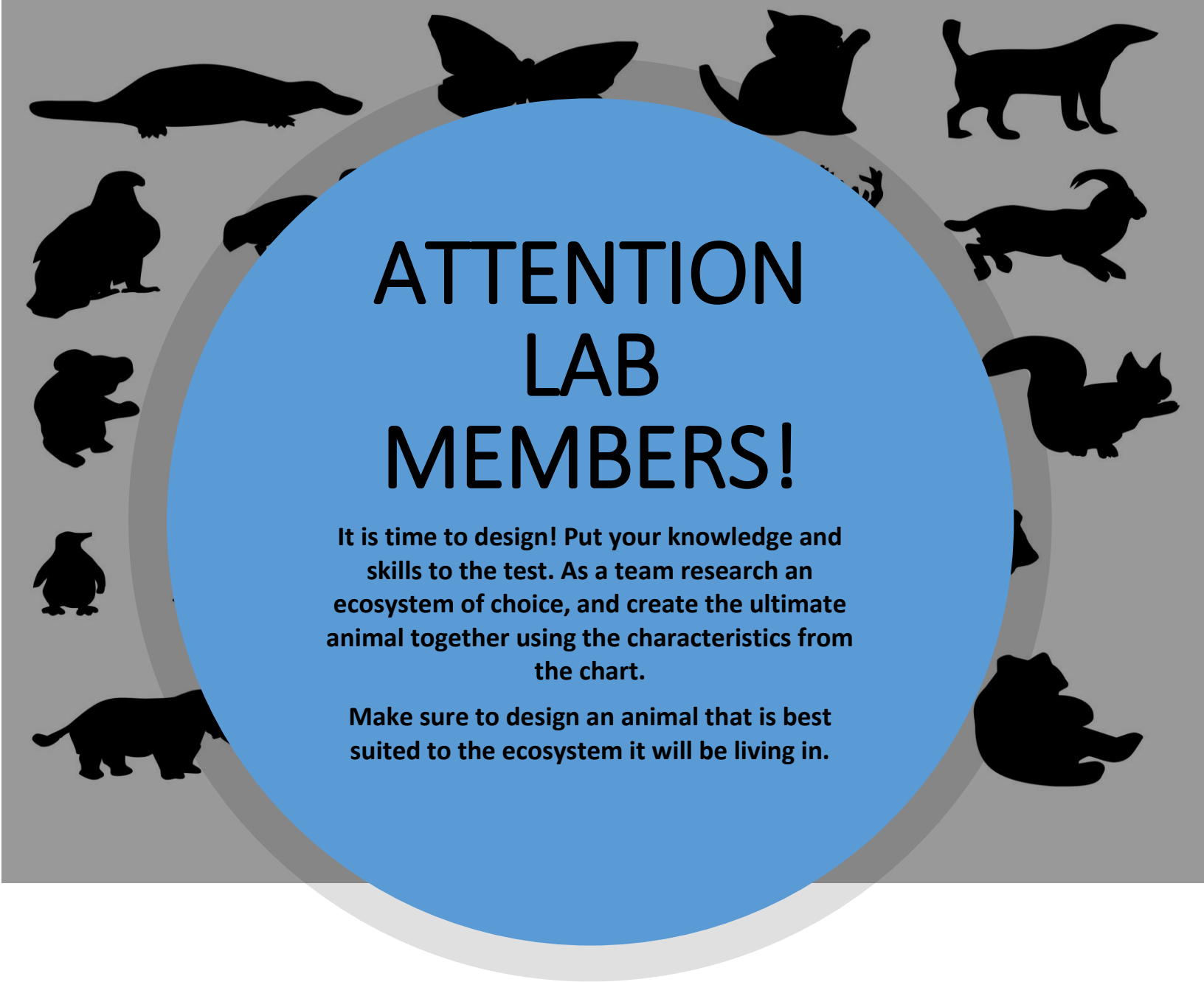
The first lesson has a short reflection about their solution to the problem, with a visual that predicts the future impact of their solution.

The second lesson has students create a work of art that displays the answer to the essential understanding.

In the third lessons, students create a tree model that is representative of their learning, and create a short caption explaining their understanding.

In the final lesson, students are able to design an animal based on what they have learned in the previous lessons, and then present their creation to the class. The persuasive paper is created with a team, so if one student may struggle with writing they can work more on the design, or if they struggle in that area, they may be able to present their findings persuasively. This allows students to be successful through collaboration.





ATTENTION LAB MEMBERS!

It is time to design! Put your knowledge and skills to the test. As a team research an ecosystem of choice, and create the ultimate animal together using the characteristics from the chart.

Make sure to design an animal that is best suited to the ecosystem it will be living in.

Persuasive Skills necessary!

After designing the animal, co-write a persuasive paper to convince the Lead scientist, and other labs that your creation is superior. You will want to include an attention grabber to garner interest, and an introduction that highlights the topic, and points of the essay. Be sure to include at least 3 pieces of relevant evidence that support how the animals characteristics will positively affect the interactions between the plants and animals that already reside in the ecosystem. Wrap up your paper with a conclusion that summarizes your argument. After writing papers, you will present your paper. Make sure to speaking clearly, be enthusiastic, have good posture and maintain eye contact.

The fellow labs will judge your presentation based on the components of the essay, and your presentation skills on a rubric checking off boxes, and leaving one comment/recommendation to improve your paper. The Lead scientist will collect the papers, and rubrics, and use this information to decide which lab gets the funding to create their animal.

Rubric

Persuasive Essay + Presentation: Ultimate Animal

Lab Team Assessed: _____

CATEGORY	4 - Above Standards	3 - Meets Standards	2 - Approaching Standards	1 - Below Standards	Score
Attention Grabber	The introductory paragraph has a strong hook or attention grabber that is appropriate for the audience. This could be a strong statement, a relevant quotation, statistic, or question addressed to the reader.	The introductory paragraph has a hook or attention grabber, but it is weak, rambling or inappropriate for the audience.	The author has an interesting introductory paragraph but the connection to the topic is not clear.	The introductory paragraph is not interesting AND is not relevant to the topic.	
Focus or Thesis Statement	The thesis statement names the topic of the essay and outlines the main points to be discussed.	The thesis statement names the topic of the essay.	The thesis statement outlines some or all of the main points to be discussed but does not name the topic.	The thesis statement does not name the topic AND does not preview what will be discussed.	
Support for Position	Includes 3 or more pieces of evidence (facts, statistics, examples, real-life experiences) that support	Includes 3 or more pieces of evidence (facts, statistics, examples, real-life experiences) that support	Includes 2 pieces of evidence (facts, statistics, examples, real-life experiences) that support the position statement.	Includes 1 or fewer pieces of evidence (facts, statistics, examples, real-life experiences).	

	the position statement. The writer anticipates the reader's concerns, biases or arguments and has provided at least 1 counter-argument.	the position statement.			
Relevance of evidence, and examples	All of the evidence and examples are specific, relevant and explanations are given that show how each piece of evidence supports the author's position.	Most of the evidence and examples are specific, relevant and explanations are given that show how each piece of evidence supports the author's position.	At least one of the pieces of evidence and examples is relevant and has an explanation that shows how that piece of evidence supports the author's position.	Evidence and examples are NOT relevant AND/OR are not explained.	
Closing paragraph	The conclusion is strong and leaves the reader solidly understanding the writer's position. Effective restatement of the position statement begins the closing paragraph.	The conclusion is recognizable. The author's position is restated within the first two sentences of the closing paragraph.	The author's position is restated within the closing paragraph, but not near the beginning.	There is no conclusion - the paper just ends.	
Presentation Skills					

Speaking Clearly	Speaks clearly and distinctly all (100-95%) the time, and mispronounces no words.	Speaks clearly and distinctly all (100-95%) the time, but mispronounces one word.	Speaks clearly and distinctly most (94-85%) of the time. Mispronounces no more than one word.	Often mumbles, cannot be understood, OR mispronounces more than one word.	
Enthusiasm	Facial expressions and body language generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language sometimes generate a strong interest and enthusiasm about the topic in others.	Facial expressions and body language are used to try to generate enthusiasm, but seem somewhat faked.	Very little use of facial expressions or body language. Did not generate much interest in topic being presented.	
Posture and Eye Contact	Stands up straight, looks relaxed and confident. Establishes eye contact with everyone in the room during the presentation.	Stands up straight and establishes eye contact with everyone in the room during the presentation.	Sometimes stands up straight and establishes eye contact.	Slouches and/or does not look at people during the presentation.	

Comments:

TEACHER NAME		Lesson #
Ms. Lawton		1
MODEL	CONTENT AREA	GRADE LEVEL
Problem-Based Learning	Science	5 th
CONCEPTUAL LENS		LESSON TOPIC
Systems		Ecosystems
LEARNING OBJECTIVES <i>(from State/Local Curriculum)</i>		
Science 5.L.2.1 Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds, forests, and grasslands. 5. L.2.2 Classify the organisms within an ecosystem according to the function they serve: producers, consumers, or decomposers (biotic factors). 5. L.2.3 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.		
THE ESSENTIAL UNDERSTANDING <i>(What is the overarching idea students will understand as a result of this lesson?)</i>		THE ESSENTIAL QUESTION <i>(What question will be asked to lead students to “uncover” the Essential Understanding)</i>
<i>Systems require interdependence</i>		<i>How do systems require interdependence?</i>
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)
- Students will know that: Interdependence is when animals, plants, people in an ecosystem are reliant on each other in some way. - Systems are a unit where different factors are interdependent on each other. - Oceans are composed of: orcas, fish, algae, water, rocks, whales - Orcas are apex predators - Humans can impact the environment by holding animals in captivity		- Students will be able to: - Analyze - Collaborate - Problem-solve - Explain - Create solutions - Present

GUIDING QUESTIONS

What questions will be asked to support instruction?

Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding

Pre-Lesson Questions: • What is happening in this clip? • How are the people interacting with their environment? • Which animals have been removed from their original environment, and why might that be relevant? • What are some things that make up a system? • How do the factors within a system interact? • What does the word interdependent mean to you? • How might two things be interdependent? • What can occur when one factor is missing, in an interdependent relationship? • How might that affect a system? • What do you know about the ocean? • How do the different animals and plant interact in the ocean? • How might humans affect some of the plants, animals, and environment? • How will this affect the overall ecosystem? • How do these examples provide evidence that systems are interdependent?	During Lesson Questions: • What do you already know to solve the problem? • What do you need to know in order to solve the problem? • How does the removal of orcas from their ecosystem impact the oceans? • How do humans affect the ecosystem? • How are the factors within the ecosystem interdependent? • How does the interdependence within a system improve an ecosystems overall function? • What is the orcas' role within the ecosystem? • How does the continued captivity of the orca impact the ecosystem? • How does the larger world rely on ecosystems? • What is the purpose of keeping orcas in captivity? • If you were in charge of keeping the oceans ecosystem stable, what would you change? • What will the future impact of keeping orcas in captivity be? • How might the ecosystem change if	Post Lesson Questions: • What was the impact on the ecosystem, when orcas were held in captivity? • What other environmental factors did this change impact? • How can you define the relationship of factors within the ecosystem? • How did you use your knowledge of the role interdependence in an ecosystem to inform your solution? • How did you use your knowledge of systems to inform you solution? • What did you consider as you worked to develop a solution? • What worked well in your problem- solving process? • What would you do differently if you worked to solve this problem again or if you revised your solution? • How might you use the perspectives of your classmates as you reflect on your own solution? • What other perspectives did you consider? • How do systems require interdependence?
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How does interdependence support a healthy ecosystem?	humans did not keep animals in captivity? - How can the destruction of one key factor affect a system? - What makes an ecosystem effective? - How can humans interact interdependently within an ecosystem? - What is the relationship between systems and interdependence? - What other options do we have? - What are some ideas you have to solve this problem? - How can the interdependence of a system become disrupted by human interactions?		
DIFFERENTIATION <i>(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.</i>			
Content	Process	Product	Learning Environment

Students who are AIG will receive content in a variety of formats, videos, articles, and infographics.	Students will create and analyze a problem, using multiple perspectives, to find a solution. Students who are AIG will receive <u>less support</u> underlining and summarizing the problem.	Students evaluate their own work by considering the future outcome/impact their solution will have on the ecosystem.	
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PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - *This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.*

Play game: Give students examples of systems, and ask What happens if . . . (you change the environment or a part of the system)?

Have students describe what happens if you disrupt a system:

https://docs.google.com/presentation/d/1uhf_rsajYpVfhLRq9N9_GUXr-UOINoBOPwSiAqyc6cs/edit?usp=sharing

Show students clip about orca killing: <https://www.youtube.com/watch?v=nBS7QGH07oo>

What is happening in this clip?

How are the people interacting with the environment?

The teacher asks the following questions:

- What is happening in this clip?
- How are the people interacting with the environment?
- Which animals have been removed from their original environment, and why might that be relevant?
- What are some things that make up a system?
- How do the things within a system interact?
- What does the word interdependent mean to you?
- How might two things be interdependent?
- What can **occur** when one factor is missing in an interdependent relationship?
- How might that affect a system?
- What do you know about the ocean?
- How do the different animals and plant interact in the ocean?
- How might humans affect some of the plants, animals, and environment?
- How will this affect the overall ecosystem?
- How do these examples provide evidence that systems are interdependent?
- How does interdependence support a healthy ecosystem?

While watching this next clip I want you to consider how orcas are an important part of the ecosystem, and how their removal will impact the ecosystem. <https://www.youtube.com/watch?v=g1VEwsl4SIY&t=42s>

The teacher asks: How were the interactions of people, animals, and environment positive? Why were these interactions positive? How were the interactions of people, animals, and environment negative?

What makes you think they were negative?

The teacher accepts responses from several students.

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

1. Problem Engagement

a. Teacher introduces the ill-structured problem:

Considering what you have seen in these two videos, I would like you to consider what the problem could be.

We are going to read a factual article (attached below #1) to gain more insight into the orcas' life. I want you to underline key words, facts that you believe are important. After you have read the article consider what you saw in the first video, and write down one sentence summarizing the problem.

2. Inquiry and Investigation:

What do you already know to solve the problem?

What do you need to know in order to solve the problem?

Students are given infographics (attached below) about orcas in captivity, and are given the opportunity to research more (on ipads if necessary)

- How does the removal of orcas from their ecosystem impact the oceans?
- **How do humans affect the ecosystem?**
- How are the factors within the ecosystem interdependent?
- **How does the interdependence within a system improve an ecosystems overall function?**
- What is the orcas' role within the ecosystem?
- **How does the continued captivation of the orca impact the ecosystem?**
- How does the larger world rely on ecosystems?
- What is the purpose of keeping orcas in captivity?
- **If you were in charge of keeping the oceans ecosystem stable, what would you change?**
- What will the future impact of keeping orcas in captivity be?
- **How might the ecosystem change if humans did not keep animals in captivity?**
- How can the destruction of one key factor affect a system?
- **What makes an ecosystem effective?**
- How can humans interact interdependently within an ecosystem?
- What is the relationship between systems and interdependence?
- What other options do we have?
- What are some ideas you have to solve this problem?
- How can the interdependence of a system become disrupted by human interactions?

Elaborate —*Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways.*

3. Problem Definition:

- a. Restate the problem, list and prioritize solutions, and choose the solution that is most likely to succeed in addressing the problem.

Students are split into small groups based on how they defined the problem. We will watch 2 videos whole group: <https://www.youtube.com/watch?v=HRGu5H69p3s>, and

https://www.youtube.com/watch?v=OvIYkfR_Hxw that examine both sides to orcas captivity. After considering the problem one final time each student must come up with an idea, to solve the problem. Each student must work quietly for 5 minutes to come up with one idea or thought regarding the videos. After thinking about it, they will collaborate with their group sharing their ideas. Each student will receive a chip and must use it to share. Everyone must use their chip one time, before a student shares twice. After sharing their thoughts and ideas they can consider what solutions could solve this problem, and then decide what they may need to research further to solve this problem. After discussing the solution they think is the most likely to work, they can work together to support their reasoning.

4. Problem Resolution:

After choosing the most likely solution students will present their findings to the whole class, and defend why their decision is the best one. They can discuss what they believe the future impact will be, and why it will be effective. As they listen to other groups share and report their solutions, they will reflect on how they could improve their solution, and what they may need to add to solve the problem more effectively.

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

5. Problem Debriefing a. Teacher and students reflect on learning

- What was the impact on the ecosystem, when orcas were held in captivity?
- How did the multiple perspectives of your classmates as build a system of thought?
- How can you define the relationship of factors within the ecosystem?
- How did you use your knowledge of the role interdependence in an ecosystem to inform your solution?
- How did you use your knowledge of systems to inform you solution?
- What other environmental factors did this change impact?
- What worked well in your problem- solving process?
- What would you do differently if you worked to solve this problem again or if you revised your solution?

Once all presentations are complete, the teacher instructs students to:

Write a reflection of their solution and draw an image of their solutions predicted effect on the ecosystem 30 years in the future.

The reflection should address:

- What impact does the solution have on the ecosystem?
- How will it impact the interdependent factors within the ecosystem?
- How will their solution resolve the problem, short-term, and long-term?
- How do systems require interdependence?

The Life of Orcas: Biology and Ecology – Orca Series I



Orcas, also known as killer whales, are one of the most distinctive and unique marine creatures – distinguished for their black and white patterns and intelligence. Yet, the life of orcas, their history and their importance to the marine ecosystem are less known.

Orcas, or killer whales, are one of the most distinctive and unique marine creatures.

Bodies – Shapes and Sizes

Orcas, as humans, are mammals: they breathe air from the atmosphere and females produce milk for feeding their young. Contrary to what their name suggests, killer whales do not belong to the family of whales; instead, they belong to the family of dolphins being the largest dolphin.



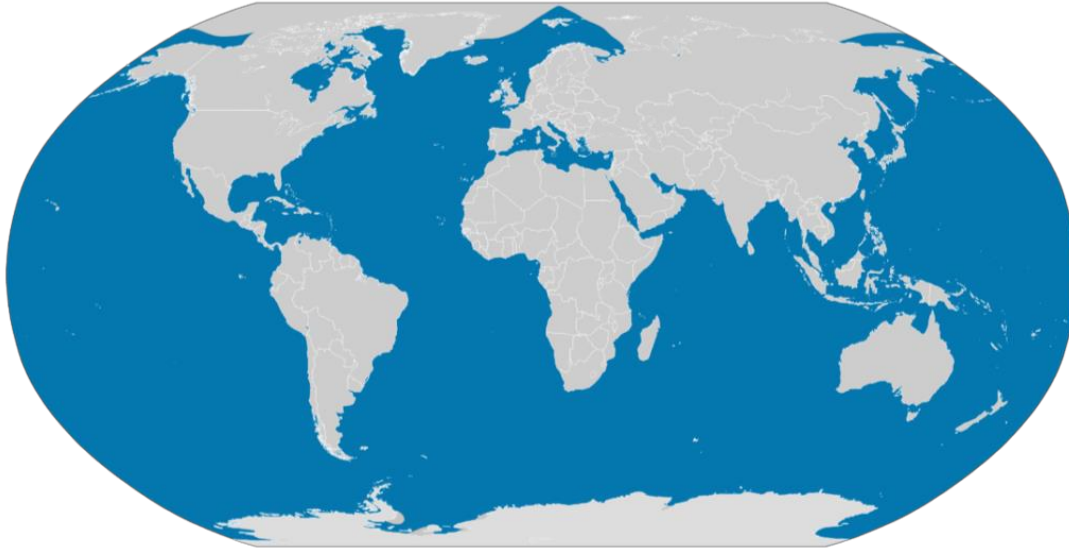
Orcas can reach a body length up to 9 meters in males -and weigh 6600 kilograms- and 7.7 meters in females. Mature males present larger extremities than females in which the dorsal fin can attain a height of 1.8 meters. Newly born orcas have a body length of up to 2.5 meters and weight 200 kilograms – pretty big for a newborn!

Orcas are the largest dolphins – not whales – that can reach a body length up to 9 meters.



Distribution and Habitat

Orcas are the most widely distributed marine mammal in the world, extending their habitat from the Arctic to the Antarctic - even found in river mouths. However, orcas are more common in coastal, temperate waters, particularly in areas of high marine productivity.

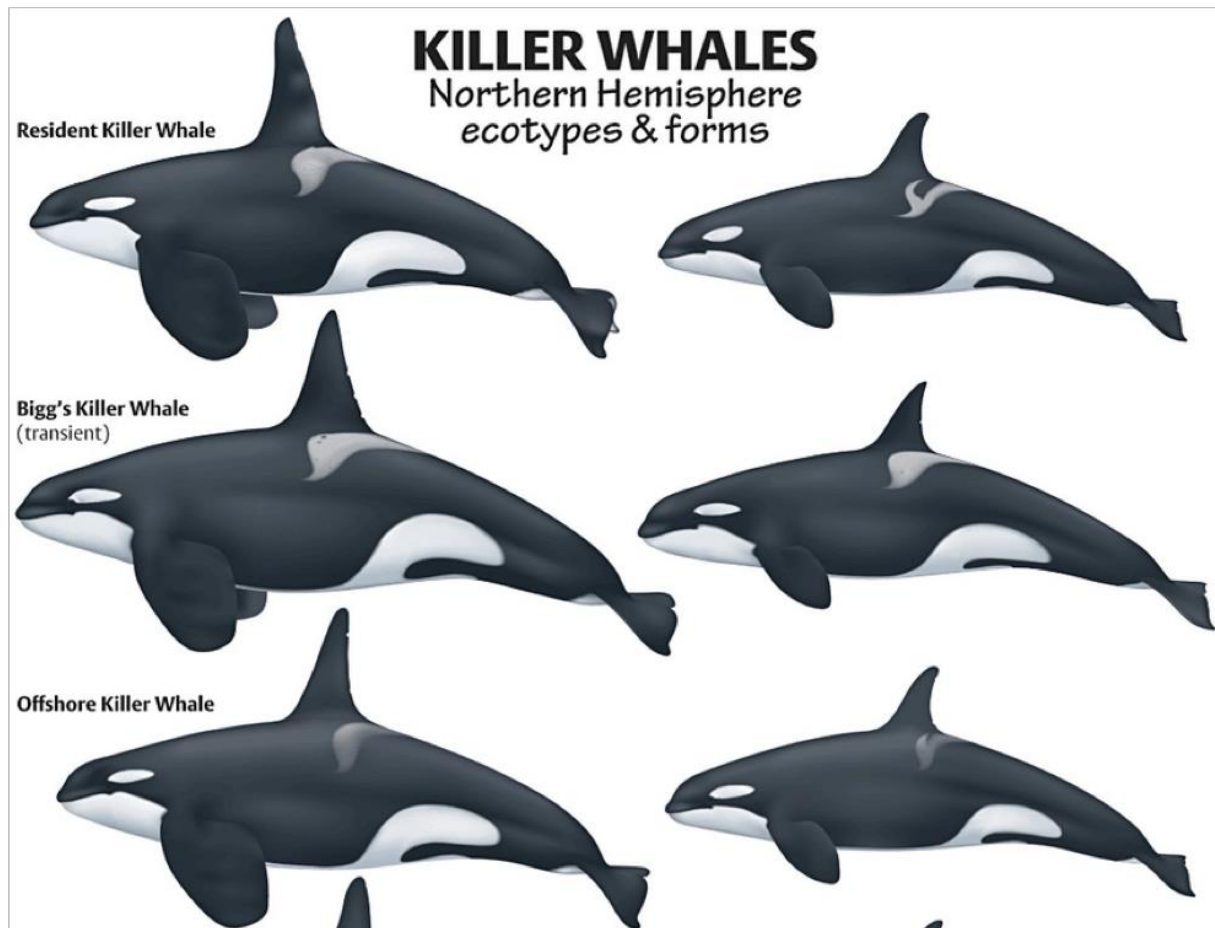


The orca is the second only to humans as the most widely distributed mammal in the world - even found in river mouths.

Population

The minimum worldwide abundance estimate of orcas is 50,000 individuals. Yet, not all orcas are the same. The most studied population of orcas worldwide, in the northeastern Pacific, have revealed that three ecotypes of orcas exist. These ecotypes differ in body size, color patterns, habitat, prey preferences, behavior, acoustics and genetics. These ecotypes sometimes co-exist in the same environment; yet they are socially and reproductively isolated from each other which is very unique among mammals.

50,000 orcas are found worldwide; yet not all orcas are the same. Three ecotypes have been found in northeastern Pacific.



Life History of Orcas

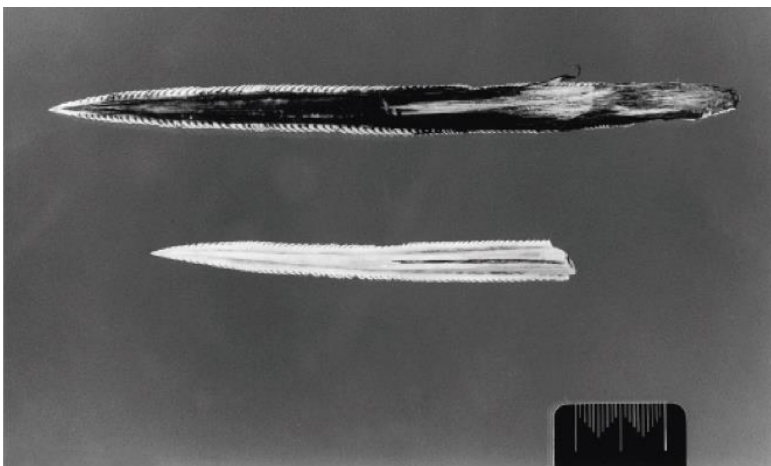
Humans and orcas share much in common. As humans, female orcas give birth for the first time at 14 or 15 years old. As humans, single young are usually born; although a set of twins is possible – but rare.

Orcas gestation period is between 15 to 18 months. Mortality on calves is high: 40% of orcas die in the first six months of life. They start weaning at an age likely between 1 and 2 years old. Females have an average of 5 successful offsprings over a 25-year reproductive life-span, which ends at approx. 40 years, when menopause starts.



Female orcas live to approximately 50 years, yet some may reach 80-90 years of age. Males attain sexual maturity at approx. 15 years, and continue to grow until they reach 21 years. A male Orca's lifespan is shorter, averaging about 30 years and can reach up to 50–60 years.

The known causes of orca mortality are few, these are related to the risks they take while capturing their prey; stranding as a result of chasing their prey in shallow waters and stingray spine injury as a result of attacking stingrays.



Life-History traits	Humans	Orcas
First time to give birth (age)	14 or 15 years old	
Number of young born	1 young (twins, rare)	
Gestation period (months)	9	15 to 18
Reproductive life-span	25 years	
Longevity (years)	up to 100	up to 90

The life of orcas and humans have a lot of similarities. We have similar cosmopolitan range, we are mammals that feed our young with milk, become reproductively active and later inactive at the same age, give birth to one young, sometimes twins, live up to 90 years, and like us, orcas are the top predators.

Top Ocean Predators

Orcas are the top predators of the ocean: they have no natural predators other than humans – they even attack the great white sharks! They prey upon a great diversity of animals, over 140 species: marine mammals (sea lions, sea otters, dolphins, whales), fish (salmon, herring, cod, tuna), sharks, rays, squids, octopuses, sea turtles, and sea birds. Orcas even prey upon deer and moose which are caught swimming across channels.

Orcas, the ocean top predator: they have no natural predators, prey over 140 species including great white sharks and moose.



Foraging Specialization

Because orcas feed on more than 140 species, they are considered generalist predators. Yet, orcas at specific geographic locations have specialized in certain prey. For example, in the northeastern Pacific, the three ecotypes have a specialized diet: one ecotype has a coastal habitat and specializes in fish, other specializes in hunting marine mammals, and the other ecotype has an offshore habitat and prey on fish.

Orcas are specialist predators. Some groups have specialized in hunting and preying on marine mammals, including humpback whales.



The Tale of the Whales Tail

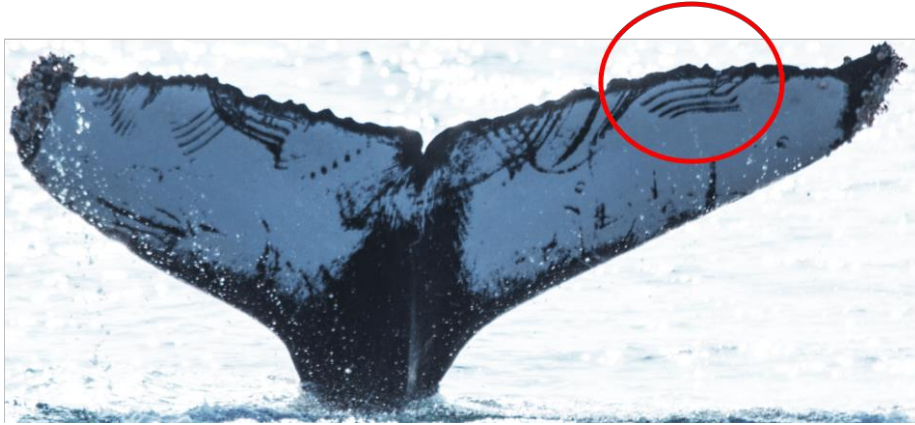
Killer whales have their name for a reason: they kill whales. The tail of the humpback whale, known as fluke, is marked for life by scars which are a detailed story of survival. This scar, known as tooth rake mark, is the evidence of an orca attack on a humpback which is made by teeth orcas in a humpback's fluke. Researchers know now that these attacks took place when humpbacks were calves, these are easy prey compared to adults.

Researchers have discovered that up to 40% of humpbacks have rake marks in their flukes, implying that orcas are attacking humpbacks around the world. Scarring is an evidence of either the prey's ability to escape, or the predator's inefficiency, or both and obviously not the result of a successful attack. Yet, attacks can have a successful outcome for killer whales: in Western Australia, killer whales attacked and killed humpback calves in 64% of attack outcomes observed.



These attacks to humpback whales might be rising. Since 1986 whales and dolphins have been protected against whaling. As a result today, 9 of 14 populations of humpbacks no longer require protection. Because humpback numbers are rising, orcas have more food. According to researchers we are now getting a snapshot of how the oceans functioned before whaling and beginning to understand what happens when one cetacean attacks another. Before whaling, orca predation on humpback calves might have been more common then and now is coming back. The story of life is forever evolving, and this dramatic story about the life of orcas is the result of conservation in action.

When killer whales attack humpback whales, they leave a scars, known as tooth rake marks. Researchers now know that these attacks can be highly successful and are rising. As humpbacks increase in numbers, orcas have more food.



Importance of Orcas in the Marine Ecosystem

Top predators play an important role in the structure and function of ecosystems. In the northeastern Pacific, human activity in the 70's caused a cascading effect in the marine ecosystem that started with their top predator. Orcas didn't have enough food, since their usual prey, seals and sea lions, were diminishing probably due to reduction in population of certain fish species and prey like seals and sea lions. As a result, orcas switch their prey to sea otters, a keystone species for the kelp forest. Therefore, the sea otter population diminished and this had a cascading effect in the kelp forest ecosystem. Since sea otters feed on sea urchins; these invertebrates increase in number and over-graze on kelp which had a terrible effect on the whole ecosystem that depends on kelp for its survival.

Orcas as top predators play an important role in structure and function of marine ecosystems. Overfishing can have a cascading effect that starts with orcas and ends in kelp forest.

Conservation

According to the International Union for Conservation of Nature, orcas are 'data deficient' because of the likelihood that two or more orca types are separate species. Historically, killer whales have been the target of directed

fisheries, culling, and persecution, some to reduce competition for other fisheries. Today, orcas are protected in most oceans.

A love story: today, orcas are protected in most oceans.

Threats

Other threats still prevail. As top predators, orcas are susceptible to biomagnification of human-made toxins, such as polychlorinated biphenyls (PCBs). Levels of PCBs in orcas from the Northeastern Pacific have been shown to be among the highest observed in any cetacean. These can affect the health of orcas through reduced reproductive success and suppression of their immune system. Climate change might also be impacting the life of orcas. Models predict major reductions in sea ice. Orcas may move into northern waters as sea ice disappears, and as a top predator, orcas may initiate major ecosystem adjustments, becoming major players in the reorganization of Arctic oceans.

Orcas, as top predators are vulnerable to biomagnification of toxins that affect their health. Climate change is also impacting the life of orcas in new ways we are just unveiling.

Biomagnification is the process by which a compound increases its concentration in an organism's tissue as it travels up the food chain.

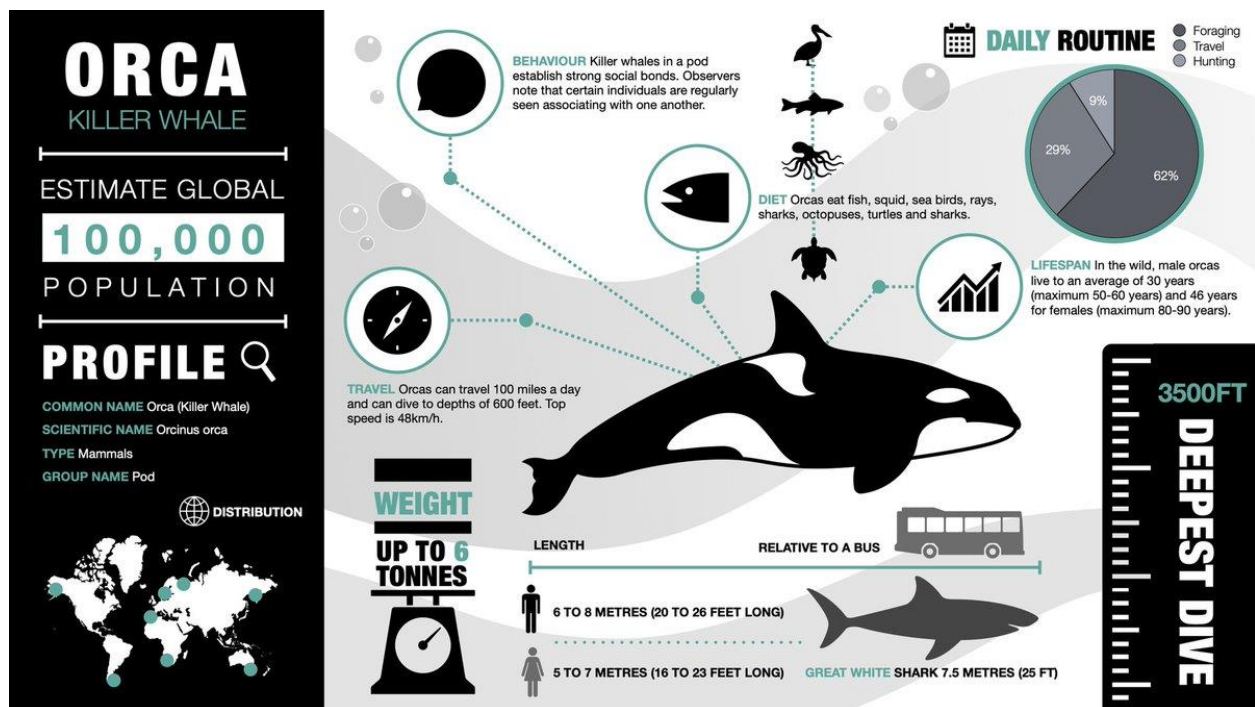
Conclusion

Orcas are our counterpart in the oceans. Like us, they have conquered our Blue Planet. Like us, they present similar life history traits. Like us, they are the top predator of the oceans. Humans have numerous encounters with

orcas in the wild; yet no fatal attack has ever been registered. This intelligent, social and sensible creature must recognize themselves in us. As we feel a strong connection with orcas, they must feel a strong connection with us.

Humans have numerous encounters with orcas in the wild; yet no attack has ever been registered.

INFOGRAPHICS:



WILD vs CAPTIVE



Lifespan

Males Av. Age: 30 yrs
(Max 60 yrs)

Females Av. Age: 50 yrs
(Max 90 yrs)

Death Rate: 2%
/year

2/3 die before reaching 10 years in Captivity.

None survive past the average Orcas lifespan.

Only 5% Make it to 20 years.

Death Rate: (3x Higher)
6% /year

Family Groups

Tight Bonds

Orcas form strong family bonds and stay together for life. Strangers don't exist.

Blood relatives

Artificial Groups

Orcas are put together with strangers. They often don't get along or even speak the same language. Orcas are moved & traded like packages.

Strangers

Habitat

Home Ranges: 100's - 1000's of kms

Swim almost 200km in a day

Oceans

Home Ranges: 14 - 400m

(2 Orca's inhabit this space)

Even the largest tank in the world is only 0.0001 of their normal habitat size.

Concrete pool

Behaviour

Aggression rarely seen. Attacks never result in injury. Animals can escape incompatible individuals.

Attacking your own calf is almost unthinkable.

0 Humans Killed

unnatural...

Orcas develop aggression.

Attacks on orcas & trainers result in serious injury or death.

Animals can't escape attacks.

Mothers often reject or attack their calves.

4 Humans Killed

Health

Little or no tooth wear.

Broken teeth are rare.

Good dental health

Despite an abundance of medical care the most common cause of death is infection.

Broken teeth are common due to obsessive gnawing on cage bars & are an entry point for bacteria and viruses.

Poor dental health

CONCLUSION:

Orcas do NOT belong in Captivity!



What can you do to Avoid tour...

ORCA CAPTIVITY

ENTERTAINMENT AT WHAT COST?

20

Only 20 of the 145 wild orcas taken into captivity worldwide remain alive today.

92%

92% of SeaWorld's orcas did not survive past the age of 25. The average life span of a wild orca is 30 for males and 50 for females, who can live up to 80-90 years old.

2.5x

The annual mortality rate of orcas is more than 2.5 times higher in captivity than in the wild.

COMMITMENT TO CONSERVATION?

for every **\$1,000,000** of SeaWorld's revenue

only **\$600** goes to conservation

(That's about 5¢ per ticket)

25 BROKEN BONDS

In the wild, orca mothers maintain lifelong bonds with their offspring. Orcas are highly social and family oriented like humans. SeaWorld's financial decisions break apart these family bonds.



4 HUMAN DEATHS

	Captive	Wild
Aggressive Acts	100+	1
Death	4	0

100% Dorsal Fin Collapse

Due to the shallow pools in which captive orcas live, all male and some female orcas have a collapsed dorsal fin. Captive orcas spend most of their time on the surface where the force of gravity acts on their fin. This occurs in less than 1% of the wild population.

1400X

An orca at SeaWorld would have to swim the circumference of the main pool more than 1,400 times to match the equivalent daily distance travelled in the wild.

The human equivalent to Tilikum's pool.
• 9.5m length
• 5.7m width
• 2.1m height

WDC { WHALE AND DOLPHIN CONSERVATION

ORCAS

BELONG IN THE SEA NOT IN CAPTIVITY

This infographic shows orcas natural adaptations for life in the oceans, and the harmful effects of captivity.

CULTURE

Orca pods learn complex behaviors taught specifically across generations

REPRODUCTION

Females mature and become sexually active at 15 years old, surrounded by family to help with birth and care

LIFESPAN

Females average 50 years (max 60-90)
Males average 30 years (max 50-60)

MENTAL

Highly intelligent
Social hierarchy
Complex language

DORSAL FIN

Up to 6 feet high

SKIN

Depth and water protect orcas from UV sunlight

HEALTH

After the first 6 months of birth, mortality rates decline and are lowest for orcas 12-20 years old

ACOUSTIC

Primary sense for communicating, hunting, and exploring the ocean realm around them

TEETH

Cone shaped for catching live prey

EFFECTS IN CAPTIVITY

Boredom, depression, psychosis, aggression, bullying from unfamiliar orcas and isolation from family

Nearly all captive male orcas have a collapsed dorsal fin, uncommon in wild populations

Exposure to UV sunlight from shallow pools and unnatural water clarity increases risks of sunburns and cataracts

Orcas from different pods, languages, and cultures forced to coexist in small tanks

Worn down teeth from grinding on metal tank cages, often leading to infections

Females in captivity are often artificially inseminated at very young ages (as young as 7), with limited to no family support. The only known cases of mother orcas rejecting their calves has occurred in captivity

Captive orcas have an average mortality rate three times higher than those in the wild

Concrete enclosures limit orcas ability to fully utilize their most important sense

A published study in Marine Mammal Science found the average lifespan of orcas in captivity to be 12 years old.

WHAT'S NEXT FOR ORCAS?

After a life of captivity, many wonder, what's next?

1.

POTENTIAL RELEASE

For some orcas, such as Lolita and Corky, scientists know their native pods and these animals still recognize their pod's vocalizations. There may be hope for reintroduction if they can reintegrate with their families.

2.

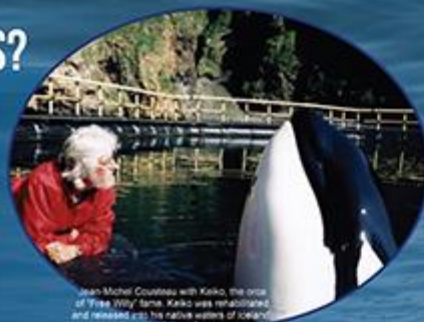
RETIREMENT TO SEASIDE SANCTUARIES

Most orcas born and raised in captivity do not possess the necessary skills to survive on their own in the wild. Coastal sea pens with continued human care would allow orcas to live out their lives feeling the natural sights, sounds, smells, and rhythmic ebbs and flows of their ocean home.

3.

EDUCATION AND CONSERVATION

Aquarium facilities can be connected to seaside sanctuaries, following up with the orcas, observing and educating the public about them in a more natural environment. Interactive technologies can replace animal exhibits, allowing people to engage in learning about marine mammal behavior and conservation, instead of being spectators. Conservation efforts should focus on protecting wild populations from increasing human threats such as food security, dams, pollution, boating, and others.



Jean-Michel Cousteau with Kekoa, the orca of 'Free Willy' fame. Kekoa was rehabilitated and released to his native waters of Iceland.
Photo by © Tom O'Leary

"The time has come to view the captivity of cetaceans as part of our past, not a tragic part of our future"
- Jean-Michel Cousteau

BRIEF HISTORY

The first orcas were captured for the entertainment industry in 1961. One of the most infamous captures occurred in 1970 in the Pacific Northwest when over 50 orcas were driven into a cove using helicopters, boats and explosives. Separating mothers from calves, the young were taken, many of which did not survive the transport. Lolita is the sole surviving orca of that capture, where she is now alone in the Miami Seaquarium. Today, her native population is endangered.

This is not conservation, it is cruelty.

JEAN-MICHEL COUSTEAU
OCEAN
FUTURES
SOCIETY

LEARN MORE AT OCEANFUTURES.ORG

Created by: Jaclyn Mandoske

EXTRAORDINARY PLACES TO SEE WILD ORCAS

HOME/CAPTIVITY INDUSTRY/TRAVEL/EXTRAORDINARY PLACES TO SEE
WILD ORCAS



[CAPTIVITY INDUSTRY](#), [TRAVEL](#) | POSTS BY : TRACIE SUGO

Say NO to the show – get on a boat!

Do you dream of seeing orcas in their natural environments? Don't get sucked into tourist traps like SeaWorld, where orcas are confined in featureless tanks and forced to perform tricks for their food. Captivity is no place for orcas – or for you.

The sheer size, incredible strength and startling intelligence of orcas are simply awe-inspiring. These features are only at their full potential when these mammals are roaming the open ocean with others of their kind. There are many 'extra-orca-nary' places all around the world where they can be seen wild and free!

Monterey Bay, California, USA

There are two types of orcas that come and go throughout the year in the rich marine environment of Monterey Bay: transient (mammal-eating) orcas and offshore orcas. Over 200 individual whales have been identified and studied here, with many of them repeatedly sighted over the years. Transient orcas seem to frequent the bay most often in April and May, when the gray whales pass by on their northbound migration. Orcas of the bay prey upon some of the gray whales' calves. It is a unique feeding opportunity for these orca – it's almost like their Thanksgiving!



CA163 “Liner” and young male CA140C cruising by some whale watching boats | Photo by Tracie Sugo

Northern Hokkaido, Japan

In the waters of Hokkaido’s Shiretoko Peninsula in the northernmost part of Japan, orcas gather in great numbers during the summer months of June to September. This population was the subject of a recent televised documentary on NHK (Japan’s national public broadcasting channel), which sparked public interest in wild whales. In the film, they discover the summertime nutrient-rich waters off the coast of Shiretoko make the area a magnet for orcas!

Auckland, New Zealand

New Zealand orcas have a varied diet and have learned to specialize their diets on sharks and rays. Because of this, they are very coastal mammals, tracing the outline of the coast in search for food. The New Zealand orca population are considered to be endangered, with less than 200 animals traveling around the entire country. The best months to look for orcas in New Zealand are October to March (the southern hemisphere’s summer). In Auckland, orcas can be seen in every month and season as they pass through the area – sometimes even in the harbor!

Southeast Alaska, USA

Summer time in Alaska – between Kodiak and Juneau – is one of the best environments for whale watching in the world. With huge gatherings of humpback whales and populations of resident and transient orcas, there is a lot to be seen! May through August or September is the best time of year to look for orcas in Alaska. Juneau and Seward seem to have more consistent sightings, while orcas come and go from other places like Homer and Kodiak during this time. Additionally, the two distinct populations of orcas (resident and transient) tend to have different ranges. Juneau tends to see both residents and transients, while Seward sees more residents and Homer can have see one or the other throughout any given season.



Fantastic Alaskan orca breach! Photo Credit: Emma Luck, Fluke Print Photography

Tromsø, Norway

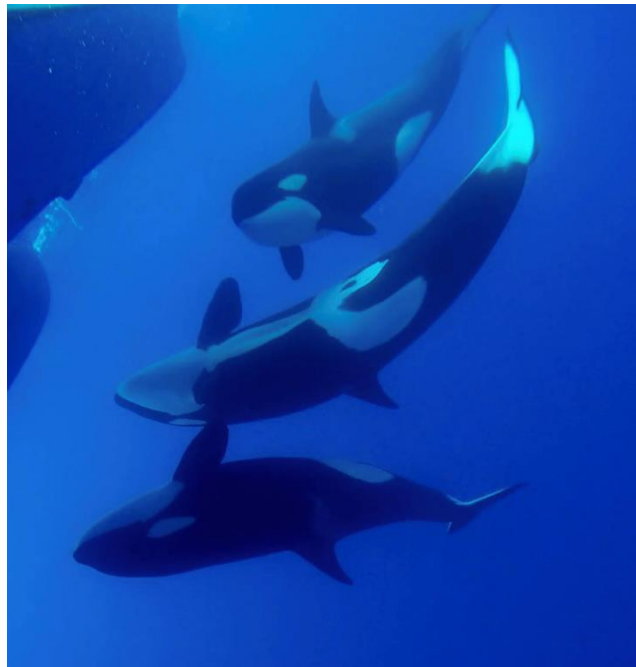
Norwegian orcas are fish-eating whales that navigate the fjord system in search of herring. These orcas are known for a cooperative hunting technique called “carousel feeding”, in which the whales work together as a team to herd together a school of herring. Then, the whales stun the fish by slapping their massive tail flukes through the school so they can be picked off and slurped up. Late October to the middle of January is considered to be the best time to find orca (as well as humpback whales) in this region of Norway.

Although Norway has a controversial reputation with whales, traveling with serious and registered small whale watching companies is one way that you can help convince Norwegian authorities that watching whales is more beneficial than whaling.

Bremer Bay, Australia

Discovered by researchers about only decade ago, the offshore Bremer sub-basin is one of the most spectacular aggregations of orcas in the southern hemisphere. It is believed that a nutrient rich Antarctic flow enters the canyon and kicks off a very potent food chain which

attracts orcas. Australia-based Project ORCA has been researching this population since 2014, and has catalogued over 150 individuals. With the sub-basin being about 50 kilometers from shore, be prepared for an offshore excursion to look for these whales – tours can be over 8 hours long! Orcas are reliably sighted during the months of January to April.



Underwater photograph of some inquisitive Bremer sub-basin orca | Photo Credit: Project ORCA

Snæfellsnes Peninsula, Iceland

About 5000 orcas live around Iceland throughout the year, coming closer to the coast during the summer months. These orcas tend to not stay in the same spot for long, which can make it a little more challenging to spot them at first. However, they tend to be most common in the herring-rich waters of the east fjords around the Snæfellsnes Peninsula. Iceland also hosts a variety of cetacean wildlife that are also quite spectacular to whale watch, such as humpback, blue and minke whales! Similar to Norway, traveling with responsible whale watching companies is one way that you can help show the authorities that watching whales is more beneficial than whaling.

British Columbia, Canada and San Juan Islands, USA (Salish Sea)

The picturesque waters between the west coast US-Canada border hosts both a population of mammal-eating transient orcas, and a population of fish-eating resident orcas – or more specifically the endangered southern resident orcas. There are several good spots in this area for both land based whale watching (such as Lime Kiln on San Juan Island) as well as vessel based whale watching. The best time to look for orcas in this area is considered to be April to

early October. There is currently a moratorium on approaching the resident orcas by vessel, due to their critical state. Learn more about how you can help them [here](#).



Triple orca spyhop in the Salish Sea | Photo Credit: Tasli Shaw

Antarctica

Not very many people have the chance to visit the icy region of Antarctica, but there are orcas here that cannot be found anywhere else in the world. The seldom seen types A, B, C and D orcas roam Antarctic and sub-Antarctic waters, each with different diets, ranges and appearances. With unique head and eye patch shape, these ecotypes are some of the most unique looking orca of all; some of them are covered in diatoms (a type of algae) giving them a yellowish or brownish color.

Orcas inhabit many parts of the globe and different populations have been found to have their own cultures due to differences in diet, behavior and vocalizations.

Keep in mind, they are wild animals and should be treated as such. The best encounters happen for both you and the whales when they are not disturbed. Don't chase or harass them; despite their large size, it can be easy to lose a whale when it doesn't want to be seen.

There is nothing quite like being in the presence of an orca. While the desire to experience them in part fuels the demand for their captivity, there are many great places around the world to experience them in their natural environment. Once you've seen whales and dolphins in the wild, it's easy to see why captivity doesn't compare to the open ocean!

TEACHER NAME		Lesson #
Lea Lawton		2
MODEL	CONTENT AREA	GRADE LEVEL
VTS	Science	5 th
CONCEPTUAL LENS		LESSON TOPIC
Systems		Ecosystems
LEARNING OBJECTIVES <i>(from State/Local Curriculum)</i>		
5.L.2.1 Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds, forests, and grasslands. 5. L.2.2 Classify the organisms within an ecosystem according to the function they serve: producers, consumers, or decomposers (biotic factors). 5. L.2.3 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.		
THE ESSENTIAL UNDERSTANDING <i>(What is the overarching idea students will understand as a result of this lesson?)</i>		THE ESSENTIAL QUESTION <i>(What question will be asked to lead students to “uncover” the Essential Understanding)</i>
Systems require Interdependence		How do systems require interdependence?
CONTENT KNOWLEDGE <i>(What factual information will students learn in this lesson?)</i>		PROCESS SKILLS <i>(What will students be able to do as a result of this lesson?)</i>
• Systems are composed from multiple components • Interdependence occurs when organisms rely on one another for survival • Grasslands are impacted by fire • Humans can impact the environment in positive ways by bringing awareness through art, or negatively by leaving fires unattended		• Observe • Utilize multiple perspectives • Interpret meaning • Make meaning • Compare and contrast • State opinions • Infer
GUIDING QUESTIONS <i>What questions will be asked to support instruction?</i> <i>Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding</i>		
• Pre-Lesson Questions:	• During Lesson Questions:	• Post Lesson Questions:

• How can art make you think from multiple perspectives? • How can we use art to represent connections? • What is necessary to create art? • How does art relate to things you see in the real world? • What is the most important part of artwork? • What is the artist's purpose? • How are the objects in images connected to each other? • What do you need to create art? • How are these things (paintbrush, canvas paint) reliant on each other? • How might missing tools affect the artists function? • How can conflicts disrupt systems? • How is an artist dependent on his tools? • How can the interdependence of paintbrushes, and paint, impact an artist?	• What is going on in this picture? • What do you see that makes you say that? • What more can you find? • How are the images in the artwork interdependent? • How do the individual parts of the artwork create a whole? • What do you mean by ____? • What evidence can you give to support your thought? • What impact do humans have on the images portrayed? • How is _____ viewpoint similar/dissimilar to _____ viewpoint? • How does this new idea connect to what we have discussed? • What emotions does this picture evoke? • What concept/situation does this artwork represent? • How do the objects in the artwork interact? • How does their interaction influence the system?	• What is new perspective did you hear? • Which ideas did you agree with disagree with? • What do you see now? • What do you think is going on now? • What do you still wonder? • Which artwork was the most powerful? • Which artwork meant the most to you personally? Why? • How is this artwork relevant? • What systems did these works of art represent? • How did the images within the artwork connect? • How might the system function if some of the animals were missing? • How might the picture appear if it was missing elements? • How are these paintings representative of a system? • What factors are necessary to create artwork? • How can humans affect the world around them? • Considering the interdependence in a system, why is human interaction within an
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		ecosystem important? • What concept do all of these art pieces have in common? • How do systems require interdependence?	
DIFFERENTIATION <i>(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.</i>			
Content	Process	Product	Learning Environment
Students will be able to choose images to discuss with groups based on interest. Content can be learned visually Ideas extend beyond facts within content area.	Open ended questions that require higher-level thinking, student led discussion.	Give students option of how to express the final question, by utilizing different art forms. (clay, paint, crayons, sculpture)	

PLANNED LEARNING EXPERIENCES <i>(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)</i>
Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students. Art can express many things! Today we will be exploring different works of art based around a grassland ecosystem, as a class, and then we will continue our exploration based on interest in small groups. We will play Kahoot to help us use some of the scientific terms to help us accurately describe these works of art. https://play.kahoot.it/v2/?quizId=552d384c-906b-4150-824a-c3f6730d3f58

After playing Kahoot! Discuss these questions as a class

- How can art make you think from multiple perspectives?
- How can we use art to represent connections?
- What is necessary to create art?
- How does art relate to things you see in the real world?
- What is the most important part of artwork?
- What is the artist's purpose?
- How are the objects in images connected to each other?
- What do you need to create art?
- How are these things (paintbrush, canvas paint) reliant on each other?
- How might missing tools affect the artists function?
- How can conflicts disrupt systems?
- How is an artist dependent on his tools?
- How can the interdependence of paintbrushes, and paint, impact an artist?

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

Teacher will gather students to look at a picture #1 for 1 minute silently observing all that they can. Relate the skill of observation to science. Scientists often have to study animals silently without making noise so they do not scare the animals in their natural environment.

After the time is up the teacher will ask Students to write down one observation on a sticky note.

Explain - *Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.*

After they are finished writing their observations.

Have students answer the 3 questions.

1. What is going on in this picture?
2. What do you see that makes you say that?
3. What more can you find?

Summarize their thoughts or ask for clarification. Pause when necessary. Let students discuss all the things they notice.

- How are the images in the artwork interdependent? What do you see that makes you say that?

- How do the individual parts of the artwork create a whole? What do you see that makes you say that?
- What do you mean by _____? What more can you find to support this thought? What impact do humans have on the images portrayed? What can you see that makes you say that? What is missing from the picture that can explain the impact?
- How are the animals in this ecosystem dependent on each other? What do you see that supports that?
- How is _____ viewpoint similar/dissimilar to _____ viewpoint? How do we use many perspectives to represent the whole system of thought?
- How does this new idea connect to what we have discussed?
- What objects in the ecosystem are interdependent? What do you see that makes you say that?
- How can is this interdependence necessary within a system?

After examining, the first picture whole group have students select which pictures they would like to examine in smaller groups. (4 options) Display the following 5 questions on the board.

1. What is going on in this picture?
2. What do you see that makes you say that?
3. What more can you find?
4. What systems can you find?
5. How might interdependence be necessary within a system?

Elaborate —*Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways*

As students examine their images in small groups ask them questions about the world around them. The animals in the image are part of a grassland ecosystem. What systems are they a part of? How do the systems in their world require interdependence?

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

After discussing the artwork have students discuss the following questions:

- What is new perspective did you hear?
- Which ideas did you agree with disagree with?
- What do you see now?
- What can you tell me about systems?
- What do you still wonder?
- How can the relationships within a system be important?
- Which artwork meant the most to you personally? Why?

- How is this artwork relevant?
- What systems did these works of art represent?
- How did the images within the artwork connect?
- How might a system function if elements from the system are removed?
- How might the picture appear if it was unfinished?
- How are these paintings representative of a system?
- What factors are necessary to create artwork?
- How can humans affect the systems around them?
- Considering the interdependence in a system, why is human interaction within an ecosystem important?
- What concept do all of these art pieces have in common?

At the end have students create their own piece of art to represent the question:

- **How do systems require interdependence?**

Have them write a short caption explaining their artwork below.

Photos: Image #1 (Whole group)



Image #2



Caption: While examining this picture consider what the artist used to create this. How can you represent ideas by utilizing different materials? How are do these materials interact interdependently to show the artists perspective

Image #3 Show half of this picture



Caption: Half of this picture is missing. Utilizing what you know about some of the animal food chains (and how predators depend on prey) make an educated guess about what you may see on the other half of this picture.

Image #4



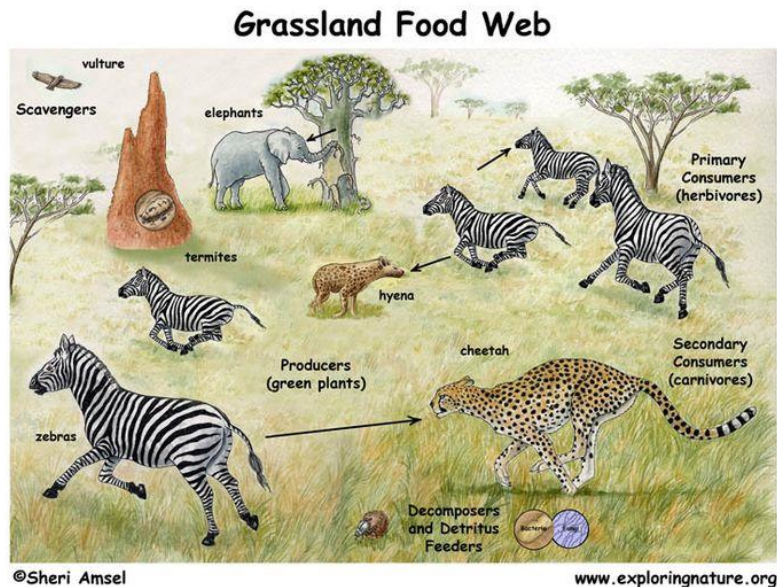
Caption: This artist created these sculptures called Wind gate in the grassland. How might these sculptures represent the ecosystem?

Image # 5



Caption: what can you infer about the current system by analyzing the different factors within this image?

Vocabulary for reference when discussing images.



5th Grade Ecosystems Vocabulary

Individual – a single organism in an environment

Population – Individuals of the same species in the same environment

Community – Populations of different organisms living in an environment

Habitat – the place where a population lives in an ecosystem

Ecosystem – A community and its environment Biome – a large-scale ecosystem such as deserts, forests, grasslands, tundra, aquatic or marine biomes.

Niche – The role or job of an organism or population in the environment

Energy Pyramid: The flow of energy through a food chain or food web.

The levels begin with the **producer** on the bottom of the pyramid and works upward, the next level is the **Primary Consumer** (1st consumer), then **Secondary Consumer** (2nd consumer) and last is the **Tertiary Consumer** (3rd consumer).

Adaptation – behaviors or physical characteristics that help an organism to survive.

Examples: camouflage, types of beaks for birds, webbed feet and feathers that repel water for ducks, camel's ability to store water, and the cactus's ability to store water or its spiny thorns to help protect it and loses less water than leaves are all physical. Behaviors such as staying in groups/herds for protection such as bison, elephants, zebras or hunting in groups

like coyotes or hyenas, bears hibernating in the winter and other animals that migrate to new locations for food or climate changes are how many animals survive.

Competition: The contest between organisms for limited resources. Examples of an animal's way of winning this competition is speed, use of camouflage, hunting in groups to scare other competition, and other physical or behavioral adaptations.

Symbiosis: Long-term relationships between organisms. The 3 types of Relationships are:

1. **Mutualism:** When both organisms benefit from their relationship, such as a clown fish and a sea anemone or bees and flowers.
2. **Commensalism:** When one organism benefits but the other one is neither harmed nor helped. The bacteria that live in a mosquito only to get a ride to another organism. The bacteria is the one that benefits, it gets a ride and the mosquito is not harmed or helped.
3. **Parasitism:** This is when one organism benefits and the other is harmed. For example a tick or mosquito. They both can feed on the blood of their host (humans or other animals) and get food. The human or animal will get a bite that could carry a disease such as malaria or lime disease.

AIG include some 6th grade words such as:

Migration-To journey between different areas at specific times of the year.

Mimicry- To mimic or copy another.

Conserve To use or manage wisely. To preserve or safe.

Overpopulation a condition in which the number of a given species is greater than the environment can handle.

Deforestation The large-scale clearing of trees by humans who use the cleared land for growing crops, grazing livestock, or the trees for timber and wood products.

Pollution The introduction of any harmful substance into the environment at a faster rate than it can be cleansed. The three main types are air, water, and ground.

Recycling To use something old to make something new.

Reduce To make something smaller.

Reuse To use something again.

Conservation To protect the diversity of life and prevent the extinction of plants and animals.

Hazard a situation that poses a level of threat to life, health, property, or environment.

Biohazard A substance that poses a threat to the health of living organisms.

TEACHER NAME			Lesson #
Lawton			3
MODEL	CONTENT AREA	GRADE LEVEL	
Kohlberg	Science	5 th	
CONCEPTUAL LENS		LESSON TOPIC	
Systems		Ecosystems	
LEARNING OBJECTIVES (from State/Local Curriculum)			
Science 5.L.2.3 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem Social Studies 5. G.1.2 Explain the positive and negative effects of human activity on the physical environment of the United States, past and present. Language Arts RI.5.3 Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in scientific, or technical text based on specific information in the text.			
THE ESSENTIAL UNDERSTANDING (What is the overarching idea students will understand as a result of this lesson?)		THE ESSENTIAL QUESTION (What question will be asked to lead students to “uncover” the Essential Understanding)	
Systems require interdependence		How do systems require interdependence?	
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)	
- Students will learn: - The negative effects of human activity such as: deforestation, and overconsumption - Deforestation: the action of clearing a wide area of trees. - Overconsumption: the action or fact of consuming something to excess. - the interdependence within a system - How humans can impact a system sustainably, and unsustainably such as logging and farming.		Students will be able to . . - Create Inferences - Compare and contrast - Support reasoning - Explain - Persuade - Analyze - prioritize	

• Sustainably: in a way that avoids the depletion of natural resources in order to maintain an ecological balance. • Unsustainably: upsetting the ecological balance by depleting natural resources.	
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GUIDING QUESTIONS

What questions will be asked to support instruction?

Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding

Pre-Lesson Questions:

During Lesson Questions:

Post Lesson Questions:

• Who does the choice of harvesting, and farming cocoa impact and why? • What is the impact of deforestation? • How is the rainforest ecosystem dependent on trees? • Who does the choice of harvesting, and farming cocoa impact? • How is the deforestation of trees impacting the ecosystem? • How does growing cocoa affect people? • How is the economic system impacted by the sale of cocoa? • Who is impacted by the deforestation of the rainforest? • What other beings might the deforestation impact, and why will it impact them? • What are the repercussions of farming cocoa? • How will the deforestation affect the farmers quality of life? • What are the benefits of growing cocoa? • How will the deforestation affect the farmers' quality of life? • How will the	• What are the facts in this situation? • What are some of the issues involved in this decision? • How will his choice impact the systems around him? • How are systems reliant on different factors? • What questions do you have about the situation? • Why is this choice so difficult? • What choices can he make? • How would you summarize the dilemma? • Who are the main characters discussed? • How will the decision impact them? • Whom else might it impact? • What else might it impact? • What kind of impact will it make? • What is your position? • How will his decision impact the system around him? • What are the long-term effects of this decision? • What are the short-term effects of this decision? • What other factors could change the	• What position did you choose? • What reasoning can you give? • Whose perspectives did you include? • Why do you think the decision is so important? • What systems will benefit from your position, and why? • Now what do you think the character should do? • What is the most important reason for this decision? • How do systems require interdependence?
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deforestation affect the worldwide quality of life?	environmental system?		
• How are humans dependent on trees? • What systems are involved in deforestation? • How will it impact the environmental system? • How will deforestation and the sale of cocoa impact the Economic system? • What happens when you change something in a system? • How are the factors within a system interdependent?	• What are the positive impacts could his decision have on the system around him? • What makes you think so? • What are some of the negative effects his decision could have on the systems around him? • What causes systems to function positively or negatively? • How do systems rely on interdependent factors?		
DIFFERENTIATION <i>(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.</i>			
Content	Process	Product	Learning Environment
There are articles that are more complex for gifted learners to gain more depth about the issues involved.	“Kohlberg’s Stages of Moral Development requires students to engage in high level process skills in order to make decisions and establish a position by using reasoning.”	Has students synthesis information instead of summarizing the information	

PLANNED LEARNING EXPERIENCES

(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)

Engage and Connect - *This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students.*

At the beginning, the teacher will create a tree diagram, (on an anchor chart) while asking students whole group

As you ask each question, write the answers on leaves of the tree.

Why are trees important?

Which systems are they a part of?

How do they impact systems?

What systems rely on trees?

What purpose do trees serve?

What would the world look like with less trees?

How are ecosystems interdependent?

After filling out this section on the bottom of the anchor chart simply write do you like chocolate. Have students write their names under yes or no. Tell students that another thing trees do is grow chocolate. Tell them they are going to read an article to learn more.

Have students read an article about cocoa and deforestation. Have them highlight facts that they think are important. This will help build some of their background knowledge so they can understand the issue more. After students read, have them talk with their table group about what they learned.

Then as a class go over these questions they have about deforestation.

- Who does the choice of harvesting, and farming cocoa impact and why?
- What is the impact of deforestation?
- How is the rainforest ecosystem dependent on trees?
- Who does the choice of harvesting, and farming cocoa impact?
- How is the deforestation of trees impacting the ecosystem?
- How does growing cocoa affect people?
- How is the economic system impacted by the sale of cocoa?
- Who is impacted by the deforestation of the rainforest?
- What other beings might the deforestation impact, and why will it impact them?
- What are the repercussions of farming cocoa?
- How will the deforestation affect the farmers' quality of life?
- What are the benefits of growing cocoa?
- How will the deforestation affect the farmers' quality of life?
- How will the deforestation affect the worldwide quality of life?
- How are humans dependent on trees?
- What systems are involved in deforestation?
- How will it impact the environmental system?
- How will deforestation and the sale of cocoa impact the Economic system?
- What happens when you change something in a system?
- How are the factors within a system interdependent?

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

Step 1: Introduce and clarify nature of dilemma

Scenario: Devon is from a family of farmers who live in the Amazon rainforest. He is a second-generation farmer, and he is proud of his heritage. His father was a cocoa farmer, and Devon is familiar with the trade because when he was a young boy he worked alongside his father harvesting cocoa. In order to farm high quality cocoa, Devon must cut down (deforest) part of the rainforest. If the cocoa trees do not get enough sunlight, the cocoa they produce will not be as high quality (worth as much). Devon would like his children to be educated since he was denied that opportunity. Currently his children are not going to school because he needs their help to harvest the cocoa in the rainforest, as he cannot afford to hire workers. He is a skilled cocoa farmer, and has a difficult choice to make. He knows that if he deforests an area and starts his own farm, he will be able to get higher quality cocoa, may be able to send his children to school, while providing a better life for his family. He knows that many of the

animals in the rainforest rely on the forest for their homes, and food. There are many animals living in the part of the forest he would need to cut down to start his own farm. He wants to provide a better life for his children, but is concerned about how his choice may affect the ecosystem around him. What should he do?

Tell students today we have a dilemma about a cocoa farmer. Read the dilemma to the class (whole group).

After reading give, students some think time to ponder what is going on without talking. Have them write one initial thought or question to ask or tell the group.

Step 2: Have students clarify the facts of the situation and identify the issues involved.

Have students clarify the facts of the situation, and identify the issues involved.

- What are the facts in this situation?
- What are some of the issues involved in this decision?
- How will his choice impact the systems around him?
- How are systems reliant on different factors?
- What questions do you have about the situation?
- Why is this choice so difficult?
- What choices can he make?
- How would you summarize the dilemma?
- Who are the main characters discussed?
- How will the decision impact them?
- Whom else might it impact?
- What else might it impact?
- What kind of impact will it make?
- What is your position?
- How will his decision impact the system around him?
- What are the long-term effects of this decision?
- What are the short-term effects of this decision?
- What other factors could change the environmental system?
- What are the positive impacts could his decision have on the system around him?
- What makes you think so?
- What are some of the negative effects his decision could have on the systems around him?
- What causes systems to function positively or negatively?
- How do systems rely on interdependent factors?

Explain - *Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.*

Step 3: Have students identify a tentative position on the action the central character should take and state one or two reasons for that position.

After the discussion whole group have students think individually without talking about what Devon should do. Have them write what choice he should make on one side of an index card, and two reasons why he should make it on the other index card. After students have finished writing the teacher will ask them to hold up their index card if they think he should take the job. Then hold up their index card if they think he should not take the job. Collect the index cards.

Elaborate —*Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways*

Step 4: divide the class into small groups:

Put students in small groups, have students (4-6), and have students share their reasons for the decision he chose. Groups can be split into groups with likeminded beliefs, or groups can be split where the issue is divided.

The teacher will tell the students to:

Share their position and reasons for that position

Discuss both positions and reasoning.

On their chart: Choose a position as a group, and write the 2 BEST reasons for supporting their position.

Step 5: Reconvene the class for a full class discussion of the dilemma.

Before reconvening have a museum walk. Have each group silently walk around, and observe the different opinions. After have, them sit in a giant circle to encourage face-to-face interaction.

The teacher asks:

- What position did you choose?
- What reasoning can you give?
- Whose perspectives did you include?
- Why do you think the decision is so important?
- What systems will benefit from your position, and why?

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

Step 6: Ask students to reevaluate their original positions individually.

After meeting and elaborating on their opinions hand students back their index cards, and have them, rethink their decision. The teacher can check their reasoning to see if they were supporting their answer with a sound reason.

- Now what do you think the character should do?
- What is the most important reason for this decision?

At the end, have students consider the final question. How do systems require interdependence? Have students create a 3D model of a tree (writing the systems name on the trunk of the tree and writing the interdependent factors on the leaves of the tree.

<https://www.firstpalette.com/craft/3d-paper-tree.html>

Scenario: Devon is from a family of farmers who live in the Amazon rainforest. He is a second-generation farmer, and he is proud of his heritage. His father was a cocoa farmer, and Devon is familiar with the trade because when he was a young boy he worked alongside his father harvesting cocoa. In order to farm high quality cocoa Devon must cut down (deforest) part of the rainforest. If the cocoa trees do not get enough sunlight, the cocoa they produce will not be as high quality (worth as much). Devon would like his children to be educated since he was denied that opportunity. Currently his children are not going to school because he needs their help to harvest the cocoa in the rainforest, as he cannot afford to hire workers. He is a skilled cocoa farmer, and has a difficult choice to make. He knows that if he deforests an area and starts his own farm he will be able to get higher quality cocoa, may be able to send his children to school, while providing a better life for his family. He knows that many of the animals in the rainforest rely on the forest for their homes, and food. There are many animals living in the part of the forest he would need to cut down to start his own farm. He wants to provide a better life for his children, but is concerned about how his choice may affect the ecosystem around him. What should he do?

The trouble with chocolate

A decade after Mars and other chocolate makers vowed to stop rampant deforestation, the problem has gotten worse

STORY BY STEVEN MUFSON
and
PHOTOS BY SALWAN GEORGES

• Published on Oct. 29, 2019

ELIZABETHTOWN, Pa. — Mars Inc., maker of M&M's, Milky Way and other stalwarts of the nation's Halloween candy bag, vowed in 2009 to switch entirely to sustainable cocoa to combat deforestation, a major contributor to climate change.

But as the United States stocks up for trick-or-treating, Mars and other global chocolate makers are far from meeting that ambitious goal.

Over the past decade, deforestation has accelerated in West Africa, the source of two-thirds of the world's cocoa. By one estimate, the loss of tropical rainforests last year sped up more in Ghana and Ivory Coast than anywhere else in the world.

"Anytime someone bites on a chocolate bar in the United States, a tree is being cut down," said Eric Agnero, an environmental activist in Abidjan, the economic capital of Ivory Coast. "If we continue like that, in two, three, four years there will be no more forests."

Worldwide, the pace of deforestation is alarming. In 2017, 40 football fields of tropical forests were lost every minute, spurred by growing demand

not only for cocoa, but also for palm oil, soybeans, timber, beef and rubber, according to Global Forest Watch, a nonprofit organization with online data and tools for gathering and monitoring forests.

Recent wildfires have focused attention on the Amazon rainforest in Brazil, but West Africa is another major trouble spot. Ivory Coast has lost 80 percent of its forests over the past 50 years. And in Ghana, trees have been chopped down across an area the size of New Jersey, according to an estimate by the minister of lands and natural resources.

Although illegal mining accounts for some of the destruction, much of it is the work of hundreds of thousands



A stream of melted chocolate runs along a piece of equipment at the Mars candy factory in Elizabethtown, Pa.

of poor cocoa farmers seeking to expand their plots by felling mature trees, often in national parks and protected forests.

Left to rot, those trees no longer capture and store carbon dioxide but instead release it into the atmosphere. According to the Woods Hole Research Center, tropical deforestation is currently responsible for about 10 percent of global greenhouse gas emissions.

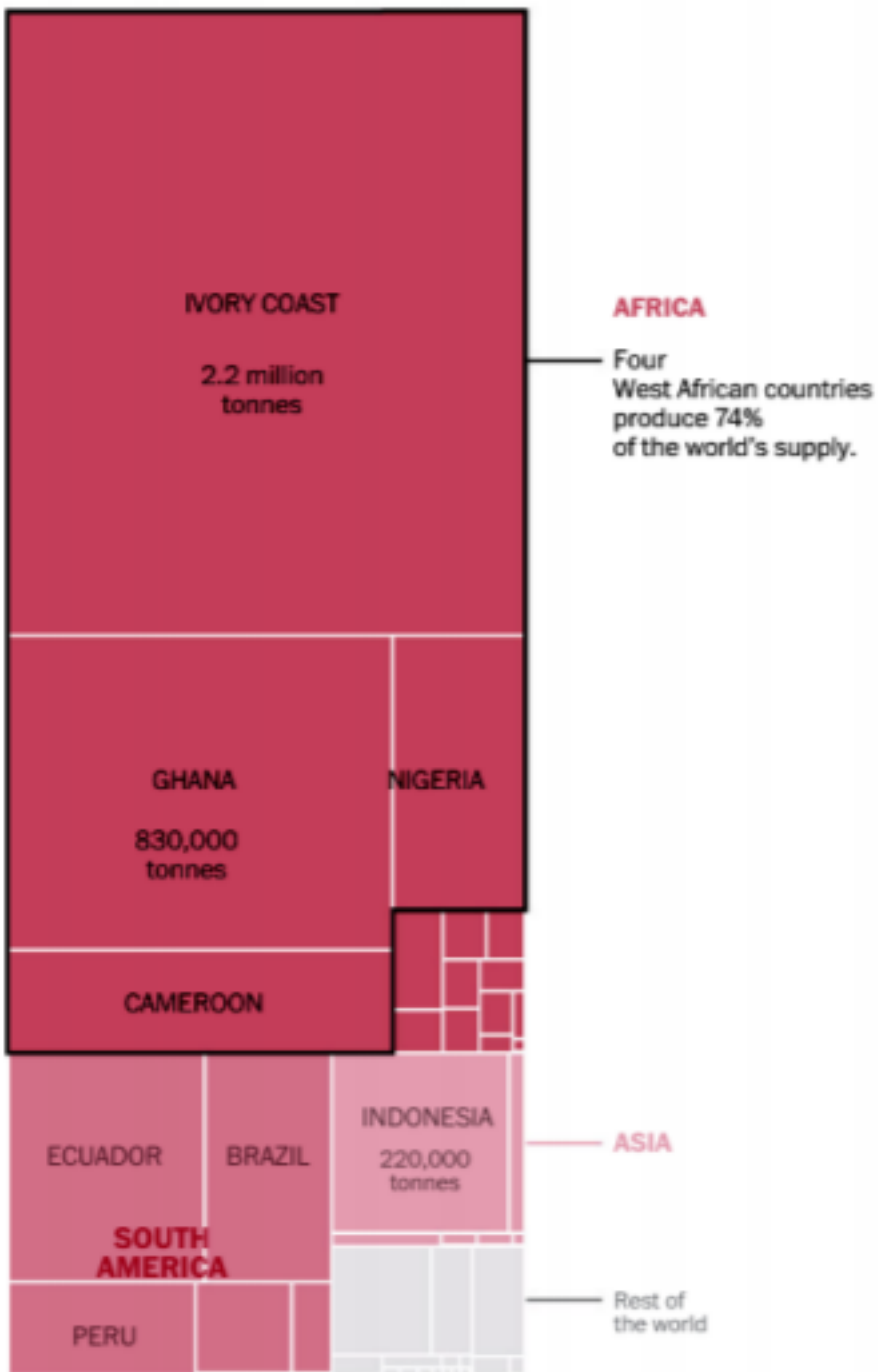
The failure to make progress against deforestation has tarnished the image and credibility of the chocolate industry at a time when it is already under fire for its practices in West Africa. *The Washington Post* reported in June about the use of child labor in West African cocoa fields, which has persisted despite promises decades ago to stop it.

Last year, Mars postponed its target date for switching entirely to sustainably produced cocoa from 2020 to 2025.

“Zero deforestation cocoa only exists where all the forest has already disappeared,” wrote Francois Ruf, an economist with CIRAD, a French agricultural research and international cooperation organization.

Traders, certification firms and the Ivorian and Ghanaian governments are struggling alongside chocolate companies to find a strategy that works. Mars, for example, has paid tens of millions of dollars extra for certified cocoa, and millions more to certification firms such as Rainforest Alliance.

World Cocoa Production



Source: ICCO and Gro Intelligence

Now, however, it's skeptical that such firms can deliver, given the difficulty of monitoring the thousands of cocoa farmers scratching out harvests on small plots.

"The myth over the last 10 years was that certification would solve the problem of deforestation," says Barry Parkin, chief procurement and sustainability officer at Mars. "In most cases, it was a little bit helpful. But it is not solving the core issues or assuring that your cocoa is deforestation-free."

For cocoa farmer Coulibaly Abou, deforestation is not a climate catastrophe. It's a living.

Since 2006, he has carved out a parcel for himself, knocking down tall trees and clearing brush to plant short cocoa trees. When the pods containing cocoa beans are ripe, he picks them, cuts them open, discards the white pulp, and spreads the wet beans on the ground to ferment and dry. It takes more than 400 beans to make a pound of chocolate, according to Sudden, a commodities trading firm.

"Everything here was once forest," Abou, 35, said earlier this year as he walked along a shady path that connects his cocoa farm with the tiny hamlet of Gloplou in western Ivory Coast. He pointed to some of the once-towering trees that had been cut down, their wide trunks left to rot.

The additional farmland has enabled Abou to support his wife and six children, although just barely. They live in a two-room hut, one of about 20 in the village.

After a bumper cocoa crop last year, the state-owned monopoly slashed prices by 36 percent. This year, the stingy prices have combined with a poor crop to leave Abou with just \$600 in earnings.

"We do all the work manually and we get just a small amount of money," he lamented as one of his children cried in the background. "When these kids do not go to school, they start asking us why we are not sending them. It is so hard for us."

Big Chocolate

Nearly 5,000 miles and a world away, in a factory in the heart of Pennsylvania dairy country, Mars transforms the beans grown by Ivory Coast farmers such as Abou. The beans are roasted, milled and blended. Bitter nibs burst into a

panoply of flavors. The factory is infused with the aroma of chocolate.

In a pristine room with high ceilings, the liquefied chocolate is poured into molds for Dove bars and fed into wrapping machines. A mechanical arm sucks up the finished candies and drops them into bags.

Mars prides itself on its sensitivity to climate change. In 2009, it was the first global chocolate company to pledge to use only sustainable cocoa. Five years later, it became the first U.S. company to join RE100, a group of companies vowing to get all of their electricity from renewable sources.

Founded a century ago around a kitchen table, Mars, based in McLean, Va., is still family owned and operates 150 factories in more



Cocoa farmer Coulibaly Abou, 35, struggles to earn enough for his family. He lives with his wife and six children, including his 1-year-old son, Sidiki, in the village of Gloplou in Ivory Coast.

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than 80 countries. It purchases enough solar and wind power to meet the needs of its operations in Belgium, Brazil, Lithuania, the United Kingdom and the United States, and, since 2007, has cut its emissions by 25 percent.

Parkin said managing for climate change makes good business sense. “The emergence of more efficient solar and wind means we can source renewable energy at a lower cost than fossil fuels. This is not fanciful anymore,” he said. “Every deal we’ve done, we’ve saved money.”

Mars — which also makes Wrigley’s gum, Uncle Ben’s rice and Pedigree pet food — looks beyond its own operations when calculating its carbon footprint. Unlike two-thirds of the 50 largest food and beverage companies in the United States and Canada, Mars looks at its entire supply chain, including the land-use decisions of West African farmers.

By that method, Mars says it emits 25 million tons of carbon a year. The vast majority — three-quarters of emissions — comes from agriculture, with 8 million tons coming from deforestation alone.

That task of doing something about it has fallen mainly on Parkin. In many companies, the sustainability chief is a public relations executive. But Parkin is head of both procurement and sustainability, merging two tasks that are often at odds.

At Mars, executives worry about the destructive effects of global warming on the agricultural commodities they need to buy. In addition to battling deforestation, the company has called

for “a serious price on carbon,” Parkin said. Mars has joined a campaign to lobby Congress to establish an “ambitious” carbon pricing system that would tax emitters.

Under a tax of \$50 per ton, Parkin said, Mars would owe more than \$1 billion a year. Congress has shown little interest in the idea. But Parkin nonetheless thinks “there will be a competitive advantage in having a smaller carbon footprint than our competitors.”

Mars and other members of the World Cocoa Foundation also have begun to urge West African farmers to plant cocoa trees in the shade of older trees rather than cut them down.

But the idea has never been popular among farmers. Shade reduces the size of cocoa harvests and delays first yields. And some farmers, especially those illegally occupying land, fear that loggers would cut down the trees anyway without paying for them.

Satellite photos and data collected by the University of Maryland show the forest cover continuing to shrink.

Corruption is ‘pervasive’

The giant chocolate companies are not solely to blame for not stopping deforestation. Environmentalists accuse governments, too.

Ivory Coast has created national parks and set aside other forests, but has not protected them. About 40 percent of the country’s cocoa crop comes from those areas, said Etelle Higonnet of Mighty Earth, a U.S.-based environmental group that issued a report called “Chocolate’s

Dark Secret.” The Marahoué National Park alone has 30,000 illegal inhabitants, according to one estimate, including small farmers and refugees from the poor, drought-ridden and strife-torn countries of Burkina Faso, Mali and Niger.

And as unrest rocked Ivory Coast in the early 2000s, stopping deforestation slipped down the government’s list of priorities.

Earlier this year, Vivid Economics, a consulting firm working with the Ivorian Ministry of Planning and Development, warned that “total loss of rural forest remains likely within a decade” in the country’s southwest region. At current rates, the report added, the entire forest in Biolequin, a major reservoir of virgin forest, could “disappear in less than a decade.”

Corruption is “pervasive,” according to the financial auditing firm KPMG, which told investors that Ivory Coast ranks 108th out of 176 countries. The distribution system for cocoa, too, “is often erratic and is subject to corruption and capricious political interference,” according to a 2017 World Bank report.

Small farmers occupy the lowest rung of the cocoa beans’ journey. They sell to middlemen, known as “pisteurs,” who transport and sell bags of cocoa beans to cooperatives. The cooperatives then sell to large international trading houses such as Olam, Cargill and Barry Callebaut, which then sell to chocolate companies such as Mars.

In Ghana, the Ghana Cocoa Board (Cocobod) is the intermediary

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Deforestation has toppled tall trees and damaged lands near the city of Bangolo, Ivory Coast.

between farmers and foreign buyers. Last year, Cocobod squeezed the nation's farmers by lowering prices below international market rates. Agnero, the activist, said that is pushing farmers deeper into the forests to enlarge their crops.

Ghana defends its record. It cites a tree-planting campaign by young Ghanaians as well as an alphabet soup of other strategies. In July, the country signed a deal with the World Bank, freeing up \$50 million to combat deforestation.

"Ghana is, indeed, not alone in this fight to keep the forest heritage for the present and future generations," the Forestry Commission said.

In Ivory Coast, Alain-Richard Donwahi, the minister of water and forests, said in an email that a new

forest code adopted in July by the National Assembly would create a "legal framework" to protect forests. However, he said, the \$1 billion cost remains a "major challenge" and help from the private sector will be "essential."

The code calls for clearing all people out of the least-damaged forests; there, Donwahi said, "no human presence is tolerated." In forests with some degradation, people will be removed over three years. And where damage is greatest, farmers will be resettled.

But ousting farmers from forest land has been a struggle. After Ivory Coast tried to drive farmers out of protected areas in 2016, Human Rights Watch said evictees had "suffered extortion and physical

abuse by forest conservation authorities," who demanded "gifts" — sometimes in cash and other times in livestock.

"While conserving forests can play an important role in combating climate change, environmental protection measures should respect the human rights of people living in protected forests," Human Rights Watch said.

Donwahi said "human rights will be respected" in implementing the new policy. But he called on chocolate manufacturers to do more.

"It is well known that cocoa beans supplying factories of chocolate companies is one of the major deforestation causes" in Ivory Coast, he said.

'Chocolate's dark secret'

In 2011, Mars's Dove Chocolate gained the Rainforest Alliance's seal of approval, which assures consumers that the cocoa came from farms that did not use child labor, harm wildlife or chop down trees. Dove's Silky Smooth Dark Chocolate began sporting the alliance's green frog seal in January 2012.

Then the Rainforest Alliance revealed that its certification system had failed; it could not vouch for every cocoa shipment. In Ivory Coast, it suspended or fired four auditing firms responsible for 90 percent of certifications awarded last year.

"We have discovered that noncertified cocoa has potentially been entering certified supply chains," the group said on its website.

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It did not specify when the lapse took place.

It was a blow to Rainforest Alliance, which trains auditing groups and pays them to inspect cocoa farms and cooperatives. Using soccer-style penalty cards, Rainforest Alliance last year issued several yellow cards to auditors and one red card.

The breakdown occurred chiefly among auditors approved by UTZ, a Dutch certification program that merged with Rainforest Alliance last year. The sole red card — for “repetitive” and “structural” flaws — went to Control Union, which last year issued 20 percent of all certifications in Ivory Coast for UTZ. Only 13 of 24 UTZ certification auditors in the two countries have been approved this year.

Today, Rainforest Alliance certifies about half of Ivory Coast’s cocoa. The other half is purchased by companies such as Nestlé and Mondelez, which rely on their own standards and sourcing programs.

Rainforest Alliance chief executive Han de Groot said the company can trace certified cocoa beans back from ships to farms. But industry experts said that would require a census, surveys and satellite maps that aren’t available. De Groot conceded that unreliable GPS coordinates for farms and forests have been a problem.

One major chocolate company, Barry Callebaut, says that it has built its own database with information on 185,000 farmers, their families, their trees and the outlines of their land. It says it has 300 people monitoring practices on the farms, and that it has developed a method of planting trees that would use drones to shoot seeds into the ground at a rate of 100,000 a day.

“This is revolutionary,” said Pablo Perversi, the company’s chief of innovation, sustainability and quality. But he said ending deforestation “is not really the role of the companies.” He said “a lot” of the responsibility belongs to the government.

Next year, chocolate companies in Ivory Coast plan to use GPS coordinates to map about 1 million of the country’s 1.6 million farms, said Richard Scobey, a longtime World Bank official who now heads the World Cocoa Foundation. That would help companies and international groups detect new encroachment on forests.

Ruf, the French agricultural expert, has decried the “declarations and zero deforestation slogans,” writing that “nothing has changed.”

Mars is cautious, too.

“Supply chains, the engines of global growth, are broken,” Parkin said in September 2018 at the

international climate conference in Poland. “We can no longer treat these as commodities of unknown origin and unknown climate impact. You’ve got to radically change how you source these materials.”



Steven Mufson

Steven Mufson covers the business of climate change. Since joining The Washington Post in 1989, he has covered economic policy, China, diplomacy, energy and the White House. Earlier he worked for The Wall Street Journal in New York, London and Johannesburg.



Salwan Georges

Salwan Georges is a staff photographer for The Washington Post. He was a photographer on The Post’s Murder with Impunity series, which was listed as a finalist for the Pulitzer Prize in Explanatory Reporting in 2019.

Peter Whoriskey in Ivory Coast contributed to this report.

EASIER ARTICLES:

Bittersweet: chocolate's impact on the environment



- ISSUE: Spring 2017

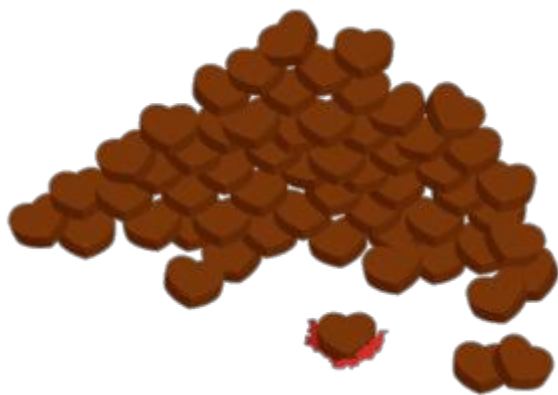
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- [Tell a Friend](#)

At least 2,000 years ago, people in the Americas began cultivating the cocoa tree for its dark, bitter beans, which they brewed into a drink spiced with hot peppers. Today, we blend the beans with milk and sugar and call the stuff chocolate. And we eat loads of it.



58 MILLION POUNDS



Amount of chocolate that Americans consume during the week of Valentine's Day, from milk chocolate hearts to boutique truffles.



= 1 MILLION LBS

70%



Estimated percentage of the world's cocoa beans grown in West Africa, where climate change is expected to boost temperatures and prolong dry spells in coming decades. That's not good news for local cocoa farmers: cocoa trees are sensitive to heat and drought.



SLOW FOOD

Global demand for cocoa is fast rising—and producers are struggling to keep pace. **It can take an entire year for a cocoa tree to produce the cocoa in just half a pound of chocolate.** Older trees also yield less cocoa, and most of the world's cocoa plantations are well past their peak production years.

SWEET SORROW



Cocoa is a critical cash crop for West African farmers, many of whom own just a few acres of land and can't afford chocolate themselves. But the plant's production is also fueling deep problems there. In particular:

DEFORESTATION

Cocoa farmers usually clear tropical forests to plant new cocoa trees rather than reusing the same land. That practice has spurred massive deforestation in West Africa, particularly in Ivory Coast. Experts estimate that 70% of the country's illegal deforestation is related to cocoa farming.

CHILD LABOR

West Africa's cocoa farmers frequently use child labor to help with growing, harvesting, and transporting cocoa beans. During the 2013-14 growing season, an estimated 2 million children were used for hazardous labor throughout Ghana and Ivory Coast.

SWEET POTENTIAL



Despite the cocoa industry's challenges, there's hope. Experts have identified a number of farming techniques that could boost the productivity of existing cocoa farms, reducing the need for clearing more forests. Additionally, candy company Mars has mapped the cocoa genome, leading to trees that are three to four times more productive than varieties often used in West Africa; they can also be more climate resistant.



INSIDE OUT

WWF works with the world's biggest chocolate companies to improve cocoa production. One, Barry Callebaut, processes 22% of chocolate globally. In November 2016, the company unveiled Forever Chocolate, a suite of sustainability goals for 2025. The goals include achieving zero child labor and deforestation in its supply chains; replanting 2.5 million acres of cocoa on existing cocoa plantations; using 100% sustainable ingredients in all products; and lifting 500,000 producers out of poverty.

Easier article:

The Animal Cost of War and Chocolate

2 MINUTE READ

BY [REBECCA RUPP](#)

PUBLISHED APRIL 2, 2015

The world's passion for chocolate is having unexpectedly far-reaching effects. It's endangering the world's primate population. So says a [study](#) by Ohio State University's [Scott McGraw](#) and colleagues, published in March in *Tropical Conservation Science*. McGraw and team spent over 200 days tramping through 18 forest reserves and five national parks of the Ivory Coast (Côte d'Ivoire) – the small country on Africa's west coast that produces some 35 percent of the world's cocoa, the key ingredient of all things chocolate. McGraw was hoping to find monkeys. Instead, he found – well, a lot of cocoa.

Cocoa—a.k.a. “brown gold”—has dominated the Ivory Coast's economy for the past 50 years, and now accounts for 22 percent of the country's gross domestic product, half of its exports and two-thirds of its jobs. As well as chocolate central, however, the Ivory Coast is a hotspot for global biodiversity. It's part of the lush [Guinean Forest Region](#), home to some 9,000 species of plants, 985 species of birds, and 320 species of mammals, among them 22 species of primates. The problem is that cocoa and biodiversity simply don't seem to get along here.

McGraw's group found that 13 of 23 protected reserves and parks now had no primate species at all, and five had lost half of their original primate populations. Two species of previously endangered primates – the Roloway monkey and the White-Naped Mangabey – were found to be so rare as to be critically endangered.

Instead of monkeys, chimpanzees, and old-growth forest, McGraw's group found "a sea of cocoa plants." About 75 percent of the supposedly protected territories had been converted to illegal cocoa plantations. There were also plantings of other crops, among them bananas, yams, maize, and rice— and even entire illegal villages, the largest with a population of up to 30,000. The conclusion was unmistakable: cocoa in, primates out.

So what happened? In part, the cocoa takeover was due to political unrest and outright civil war in the Ivory Coast, during which prolonged period the government had little time to spare for monitoring forest reserves. People, unopposed, simply moved in, cut down trees and planted cocoa. Another problem was the decline of legal cocoa plantations: disease, productivity drop-off, and lack of maintenance during the Ivory Coast's wars all took their toll. And a third was the exploding international demand for chocolate. (See [Can GMOs Can Save Chocolate?](#))

The Ivory Coast's story isn't an isolated incident. It's just an extreme example of the dive biodiversity is taking worldwide. We human beings have, at a guess, modified about half of the world's land surface to suit ourselves, for – among other things – agriculture, roads, cities, and towns. A recent [study](#) in the science journal *Nature* calculated that, over the past 500 years, our meddling has led to a 13.6 percent decline in total number of plant and animal species.

Monkeys and cocoa, however, don't have to be in a state of hopeless stand-off. In Brazil, for example, the practice of [cabruca](#) – rainforest-friendly chocolate – promotes compromise. In shade plantations, tall old-growth trees are preserved and cocoa plants are grown in the forest understory. For the Brazilian [golden lion tamarin](#), this has been a lifesaver. Deforestation, however, for Ivory Coast primates, is – says Scott McGraw – a "death knell."

TEACHER NAME		Lesson #
Lawton		4
MODEL	CONTENT AREA	GRADE LEVEL
Simulation	Science	5 th
CONCEPTUAL LENS		LESSON TOPIC
Systems		Ecosystems
LEARNING OBJECTIVES <i>(from State/Local Curriculum)</i>		
5.L.2.1 Compare the characteristics of several common ecosystems, including estuaries and salt marshes, oceans, lakes and ponds, forests, and grasslands. 5.L.2.2 Classify the organisms within an ecosystem according to the function they serve: producers, consumers, or decomposers (biotic factors). 5.L.2.3 Infer the effects that may result from the interconnected relationship of plants and animals to their ecosystem.		
THE ESSENTIAL UNDERSTANDING <i>(What is the overarching idea students will understand as a result of this lesson?)</i>		THE ESSENTIAL QUESTION <i>(What question will be asked to lead students to “uncover” the Essential Understanding)</i>
<i>Systems require interdependence</i>		<i>How do systems require interference?</i>
CONTENT KNOWLEDGE (What factual information will students learn in this lesson?)		PROCESS SKILLS (What will students be able to do as a result of this lesson?)

Students will know that: • Ecosystems are composed of abiotic (non-living), and biotic (living) factors • Students will be able to describe the ecosystem using terms such as: • Tundra: The coldest of the biomes, located at the top of the world. The soil is frozen. Permafrost, or permanent ice, usually exists within a meter of the surface. • Survival: the state or fact of continuing to live or exist, typically in spite of an accident, ordeal, or difficult circumstances. • Ecosystem: A biological community of interacting organisms and their physical environment. • Environment: The surroundings or conditions in which a person, animal, or plant lives or operates. • Carnivores: Animals that eat herbivores and sometimes other • Herbivores: Animals that eat only plants. • Predators: Any carnivorous animal that exists by preying on other organisms. • Prey: An animal hunted or seized for food, especially by a carnivores animal. • Omnivores: Animals that eat both plants and animals. competition, • Consumers: Animals that get their energy from producers or from organisms that eat producers. • Primary consumers: consumers that eat producers • Secondary consumers: consumers that eat primary consumers • Tertiary consumers: consumers that eat secondary consumers • Producers: Make their own food. Ex. green plants energy • Decomposers: Plants and animals that break down dead plants and animals	• Communicate effectively • Analyze events • Infer • Compare and contrast • Classify • Utilize multiple perspectives • Research • Work collaboratively as a group • Design an animal that is independent within an ecosystem • Prepare, and present a persuasive essay
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into organic materials that go back into the soil. • Food chain: a hierarchical series of organisms each dependent on the next as a source of food. • Food web: a system of interlocking and interdependent food chains. • Human activity: - something that people do or cause to happen. • Interdependence: the dependence of two or more people or things on each other. • System: a set of things working together as parts • Organisms: an individual animal, plant, or single-celled life form. • Adaptation: The change that living things go through to fit better with their environment. • Pollution: The introduction of any harmful substance into the environment at a faster rate than it can be cleansed. The three main types are: air, water, and ground. • Overpopulation: A condition in which the number of a given species is greater than the environment can handle. • Symbiosis: The types of relationships between two species. • Limiting factors: An environmental factor that tends to limit population size. • The definition of Interdependence, and its importance within a system		
GUIDING QUESTIONS <i>What questions will be asked to support instruction?</i> <i>Include both “lesson plan level” questions as well as questions designed to guide students to the essential understanding</i>		
Pre-Lesson Questions:	During Lesson Questions:	Post Lesson Questions:

1. What characteristics does your animal have? 2. How do these characteristics form an animals system? 2. How will these characteristics help it survive in the larger ecosystem? 3. What kinds of environmental factors will hinder your animal's survival? 4. What characteristics would best suit an animal living in this system? 5. How do the different factors within the ecosystem reflect interdependence? 6. How do humans impact the system? 7. How does the system require interdependencies? 8. How can the organism within a system work positively? Negatively? 9. What skills would an animal need to survive in this environment? 10. How will the abiotic and biotic factors impact survival? 11. How do the factors within the ecosystem impact interdependence? 12. What kind of factors within the system would best support the survival of the system?	1. What does this image mean? 2. How will these events influence your animal's survival? 3. What do you interpret in this image? 4. Why is this survival skill important? 5. Why should your animal have balanced points? 6. What factors have helped your animal? 7. How do the factors interact interdependently? 8. How can labs share information and resources to help one another? 9. How does bargaining help your chance for success? 10. How can the lab teams, relationships be described? 11. What characteristics make your animal unique? 12. What traits work interdependently within your animals system to help it survive? 13. Which traits are the most important for survival in the environment? 14. What does this entail? 15. How can this event impact your animal? 16. How are the events connected? 17. What makes up this system? 18. How does the system require interdependence? 19. How is the survival of the organism related to interdependence?	1. What was difficulties did your animal face within the ecosystem? 2. How did your animal interact with the other factors already within the ecosystem? 3. How does this relate to the interdependence within the ecosystem? 3. What characteristics did the winning animal have? 4. What characteristics allowed the animals to interact interdependently within the ecosystem? 5. How did the creation of your animal, impact the current ecosystem? 6. How do humans impact the system? 7. How did one factor create a domino effect? 8. How did working with the other labs in this class system impact your chance for victory? 9. How were the factors within the ecosystem interdependent? 10. What factor affected the survival of your animal the most? 11. How do the varying factors and organisms within an ecosystem support each other? 12. How do systems require interdependence? Give performance task.
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DIFFERENTIATION <i>(Describe how the planned learning experience has been modified to meet the needs of gifted learners. Note: Modifications may be in one or more of the areas below. Only provide details for the area(s) that have been differentiated for this lesson.)</i>			
Content	Process	Product	Learning Environment
Different articles on ecosystem according to reading level Vocabulary is complex, and above grade level.	-Students will crucially examine visual images, and determine events through critical thinking -Students will experience the essential understanding through participation in a simulation -students collaborate within teams, and the larger classroom.	Students will create a diorama of an ecosystem and animals within the ecosystem Students will create a persuasive essay and present it to persuade the lead scientist to give them funding to create their animal.	Simulations are student led

PLANNED LEARNING EXPERIENCES <i>(What will the teacher input? What will the students be asked to do? For clarity, please provide detailed instructions)</i>
Engage and Connect - This phase focuses on piquing students' interest and helping them access prior knowledge. This is the introduction to the lesson that motivates or hooks the students. Students will Play a vocabulary game to learn and define scientific term that have to do with the ecosystem: Tundra, domino effect, Survival, Ecosystem, Environment, Carnivores, Herbivores, Predators, Prey, Omnivores, Consumers, primary consumers, secondary consumers, tertiary consumers, Producers, Decomposers, Food chain, Food web, Human activity, Interdependence, System, Organisms, Adaptation, Pollution, Overpopulation, Symbiosis, limiting

factors,

- They can draw or define the word, but can't write the actual word out
- GAME LINK: <https://sketchful.io/room/INhub>

The teacher can use this game to help make lab teams with a balanced knowledge.

You will now take on the role of experimenters in a lab. You are working on creating the ultimate animal. To perfect this process you will generate random animals in your lab, and observe its survival capabilities in an ecosystem. You will discuss with your lab, which traits will help it survive, how it affects, and is affected by the other animals and plants within the system. We are looking for the ultimate survivor! After simulation random creations, you will use what you know to create your own animal. "Give performance task"

Students will roll for animal characteristics:

Animal Generator

1. Roll for legs

D(4)	Legs
1	No legs
2	2 legs
3	4 legs
4	8 legs

2. Roll for type of feet

D(4)	Feet
1	Webbed feet
2	Paws
3	Claws
4	toes

3. Roll for body covering

D(6)	Body covering
1	Dry skin
2	Slippery skin
3	Heavy Fur
4	Short fur
5	Feathers
6	Scales

4. Roll for movement

D(10)	Movement
1	Swim
2	Fly
3	Climb
4	run
5	Dance
6	walk
7	jump
8	hop
9	slide
10	swing

5. Roll for color/pattern

D(10)	Pattern
1	Brown
2	Black
3	Green
4	Grey
5	Orange
6	White
7	Yellow
8	Mixed colors
9	Stripes
10	spots

5. Roll for Size

D(20)	About the size of a
1	Ant 1mm
2	Hummingbird 5cm
3	Lizard 10 cm
4	Squirrel 25cm
5	Parrot 40cm
6	Cat 50cm
7	Dog 70cm
8	Pig 1m
9	Person 1.7m
10	Leopard 1.9m
11	Dolphin 2m
12	Lion 2.5m
13	Polar bear 3m
14	Liger 3.5m
15	Hippo 4m
16	Rhino 4.5 m
17	Elephant 5m
18	Giraffe 5.5m
19	Shark 6.5m
20	Whale 10m

6. Roll for extraordinary senses

D(6)	sense
1	Vision
2	Hearing
3	smell
4	taste
5	Touch
6	Choose 2

Then students will read the differing articles on the environment. Based on the environment and animal characteristics students will choose their 5 animal survival skills based on their characteristics.

Shelter	Food	Adaptation	Defense	Reproduction	TOTAL
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	
0	0	0	0	0	
					0
					0
					0
					0
					0
					0
					0
					0
					0
1-5	1-5	1-5	1-5	1-5	Total 15

- What characteristics does your animal have?
- How do these characteristics form an animals system?
- How will these characteristics help it survive in the larger ecosystem?
- What kinds of environmental factors will hinder your animal's survival?
- 4. What characteristics would best suit an animal living in this system?
- How do the different factors within the ecosystem reflect interdependence?
- How do humans impact the system?
- How does the system require interdependencies?
- How can the organism within a system work positively? Negatively?
- What skills would an animal need to survive in this environment?
- How will the abiotic and biotic factors impact survival?
- How do the factors within the ecosystem impact interdependence?
- What kind of factors within the system would best support the survival of the system?

Now you will read a little more about the environment where your animal will live.
Students will read the articles *differentiated* and design a diorama of the ecosystem.

Explore - *In this phase, the students have experiences with the concepts and ideas of the lesson. Students are encouraged to work together without direct instruction from the teacher. The teacher acts as a facilitator. Students observe, question, and investigate the concepts to develop fundamental awareness of the nature of the materials and ideas.*

Students will read the rules together, and then we will begin to play the game.

SURVIVAL OF THE FITTEST!

BASIC RULES

The simulation is governed by a small set of basic rules. The Lead Scientist (simulation leader) may introduce new rules at any time. You are permitted to request clarification of rules or judgments as needed.

[1. START DATE] The simulation begins in 2020—one month passes in each round. You are all mad scientists in a lab, who are working on designing the perfect animal. To better understand how it interacts within a system you will randomly roll for characteristics, and as we play try to determine the best animal for the different ecosystem.
which traits are beneficial within the system, and help to create an efficient and balanced ecosystem? (A t-rex though strong might not benefit the system it lives in.)

[2. Lead Scientist] The Lead Scientist (simulation leader) is the final authority on all matters related to the simulation—each Lab is permitted to appeal a decision of the Lead Scientist once during the simulation.

[3. Animal authenticity] Your animal adheres to its real-world (a) needs and (b) wants. Use the article to learn about the environment your animal will be surviving. *differentiated articles on ecosystem* fill out the animal research report.

[4. INTERACTIONS] Labs are permitted—and encouraged—to interact. There is no restriction upon diplomacy and trading, so long as those activities are (a) plausible and (b) conform to restrictions given by the Lead scientist.

[5. Survival] Animals acquire points through survival of rounds. see “Survival Rates” below) or claiming or other rewards. While resources cannot be traded, you may exchange animals characteristics, or evolutions with other labs, to help build an animal that works interdependently with the other factors within the ecosystem

GOALS AND VICTORY

Upon concluding the simulation, each animal will receive points as specified below. The Lead Scientist may announce additional rewards or penalties at any time. The animal with the highest end score is the victor.

[1.Survival] Your animal has an opportunity to generate points each Month (see “Survival Rates” below). Each chip is worth 1 point toward VICTORY.

[2. BALANCED] Your animal should attempt to collect a balanced portfolio of survival needs— as your animal thrives, ensure that your largest holding in any one area (shelter, food, adaptation, defense, reproduction) does not exceed your smallest holding by more than 1 unit—examples: 5 shelter and 4 food (*balanced*), 6 adaptation and 4 defense (*not balanced*). Survival balance confers 5 points toward VICTORY.

[3. AUTHENTICITY] Use storytelling, events, and partnerships to develop a unique animal. The most well depicted animal (as determined by the sponsors) gains 3 points toward VICTORY. *Animal research report*

[4. Teamwork/Interactions] The Lead scientist will occasionally announce rewards for labs working interdependently with each other to help build and create an animal. This will confer *an indeterminate number of points* toward VICTORY.

Survival

[SURVIVE] Animals experience survival rates at the beginning of each round.

[HOW TO ROLL SURVIVAL] Using a d10, roll once per category during “Survival” phase in each month. The roll is successful when the die result is *equal to or lower than* the animal level in that sphere of activity. [OUTCOME

OFSURVIVAL] A successful roll yields one point (chip) in that category. Collect chips at the simulation table, and spend points by returning them to the appropriate container.

LEVEL

SHELTER FOOD ADAPTATIONS DEFENSE REPRODUCTION

1 Roll = 1 Roll = 1 Roll = 1 Roll = 1 Roll = 1

2 Roll = 2

(or below)

Roll = 2 (or below)

Roll = 2 (or below)

Roll = 2 (or below)

Roll = 2 (or below)

3 Roll = 3

(or below)

Roll = 3 (or below)

Roll = 3 (or below)

Roll = 3 (or below)

Roll = 3 (or below)

4 Roll = 4

(or below)

Roll = 4 (or below)

Roll = 4 (or below)

Roll = 4 (or below)

Roll = 4 (or below)

5 Roll = 5

(or below)

Roll = 5 (or below)

Roll = 5 (or below)

Roll = 5 (or below)

Roll = 5 (or below)

Students will interpret the meaning of the d100/event slides, <https://docs.google.com/presentation/d/1lOfQ0NGVFzA9d2M3bKS5ONbgkfx4eSCSbLORJGgG9os/edit#slide=id.p> and this will change the game as we move along. Students will interpret the slides, and make a persuasive argument to support their ideas. If they persuade the class this can change the outcome of the game. As a class, we can critically think and interpret these slides to best help our animal survive. If we analyze the polar bear as a predator to hunt our animal, we might be in trouble. If we interpret it as a polar bear caring for its cub and not being able to travel too far to hunt us that will affect the outcome of the game.

Explain - *Students communicate what they have learned so far and figure out what it means. This phase also provides an opportunity for teachers to directly introduce a concept, process, or skill to guide students toward a deeper understanding.*

Students will interact with more scenarios d100 and analyze the pictures. They will trade survival points with each other, and discuss how best to support their animal. (As students hit a craft animal/origami they will watch short clips to deepen their understanding of the organisms in the environment), and determine how this will affect their animal.

How can the system of labs (sharing resources help the survival of their creations?)

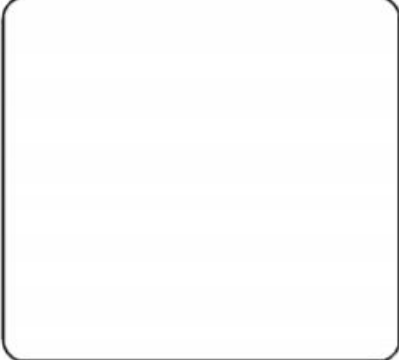
1. What does this image mean?
2. How will these events influence your animal's survival?
3. What do you interpret in this image?
4. Why is this survival skill important?
5. Why should your animal have balanced points?
6. What factors have helped your animal?
7. How do the factors interact interdependently?
8. How can labs share information and resources to help one another?
9. How does bargaining help your chance for success?
10. How can lab teams, relationships be described?
11. What characteristics make your animal unique?
12. What traits work interdependently within your animals system to help it survive?
13. Which traits are the most important for survival in the environment?
14. What does this entail?
15. How can this event impact your animal?
16. How are the events connected?
17. What makes up this system?
18. How does the system require interdependence?
19. How is the survival of the organism related to interdependence?

Elaborate —*Allow students to use their new knowledge and continue to explore its implications. At this stage students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them in new ways*

Students will elaborate on events, and the game will adapt with their animals. Students will critically think and analyze how factors within a system are interdependent.

Example: One of the slides is an oiling rig. This could impact the prey in the area, so predators may go hungry -1 for food, or the animals desperate need for food could change what they eat (humans instead of other animals this could change how their animals are impacting with the environment, as oiling changes the environment they live in. How might this impact their animals' survival? (It might be that their animals are all negatively impacted with a -1 roll for food, or shelter) They can use points they earned from victory to adapt their animal, or to begin a fundraiser to promote environmental awareness to support their animals survival. (A cute animal might do that) a predator might try a different food source. The student's discussion will affect what happens in the game, and how their animal is depicted.

As the game goes on students can fill out this sheet to more clearly define their animal, and receive bonus points.

Animal Research Report		
by: _____		
Animal Name: _____		
This animal is a: ☐ Amphibian ☐ Bird ☐ Fish ☐ Insect ☐ Mammal ☐ Reptile		
Here is a picture of my animal.	Animal Facts	
	Height/Size: _____	
	Weight: _____	
	Color: _____	
	It has fur/feathers/skin: _____	
	What it eats: _____	
	Where it lives: _____	
	Predators: _____	
My animal's habitat is...	Lifespan: _____	
	Three Interesting Facts About My Animal:	
	1. 	2. 

Evaluate: *This phase assesses both learning and teaching and can use a wide variety of informal and formal assessment strategies.*

Students will analyze which team won and why. They will think about how the systems induce interdependence, and tally their victory points.

- **What was difficulties did your animal face within the ecosystem?**
- **How did your animal interact with the other factors already within the ecosystem?**
- **How does this relate to the interdependence within the ecosystem?**
- **What characteristics did the winning animal have?**
- **What characteristics allowed the animals to interact interdependently within the ecosystem?**
- **How did the creation of your animal, impact the current ecosystem?**
- **How do humans impact the system?**
- **How did one factor create a domino effect?**
- **How did working with the other labs in this class system impact your chance for victory?**
- **How were the factors within the ecosystem interdependent?**
- **What factor affected the survival of your animal the most?**
- **How do the varying factors and organisms within an ecosystem support each other?**
- **How do systems require interdependence?**

Give performance task (attached in assessment section)

Challenging Article

Tundra biome a barren land the word “tundra” comes from a Lapp word, meaning “barren land”. The area is flat, with scarce vegetation and virtually no rises: a cold desert. The climate of the tundra depends on the region being either oceanic or mainland. For instance, in the European tundra, which is heated by the Gulf Stream, the land is unfrozen for many months, while the Canadian mainland tundra is always frozen. In Europe, the tundra begins at 7°N latitude, while in eastern Canada it begins at 55°N. During the long winter, the monthly minimum temperatures never drop below –10°C in the European tundra, and can reach –30°C in Alaska. In eastern Siberia, the average winter temperature can reach –50°C. Since the sun does not rise in winter, the tundra spends several months in long, cold darkness. Conversely, during the summer the sun is always, or almost always, above the horizon with no real nights. The solar energy that reaches the ground is in any case little, since the sun stays very low on the horizon. It ensues that the water trapped in the soil freezes down to many meters, forming a layer of hard soil, the surface of which thaws in summer only. The frozen soil of the tundra is called permafrost (from the English permanent frost). Evaporation is very low, therefore, even if it rains very little; nevertheless, the melting of the upper layers of soil form large wet areas during the Arctic summer. The Tundra in the world The biome of the tundra covers the northernmost lands of Europe, Siberia and north-America. Overall, the tundra covers 5% of lands above sea level. Some areas of tundra can also be found at the southern end of south-America. In the Austral hemisphere, large expanses of perennial ice cover Antarctica; mosses and lichens grow, however, in some very small areas along the borders of the mainland. The mountains of the temperate areas, above 2,000 meters, do not have trees either, because of the cold, so they look like the tundra. This is the Alpine tundra, the so-called *parámo*, on the Andes. The Alpine tundra has some of the same plants as the real tundra, for instance dwarf willows, and some of the same species of insects. The Alpine tundra has no permafrost, day and night alternate every 24 hours and sunlight is more intense. Its typical animals are marmots, chamois, ptarmigans and chaffinches. Plants of the tundra The vegetation of the tundra is almost entirely composed of perennial plants, camephytic plants (cushion-like plants) and hemicryptophytic plants (perennial herbaceous plants). Cushion-like plants include Ericaceae and saxifrages, while hemicryptophytic plants include sedges. There are no forest trees at all. Shrubs, birches and willows are few and small, to resist frost and strong winds. Mosses, rushes, graminaceous plants and peat mosses (a type of moss which has adapted very well to live in swampy areas) grow in wet areas, where the land is soaked in water. In summer, many short-stemmed flowers deck the tundra in bright colors. Because of the cold, plants have a very slow growth cycle: the reindeer moss (*Cladonia rangiferina*), for instance, takes one year to grow just 1-5 mm taller. Animals of the tundra Despite the cold temperature, the tundra is inhabited by a lot of animal species. Many animals migrate to avoid the colder months. Others have developed, instead, different systems to defend themselves from the cold, through which they can survive in the tundra even during the long, cold winter night. In the tundra, animals cannot hibernate since the frozen soil cannot be dug up to make shelters or tunnels and because the warm season is too short to provide enough food to stock. Many small animals, such as the lemming, dig tunnels under the snow to look for food and to escape predators, but the ermine, a small carnivore

with a nimble tapering body, can run after them even into their narrow tunnels. Arctic Home / Ecosystems / Tundra foxes hide stocks of frozen meat that they eat during the winter. Arctic hares take shelter under the snow, but feed above ground, thus risking to be attacked by wolves. Many of the species that stay in the tundra in winter, such as the willow capercaille, the Arctic fox, the Arctic hare and the ermine, change their color to camouflage themselves. In summer, they have, therefore, dark and brown coats, while in winter they are snow-white.

Most animals avoid the cold by migrating. In early summer, many species come back in droves from elsewhere: caribou, reindeers, grizzlies and grey wolves, for instance, come back from the boreal forests. Reindeers move in large herds; reindeer-does breed in early summer, as soon as they come back from the tundra. Grey wolves are also born in the warmer months, when they appear in the tundra as they run after large herbivores. Birds of the tundra The birds of the tundra are mostly migrant birds. Some of them, such as the greater willow chicken, move short distances away, while others travel for thousands of kilometers. The Arctic tern travels 36 thousand kilometers to reach the northern tundra from Antarctica! The goose is perhaps the most typical bird of the tundra. Many different species come here to breed after spending the cold months in the Mediterranean, Mexico, Africa or in the south of the United States. In summer, wet areas are the ideal place for many species of insects, that spend the winter as eggs. Mosquitoes and flies are so many as to force the big mammals, such as the musk ox and the caribou, to leave the swampy areas to reach higher, drier lands.

The abundance of insects in the summer attracts to the tundra very many species of insectivorous birds, which migrate there just to take part in the feast. Birds and lemmings attract pigeon hawks, falcons and other birds of prey. The origin of tundra The tundra as it looks today seems to have appeared on earth just two million years ago, before the succession of ice ages and following a general and lengthy cooling of the earth. The typical species of animals of plants that can be found in this biome must have come from high mountain areas. These organisms found a favorable habitat in the tundra, because it was like their native one. From mountain areas, the plants and animals that could resist cold and dry climates colonized the new desert and frozen habitat by perfectly adjusting to it. Whenever the Earth underwent some general cooling, the tundra expanded to lower-lying lands, from which it withdrew later, during warmer interglacial eras.

http://www.eniscuola.net/wp-content/uploads/2013/11/migrazione/assets/3746/pdf_tundra_biome.pdf

Tundra junior The landscape of the tundra is flat with little vegetation; it is like a cold desert.

The climate in the tundra varies according to whether it lies in an oceanic region or in a continental one. For example, in the European tundra warmed by the Gulf Stream, the ground is not frozen for many months while in the Canadian continental tundra it is always frozen. In Europe, the tundra begins at latitude 7°N, while in East Canada it starts from 55°N. During the long winter, the monthly minimum temperatures never drop below -10°C in the

European tundra but reach -30°C in Alaska. In Eastern Siberia, the average winter temperature can drop to -50°C. Since the sun does not rise in the winter months, the tundra passes various months in a long, frozen night. On the contrary, in the summer period, the sun never sets and it stays over the horizon so that there is no real night. However, the sun does not heat a lot and the water contained in the soil ices to a depth of many meters and forms a layer of hard soil that thaws on the surface only in summer. The frozen soil of the tundra is called permafrost. Evaporation is greatly reduced, hence, even if it rains very little, during the arctic summer many moist areas are formed as a result of the melting of the topmost layers of soil. The tundra biome includes the northernmost areas of Europe, of Siberia and of North America. The tundra biome occupies 5% of the land surface. Some tundra areas can be found even in the southern tip of South America. On the mountains over 2000 meters in temperate zones, an environment without trees, as a result of the cold, can be found. This eco-zone resembles the tundra and is called alpine tundra. Common to both the real tundra and the alpine tundra are some plants, such as the dwarf willow, and some insect species. In the alpine tundra however there is no permafrost, the alternation of day and night does take place within 24 hours and solar radiation is more intense. Animals that characterize this biome are the marmot, chamois, Rock ptarmigan and the finch. The vegetation consists almost exclusively of perennial plants such as cushion and herbaceous plants. There are no tall trees. Shrubs, such as birch and willow, are rare and are small to withstand the bitter cold and the strong winds. In the humid areas, where the soil is saturated with water, mosses, rushes and gramineous plants grow. Plants grow very slowly due to the cold: Reindeer lichen, for example, takes an entire year to grow just 1-5 mm. Despite the low temperature, the tundra is populated by many animals. Many of these migrate to avoid the colder months. Others, instead, protect themselves from the bitter cold in many other ways. In the tundra hibernation is not possible, because the frozen soil does not allow animals to dig shelters and galleries and because the warm season is too short to ensure a sufficient accumulation of food supplies. Many small animals, like the lemming, dig tunnels under the snow to search for food and to escape from predators, but the stoat, a small carnivore with an agile, streamlined body, manages to chase them even in their narrow burrows. The arctic fox hides supplies of frozen meat and feeds on them during the winter. Arctic hares find shelter under the snow but feed on the surface, risking the attack of foxes. Many of the species that remain in the tundra even during the winter months, like the willow capercaillie, the arctic fox, the arctic hare and the stoat, change color to camouflage themselves. Hence, in summer they have dark, brown fur that turns as white as the snow in winter.

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Thank you to Oakley, E. (Spring, 2020) Simulation overview, and format

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