California Grizzly Bear Reintroduction Unit

Lesson 4
Jigsaw Lesson:

Time:
Variable

Supplies:
1. Jigsaw Roles Packets

Educational Outcomes:
1. Students gain an understanding of wildlife conservation and how it works in a real world context.
2. Students will be able to articulate the importance of different perspectives and think critically about the different perspectives.
3. Students will have honed their own opinion on the reintroduction of grizzly bears to California using the lens of the role they have chosen.

NGSS Standards fulfilled:
1. SEP-1; SEP-3; SEP-4; SEP-7; SEP-8
2. All of the Environmental Principles and Concepts
3. LS2.A- Interdependent Relationships in Ecosystems
4. LS4.D - Biodiversity and Humans
5. LS2.C - Ecosystem Dynamics
6. WHST.6–8.1.a–e
7. WHST.6–8.9
8. MS-LS1-5; MS-LS2-5.

Steps:
1. After students are assigned or elect their Grizzly Reintroduction Roles, break the students into homogenized groups (the same disciplines).

2. Utilize the Role Packets and decide what content to cover about these roles. It is suggested to utilize all the packet contents to increase student knowledge. It is also advised to go in the explicit order. However, there are different forms of media, assignments, and content for students to go over. Some of this can be seen as group work and other parts can be done as homework. This could take as little or as long as the teacher wants. The longer the student groups spend on their specific role and the more packet content they cover the more knowledgeable they will be about their specific role.

3. If available, take the time to connect students to actual people in the community who are living their lives as the role discussed in the packet. Invite them into the classroom. Have a zoom session with them. Use the interview questions in each packet to learn more about your specific local expert.

In order to connect with real professionals in your community, consider reaching out to:
• Local Natural History Museum
• The California Grizzly Research Network website; there are names and emails on the site.
• LaBrea Tar Pits
• Universities (UCSB, UCLA, etc.)

Jigsaw Role

Bear Scientist

Contents:

Background information on packet content

1. Interview with a bear scientist; who am I?
2. A scientific article by a bear scientist
3. "What my research looks like" video
4. Camera trap footage
5. News articles on bears
6. Grizzly Bear Habitat observations
7. Take-home assignment

Background Information on Packet Content

1. Interview with a bear scientist; who am I?

2. Supplemental scientific article by a bear scientist

    This article can be found in the Extra/Higher level materials folder and can be added if appropriate. It is a scientific article written by an environmental biologist, park warden, and botanist, about the ecology of winter dens for grizzly bears in Banff National Park. This article shows the kind of research that a scientist would do, and why it can be helpful. In this research specifically, the research is informing the park managers on where the dens can be found, so that they can be aware of the bears' locations in the winter and respect their space. It shows different research methods such as aerial observations, soil samples, vegetation observations, altitude readings, and more. The highlighted portions are the most valuable for students to read, but they are encouraged to skim over the whole article. They should pay special attention to the authors of the paper, the abstract at the beginning, and the research methods.

3. "What my research looks like" video

    This video shows what a bear scientist's research looks like, in order to give students a better idea of a bear scientist's job. It shows bear trapping, data and sample collection, and tracking devices. It also explains what this research is used for and why it is important.

4. Camera Trap Footage

    This short video shows some of the footage that could be captured by a scientist from a camera trap. This video is meant to show students what kind of data scientists would look at, as well as what bears look like and examples of their different behaviors.

5. Meet a Bear Biologist Video

    This video introduces Rae Wynn-Grant, a bear scientist, and shows the kind of work she does in the field.

6. News article about bears

    These articles show more research and news on bears, but in an easier to read format for students. One is about bears and seed dispersal and the other is about bear research in a controlled setting to examine heart rates and hibernation. The second article can also be found separate from this packet in the Bear Scientist folder.

7. Grizzly Bear Habitat Observations and Conflict Areas

In this study, Ian McCullough, a research biologist with the CGRN and UCSB, looked at the different kinds of habitats and ecosystems that grizzly bears most likely used to inhabit in California. This kind of analysis shows us what areas would be good habitat for bears today. It also includes conflict areas, which gives us an idea of areas that would not be suitable for Grizzlies today, based on data and observations.

8. Take-home field assignment

This assignment is meant to serve as an example of a scientist's field work. The student should bring this paper home, spend some time outside in their neighborhood/community, and answer the questions. It will allow students to practice wildlife observation and critical thinking. It can be edited to fit the needs of your classroom.

Interview with a bear scientist. Who am I?

Video Link

Transcription of Interview:

Hi I'm Alexis Mychajliw and I'm recording answers to the bear scientist's role portion questions.

How would you describe a bear biologist? What parts do you like, and which are your least favorite?

A bear biologist is a scientist who studies some aspects of bears as organisms and how they act in their environments, which means there are many different scientific tools you can incorporate into your studies. A bear biologist might study bears in the wild, in zoos, or even extinct bears from fossils and museums. My favorite part of being a bear biologist is getting to see their tracks, safely, in the wild. I spend a lot of time studying bear samples in the laboratory so I don't often get to see a living bear. I like knowing that the work I do in the laboratory is directly connected to living animals in the wild. One time, when I was working in Japan, I saw giant claw scratch marks on a tree from a brown bear that had been stretching, and it was one of the coolest things I've ever seen. My least favorite part of being a bear biologist is when there's a conflict between bears and humans. Sometimes bears come into urban areas to look for food and it's unsafe for both humans and the bears. This is happening more and more as human populations expand into bear habitat and as our climate changes, which in turn alters which foods are available to the bears. Seeing this conflict is hard and leads to some really tough discussions and decisions, but it's important as bear scientists that we know how to balance the needs of both bears and humans to ensure the well-being of everyone now and in the future.

Tell me about what kinds of things you study and research in the field.

I primarily study the history of bears in North America, their ecology, diet, and evolutionary patterns as well as what caused their extinction in some places. I use hair and skeletal material such as teeth and jaws to sample long dead animals, which requires some advanced techniques and chemistry. For example, I've worked with fossils from the La Brea Tar Pits of Los Angeles to document the earliest arrival of grizzly bears in California thousands of years ago. I had to use special chemicals to remove the tar, which is actually just asphalt, from the bones, then extract proteins from the bones and use a technique known as radiocarbon dating to determine how long ago the bear died. I don't often get to interact with living bears but I spend plenty of time with bear skulls, including those of the extinct giant short-faced bear which is pretty awesome.

How much education did you need to get to this point, and where did you study?

I want to start by saying that everyone has a different path and there are many different approaches to studying bear biology that are equally valid. I am more of an academic scientist, which means that I ended up in school for many years and my job is mostly research and teaching at a university. However there are many bear biologists who I know learned more from being outside and through personal experience, than going to school for as many years as I did. So don't let my personal story make you feel like you aren't ready to be a bear biologist if you don't like school that much. I went to school for four years as an undergraduate at Cornell University in upstate New York, where I studied biology and natural resource management. Then, I went to graduate school to pursue a PhD in biology at Stanford University in California, which took me another five years. I didn't actually start studying bears until after I finished my PhD. Before that, I studied the conservation of other mammal species. As long as you develop a solid foundation in biology, you can then choose to study different species when the opportunity arises. I've been studying bears now for the past three years as a professional scientist and I learn something new every day.

Are there several kinds of specializations a person can have as a bear scientist? Tell me about some.

There are many different things a person can study about bears, which means that there are often different specializations that rely on different scientific techniques. For example, someone could be a specialist on studying diseases and health problems that affect bears, and might have a background as a veterinarian. Another specialist could work specifically on the evolution of bears as a group, studying fossils that are millions of years old from all over the world. Some specialists might study the behavior of bears and have to spend hours in the field watching them through binoculars or keeping track of them using camera traps. A bear geneticist could focus on studying the DNA of bears and reconstruct the family tree of different bear populations and species. An important specialization is human-wildlife conflict, in which a researcher will study how people living near bears feel about the bears or might take steps to protect their livestock.

Why is your research important for the reintroduction conversation?

If there is a reintroduction plan being discussed, it by definition means that the target species has disappeared from the landscape and can no longer be studied in the present day, otherwise you wouldn't need to reintroduce it because it would still be there. Because we can't study the animal directly in the present, we need other sources of data to tell us critical pieces of information like what its diet was, what it looked like, and what resources on a landscape it needed to survive. My research opens a direct window into past populations of bears and we can use museum specimens and fossils to reconstruct what their lives were like. This gives us a baseline or set of reference conditions with which to determine what the goals of a reintroduction activity should be. How many bears should there be? Where exactly should we put them? You need to look to the past to help plan for this future. Another dimension of my research relates more to the way that bears and people interact with each other, which is important for reintroduction because overhunting and persecution is what caused the loss of bears in the first place. In California there's a lot of misinformation about bears that originates from stories in the 1800's, calling them giant man-eating carnivores. When we study the bones of bears however, it turns out that they were much smaller and more herbivorous. By changing the story we can make people today better appreciate the true nature of the bears and be less weary of their introduction.

Grizzly bear trapping video

Camera trap footage

Meet a Bear Biologist Video

News Articles

newsela

What does a bear do in the Alaska woods? Disperse seeds

By Dan Joling, Associated Press, adapted by Newsela staff on 02.26.18
Word Count **547**
Level **MAX**

A black bear walks through dense bushes of blueberries in Juneau, Alaska. A study of bears and berries has determined that the big animals are the main dispersers of fruit seeds in southeast Alaska. Photo from: Taal Levi and Laurie Harrer via AP

Does a bear leave scat in the woods? The answer is obvious but the effects on an ecosystem may not be.

Researchers from Oregon State University did a study. It concludes that brown and black bears -- and not birds, as commonly thought -- are primary distributors of small fruit seeds in southeast Alaska. The bears spread the seeds through their excrement.

"Bears are essentially like farmers," said Taal Levi, an Oregon State assistant professor. "By planting seeds everywhere, they promote a vegetation community that feeds them."

Seed dispersal is a key component in the understanding of any ecosystem, Levi said. The study is the first instance of a temperate plant being primarily dispersed by mammals through their gut. The finding suggests repercussions for plant life when bears are removed.

of ways to help animals get around without mingling so dangerously with cars. There are 38 underpasses and six overpasses. Grizzlies, wolves, coyotes, moose, elk and other large mammals have used them more than 150,000 times since 2012, according to park officials. Parks Canada concludes that the crossings and other security measures have reduced collisions by 80 percent. The crossings also help the population mingle, and therefore stay genetically diverse. In a 2014 study, researchers used barbed wire to (gently) snag hair samples from wandering bears. A DNA analysis revealed that black bears and grizzlies that cross the road tend to mate with ones on the other side.

Animal infrastructure like this is obviously useful, but it's expensive to install. An overpass might run as much as $4 million (though an underpass is just a fraction of that). Perhaps more importantly, it can be tricky to get animals to use them. For "wary animals like grizzly bears and wolves, it may take up to five years before they feel secure using newly built crossings," Parks Canada writes. Ford and company wanted to understand where and how the grizzlies got from one side of the road to the other. They spent 17 years tracking the bears. Their research is newly published in the Wildlife Society Bulletin. It throws a heap of data behind the question of which crossings are the most effective.

Monitoring Crossing Sites

Ford and his collaborators started off monitoring 23 sites. They stopped by every few days to look for footprints in specially placed track-pads or swaths of sandy-loam soil. As new structures went up over the years, the researchers threw more high-tech surveillance into their effort. By 2008, they had installed cameras at 44 sites. The sites spanned a 60-mile stretch of the highway. The crossings include overpasses, open-span bridges and three types of underground culverts: small concrete ones, and both small and large metal ones, all of which look something like subway tunnels for quadrupeds.

This long view is critical because grizzlies are slow to reproduce. Researchers needed to look for a long time to gauge whether family units changed parents' behavior. Does having cubs make adults behave differently?

Structures Affect Animal Patterns

It seems to. Single male bears traipsed through the culverts, but family groups were vastly more likely to choose the overpasses. While box culverts are significantly cheaper than overpasses, the researchers write, for the sake of long-term population health, the structures need to be diverse. "A highway with crossing structures that do not address the behavioral patterns of family groups is equivalent in function to a highway without crossing structures altogether," they write.

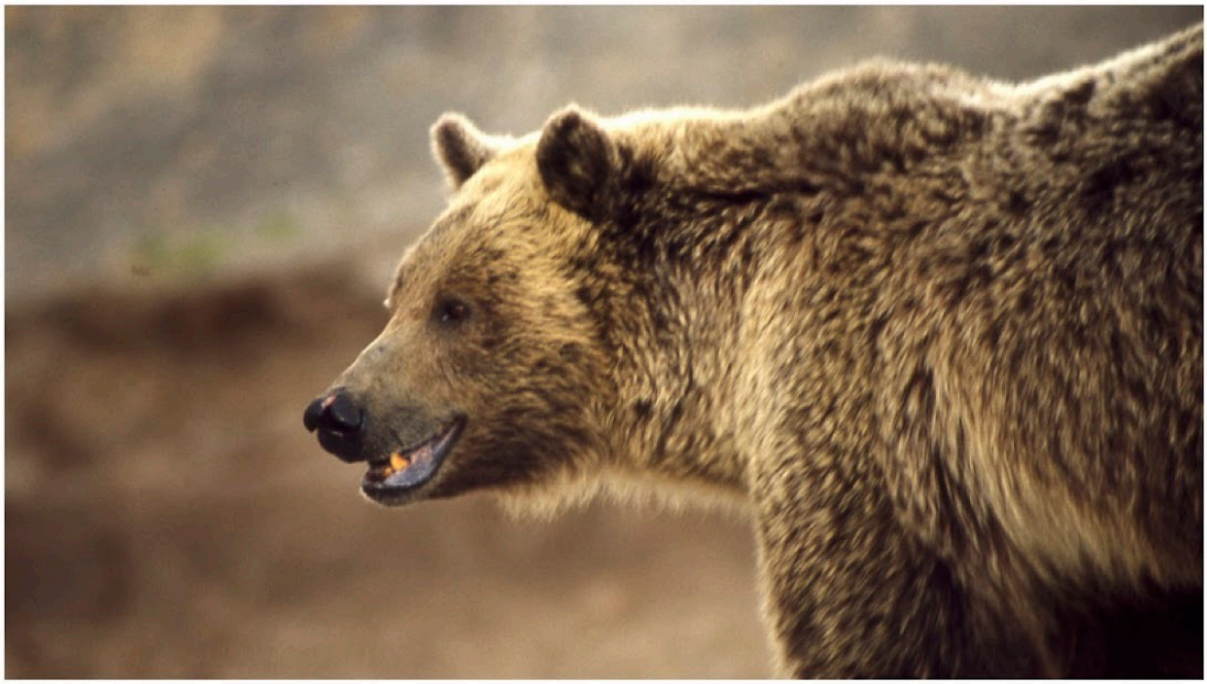
Sometimes it is important to have the option to take the scenic route.

ScienceNews for Students

ANIMALS

The secret lives of grizzlies

By studying grizzlies in captivity, scientists are gaining insights into how bears—and their hearts—tick.



Adult grizzlies are big and powerful.

BRYAN HARRY/NATIONAL PARK SERVICE

By **Emily Sohn**

January 30, 2008 at 12:00 am

The first time Lynne Nelson entered a den of hibernating grizzly bears, she felt a little nervous. The captive bears had known her since they were babies, but they hadn't eaten in weeks. And each young-adult animal weighed more than 150 pounds. They weren't fully grown, but they were definitely big enough to hurt her.

"I didn't know what to expect," says Nelson, a veterinarian and heart specialist at Washington State University (WSU) in Pullman. "I didn't know if they had forgotten us, if they would be fearful or hungry, or wonder why we didn't bring a big load of food."

As soon as she and her colleagues walked into the den at WSU's fenced-in Bear Center, however, they were surprised to find that the resting bears acted just like cubs: They licked the researchers' faces and tried to sit in their laps.

Now, years later, the grown-up captive bears still act the same way during hibernation, possibly because they feel safe and are free from the stress of having to defend themselves and hunt for food, as they would in the wild.

Such odd, babylike behavior among adult bears is not the only thing that makes grizzlies so interesting, Nelson says. For years, she has been documenting some remarkable changes in the bears' heart activity during hibernation.

Because bear hearts work like human hearts do, Nelson hopes her findings might one day help doctors better treat heart problems in people. And other research with the eight or so captive grizzlies at WSU's Bear Center might help scientists understand and protect bears in the wild.

The heart of a bear

Heart rate is one thing people have in common with grizzly bears. An average human heart beats between 60 and 100 times per minute. An average grizzly's heart runs between 70 and 90 beats per minute (bpm)—but only in the summer.

As winter approaches, grizzlies settle down in protected dens where they will hibernate for 4 to 6 months. During hibernation, the bears don't sleep all the time but they do stop eating, drinking, and going to the bathroom. They continue to move around, but move more slowly. Over the winter, they lose about 30 percent of their body weight.

Lynne Nelson and colleagues at the WSU Bear Research Center have trained grizzlies to cooperate in experiments.

Washington State University

Scientists have long known that a grizzly's heart rate drops to between about 5 bpm and 25 bpm during hibernation. But how can a bear's heart rate stay so low for so long without causing any permanent damage to the animal? It's a question that scientists would like to answer. Such a slowly beating heart is a sign of major stress in a human. In fact, a person with a heart rate that low would die.

"Why don't the same kinds of stresses that would kill us affect these bears?" Nelson asks. "That's the million-dollar question."

Hibernation investigation

Studying the hearts of hibernating wild grizzlies isn't easy. Previously, researchers had to trap the bears, put heart monitors on them, and attach tracking collars so they could retrieve the monitors later.

But to get more detailed information, today's researchers need to monitor an animal's heart with special equipment. They also need to draw blood samples. These kinds of tests require that an animal sit still for at least 20 minutes at a time. Wild grizzly bears, however, are not known for their cooperation skills.

Researchers have tried using anesthesia to sedate wild bears before collecting measurements. But these drugs slow the heart, among other effects, masking the animal's natural state.

In 2001, Nelson and her colleagues decided to try a new approach: They adopted two 4-week-old captive female grizzlies, just as the cubs were starting to open their eyes. Bears weigh about 5 pounds at that age, Nelson says. Full-grown adult females weigh up to 450 pounds.

Two grizzly cubs play in a pool at the WSU Bear Center.

Washington State University

In their facility in Pullman, the researchers raised the animals. They used dog-training techniques to teach the cubs how to sit, lie down, and tolerate medical tests. The animals were quick learners.

"They're incredibly smart," Nelson says. "Often, we could show them what we wanted them to do just once, and they would get it from then on. It was really amazing."

Sleepy time

To study hibernation, the researchers begin by reducing the amount of food the animals get. They do this when the weather starts turning cold in October, because in the wild, a declining supply of food is one factor that triggers hibernation. Soon after, the bears enter artificial dens made of concrete and filled with hay for warmth and comfort. There, they settle down for the winter, usually with one other bear that they choose themselves.

At the WSU Bear Center, grizzlies can roam between indoor and outdoor enclosures.

Emily Sohn

Four to six weeks later, the scientists enter the den to record heart measurements and other data from the bears. They do the same thing every month until the weather turns warmer.

So far, the research has revealed some surprises. The scientists have found, for example, that a grizzly's heart rate not only drops during hibernation but also varies a lot. It can jump from 4 bpm one minute to 25 bpm the next, and then quickly drop back. Nelson's studies also show that two of the four chambers in a grizzly's heart stop beating during hibernation. The phenomenon has never been seen in any other type of hibernating animal, and scientists don't know what it means.

In a human heart, dramatic changes in heart rate are signs that something is seriously wrong. Figuring out how and why the hearts of hibernating bears can do what they do and still stay healthy might give doctors clues about how to treat life-threatening heart problems in people.

For example, researchers could try to develop medicines that would allow a diseased human heart to temporarily rest, just as a hibernating bear's heart does. If a sick person's heart didn't have to work so hard, Nelson says, he or she might be able to manage the disease better.

Grizzly bears may have a lot to teach scientists about the human heart.

Emily Sohn

And it's not just the hearts of hibernating grizzlies that deserve attention from the medical community, Nelson says. For reasons scientists cannot yet explain, bears can hibernate for months without losing strength in their bones and muscles. When people must stay in bed for a long time for medical reasons, on the other hand, they lose both bone and muscle mass. That's something doctors would like to prevent.

Getting the bear facts

Researching bears in a fenced-in facility can be interesting, but how much can studies of captive bears tell us about wild bears? A lot, say WSU researchers.

Graduate student Jennifer Fortin is studying what grizzly bears eat in Yellowstone National Park. Historically, Fortin says, Yellowstone's grizzlies ate lots of cutthroat trout, a type of river fish. But cutthroat trout populations have crashed in recent years because of overfishing and habitat destruction. Scientists don't know what the grizzlies are currently eating.

Scientists study grizzlies in places such as Yellowstone National Park by placing tracking collars on them, like the one this mama bear is wearing.

NPS Photo by John Good

To find out, Fortin and colleagues started with a study at the Bear Center. They fed known amounts of fish to the bears. Then, they analyzed the chemical composition of the bears' hair. From the data they collected, the researchers created a formula to link fish consumption with mercury levels in the bears' fur. (Fish have a metal called mercury in their bodies that they get from the environment. When bears eat the fish, they ingest the mercury, which later shows up in their hair.)

Next, the researchers moved out into the field. They outfitted wild bears with tracking collars that allowed them to trace the animals' steps. As the scientists followed the bears' trails, they collected the grizzlies' droppings and hair. Using the formula they developed in the lab, the scientists are figuring out whether the wild bears are replacing cutthroat trout with other types of fish or are eating other kinds of food instead.

Results aren't yet available, but Fortin hopes to use what she finds out to help Yellowstone's grizzlies. Once they know what the bears eat, the park's wildlife managers can better protect the animals' food supply. In the same way, Nelson's work with hibernation in the lab might help field biologists protect bears from noise and other disturbances that might stress the animals in the winter.

Science News for Kids *reporter Emily Sohn gets up close and personal with a grizzly bear at the WSU Bear Center.*

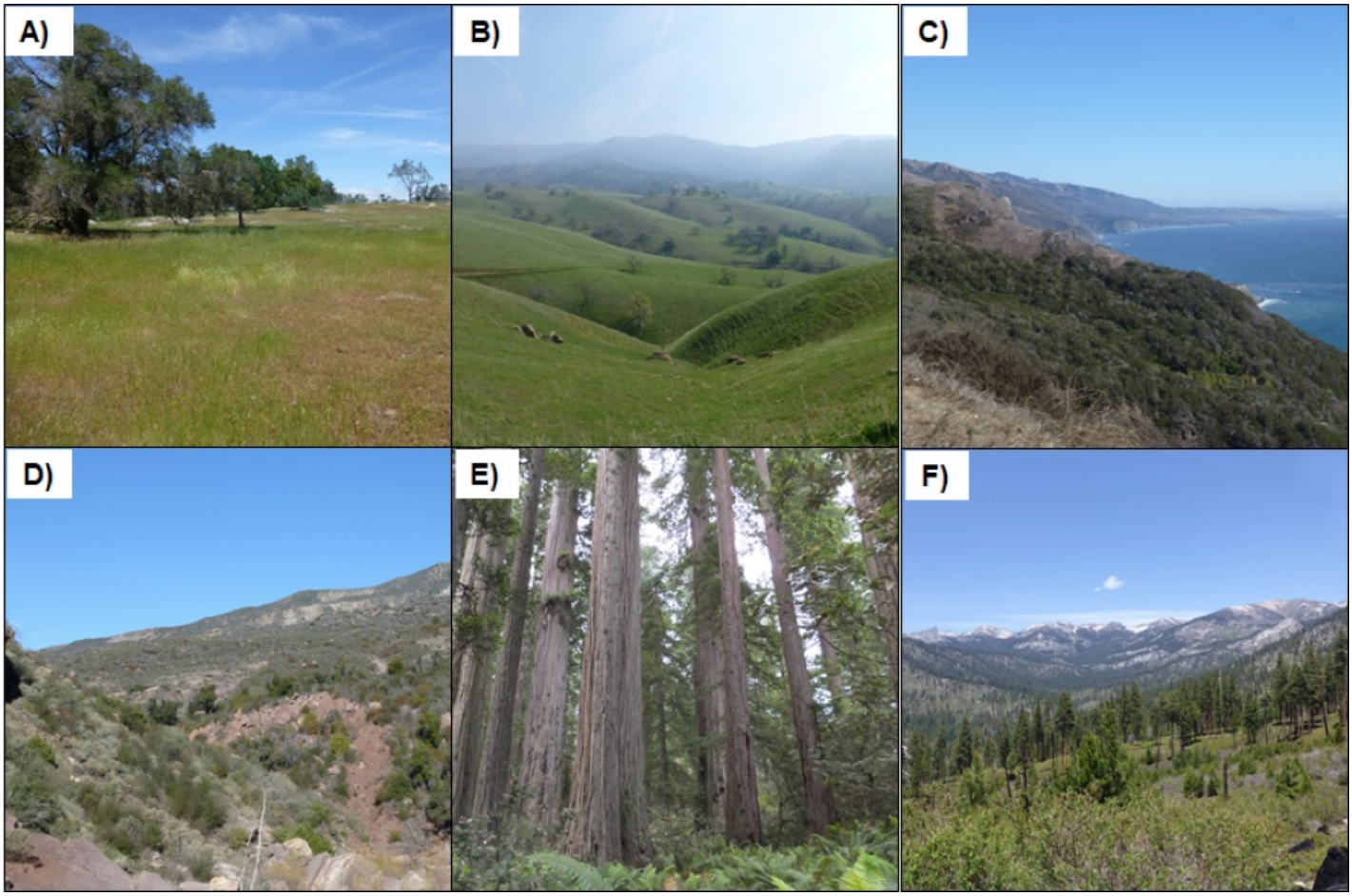
Courtesy of Emily Sohn

More than ever, some researchers say, grizzlies need this kind of protection. In the United States outside of Alaska, grizzly bear numbers have dropped to less than 1,000. A few centuries ago, the population topped 100,000.

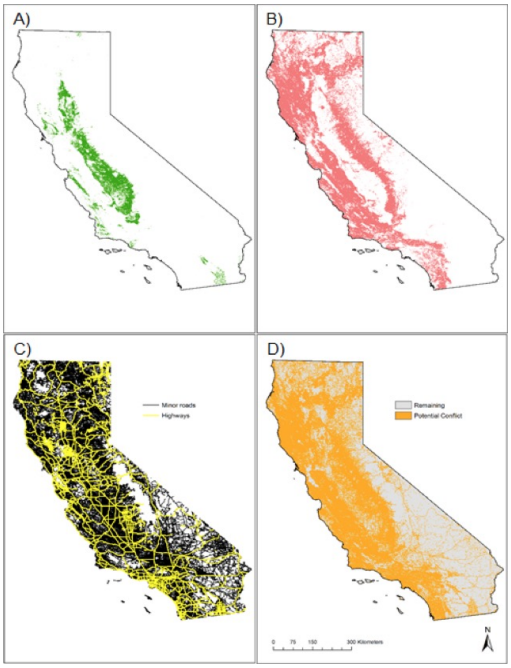
Grizzly bears get a lot of attention when they steal food or hurt people, Fortin says. "But they don't get enough publicity for the fact that they're a unique species," she says.

"They deserve our respect," she adds. "And we have a responsibility to do our part in making sure that they can live as naturally as possible without our interference."

Bear Mapping Range and Conflict Areas



The California grizzly once inhabited A) oak woodlands, B) grasslands, C) coastal sage-scrub, D) chaparral, moist coastal forests and F) montane mixed-conifer forests. Recent analyses suggest that only the Sierra Nevada could support a reintroduced grizzly population given modern human presence across California's landscapes.



The last grizzly sighting occurred in Sequoia-Kings Canyon National Park in the southern Sierra Nevada (F) in 1924, but this was historically marginal grizzly habitat compared to A-E. Photos: Ian McCullough. Components of conflict risk mapping for potential conflicts between humans and grizzlies. A) High-calorie crops (sunflower, sugar beets, tubers, berries, tree fruits and nuts; source: USDA), B) medium-to-high productivity rangeland (source: Cal Fire), C) Highways and minor roads (source: TIGER), D) potential conflict areas and remaining land

Take-Home Assignment

Instructions: You are a scientist studying your local wildlife communities, and today at work you will be out in the field! Step outside of your home and into your neighborhood (this can be anywhere that is outside and has insects or animals), take this paper and a pencil with you, and answer these questions.

1. Choose an animal or insect that you can easily observe for a few minutes. Write down a short description of what you observe about it (appearance, behavior, surrounding environment, etc.) and make a quick sketch of it below.

2. If you had one year to research this animal/insect, what are three research questions that you could ask? They should be questions that you cannot immediately answer just by looking at the organism, but questions that you would need to do some research and data collection to answer.

3. What are some threats to this organism that you can think of? Is its habitat at risk of harm? Are humans killing it? Does it have major predators in the area?

Jigsaw Role

Environmental Historian

Contents:

Background information on packet content

1. Interview with an Environmental Historian. Who am I?
2. Environmental Historian Video
3. What is Environmental History? Video
4. Environmental Historian talking about his research--Prof. Dr. Poul Holm on "The Environmental History of World Fisheries"
5. Historical maps of grizzly bear range
6. Article "The Anthropocene: A New Epoch of Human Control Over the Planet"
7. Take home assignment

Background Information on Packet Content

1. Interview with an Environmental Historian. Who am I?

2. Environmental Historian Video

This short video is part of an interview with an environmental historian, and in this portion he explains the field of environmental video.

3. What is Environmental History? Video

Another video explaining what exactly Environmental History is, and why it is important.

4. Environmental Historian talking about his research--Prof. Dr. Poul Holm on "The Environmental History of World Fisheries"

This video is of an Environmental Historian discussing his project on Fisheries histories. Students should notice that his research revealed that cod once lived in warmer waters than the ocean is at now, suggesting that they may be more tolerant to sea temperature increases. This is an important application of environmental history research.

5. Map of historical grizzly bear range

Here is an example of mapping done by Dr. Ian McCullough, who researched the historical habitats of the grizzlies, giving us a better idea of what kinds of habitats they might thrive in if they are reintroduced here.

6. News article about the Anthropocene

This is an article discussing the history of the environment and human interactions with it.

7. Take Home Assignment for Historian.

This is to help students examine periods of time and their environment like an environmental historian would.

Interview with an Environmental Historian. Who am I?

Video Link

Transcription of Interview:

So how would you describe environmental history?

I would describe environmental history as the dynamic between people and nature over time, so how they shape each other.

Why is environmental history important, especially in the California Grizzly Research Network and the reintroduction conversation?

Sure, so environmental history is important because it helps us understand where we came from, right, and why we are facing the situations that we're facing today, and I think it's important in the context of the grizzly group or the Grizzly Network because we're faced with this possibility of considering the reintroduction of these animals back into a landscape they no longer occupy. And that's going to be a hard decision, and the more that we know about how and why they were taken out of this landscape, mostly by human causes, I think the better we'll be able to make decisions for today and for tomorrow.

Can you tell me what a day in the life of an environmental historian looks like?

Yeah that's a very good question! So a day in the life of somebody doing environmental history, what a great question, is probably reading some books and articles by people who are experts either in history or in ecology or in education or in politics, and understanding, you know, just doing a lot of reading. Sometimes it means going to the archives, which means going to usually a library where you look at material that's from the past, that's been collected and organized. And you take all this information and you try and make sense of it. You try and put it into a story, you try and explain how and why grizzlies were exterminated from the California landscape. What that meant to people, both let's say in the 1840s or 1850s, and what it might mean to people today. So looking for different sources to kind of answer those questions and then figuring out how to tell the stories.

Can you describe an event that encouraged you to pursue this kind of work?

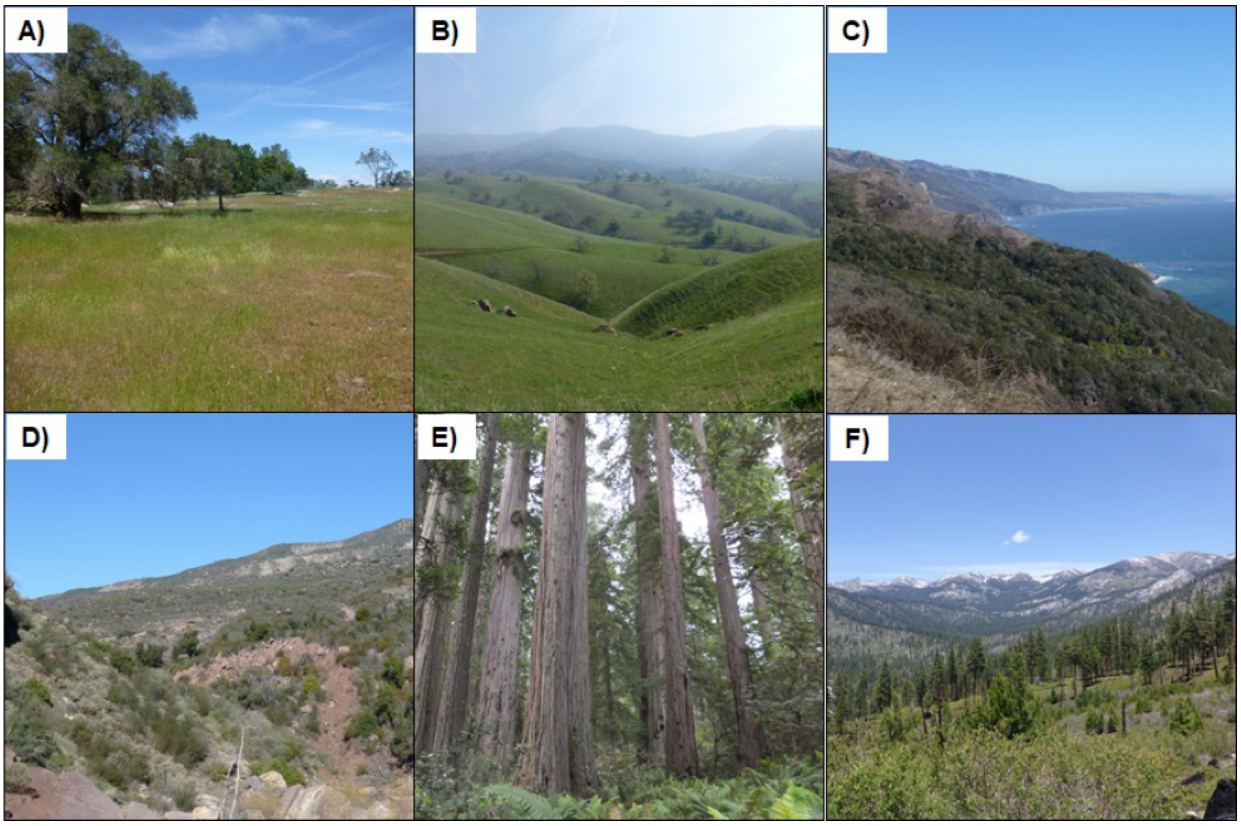
Sure! So when I was a child, my grandmother had come to this country from elsewhere, and I had a conversation with my grandmother about whether or not she thought the United States was better than the place that she came from. And she told me that she thought the place she had come from was better, and that blew my mind. I thought, how could any place be better than the United States?! And I think that's a moment where I started to understand that what I take as like natural or god-given or just the way that things are, is not actually the case, and so thinking about how powerful stories are to people for their sense of identities and for how they are in the world was a really pivotal moment for me.

Environmental Historian video

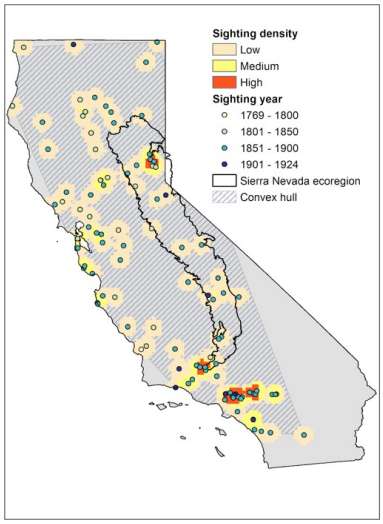
What is Environmental History? Video

Prof. Dr. Poul Holm on "The Environmental History of World Fisheries"

Historical maps of grizzly bear range



The California grizzly once inhabited A) oak woodlands, B) grasslands, C) coastal sage-scrub, D) chaparral, moist coastal forests and F) montane mixed-conifer forests. Recent analyses suggests that only the Sierra Nevada could support a reintroduced grizzly population given modern human presence across California's landscapes. The last grizzly sighting occurred in Sequoia-Kings Canyon National Park in the southern Sierra Nevada (F) in 1924, but this was historically marginal grizzly habitat compared to A-E. Photos: Ian McCullough.



Grizzly sightings in California by density (3-cell radius neighborhoods of 10 km cells) and year based on Grinnell (1938), Storer and Tevis (1955), and newspaper accounts of hunting expeditions, livestock depredations, and reported encounters with humans. Gray dashed area is a minimum convex hull of sightings (1769-1924). The Sierra Nevada ecoregion (US EPA Level 3) represents only a portion of historical grizzly range in California, but was identified by Carroll (2005) as the only region capable of supporting a viable grizzly population today, largely due to its remoteness. Spatial analyses were performed in ArcGIS v. 10.3.1.

Carroll, C. (2005). Priority areas for grizzly bear conservation in western North America: an analysis of habitat and population viability. Report. Klamath Center for Conservation Research, Orleans, CA.

Grinnell, J. (1938). *California's grizzly bears.* Sierra Club.

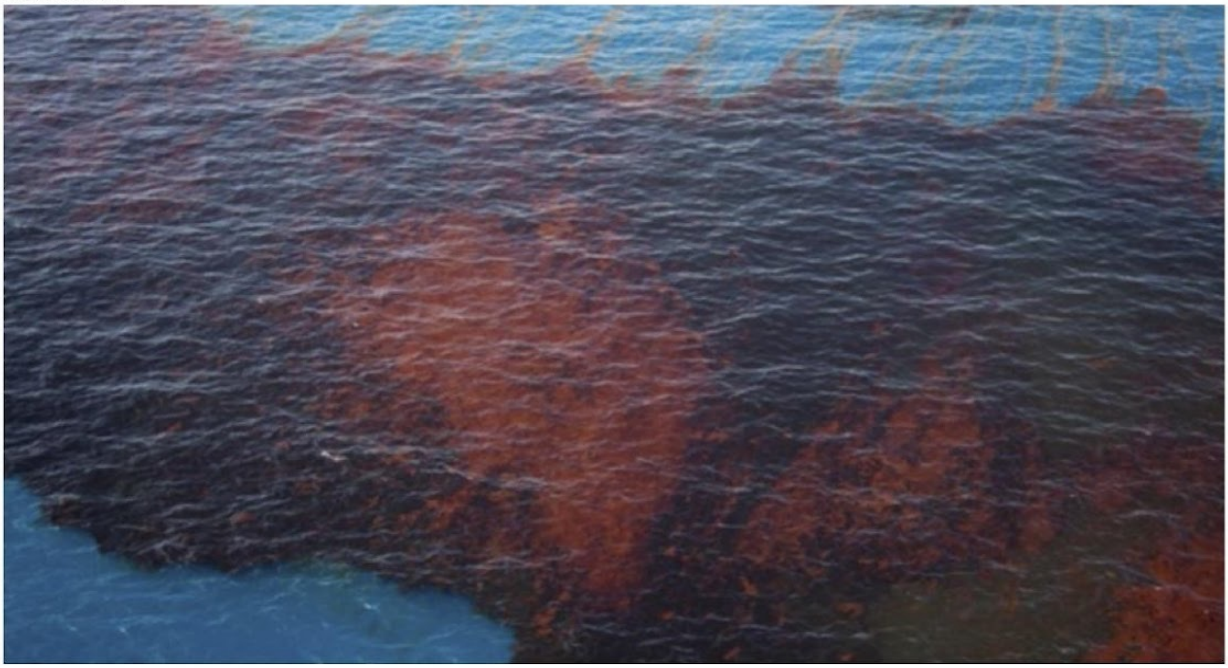
Storer, T. I., & Tevis, L. P. (1955). *California grizzly.* Univ of California Press.

The Anthropocene: A New Epoch of Human Control Over the Planet

newsela

The Anthropocene: A New Epoch of Human Control Over the Planet

By Cynthia Stokes Brown, Big History Project, adapted by Newsela staff on 07.30.16
Word Count **1,112**
Level **880L**



TOP: Oil from a spill in the Gulf of Mexico. Images: Big History Project

For the first time in the history of life on Earth, a single species, humans, has the ability to change the entire biosphere.

The case for the Anthropocene

Geologists have a system for naming large segments of Earth's time. Thousands of years are called "epochs." Tens of millions of years are "periods." Hundreds of millions of years are "eras." The longest measurements of time are called "eons."

Geologists call our current epoch the Holocene. It started about 10,000 years ago, when temperatures stabilized after the last ice age. The word Holocene comes from Greek roots: *holo* for "whole" and *cene* for "new." Hence, Holocene means "wholly new."

In 2000, a Nobel Prize-winning chemist suggested that a new epoch has begun — the Anthropocene. The chemist, Paul Crutzen, argued that we have entered an epoch of human domination over the planet. *Anthropo* is the Greek root for "human."

The name Anthropocene has not been officially adopted, but many geologists are using it.

Evidence of change

How do we know that humans have begun to dominate and alter the life systems of Earth? The most prominent answer is a familiar one: climate change.

Plants and animals are moving northward. Glaciers are melting. Storms and droughts are getting more severe. Weather patterns are changing. Behind these weather patterns are changes in the Earth's atmosphere that scientists can track over geologic time.

A small part of Earth's atmosphere is made up of "greenhouse gases." These gases hold in heat reflected from Earth and do not let it escape into space. One of these greenhouse gases is carbon dioxide (CO_2).

During the past million years, CO_2 in our atmosphere ranged from 180 parts per million (ppm) to 280 ppm. This was not affected by humans.

But since the beginning of human agriculture, the atmospheric concentration of CO_2 has risen from 280 ppm to about 390 ppm. This rise happened much faster than ever before. It was mostly caused by humans burning fossil fuels during the last 250 years. Some of these fossil fuels are oil, gas and coal.

Leading scientists now say that we must reduce the concentration of CO_2 to 350 ppm. To do this, humans must cut CO_2 emissions by almost 5 percent every year until 2050. If we do not do this, our climate could warm, with devastating consequences.

But CO_2 emissions are increasing. In 2011, they went up almost 6 percent. China produced 25 of the total. The United States produced 16 percent.

You might think that natural changes in climate happen slowly and gradually, but it does not always happen that way. Sometimes change speeds up because of feedback cycles. That is what happened at the end of the last ice age.

For example, when glaciers at the poles melt, there is less area of whiteness to reflect the Sun's heat back into space. Instead, the heat is absorbed into the land and water, warming it and causing more melting of the glaciers. They then reflect even less heat. The feedback cycle continues.

CO_2 emissions don't just affect the atmosphere. They have changed the chemistry of the oceans as well. The oceans are absorbing extra CO_2. This makes the water more acidic. Creatures that form calcium shells have trouble in acidic water. Runoff from fertilizers and pesticides further pollutes the oceans, causing rapid increases of harmful algae. Widespread overfishing threatens marine species worldwide.

More than just sea life is at risk. The biodiversity of all sectors of the planet is declining faster than usual. The present rate of decline is between a hundred and a thousand times the usual rate. Up to half of all species face extinction in the twenty-first century. Many biologists believe the current extinction will rank as one of Earth's six major ones.

Another way that humans are changing Earth's systems lies in our ability to create artificial chemicals like drugs, pesticides, plastics, and synthetic fabrics. The Earth is absorbing these

chemicals, with unknown side effects.

Nuclear energy is a powerful force that humans have developed. The United States dropped two atomic bombs on Japanese cities in 1945 to end World War II. Since then, a handful of nations have tested bombs. There have been several major accidents at nuclear plants. But so far, nuclear power has not been used destructively on a massive scale.

There are many nuclear weapons today, some ready to launch in just 15 minutes. Nuclear war could kill millions of people and produce a "nuclear winter" that could be as destructive as the asteroid that wiped out the dinosaurs 66 millions years ago.

The evidence we've discussed comes from biologists and climate scientists. But geologists have a very specific way of determining historical periods. They look for evidence in the rocks. Or at least in layers of mud that will become rock. They are finding evidence. Worldwide sediments contain radiation from atomic bomb testing in the 1960s. Similar evidence of chlorine from bomb testing and of mercury associated with the burning of coal also exists in ice-core samples.

Environmental historians support the claims of geologists. For example, scholar John McNeill wrote "the human race, without intending anything of the sort, has undertaken a gigantic uncontrolled experiment on the Earth."

What's ahead?

People disagree on what these changes might bring and how humans can deal with them. English scientist James Lovelock believes that humans can no longer control change. He thinks the planet will return to a balance that may not support much human life. According to Lovelock, the best we can do is try to adapt to the changes.

Others believe humans are clever enough to find our way out of any tight spot. We can use our collective learning to create new ideas, new technologies and new solutions. We survived previous crises. We can do it again.


A wind farm in Germany

Geologists continue to debate other questions: When did the Anthropocene begin? How do we know when we have reached the critical point of human influence on the Earth? Considering these questions has allowed scientists to examine contemporary change.

Meanwhile, people have to face this decisive period in planetary history. Human decisions made in the near past and those made in the near future will determine the direction of life on our planet.

Many leading scientists believe that we have at most 10 years to change our destructive behavior and to implement new technologies. Otherwise, humans could face a breakdown in our planet's life-support systems. Many people trust that human cleverness will be able to get us through this decisive period. It will take the commitment, innovation, and cooperation of a large portion of all humans on the planet to accomplish this.

Take Home Assignment

Directions: You are tasked with learning how to think like an environmental historian. To do this, you must pick a place (ex: your school, your house, your city hall, Yosemite National Park, etc) to examine as an environmental historian would. You should either:

1. Write a story (250-500 words) detailing the environmental history of the place you chose. You can do research at your local library or online. You can go back in time all the way back to 1770! Your goal is to talk about how people have interacted with that piece of land (the environment) over the years.

2. Create a comic strip (at least one page large) detailing the environmental history of the place you chose. As with choice #1, you can do your research at your local library or online, and you can go as far back in time up to 1770! Your goal is to illustrate the different ways in which people have interacted with that piece of land that you chose (the environment) over time.

Jigsaw Role

Environmental Educator

Contents:

Background information on packet content

1. Interview with an Environmental Educator. Who am I?
2. Video: What is Environmental Education?
3. Video on the value of Environmental Education
4. Meet an Environmental Educator Video
5. Article on importance of outdoor learning
6. Take-Home assignment

Background Information on Packet Content

1. Interview with an Environmental Educator

2. What is Environmental Education? Video

This video explains how to define Environmental Education, and why it is important. It also addresses life-long learning and the outcomes of environmental education. This is a good way for the students to get a base-line understanding of EE.

3. Value of Environmental Education Video

The video gives a glimpse into what environmental education looks like and why it is valuable for students.

4. Meet an Environmental Educator Video

This video introduces Briana Steele, an environmental educator. She talks about her job and why she thinks it is important.

5. The importance of outdoor learning article

This article can be found in the Extra/Higher level materials folder and can be added if appropriate. It is a paper written by an educator that analyzes the importance and benefits of environmental education. To make the reading less overwhelming, you can have the students just read the abstract and skim the second page.
There is a more digestible article about the importance of outdoor education that discusses research on the role of outdoor educators, that can be found here and also in the Environmental Educator role folder.

6. Take-Home Assignment

The take-home assignment is meant to allow students to think critically about what an environmental educator does and what they teach about. By the end of the assignment, the students should have thought about different topics that are important in the subject of grizzly reintroduction such as the pros and cons for the community, the risks involved, the history of the bear and our extinction of it, and why conservation is important.

Interview with an Environmental Educator. Who am I?

Video Link

Transcription of Interview:

How would you describe an environmental educator?

An environmental educator is a person who comes from either a formal background of studying environmental education or a more informal background of just doing environmental education for a long time, and they're somebody who focuses on taking students out of a formal setting of learning into a novel natural setting, or somebody who uses environmental literacy in their curriculum, in their classroom. So, there's lots of different types of environmental educators of all sorts of diverse backgrounds, and you could be any type of person to be an environmental educator. You could have a science background, you could have a humanities background, you could have a social science background, or you could have no formal educational training, just training with perhaps indigenous people that you learned a lot of different eco-literacies from. So there's lots of different types of environmental educators and I would use lots of different ways to describe them because they could be so diverse.

Why are environmental educators valuable and important?

Environmental educators to me are very important, especially in this time that we live with different environmental crises just taking over our world. And so what an environmental educator does, is bring different knowledge of combating different environmental disasters into the light of learning. And so to me, that's incredibly valuable because it sets up students and next generation of students of all ages, K through 12 and undergraduates and graduate students to be able to look at environmental problems in the world and combat them and know the different tools to combat them. So environmental educators can, you know, have really great value, meaning that they're preparing environmental problem-solving and critical thinking in the environment for older people but also it could be younger kids who just need to get outside of the classroom and experience nature so that a love of nature is created and nurtured, and so that we have greater stewards of the environment for the next generation. So, taking all of these lessons into consideration in a K through 12 and an undergraduate classroom pushes a generation of people who want to take care of the environment, which is pretty much the most important thing, because we can't do any other type of learning unless we have a planet that is healthy to learn on. So, environmental education is invaluable and the most important in my opinion.

Tell me about your favorite parts of environmental education.

There's so many parts! So yeah, I love conservation education. I love early childhood environmental education. I love preparing undergraduates for thinking critically about the environment. I think those are my top three. So conservation education would be taking issues of wildlife and biodiversity and helping students understand the importance of that, and doing the outreach component to a lot of the more science oriented projects at conservation, like conservation biology projects. And so that's one of my favorite things is to go into a community of learners, be it in a formal or informal setting in a school or in just a group of community members or something, and talking to them about conservation projects that are going on in their communities and making translucent the science that's going on so that everyone can be involved, so that you avoid problematic things like scientists coming in and to certain communities and just doing a bunch of science without talking to the people who are actually living there, which is called helicopter research. And when that happens there's a lot of social problems that come from that, and so conservation education is really one of my favorite things to do as a practitioner of environmental education. To go into those communities and help even the scale of science conservation and the community members that are there. And then the other one is early childhood education and I think that that's really fun because that's you know one to three year olds, and just getting these tiny little humans outside is mainly how that type of environmental education works, getting them in gardens, getting their hands dirty, letting them play with worms. Just teaching them about simple systems like the decomposition system and teaching them about where food goes and teaching them about recycling. These kind of tiny little lessons that are really important for little little kids, it's really fun to see because of course humans are so naturally in love with nature. Even a baby. If you have a baby who's crying and won't stop crying, almost nine times out of ten if you take that baby outside just sit under a tree with that baby, that baby calms down. So I love that age because often they can't communicate very well but it's so obvious and innate to see the love of nature in those young kids. And then I also love that part of environmental education at the college level because you get to see real problems and look at complex, involved, hard to solve, current stuff that even the leading scientists don't know what to do about and to engage nineteen to twenty five-year-olds in that conversation, and get them thinking about their own role in the conversation about the environment is just really inspiring because it's like, these are the future leaders of the very next generation. And it's exciting to see what they're going to do and how they're thinking about things and to be able to help mold that and help them become those great environmental leaders. It's a really rewarding experience. So that would be my three favorite parts of environmental education.

Why is your work important in the conservation conversation?

So I sort of touched on this earlier but conservation is traditionally a part of the biological discipline, a hard science, and I think that that has been a mistake to look at it in such a narrow way. I think it's important that not only our educators or people who know how to take science, hard science and translate it and make it translucent and make it accessible to everyone, that's important in itself, but it's important for lots of voices to be in the conservation conversation and education is just one part. And education becomes twofold in that conversation as outreach and learning and so it is important that the public is informed, especially in the case of the reintroduction of grizzly bears to certain areas. It's important that those humans who are living in the areas where grizzly bears could be reintroduced understand what it means to introduce such a charismatic carnivore as they say to your own neighborhood. So that's important, but like I said, environmental education is just one other of many voices that need to be involved in that conversation.

Describe what you needed to do to prepare to be an environmental educator.

For me, my path as an environmental educator is very long. It was always more of a hobby for me until I became empowered to see that the work I could do could actually change people and communities on the ground. And that started when I earned a grant that allowed me to go into a very rural area in Indonesia and assist the people with the least amount of power and the softest political voice to be able to help them make environmental change in their local community. So this was specifically in Indonesia in a rural area called Gorontalo where women and children were appealed to come with me and start doing beach cleanups because the trash disposal problem in Indonesia is really really intense. And to get those people down and advocating in their community to help their local beaches was really great to empower those people but to help empower those people but then to also work with local governments to enact different policies that would help protect beaches and reefs from litter. It's a very small goal in a local area but seeing that what I did actually made a difference made me switch from looking at environmental education as a hobby to more of a possible career. And then after that I just continued that. I loved going into different communities and seeing what sort of environmental problems they had and helping them to solve it. And so that really empowered me to begin to think that "yeah, I can do this as an environmental educator." And then I went to probably the most important experience that I had, going into the neotropical forest which is in Central America and working with indigenous people to learn about how to save the rainforest essentially and how to work with people to facilitate that. And seeing that change in short periods of time just you know working really hard to make that good environmental change empowered me and I think that those experiences, real life experiences, coupled with my research and my training in an academic sense; I mean I have two masters degrees and almost have my PhD so I have I've studied a lot and so I think studying is really important too to understand the actual research behind a lot of this; but on the ground work, that's what's so amazing about being an educator, that it's not just about being in an Academy or in what they call the Ivory Tower, it's about going and being on the streets and in the jungle and on the ground and actually doing the that really helps you be a more well-rounded environmental educator and make those crucial changes that need to happen.

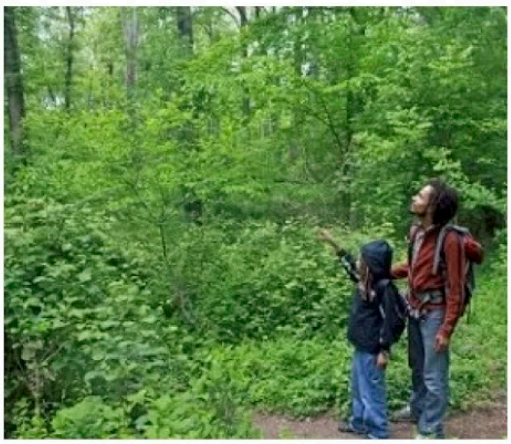
What is Environmental Education?

Video on the value of Environmental Education

Meet an Environmental Educator

Outdoor learning and green time: How kids benefit from learning and playing in nature

Studies show that outdoor learning delivers many benefits — reducing stress, improving moods, boosting concentration, and increasing a child's engagement at school.



What happens to children when they encounter trees and greenery? When they go for a brief nature walk, learn lessons outdoors, observe wildlife, or simply relax in front of a nature scene?

Such experiences can be exhilarating, fun, inspirational. For many people, they are an essential part of life. We owe children access to nature. It's a *human right.*

Yet many kids are missing out.

For example, in a study of 11-year-olds living in a British city, researchers monitored how kids spent their time each day after school. Most kids spent less than 30 minutes outside during after school hours (Cooper et al 2010).

And in a survey of preschools in Ohio, half the children in full-day daycare spent less than 23 minutes each day outdoors. One in three kids spent ***no*** time outdoors (Copeland et al 2016).

That's alarming if you agree that nature experiences are a human right. But even if you don't, you should care about something else: The measurable psychological and educational impact of time spent in nature.

Studies indicate that playing and relaxing in natural settings can defuse stress. Brief nature walks can reduce anxiety, distraction, and symptoms of ADHD. And when schools take kids outside to learn, kids have become more motivated and self-directed.

Do these field trips spoil kids for conventional classroom work — making them too restless and distracted to settle down?

Research suggests otherwise. Lessons held outdoors appear to increase student engagement in school — even after they come back inside.

So the conclusion is inescapable. Here are the details.

The benefits of playing — and walking — in green spaces

Exposure to natural settings appears to have an intrinsic effect on our emotional and cognitive functioning. For example, consider the circumstantial evidence.

In a massive study tracking almost a million Danish children, researchers used satellite imagery to calculate how much greenery kids encountered in and around their homes during childhood

their homes during childhood.

The researchers focused on a zone of 200 meters around each child's residence, and scored the density of vegetation. They also monitored children's mental health outcomes. Were there any links?

To answer this question, researchers compared kids living at either ends of the "greenery" spectrum, and they found clear differences.

Kids who had grown up around the lowest levels of vegetation had a 30% higher risk of neurotic, stress-related, or psychosomatic disorders — even after researchers adjusted for the effects of socioeconomic status. The children were also at higher risk for mood disorders and substance abuse (Engemann et at 2019).

The findings are consistent with an earlier study of children living in rural communities of the United States:

Among kids experiencing life stressors (like bullying), the children who reported the fewest psychological problems were those who had greater access to nature. And once again, the link held even after accounting for socioeconomic factors (Wells and Evans 2003).

Both studies point to the psychological benefits of spending time in nature. But these studies report correlations only. They don't provide us with strong evidence of causation. For that, we need experimental studies — studies where researchers can randomly assign participants to experience different "doses" of nature.

What does the experimental evidence tell us?

Not surprisingly, nobody has attempted any long-term experiments on children. It wouldn't be ethical! But many short-term experiments have been conducted — on both children and adults — and the results are telling.

In a series of experiments conducted in Japan, researchers assigned volunteers to take walks in both natural and urban settings. The walks were matched for length and physical difficulty, so people got similar amounts of exercise in both conditions. But the nature walks were linked with unique benefits, like reduced feelings of anxiety, and lower levels of the stress hormone, cortisol (Park et al 2010; Song et al 2014; Song et al 2015).

Researchers in the United States have performed a similar experiment on patients suffering from clinical depression, and found that nature walks improved people's moods, and increased their performance on a test of concentration and short-term memory (Berman et al 2012).

They have also tested the effects of nature walks on children with ADHD, or attention deficit hyperactivity disorder, and found that they, too, showed enhanced concentration abilities after a 20 minute nature walk (Taylor and Kuo 2009).

The kids in this study each took three different walks — one in a green space, and two in quiet, urban settings with minimal levels of foot traffic. But only the walk among greenery delivered attention benefits, and these benefits were substantial — "roughly equal to the peak effects of two typical ADHD medications" (Taylor and Kuo 2009).

The results tie in with previous, correlational research: Kids who spend more time participating in "green" outdoor activities tend to have less severe attention deficit symptoms (Kuo and Taylor 2004).

So it appears that playing and walking among greenery is helpful. And what's even more remarkable is that you don't have to be physically active to experience the effects.

Just *looking* at nature can defuse stress and boost concentration

A growing number of studies suggest that people can experience emotional and cognitive enhancements from *merely looking* at scenes of nature (Velarde et al 2007).

That's especially important when you consider how much of the time kids are required to remain indoors. Might kids reap benefits from looking out a window? It appears so.

In one experiment, researchers randomly assigned high school students to classrooms that were either

- windowless,
- containing a window that looked out onto trees and other greenery, or
- containing a window that looked out onto a human-built environment.

The students were each attached to sensors that monitored heart rate variability and other physiological markers of stress. Then the students were given 30 minutes of work to do — tasks that included public speaking, mathematical calculations, and proofreading.

Such efforts can fatigue one's attention span and working memory skills, which is why it helps to take a break. But does it matter what you do during that break? Does it matter if you have a window to look out of?

The researchers wanted to know, so immediately after the 30 minute work session ended, they gave students a standard test of working memory and attention. Then, after a ten minute break, they re-administered the test, and looked for changes.

Only the students provided with a "green view" showed improvements in attention and working memory.

Furthermore, these students experienced faster recovery from the stress associated with the school tasks.

The students with the windows overlooking buildings or parking lots showed no such improvements after the break. And in this respect, their outcomes were indistinguishable from those of students who had no window at all (Li et al 2016).

Outdoor learning among third graders: Refueling students in flight

To benefit from nature experiences, must we stop working? Or can nature experiences benefit us even while we are studying and learning?

This was the question that interested Ming Kuo and her colleagues, so they secured the help of a couple of third grade teachers to investigate.

The researchers asked the teachers to present a 10-week long life science curriculum to each of their classes.

Every week, teachers taught one lesson *outdoors*, in a green space.

On a different day that same week, teachers also taught a second life science lesson *indoors,* carefully designed to match the outdoor lesson in key ways:

1. Both lessons were taught by the same teacher.
2. Both lessons were held at roughly the same time of day.
3. Both lessons included hands-on activities, and, when appropriate, featured natural materials (like leaves or seeds).
4. Both lessons treated the same topic (for example, the identification of different types of leaves), with the second lesson representing an extension of ideas introduced during the first lesson.

To control for the order in which the two lessons were presented, some weeks scheduled the outdoor lesson first; others scheduled the indoor lesson first.

After each lesson, students were given brief bathroom breaks. Then they continued the school day in their regular classrooms, where a researcher (who wasn't told what sort of lesson the students had just completed) joined them for a 20 minute observation period.

During this observation period, the researcher noted how many times students had to be redirected by their teacher to stay on task. Did a student require a reminder to get back to work? That counted as a "redirect." Did a student need to be told to sit down? Or stop talking out of turn? Or otherwise require prompting from the teacher?

All of these instances were tallied up, giving the researchers an objective measure of how distracted or disengaged students were. A high number meant kids were frequently off-task. A low number indicated they were engaged. Kuo's team also collected self-reports from teachers and students, and compared the data across conditions.

Altogether, the researchers had 20 observation periods to analyze, but the results were clear-cut.

Kids consistently showed more engagement immediately after returning from the outdoor lesson.

In fact, the researchers note, "the number of redirects after a lesson in nature was roughly half (54%) that of redirects after a classroom lesson."

After the indoor lesson, teachers had to deal with approximately one interruption every three and a half minutes. After the outdoor lesson, interruptions occurred only once every 6 and a half minutes — a difference that any third grade teacher will tell you is important (Kuo et al 2017).

Evidence that outdoor learning helps older kids, too

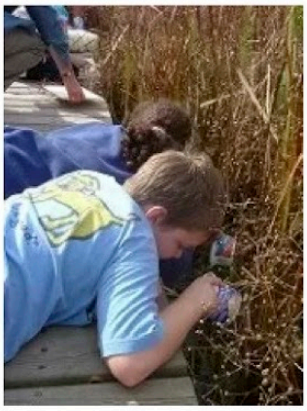
Does outdoor learning primarily benefit young children, who have more trouble staying on task to begin with? Studies of older kids suggest otherwise.

For example, research indicates that tweens and teens do a better job of keeping themselves focused and motivated when they learn lessons in outdoor, natural settings (Dettweiler et al 2015; Dettweiler et al 2017).

In addition, high school students may show better long-term retention of academic content if they learn it outdoors (Fägerstam et al 2013).

And research hints that outdoor learning may help older kids maintain healthy stress hormone rhythms (Dettweiler et al 2017a).

So why is outdoor learning beneficial?



One spoiler explanation is that kids are merely responding to the novelty. For many kids, going outside to learn is something new, and this alone could inspire them to pay more attention.

But researchers doubt this was an important factor in the study of the third graders receiving 10 weeks of outdoor nature lessons.

If novelty were responsible for increased student engagement, we'd expect to see the effect wear off as the weeks rolled by. Researchers saw no evidence of this (Kuo et al 2017).

This leaves us with other possibilities. Maybe kids just need a change of scene every so often — even if this means revisiting a series of different, but familiar places.

It's also likely that outdoor learning helps because it incorporates several factors beneficial in their own right — like bright light and exercise (which enhance attention and mood).

But we should keep in mind that researchers have found evidence for a "nature effect" above and beyond the effects of daylight and exercise.

For example, in the window experiment, students experienced similar levels of daylight regardless of the view outside. But only students exposed to a view of nature (trees) experienced enhanced concentration and better stress recovery.

And in the walking experiments, researchers controlled for the mood-enhancing effects of physical exercise by making both types of walk — urban and green — equally long and equally difficult.

So we need to recognize that there is something special about being in nature.

For many of us, witnessing nature is intrinsically rewarding. It can inspire positive emotions and meaningful, introspective experiences.

It might be the beauty, or the awe-inspiring forces we witness — like the rush of water, or the controlled dive of a bird.

It might be that being surrounded by other, nonhuman living things and geological features makes us aware of being part of something much bigger than ourselves.

It might be the perspective we discover during immersions in nature: the awareness that our everyday, human doings represent only a small sliver of reality.

Such realizations are prized in many spiritual traditions, and experiments confirm they help us cope with stress. To the degree that kids share these sensibilities — or learn to associate nature with pleasant, invigorating, or uplifting experiences — that's bound to affect the way they react to outdoor learning.

If teachers also experience these effects, that would be an added bonus. As Ming Kuo and her colleagues speculate:

"Teachers, just as much as students, might benefit from all these aspects of lessons in nature — perhaps teachers are able to teach in a more engaging way after a bit of walking, a bit of a breather and change in scenery, and a dose of nature has rejuvenated their attention and interest and reduced their stress levels."

And a recent study suggests an additional factor. Researchers interviewed 12-year-olds about their outdoor learning experiences, and discovered a recurring theme.

Many kids felt they had more *autonomy* during outdoor lessons, and they felt inspired to take charge of their own learning (Dettweiler et al 2017b). For instance, one student said:

"I liked it to have had permission to do everything myself. It's really nice, that one is allowed to think a little and do experiments."

So perhaps that's a crucial ingredient — allowing students more leeway to take the initiative.

More reading

Interested in ideas for outdoor learning? See this guide to preschool science activities, and this article about teaching young children about wildlife through outdoor learning.

In addition, my article about the evolutionary art of tracking considers the cognitive challenges posed by reading the signs left behind by animals.

Of course, you can also play when you're outdoors, and studies suggest outdoor play benefits kids in a variety of ways. Learn more about it in this Parenting Science article.

To read more about the benefits of taking a break from academic work, see these guides:

- "The cognitive benefits of play"
- "Exercise for children: Why keeping kids physically fit is good for the brain and helpful in the classroom"

For more information about attention and focus, see my articles about ADHD and teaching self-control.

Take-Home Assignment

You are an Environmental Studies professor, and have been asked to give a talk on grizzly bear reintroduction at the local middle school. There will be students as well as many community members attending. Your goal is to educate the community about the reintroduction, and give them the informational tools to be stewards of their local environment.

Create a lesson plan, in bullet point form, with the different topics you feel that you should cover during your talk. What information do you think is important for people to know about reintroduction? You do not need to make a detailed outline with all the facts and figures, just a general outline of the kinds of topics you find important. Also, are there any experts in your class that you could bring in as guest speakers? Look around at the different roles your classmates have; they could be helpful for enriching your talk! Mention them below and why their expertise would be useful.

Topics to Cover:

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Possible guest speakers/experts:

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Jigsaw Role

Environmental Lawyer

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2.What is an Environmental Lawyer?

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Background Information on Packet Content

1. Interview with an Environmental Lawyer

2. What is an Environmental Lawyer?

   This section explains the basic idea behind environmental law. The endangered species act is also linked here, and it may be helpful for students to skim in order to get some more background information.

3. What does one need to know about Environmental Law? Video

   In this video Elizabeth Fisher, an author and environmental lawyer, explains the basics of environmental law and what one needs to know about it.

4. Article on what an Environmental Lawyer does

   This short article gives more information on the field of environmental law.

5. Take Home Assignment

   This homework assignment asks students to write a speech about an environmental problem and come up with a law that can solve the problem. Teachers can ask them to give their speeches to the whole class or to the group of other environmental lawyers after completing the packet.

Interview with an Environmental lawyer

Video Link

Transcription of Interview:

Okay, do you think you can explain to me how you got interested in becoming an environmental lawyer?

Sure. So I worked between college and law school as a field biologist for the US Fish and Wildlife Service, and it was a wonderful time. I was working tagging elephant seals and banding birds, and it was wonderful and I had been admitted to law school because I wanted to do something that helped to help people. And so I went there, and after my first semester, I just felt, I didn't feel connected. And so I decided that I wanted to have a career in the environmental field, so I did a joint degree between law and engineering. So when I graduated, I had an expertise in how the legal system works, but also a better sort of scientific understanding how the natural world works and that combination has been very helpful.

And then, how did you become an environmental lawyer? You said you went to law school and everything so I guess.

Yeah, I had a long-standing interest in the environment. I was a boy scout growing up, so I used to go camping a lot. I used to do a lot of stuff in the water, and so I wanted a field that sort of gave back.

And then, have you always been involved in kind of policies and everything or did that kind of start after you went into environmental law?

Well, if you work as a lawyer, you're always somehow involved with environmental policy because laws basically are the ways that policies get implemented. So you might have a policy that says we want to clean up the coast. And that's fine as a general goal, a general policy, but the question is how are you going to make that happen. So you're going to have laws that that fines people for littering, that sends people to jail for littering. What are the laws that are actually going to be passed, that are going to implement the policy? And then lawyers get involved essentially in a lot of ways. One of them is prosecuting people who violate the laws. One of them defending people who violate the laws. One of them is working with people and companies who say, "I want to do this, does this violate the law? How can I do this and stay in compliance?"

And then, what would your kind of day-to-day routine be?

Yes, there are many, many different types of lawyers so let me just give you a few examples.

Okay.

So one example might be that you work for a law firm and your clients. So for example, let's say Patagonia for example, they're based in Ventura, and they say they want to build a manufacturing plant in Ventura. They say, "We have this waste that we produce from our manufacturing process for making the jackets and such. How can we dispose of the waste in compliance with the laws?" And so I would, you know, if I'm their lawyer, I would work with them and say ok if you produce you know this kind of sludge, this is what you have to do. If you produce this I don't know chemical, dimethyl terrible, call it what you will, this is what you do. If you have air emissions, this is what you do. There are laws that cover all those. So one kind of lawyer works with clients to say this is what you have to do to stay in, to follow the law. Second type of lawyer would be working for the government. And let's say that Patagonia again just to take an example, let's say that they did not dispose of their waste properly. They just dumped it in the ocean, or they dumped it out their backyard. And the government comes in, the county or the state, and says, "hey you violated the law." They then have to go, if Patagonia doesn't agree, says no, you know they don't plead guilty, they say no you know we complied with the law or we didn't do what you said we did, then the government has to bring a case against them. And the government will have a lawyer, a prosecutor, sometimes a district attorney, sometimes a state's attorney, who will bring the case against them. That means there's a lawyer on the other side as well who will be a defense attorney, usually from a private firm, and they will defend Patagonia saying again either they didn't violate the law or they didn't do what you said they did.

Interesting and those are usually always environmental lawyers in terms of anything that comes down to the environment. Those are the specialty environmental lawyers?

I mean you can have other lawyers do that but generally its environmental lawyers. Then there's a fourth category which is more sort of pure policy which is when agency's environmental agencies try to take a broad policy and to pass laws or regulations to implement it. Someone has to write those, and that's almost always lawyers. And so lawyers get very involved in policy, with policy as well. And then the final category is let's say you want to work for an environmental group like Friends of the Bay or you know Save the Save the Seal, and you're unhappy with the proposed project that's going to affect the seal rookery, and you want to challenge that project make sure it's not built. You as a lawyer are going to bring lawsuits or negotiate with them to try to change what they're doing. And that's what lawyers do also.

I mean could you explain to me your favorite thing about your career?

Well my career is as much a teacher as an environmental lawyer. So as a teacher environmental law, I love seeing students who are excited about the environment. And so to teach them how to work in the field but also challenge some of their assumptions. Right. So a lot of people working in the environmental field assume government is always good and private companies are always bad, and that's not true. Right. There are a lot of private companies who are trying to do the right thing. There's sometimes government officials who are actually doing things that harm the environment. It's not a simple black and white situation. So that's as a teacher, as someone who works with governments a lot, helping them develop policies you know. I do a lot of work with drinking water for example, and so you know I work with EPA to help them develop rules to try to improve the quality of drinking water around the country.

And then, do you think you could tell me the hardest part about being an environmental lawyer?

So there are two things that are hard. The first is being an environmental lawyer. You get into environmental law because you love the environment, but your work is done in an office and in a courtroom. And so even though I got into the field because I love the environment, I'm actually not working in the environment. I'm working to protect the environment and I'm working in an office. So that's hard. The second thing is that you don't always win. A lot of times development goes ahead, the environment is harmed, and you know you fight the good fight. But this is a field where oftentimes you lose. But you know some of the time you do win and that and that basically has to be enough.

And then, how do you feel like you help the community as like an environmental lawyer?

So the main thing I do that helps the community is I serve on the board of an environmental group called the Environmental Defense Center. That's based in Santa Barbara, and it's the main environmental group for the Central Coast of California. And so we're very involved in opposing offshore oil drilling, onshore oil drilling, and sort of promoting Creek restoration. And so I'm quite active on that board. And so I basically the way I help in the community is basically to help in this environmental group.

Can you explain the process of education that one usually goes through to become an environmental lawyer?

Sure! So to become any kind of lawyer, not just environmental lawyer, you need to graduate from college. And then you apply to law school. And law school is a three year graduate school, and there' great law schools in every state all over the country. And once you're in law school, everyone takes pretty much the same courses the first year, but after that you can specialize. And so if you want to do environmental law, you might take courses like International Environmental Law or Natural Resources Law or Wildlife Law. And then oftentimes in the summers between your years, you'll work in the environmental field as well, either for the government or an environmental group, for a private firm. I've always thought that it's helpful to have a scientific background working in the environmental field because a lot of what you're dealing with is science. Right. How do we know the environment is improving or being degraded? How do we know a particular action is harming species or helping species? So a lot of science is involved with that and it's good to have a background so you're comfortable talking with scientists.

So you would suggest majoring for your undergraduate in like a science field if you want it.

I don't think you have to major, I majored in history.

Okay.

But I took chemistry, physics, biology, math. So I think the major can be whatever excites you, but in addition to your major, make sure you get a solid grounding in the basic sciences.

What is an Environmental Lawyer?

An Environmental Lawyer works to maintain and support regulations concerning the environment. This includes upholding regulations such as clean water, pollution standards, clean air and other environmental issues. Many times an Environmental Lawyer works for the government or large environmental organizations. Other times they work for themselves during private consulting with different companies. An Environmental Lawyer is like other lawyers but they specialize with wildlife and natural resources. Many times Environmental Lawyers can pick the cases that they work on and follow closely to the events that are happening around the world.

How does one become an Environmental Lawyer?

To become an Environmental Lawyer, you must have a bachelor degree. This can be a bachelor degree in anything. To be a lawyer, one must also obtain a law degree from a law school. In order to attend a law school the student must pass the Law School Admission Test. During law school, this is where the student must complete specific environmental law courses.. After or during law school the student must complete internships or part-time jobs. An Environmental Lawyer must pass the bar exam to be licensed and continue to stay current with their skills and law education to maintain their license. An Environmental Lawyer must be an excellent communicator in written and verbal language. They also are good at problem solving and researching current events.

What does an environmental lawyer need to know to make a decision about grizzly bear reintroduction?

The Endangered Species Act

What does one need to know about Environmental Law? Video

Articles on what an Environmental Lawyer does

What Does an Environmental Lawyer Do?

Environmental lawyers uphold regulations and advocate for new policies related to clean water, clean air, global warming, land use and other environmental themes. Find out about environmental law career opportunities, professional requirements and employment information for lawyers by reading on. Schools offering Juris Doctor degrees can also be found in these popular choices.

Government Agencies

Federal agencies such as the Environmental Protection Agency (EPA) and the U.S. Department of Justice employ environmental lawyers to advocate for a number of issues, such as regulations guided by the Clean Air Act with regard to manufacturing, energy companies, farming, construction and healthcare. You are responsible for getting these companies to adhere to regulations by helping them understand specific environmental laws. You also are responsible for taking violators to court on behalf of the government.

Every state and most American territories have their own environmental agencies, which monitor all energy, mining, utilities, waste, water and radiation issues. Lawyers are needed by these agencies to help enforce regulation by interfacing with EPA officials and industry professionals.

Non-Profit Organizations

Organizations such as the Environmental Law Institute, Greenpeace and the Alliance for Climate Protection work with government agencies and act as a watchdog for environmental protection. As a lawyer with one of these organizations, you research problems or incidents and litigate for the concerns of the organization.

Take-Home Assignment

Name:

Date:

Instructions: You are an environmental lawyer. Your job is to find a current event about an issue within the environment (e.g. pollution, climate change, etc). Based on that environmental issue, please answer the following questions.

1. What is the environmental current event you chose?

2. What can you do as an Environmental Lawyer to combat this problem?

3. A lawyer must persuade others within a courtroom setting. Write down what you would say in order to pass a law to reduce the effects of this environmental issue. This should be written as a speech and should be around 100 words.

Jigsaw Role

The Paleontologist

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6. Take home assignment: creative approach to paleontology

Background Information on Packet Content

1. Interview with a Paleontologist

2. Introduction to Paleontology Articles

   The first article will serve to introduce students to the field of paleontology, in addition to the tools and research methods paleontologists use
   This second article is useful to students because it will help them see paleontology applied by discussing how a new species was discovered by paleontologists' examination of fossils

3. Paleontology Field Expedition Video

   This video shows students what field work looks like for a paleontologist.

4. Paleontologist talks about Grizzly Bear

   In this video, Alexis Mychajliw speaks about her work using paleontology to learn more about the California Grizzly Bear. Students should watch from 1:19:00 - 1:34:00.

5. Additional In Class Assignment

   (This additional assignment can be found in the Paleontologist folder within the split up roles packets folder) Student get the option to draw and describe their own fossil, make one out of play-dough, or write a 250 word story or 50 word poem about anything to do with paleontology, using at least 10 of the "power words" at the bottom of the two articles. Students will present these to each other in their paleontology groups.

6. Take-Home Assignment

   This will help students to think like a paleontologist. They will be provided with a picture of a fossil, and will have to answer questions about the picture as a paleontologist would. There are no wrong or right answers; students should be graded on the effort they put in. This should only take students about 5 - 10 minutes.

Interview with a paleontologist

Video Link

Transcription of Interview:

Hi, I'm Alexis Mychajliw and here are the recorded answers for the stakeholder prompt about being a paleontologist.

How did you make the decision to become a paleontologist?

I don't think there was ever a moment I decided to be a paleontologist. I technically have ever taken a paleontology class, despite working out a world-famous paleontological research site, the La Brea Tar Pits. Sometimes science takes you to unexpected places when you're following your curiosity or trying to solve a problem. I'll also say that I don't study dinosaurs, sorry! But instead focus on species millions of years closer in time to us. I study the past 50 thousand years right up until the present day, spanning an ice age. Like what seems to be a rite of passage for many young kids in the U.S., I went through the dinosaur phase and watched Jurassic Park obsessively. But after that, I turned to studying living organisms and their ecosystems, being curious about wild animals- their diversity behavior and later on their conservation. As a teenager, I knew that I wanted to study biology to have the tools to protect the animals I cared about. So in college I studied biology, ecology and evolutionary biology to be specific, in a conservation context. I was training to be a conservation biologist who used genetic data to inform policy decisions. I wanted to know how understanding the history of a species, its evolution, its reasons for being threatened in the present, could help us better forecast what its future might look like. This is especially important in the case of climate change and growing human populations around the world. Then I went to graduate school to get a PhD studying the conservation of rare mammals on islands. When I arrived at my field site for the first time in the Caribbean, I realized that so much had changed in the past decades and even hundreds of years that to conserve the surviving species, I needed to know something about their history. This meant I literally had to dig deeper. I learned how to be a paleontologist through my fieldwork as a PhD student, reading many different papers and consulting with experts, and came to see how fossil information from the recent past can answer so many questions that data from the present day alone cannot. I climbed into a cave, started digging, and now I guess you can say I'm a paleontologist. After my self-training during graduate school, I then worked as a paleontologist for two years at the La Brea Tar Pits in Los Angeles California, where I used fossils to help us understand the future impacts of climate change in Southern California and to also guide reintroduction conversations about the California Grizzly Bear. Now, I like to think I'm both a conservation biologist and a paleontologist, which is an interesting way to see the world. I can see how our present-day extinction crisis has its roots in past extinctions as part of a single story in our history, and I can share that story with many different audiences to achieve my ultimate goal, which has always been to protect the wild animals I care about.

Can you talk about some of your favorite things about being a paleontologist? How about your least favorite things?

Being a paleontologist is like carrying around your own personal time machine at all times. It really challenges you to think on timescales that are not intuitive for most people, because human lives are on the scale of decades, but the changes we study as paleontologists are often on the scale of thousands to millions of years. I love being able to change the way people think about the world around them and think about time. One of my favorite things to do is tell people what their hometown would have looked like thousands of years ago, like mammoths and saber-toothed cats roaming Ice Age forests in downtown Los Angeles. I think it gives people a special connection to a place they live and makes us appreciate that we're just a tiny part of a much bigger picture in time. One of my least favorite things is when I'm working in the lab and a sample does not work. For example, I need to isolate proteins from bones when studying the diets of extinct animals. However, if the fossil is badly preserved; maybe it's been exposed to a lot of water or heat or sunlight, then the proteins have likely all disappeared or been damaged. This means that I lose a data point in my research, which I definitely don't like.

Please tell me about what your thought process is when you begin examining a fossil.

The most important thing about a fossil is not the fossil itself, but the context. Finding just a bone in isolation with no associated information is like having a few words from a sentence in a novel without the page numbers or surrounding paragraphs. Maybe you can get a tiny bit of meaning but you'll never see the full story. So, when I'm working with fossils, I'm usually working with the fossils within what we call the matrix: the rocks and dirt containing the fossil. The matrix can tell us about how the fossil deposit was formed, and what that means about interpreting the past environment of that fossil. Stratigraphy is also very important. That is, the sequence of fossils when you're excavating. Like a layer cake, sediments are deposited in a series, and we need to know where the fossil is, relative to other fossils in the layer cake. Knowing the stratigraphy means we can understand which fossil came first, which you can imagine is very important if you're trying to study how animals change over time or determine when they go extinct.

Is there anything you think young students should know about paleontology?

Paleontology is not just about dinosaurs. If I had known that paleontologists could study the ancient remains of still-living animals, I probably would have taken a paleontology course in college. Paleontology is one of the best tools we have to help us plan for life in a changing climate, because climate has already changed in the past. So if you're interested in conservation biology or environmental science, I would recommend that you try to take at least one paleontology class. There are paleontologists who study animals and plants, but also those who study paleoclimate and also paleoecology. Almost everything you can study in the present day, you can also find some way to study its past history.

Can you share your advice for young students looking to head into the field of paleontology?

Paleontology requires bringing together knowledge from many different disciplines like biology, geology, physics, and chemistry. There are many different pathways into being a paleontologist and all of them are equally valid. It is up to you to find what excites you the most about studying the past. While going out into the field to excavate is fun, not every paleontologist does that. Some paleontologists work in labs, others work in museums, others still work at their laptops. What's most important is to find the questions and organisms that excite you the most, because the one universal thing about being a paleontologist is that it is hard work, so you need to stay excited about what you're working on.

Introduction to Paleontology Articles

Scientists Say: Paleontology
This is the study of prehistoric life based on fossil evidence

Paleontology is the study of ancient life forms like these fish, which are preserved as fossils in rock.
BOBAINSWORTH/ISTOCK/GETTY IMAGES PLUS
By Carolyn Wilke

October 28, 2019 at 5:30 am

Paleontology (noun, "Pay-lee-en-TOL-oh-gee")

This is the study of prehistoric life based on fossil evidence. Fossils provide evidence about life on Earth millions, or even billions, of years ago. They can be preserved remains of living things, such as bones or teeth. Fossils also can be impressions left in stone, like animal tracks or the shape of a leaf.

Scientists who study fossils are called paleontologists (Pay-lee-en-TOL-oh-jists). Paleontologists compare fossils to find clues about early organisms and how they lived. Fossils can show how organisms evolved over very long periods of time. They also show how living things today relate to those from millions of years ago. Some fossils even give clues about how ancient organisms went about their daily lives. For example, fossil footprints suggest some dinosaurs lived in groups.

Power Words

• Biology: The study of living things. The scientists who study them are known as biologists.

•Dinosaur: A term that means terrible lizard. These ancient reptiles lived from about 250 million years ago to roughly 65 million years ago. All descended from egg-laying reptiles known as Archosaurs. Their descendants eventually split into two lines. For many decades, they have been distinguished by their hips. The lizard-hipped line are believed to have led to the Saurichians, such as two-footed theropods like *T. rex* and the lumbering four-footed *Apatosaurus* (once known as Brontosaurus). A second line of so-called bird-hipped, or Ornithischiandinosaurs, appears to have led to a widely differing group of animals that included the Stegosaurs and Duckbilled Dinosaurs. But a new 2017 analysis now calls into question that characterization of relatedness based on hip shape.

•Extinct: An adjective that describes a species for which there are no living members.

•Fossil: Any preserved remains or traces of ancient life. There are many different types of fossils: The bones and other body parts of dinosaurs are called "body fossils." Things like footprints are called "trace fossils." Even specimens of dinosaur poop are fossils. The process of forming fossils is called fossilization.

•Geology: The study of Earth's physical structure and substance, its history and the processes that act on it. People who work in this field are known as geologists. Planetary geology is the science of studying the same things about other planets.

•Organism: Any living thing, from elephants and plants to bacteria and other types of single-celled life.

•Paleontologist: A scientist who specializes in studying fossils, the remains of ancient organisms.

•Paleontology: The branch of science concerned with ancient, fossilized animals and plants. The scientists who study them are known as paleontologists.

•Parasite: An organism that gets benefits from another species, called a host, but doesn't provide that host any benefits. Classic examples of parasites include ticks, fleas and tapeworms.

•Prehistoric: An adjective for something that happened tens of thousands to millions of years ago, periods before people began deliberately recording events.

Paleontologists find the first fossilized egg inside an ancient bird

The unlaid egg may have killed its mother 110 million years ago

This ancient bird is *Avimaia schweitzerae*. It lived about 110 million years ago in what is now northwestern China. When the bird died, its body held an unlaid egg (the lighter brown smudge).

By **Carolyn Gramling**

April 29, 2019 at 5:45 am

When a sparrow-sized bird died about 110 million years ago, she had an egg inside her body. Over time, pressure crushed and flattened that egg. Now scientists report it's the first unlaid bird egg found inside a fossil.

Scientists unearthed the fossil 11 years ago in northwestern China. Last year, paleontologists led by Alida Bailleul took a closer look. Bailleul works in China at the Key Laboratory of Vertebrate Evolution and Human Origins in Beijing.

At once the researchers noticed something odd: The bird had a strange sheet of tissue between her pubic bones. Bailleul examined a piece of the tissue under a microscope. She found that it had come from an egg. The researchers shared their discovery March 20 in *Nature Communications*.

The egg was a first. The bird was too — a new species. The researchers named it *Avimaia schweitzerae* in honor of Mary Schweitzer. She's a paleontologist who works on fossilized soft tissues.

Further analyses turned up more surprises. The mother bird's skeleton holds traces of *medullary bone*. This is a calcium-rich tissue that helps to form eggshells. Modern birds make this tissue while they're producing eggs. The new finding is the strongest evidence yet that ancient birds did the same thing.

The scientists also found tiny mineral spheres in the shell's outermost layer, or *cuticle*. There are similar spheres in the egg cuticles of modern water birds, such as quails and ducks. The spheres may protect embryos from microbial infections. Until now, no one had ever seen them in a fossilized egg.

This bird and her embryo had some problems, though. The eggshell has two layers instead of the usual one. That suggests that the egg had stayed in the bird's body for too long. And the egg's layers are extremely thin — thinner than a sheet of paper.

In today's birds, these symptoms can point to a deadly condition called egg-binding. That's especially true in small birds that are under extreme stress. In egg-binding, a bird is unable to lay the egg. The researchers think this ancient, unlaid egg may have been what killed its mother.

Power Words

•**Birds:** Warm-blooded animals with wings that first showed up during the time of the dinosaurs. Birds are jacketed in feathers and produce young from the eggs they deposit in some sort of nest. Most birds fly, but throughout history there have been the occasional species that don't.

•**Calcium:** A chemical element which is common in minerals of the Earth's crust and in sea salt. It is also found in bone mineral and teeth, and can play a role in the movement of certain substances into and out of cells.

•**Cuticle:** Term for a tough but bendable protective outer shell or cover of some organism, or of parts of an organism.

•**Egg:** The unfertilized reproductive cell made by females.

•**Embryo:** The early stages of a developing organism, or animal with a backbone, consisting only one or a few cells. As an adjective, the term would be embryonic — and could be used to refer to the early stages or life of a system or technology.

•**Evolution:** (v. to evolve) A process by which species undergo changes over time, usually through genetic variation and natural selection. These changes usually result in a new type of organism better suited for its environment than the earlier type. The newer type is not necessarily more "advanced," just better adapted to the particular conditions in which it developed.

•**Fossil:** Any preserved remains or traces of ancient life. There are many different types of fossils: The bones and other body parts of dinosaurs are called "body fossils." Things like footprints are called "trace fossils." Even specimens of dinosaur poop are fossils. The process of forming fossils is called fossilization.

•**Infection:** A disease that can spread from one organism to another. It's usually caused by some type of germ.

•**Medullary Bone:** A type of porous, spongy tissue that develops within the core of bones in birds that are preparing to lay eggs (and therefore female). The same tissue recently showed up in the fossil remains of a *Tyrannosaurus rex*.

•**Microscope:** An instrument used to view objects, like bacteria, or the single cells of plants or animals, that are too small to be visible to the unaided eye.

•**Mineral:** Crystal-forming substances that make up rock, such as quartz, apatite or various carbonates. Most rocks contain several different minerals mish-mashed together. A mineral usually is solid and stable at room temperatures and has a specific formula, or recipe (with atoms occurring in certain proportions) and a specific crystalline structure (meaning that its atoms are organized in regular three-dimensional patterns). (in physiology) The same chemicals that are needed by the body to make and feed tissues to maintain health.

•**Paleontologist:** A scientist who specializes in studying fossils, the remains of ancient organisms.

•**Pressure:** Force applied uniformly over a surface, measured as force per unit of area.

•**Species:** A group of similar organisms capable of producing offspring that can survive and reproduce.

•**Stress:** (in biology) A factor — such as unusual temperatures, movements, moisture or pollution — that affects the health of a species or ecosystem. (in psychology) A mental, physical, emotional or behavioral reaction to an event or circumstance (stressor) that disturbs a person or animal's usual state of being or places increased demands on a person or animal; psychological stress can be either positive or negative.

•**Symptom:** A physical or mental indicator generally regarded to be characteristic of a disease. Sometimes a single symptom — especially a general one, such as fever or pain — can be a sign of any of many different types of injury or disease.

•**Tissue:** Made of cells, it is any of the distinct types of materials that make up animals, plants or fungi. Cells within a tissue work as a unit to perform a particular function in living organisms. Different organs of the human body, for instance, often are made from many different types of tissues.

•**Vertebrate:** The group of animals with a brain, two eyes, and a stiff nerve cord or backbone running down the back. This group includes amphibians, reptiles, birds, mammals and most fish.

CITATIONS

Journal: A.M. Bailleul et al. An Early Cretaceous enantiornithine (*Aves*) preserving an unlaid egg and probable medullary bone. *Nature Communications*. Published online March 20, 2019. doi: 10.1038/s41467-019-09259-x.

Paleontology Field Expedition Video

Paleontologist talks about Grizzly Bears
1:19:00 - 1:34:00

Take-Home Assignment

Directions: You will examine the picture of this fossil and try to determine what it is, and characteristics of it, in the way a paleontologist would.

1. How many appendages does it have? Do they all seem like they serve the same functions, or different functions?

2. Does it seem to have teeth? If so, what would they be used for? If not, what does it have instead?

3. What are some defining characteristics of this fossil?

4. Does it seem like an organism that has already been discovered? Why or why not?

5. What else would be important information to know about the fossil and the organism?

Jigsaw Role

The Rancher

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3. Day in the life of a Rancher Video
4. What a Rancher looks like Video
5. Importance of Livestock Article
6. Article about Rancher and Grizzly Bear Conflict
7. Take-Home Assignment

Background Information on Packet Content

1. Interview with a Rancher

2. Who am I?

   This gives the student a narrative to build on.

3. Day in the life of a Rancher Video

   This video walks the students through the daily life of a rancher. This allows the students to have an idea of how much work goes into running a ranch and maintaining livestock.

4. What a Rancher looks like Video

   This video introduces Maggie Schmidt, a ranch manager in Montana, and follows her around on a typical day on her ranch. She talks about her job and its challenges and why she loves it.

5. Importance of Livestock Article

   This video helps students understand the cost of cattle and insight into understanding cost-benefit analysis. In order to completely understand the importance the livestock have to the rancher and why a rancher might not be too fond of the idea for a grizzly bear reintroduction, the students need to understand costs and benefits.

6. Article about Rancher and Grizzly Bear Conflict

   This article offers students a real-life example of how much it costs ranchers to lose livestock to bears.

7. Take-Home Assignment

   This assignment gets students thinking like a rancher.

Interview with a Rancher

Video Link

Transcription of Interview:

Okay could you tell me a little bit about your ranching business and how you got into it?

Well we've been in the lemon and avocado business for a long time, I was in the cattle business and in high school my dad was in it; my family's been in it for a long, long time. And then I kind of got back into it about 30 years ago. We have cattle on four different ranches around Ventura County so it's more of a disease than that a business.

Okay, and then what is your favorite part about being a rancher and why?

Just being able to get out and be out and about, and get to see incredible things nature wise. It's just a great place. And it's a good family thing, you gotta do it with your family and the kids get to go help you and learn, grandkids are going and helping me so it's something to do.

That's great! Is every day different, would you say?

Mostly! Yeah, yeah mostly!

And then what is the hardest part about being a rancher?

Probably one of the more difficult parts is getting calls at odd hours or that cows are out on the road or something like that. That all of a sudden, you've got to go solve that kind of a problem. Or getting things done on time when weather and things are going against you, like this last year when it was so wet and you know which we don't ever complain about being too wet because we're in the grass business, so that's really the business we're in is growing grass and sending a cow out to harvest it for us. So, that's kind of what we do and so we don't ever want to turn down rain, not that we can anyway.

Okay, and then how do you think a large carnivore like a bear might affect your work as a rancher?

Black bears, we deal with them all the time.

Really?

Yes, I've got two different ranches that are major bear habitat. One in Fillmore, one in Ojai. A few years ago I was on foot because I couldn't get into the area that I wanted to check some cows in, and literally got cornered by, and kind of held down by a bear for at least fifteen or twenty minutes. And I think it had some cubs somewhere and was probably being protective of the cubs. I never saw the cubs, because I was too busy watching my backside to look for cubs, but anyway, it held me down and luckily where I was I had phone reception and I called my buddy that was nearby, and he came up with a dog and we started yelling and the bear took off. So yeah it was very spooky, I will tell you.

And so do they also have like some impact on your cattle and everything as well?

I have heard that bears will go after a cow when she's calving. Okay I don't know that I've had that; I've had bears come in and eat cows that are already dead, and they tend to like them after they've been hanging around for a little while they're kind of nasty. Lions will eat them when freshly dead, and bears will; and we have this all on camera by the way; we've got a lot of trail camera footage of bears eating cows or calf that we have whatever that has maybe died calving or something like that you have always have a debt loss in that cow business. And so we'll drag them to this one part of the ranch and or take them back to this one part of the ranch and the bears will kind of come around there and help dispose of them, just like the coyotes and the vultures and everything. So they will feed on them. I haven't personally don't know of them attacking a cow, but I've heard that they will go after a cow having a calf.

And then do you have any thoughts about the grizzly bear possible reintroduction in California?

I think grizzly bears are awesome! I really do. And I think they're perfect, in Alaska.

What is your thought process?

In California, no. I don't think so. They're an apex predator, they are, we even in our northern part of the state there's way too much population right now. That they are bringing the wolf back into California, the wolf was not in California. And they are bringing it where you know, because a lot of people think that would be cool. Wolves and grizzly bears are major predators and they have a lot of grizzly up in northern Idaho- I had a business up there at one time and they, I don't know it was a big dang animal and it will kill you. And the wolves, same way they're tough. Lions are a little more skittish; we have tons of them. We have tons of lions. I can show you, I have a picture of a lion kill and I know my neighbor has lost four calves in the last couple weeks - to a lion.

Mountain Lion?

A mountain lion, yes. A California mountain lion. So, we have predators. We have plenty of them. And there are a lot of lions, like I'll show you a picture of a ranch in Fillmore that we caught one on a trail camera the other night. So we have enough predators around, I don't think we needed another one with a grizzly bear. They're not endangered and I don't think in my personal opinion we need them. Not here. Yeah and I'm not saying they're not great where they are, you know that's awesome! Keep them up there! But like I wouldn't want to see polar bears down here.

And then could you describe your worldview regarding wildlife conservation?

Worldview, that's interesting. Well I think that as far as that, I think I mean all species come and go seems like. I mean we know there's starting with the dinosaurs and the saber-tooth tigers, there's been stuff that's been here for a long time and that's knocked out for one reason or another and new species kind of start up, and I mean on a big scale I would say. As far as conservation goes locally, you don't ever want to see anything, you know nature is great, but we're part of it and I think it needs to be kept in balance. Just like they talked about and I'm sure you've heard about all the lions in the Santa Monica Mountains, and this big overpass thing that they want to do. Some things you just have to kind of say well, you know, again lions aren't going extinct, there's tons of them. So catch one, put it in there, spend 80 million bucks on something like that, or 80 million bucks bringing back the wolf, or anything it's kind of crazy. But it's just got to be kept in balance that's all. And hey, I love it; I see it every day! I mean I live with that, it's part of my deal, it is out and with nature. And getting along with it. We've got in this county a problem with in certain areas on one of the ranches we've got a problem with feral hogs and you know, so that's a problem. Yeah you know, so that they get in and start messing with what's supposed to be here, and so it's a balance. It's a balance.

Well thank you so much for that interview!

You're very welcome.

Who am I?

You are a rancher in the foothills of the Sierra Nevada. You have 300 different types of livestock including cattle, sheep, horses, pigs, chickens, and goats. This farm has been passed down for many generations within your family. It is your turn to take on the responsibility and make your family proud. Everything you have ever known has been on this ranch and you have always known that you would one day own it. So to prepare for this large responsibility you chose not to get a degree after high school and stayed back to learn what it takes to run the land. Part of the job as a rancher is you need to make sure that each of the livestock are well taken care of to the best of your ability. There is time as well as money that needs to be thought about when running a ranch. You must make sure to keep records of the health and breeding of the livestock as well as the cost to purchase and sale of them. This means that you must take into account the costs and benefits of each of your livestock animals. You hold the worldview of realism. This means that you accept the situation as it is and deal with it; you don't shy away from the situation or challenge. Every morning you wake up bright and early at 5am, you need to make sure there is enough time to do all the activities for the day. The first thing you do is grab the food for the cattle and start feeding them and then feed all the other livestock. At this time you are shoveling the breakfast for the animals. It is the most important meal of the day. It is also important to check to make sure all your 300 livestock are checked for any problems that could have occurred since yesterday. By 6am you are in your truck to do this check up. This can take a long time making sure all your 300 livestock are taken care of and healthy. By 9am you must start looking into your records and paperwork to make sure all the animals are in the right place and in the pens. You must take the cattle from one field into another field so that you can fertilize the fields and allow there to be fresh grass for the cattle when they move into the new field. Your day ends around 4pm and then you can relax for the rest of the day. Yes, everyday is long and it takes a lot of work, but you have some fun enjoying being with the animals and riding horses. Your livestock is very important to you because this is your livelihood. You are the person that makes sure there is money so that you can feed and support your family. The health and safety of your livestock is one of your highest priorities and you will do what it takes to make sure they are okay. For an example of how much livestock costs look to the cost article in this packet.

Day in the life of a Wyoming Rancher Video

What a Rancher looks like Video

Importance of Livestock Article

YOUNG CAN MAKE MONEY IN CATTLE
By Gene Johnston
8/2/2012

If young people are going to be brought back into farming and ranching, you'd think it would be now. The opportunity to make money in the cattle business has never been better, especially with mama cows that usually don't eat grain or purchased feed. High calf prices convert to higher net income for the owner.

So wouldn't this be the time to incorporate a new generation of young cattlemen and women? Especially when you consider that, of all the farmers and ranchers, cattle producers are among the oldest.

Rabo AgriFinance relationship manager Matt McKamey from Montana says a ranch that can support the labor and management of one family unit is in the 300- to 500-cow range. For example, say it's 300 calves, sold at 550 pounds at an average of $1.60 a pound (all conservative numbers). Those are $880 feeder calves with gross sales of over $260,000.

All the costs associated with that business – land, equipment, fuel, cows, health – are inflated. It will take at least 3,000 acres of Montana land and a line of credit in the area of $250,000 (give or take), says McKamey. Still, the potential net is a good income, probably better than most young professionals outside of ag earn.

BEST OPPORTUNITY

While other enterprises in agriculture look as promising, the cattle business is the best place to get a start.

At the Cattle Industry Convention last winter in Nashville, Tennessee, ranchers gave the following responses when asked if they thought the trend of bringing youngsters back into agriculture was improving.

Bill Rhea, an Arlington, Nebraska, farmer who backgrounds cattle on pasture and also runs a feedyard, says absolutely yes; we are attracting young talent. His farm is a prime example, where three of his sons are partners.

"It's been the lack of money in farming and ranching that has pushed so many of our young people into urban jobs," he says. "The money is back in farming. The cattle business, in particular, looks attractive, where a young person with ingenuity can get a start with a few cows and grow. I don't think you can do it now with hogs or poultry. But with cattle, you can see potential for an income that competes with the city job."

BIG FARMS TURN SMALL

Jana Malot of Harrisonville, Pennsylvania, has similar optimism, but it comes from a different angle in her area.

"We have more young people coming back into agriculture around us on small farms," she says. "In some cases, people are taking what was once a large farm and breaking it down into maybe four small farms, then producing things such as beef for the local market. It's young people – in many cases young women – who are leading this. Our farm numbers are growing. It's not a bad thing."

Ultimately, with a land-intensive business like farming or ranching, it's the cost of dirt that limits the participants.

So says Steve Anderson from Carthage, Tennessee. Development of land for homes and businesses there is going to put everyone – young or old – out of agriculture, he says.

"It's hard to justify running cattle on a piece of ground where you might make $100 an acre, when you can sell that land for 20 times what you paid for it originally," says Anderson. Other businesses in his area, notably banks, don't seem very interested in cattle or agriculture, either, he notes.

DOUBLE THE COSTS

The new president of the National Cattlemens' Beef Association, J.D. Alexander from Nebraska, says there is definitely more money in farming and the cattle business than ever before, and income potential matches that of urban jobs. But he tempers any enthusiasm with the sheer cost of running a cattle business today.

"If I total up my feed and cattle inventory, my rental rates, and my machinery costs, I think it costs me twice as much to run my operation as it did five years ago," says Alexander. "It's still not easy on the farm."

Rancher and Grizzly Bear Conflict Article

Overview:

Concerned ranchers within Washington state told the *Capital Press* about their fight against grizzly bear reintroduction. The ranchers allow their livestock to graze in the north mountains of Washington. Grizzlies have been known to kill calves and cows. The article used Wyoming as an example of a state that has grizzly bears. In Wyoming, the state compensates the ranchers for losing their livestock to grizzly bears. For example, Wyoming paid the ranchers $445,000, in 2016, for the live stocked killed by grizzlies. The state of Wyoming found that 136 cattle were killed by the grizzlies in 2016. It is thought that grizzlies will kill the adult cows while the wolves tend to kill the smaller livestock. According to this article, although there are compensations made to the ranchers, the ranchers don't want grizzlies around their cattle. The ranchers believe that a management tool to keep grizzlies from killing their livestock is by hunting. This article shows how the perception of ranchers in Washington.

Washington ranchers told to fight grizzly reintroduction

By: Dan Wheat (May 31, 2018)

A grizzly bear in Yellowstone National Park. The head of the Wyoming Stock Growers Association says Washington ranchers should do all they can to prevent reintroduction of grizzly bears in the North Cascade Mountains.

Ranchers with grazing allotments in Washington's North Cascade Mountains should do all they can to prevent reintroduction of grizzly bears, says the leader of the Wyoming Stock Growers Association. "My advice is become very active and do everything possible to prevent a reintroduction because once that happens there's no relief, no satisfactory response," says Jim Magagna, 75, executive vice president of the association in Cheyenne.

Grizzlies will kill calves and even cows and are a worse problem for ranchers in the northwest corner of Wyoming than wolves, said Magagna, himself a sheep rancher on the edge of grizzly range.

On May 23, the Wyoming Game and Fish Commission approved the state's first grizzly bear hunt since 1974, saying the bears have exceeded recovery criteria since 2004 and that management is necessary. Fall hunts will occur for 13 to 22 bear. Environmental groups have filed lawsuits to stop the hunts.

Idaho also approved a hunt and the two states, plus Montana, are working together on grizzly management, said Renny MacKay, Wyoming Game and Fish Department spokesman.

Grizzly populations in and near Yellowstone National Park have increase since they were federally listed as a threatened species in 1975 and delisted last year, Magagna said. There are 718 grizzlies in a suitable habitat area which is part of the Yellowstone ecosystem and the criteria was 500 bear, MacKay said.

While cattlemen favor the hunts, the states are doing them as proper management more than in response to the cattlemen, MacKay said. Wyoming pays ranchers for loss of livestock on a formula that figures there are more kills for every one reported, he said. The state paid $455,000 for livestock kills by grizzlies in 2016, $509,000 in 2015 and $301,000 in 2014, he said. The state confirmed 136 cattle killed by grizzlies in 2016, 24 lambs, 5 ewes, 46 chickens, 13 domestic turkeys, 3 pigs, 3 ducks and 1 dog, he said.

About nine ranches run more than 4,000 mother cows, plus calves on thousands of acres of summer range in the Bridger-Teton National Forest in northwestern Wyoming, Magagna said. It's believed to be the largest U.S. Forest Service grazing permit in the nation and ranges from 8,500 to 11,000 feet elevation, he said. The ranches on that permit experienced a maximum of 2 percent loss of calves per year prior to 1992 when there were no wolves and very few grizzlies, Magagna said.

Wolves were reintroduced and spread out and losses went to 4 to 6 percent, he said. Since grizzlies have increased in number, losses have gone to 9 to 14 percent, he said. "The ranchers tend to think losses to wolves have declined a little bit as losses to grizzlies have increased," Magagna said.

Grizzlies have greater overall impact and ranchers have had to add more range riders to protect cattle, document losses for state compensation and move cattle more often for protection if a certain meadow is hard hit, messing up grazing rotations, he said.

"Grizzlies will kill adult cows. This area lost 48 calves to all causes in 1995 and 286 in 2017. The biggest change in that time was more wolves and grizzlies," Magagna said.

Ranchers are investigating large dog breeds of Eastern Europe used there to protect cattle from large bear, he said.

Wyoming Stock Growers Association has worked hard to minimize grizzly protection zones and has intervened in a lawsuit to support delisting, he said.

"Even with compensation for losses, our ranchers are not in business to raise high-quality beef for grizzlies but for the marketplace," he said. "Grizzlies unsettles our herds and that results in lower weights and conception rates. Summer time is the breeding season in the high country.

"We definitely think there are too many grizzlies where the livestock are. The trophy hunts are a management tool, but at the levels they're starting at won't eliminate or significantly reduce our loss of livestock. The best we can hope for is it maintains the status quo."

Take-Home Assignment

Name:
Date:

Instructions:

Because your role is a rancher, you have to start thinking like one.

Please answer the following questions:

1. Choose an animal to have on your ranch. Do some research and estimate the price to purchase this specific type of ranch animal. Write down this item and the estimated cost of the item.

2. List some goods and services that come from this animal. Is this animal for meat, milk, travel, entertainment, etc.?

3. Now a grizzly bear has come into your ranch and killed this animal. Another bear returned a week later and killed two more. How much money would you lose? Consider how much money (in food, water, veterinary care, etc.) you invested in the animal since its purchase.

4. List three possible solutions that might prevent another grizzly coming to kill one of your animals?

1.

2.

3.

5. How does the loss of your animals make you feel about the reintroduction of grizzly bears to California?