

SONORAN DESERT DISCOVERY WORKSHOP LESSON PLAN

Apex Carnivores in the Ecosystem:

Preventing Environmental Collapse

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Apex Carnivores in the Ecosystem: Preventing Environmental Collapse

Summary of Activity

Apex predators play a crucial role in maintaining ecosystem function. Specifically, apex predators help maintain balance by keeping herbivore populations regulated. As human activities continue to reduce and extinguish predator populations, many herbivores become overpopulated, and ecological balance is lost. Although some species may become more abundant, the majority will suffer losses due to ecological changes. Our objective is to teach the importance of apex predators in preserving overall biological diversity. We focus on the five top predators native to Arizona; the jaguar, mountain lion, Mexican wolf, grizzly bear, and black bear. We will recount the stories of past persecution of these predators, and present current conservation efforts to preserve remaining populations. We will have skulls, tracks, and skins of these Arizona predators on hand to teach distinctive characteristics for identification. The “Oh Deer” activity will be used to show ecosystem stabilization by the top-down regulation provided by apex predators. Radiotelemetry equipment will be present to demonstrate field methodologies used to study carnivores in the wild.

Elevator Speech:

Quick – Did you know that Arizona has more top predators than any other state? - Top or apex predators are a critical part of the ecosystem; regulating prey populations and maintaining biological diversity (everything from butterflies to flowers).

Paragraph - Apex predators play a crucial role in the ecosystem by maintaining balance and keeping herbivore populations regulated. As human activities continue to reduce and in some cases extirpate predator populations, many herbivores have become overpopulated and ecological balance has been lost. Our objective is to teach the importance of apex predators in preserving ecological integrity and biological diversity here in Arizona.

Introduction

Apex predators serve a critical role in maintaining the integrity of ecosystems. Without these predators, the top-down regulating force on the environment disappears, resulting in

trophic cascade and systematic food chain collapse. The removal of predators at the highest trophic level leads to an increase in herbivores (primary consumers) that over-consume the primary producers, subsequently leading to the decline of producers and all other species that depend on them (Pace et al 1999). The restoration of apex predators into formerly occupied range can restore ecosystem function by reducing herbivore populations and allowing regeneration by the primary producers (Ripple and Beschta 2003). Apex predators also keep other predator (secondary consumer) populations in check both directly by killing individuals and indirectly by being socially dominant (Crooks & Soule 1999). The absence of apex predators has resulted in population explosions of secondary consumers or “mesopredators” (Prugh et al. 2009), again resulting in ecological imbalance.

The reintroduction of gray wolves back into Yellowstone National Park is an excellent example of the power an apex predator has in an ecosystem. Since the reintroduction program began, elk and coyote populations have been reduced, while willow and aspen populations have rebounded. Some scientists predict that more long term impacts on other species populations will be observed in the future (Smith et al. 2003).

Populations of large predators are under pressure throughout the world (Prugh et al. 2009). 25% of the Order *Carnivora* has a “Vulnerable” or greater designation on IUCN’s red list, and another 10% are on the “Near-threatened” list (IUCN 2009). Urban development and the subsequent loss and fragmentation of habitat, coupled with historic over-hunting, have contributed to the serious decline of large carnivore populations, and often localized extinctions. Incidentally, managing the landscape for apex predators ensures the continued existence of most flora and fauna found within the region, since predators serve as an umbrella species. One of the keys to carnivore conservation and management, and consequently survival, is knowledge and its dissemination.

Background

Five species of apex predators were historically found in southern Arizona:

Jaguar (Panthera onca)

Jaguars historically ranged as far north as the Grand Canyon, but were probably never common in Arizona (Brown and Lopez Gonzalez 2001). Persecution and a high market value for jaguar fur led to the extirpation of the jaguar from the United States in the 1930s. Despite this, jaguars continued to have an intermittent presence in southeastern Arizona. Jaguars are currently listed as an endangered species and the closest breeding population of jaguars is approximately 200 miles south of the US border in Mexico. That jaguars do still occasionally enter southern Arizona (McCain and Childs 2008) suggests the potential for this species to rebound given the proper protection. However, the completion of the US-Mexico border fence will prevent re-colonization.

- The 3rd largest cat in the world
- The largest and most powerful feline in the western hemisphere
- Weighs between 100 and 250 lbs.
- Adults are 6' to 8' long
- Has a rosette spotted coat
- Dense forest is the preferred habitat
- Solitary
- Stalk and ambush predator
- Can travel distances of over 500 miles

Did you know? - The jaguar has an incredibly powerful bite, allowing it to pierce the shell of tortoises and other armored animals. Jaguars employ an unusual killing method by biting directly through the top of the skull into the brain of its mammalian prey.

Mountain Lion (Puma concolor)

The Mountain Lion (*Puma concolor*) is also known as a puma, cougar, and panther.

Perhaps the most adaptable of all apex predators in the new world, mountain lions occur in a wide variety of habitats and probably survived past predator eradication campaigns because of their highly cryptic and solitary nature, as well as their natural propensity to inhabit some of the most rugged terrain around (Logan and Sweanor 2001). Although mountain lion populations are decreasing, of all the large carnivores in Arizona, it is the only species that currently has any probability of long term persistence.

- The 5th largest cat in the world
- Males are over 2' tall at the shoulder and can be over 8' long
- Males generally weigh 115 to 200 lbs., females are slightly smaller
- Can purr, but cannot roar
- Only eat fresh meat. Diet includes: deer, elk, bighorn sheep, javelina, and livestock
- Ambush hunter and stalks its prey
- Solitary animal
- Territory size depends on the amount of available prey
- Mountain lions urinate to mark territories

**Just in case!* - If you come across a mountain lion in the wild, do not corner or provoke it. If you feel threatened, try to look larger than you are. Give them plenty of room to leave the area without feeling threatened by you. Slowly back away, DO NOT RUN, and if attacked fight back! If you ever want to see a mountain lion up close, go to the Arizona-Sonora Desert Museum just west of Tucson.

Mexican Gray Wolf (Canis lupus baileyi)

The Mexican Gray Wolf (*Canis lupus baileyi*) is the rarest, most genetically distinct, and smallest subspecies of the gray wolf in North America.

Until recently the Mexican wolf ranged throughout the Sonoran and Chihuahuan Deserts from Mexico, east to western Texas, and west to Arizona. Trappers eradicated the Mexican wolf by the 1950s in the United States. In 1998, a reintroduction program began releasing Mexican wolves back into the wild in Arizona (Brown 2002). Today approximately 300 Mexican wolves exist in the wild and captivity.

- Males are up to 5.5' long (around the size of a German Shepherd dog), with females slightly smaller
- Adults weigh 50 to 80 lbs.
- Mexican wolves live in packs consisting of one adult (alpha) pair, pups, and related yearlings
- Howling is an important form of wolf communication
- Breeding occurs in February, and litters of up to 8 pups are born in mid-April
- Diet includes deer, elk, pronghorn, small mammals, and livestock

Did you know? - Killing a Mexican wolf is a violation of the Federal Endangered Species Act, and invokes a fine up to \$50,000 and/or 1 year in prison.

**Just in case!* - If a wolf should approach you, raise your arms to look as large as possible. Throw rocks and yell to scare the animal away and back away slowly. Never, ever run!

Grizzly Bear (Ursus arctos arizonae)

The Grizzly Bear (*Ursus arctos arizonae*) was the largest apex predator found in Arizona.

Grizzlies were once found throughout the Western United States, including most of eastern Arizona. This species was extirpated from Arizona in 1923 due to trophy hunting and persecution from ranchers. All grizzly bears south of the Yellowstone population have been eradicated.

- Solitary
- Females produce 1 to 4 cubs (usually 2)
- Males weigh between 500 and 800 lbs., females weigh between 250 and 450 lbs.
- They have much longer claws than the black bear
- They are actually an omnivore, and their diet consists of plants and animals

- Grizzly bears have a characteristic “hump” on their shoulder differentiating them from black bears
- Grizzly bears are always brown in color

**Just in case!* - Grizzly bears normally avoid contact with people. Even so, they can be extremely dangerous. If you see a bear, try to back away slowly and if you are being attacked it is best to play dead.

American Black Bear (Ursus americanus)

The American Black Bear (*Ursus americanus*) is currently the only bear species found in Arizona.

The extirpation of the grizzly bear led to the ecological release of the American black bear to fill the grizzly’s ecological niche. Prior to 1929, black bears, like most carnivores, were considered to be “predatory” animals and were given no legal protection in the state of Arizona. The same ranchers and government agents who eliminated the grizzly bear sought to do the same to its smaller relative. Bears were poisoned, trapped or shot on sight under the semblance of protecting livestock. In 1924 it was estimated that only 1,500 black bears remained in all of the Southwest. Today, bear populations have rebounded and they are found throughout the state.

- Black bears are shy, curious and intelligent
- Diet primarily consists of berries, roots, insects, cactus fruit, and sometimes vertebrates
- Males weigh from 150-600 lbs. and Females weigh from 100-350 lbs.
- Cubs are born in January and stay with the mother for ~ 1.5 years
- They can live up to 20 years of age in wild
- Habitat – primarily found at elevations between 4,000 and 10,000 feet
- Black bears generally “hibernate” from November through March
- Black bears can vary in color from black, to brown, to blond and cinnamon

Did you know? - During droughts, black bears will travel long distances to find food. In recent years bears have entered both Phoenix and Tucson searching for food.

Food for thought! - Bears are not true hibernators; the body temperature of bears stays normal throughout the winter. They burn an estimated 4,000 food calories a day. While in hibernation they can awake and move about quite often. Yet they can exist for three months or more without food or water.

In animals that do truly hibernate, like ground squirrels, body temperature drops to within a few degrees of the cold outside its den. The heart will beat only once or twice a minute. When it is active, the squirrel may breathe a few hundred times each minute, but in hibernation it takes a

slow breath only once every five minutes. Despite these changes, its blood remains saturated with oxygen.

**Just in case!* - Black bears normally avoid contact with people, although they can be attracted to our trash. If you do encounter a bear, do not corner or provoke it. If you feel threatened, try to look larger than you are. Back away slowly and if you are being attacked, fight back!

Credit for Activity

This workshop was designed by Aletris M. Neils and Geoffrey H. Palmer. Aletris Neils modified the “Oh Deer” activity from Eileen Jones (her 8th grade science teacher).

Estimated Time to do Activity

This workshop will take approximately 30 to 45 minutes to complete. Segments of the workshop will be adaptable in length (5-15 minutes) to accommodate people that cannot stay for the entire duration.

Goals of Activity

There are 5 main goals of this workshop:

Goal A: To get the audience to understand the role apex predators play in a functioning ecosystem and the devastating ecological effects of removing them; hopefully instilling a desire to conserve and protect carnivores.

Goal B: Introduce the audience to the history, natural history, and future of Arizona’s apex predators.

Goal C: Get the audience to recognize differences and similarities between apex predators found in southwest.

Goal D: To instill a general respect, appreciation, and sense of wonder for large carnivores and biological diversity.

Goal E: To foster a sense of humans belonging in the environment, and realization that their actions influence the natural world.

Materials Needed

The materials needed include the “Bones Box” from Arizona Game and Fish, and posters describing the five apex predators that are native to Arizona and their roles in the ecosystem. We will have a radiotelemetry receiver and transmitter to discuss field techniques. We will need four easels for each of our four posters, and three tables for the animal tracks, skins, and skulls. To create the tracks, we will use the rubber track casks provided in the “Bone Box” and make impressions in a Tupperware of substrate (soil, sand, mud etc.), as well as have the option to use an inkpad to make tracks on paper (the paper they can take home with them). We will ask what differences people see in the track shape? Total materials needed for our workshop are:

1. AZGFD Bone Box (skulls, skins, and tracks of key species)
2. Telemetry Equipment (receiver, antennae, and collar)
3. 4 Posters (as described below)
4. 3 Tables and 15 chairs (set up in a horse-shoe pattern)
5. Tracking materials (bin of substrate, paper, and ink pad)

Preparation

Engage:

Encourage audience members to participate by asking them if they would like to approach the table and hear about predators in Arizona? Once people are at the table you can ask them to touch or hold up each of the skins of the apex predators, and persuade them to make track prints in the soil or ink provided. Discuss the importance of teeth to mammals with the audience after showing the differences in teeth between felines, canines, and ursids. Get visitors to point out the different types of teeth on the skulls, and get them to predict what the animal eats based on the shapes/sizes/number of teeth present. Ask the question: “What does human dentition say about our dietary needs?” (answer: we have molars that are similar to bears, so we are omnivores). Encourage audience members to go home and look at the teeth and paws of their pet dogs and cats to see similarities with skulls and tracks presented.

Preparation:

Obtaining a “Bones Box” from the Arizona Game and Fish Department (phone number: 520-628-5376) or other collection of apex predator skulls and tracks will be necessary for the teeth and tracks discussion. Presenter will need to be able to explain difference in paw pattern, especially between felines and canines, and how that changes the track left by that animal. The ability to recognize the different kinds of teeth (incisors, canines, and molars) will be essential, especially recognizing the carnassial pair of Carnivores as this structure is used for shredding and cutting away pieces of flesh (Premolar 4 (P4) on upper jaw, Molar 1 (M1) on lower jaw). Presenter will be able to point out differences in the number of teeth between groups of predators, and be able to predict how carnivorous each species will be based on number, shape, and size of all teeth.

Lesson on teeth:

A dental formula is a standardized way of writing out the number of incisors, canines, premolars and molars on a skull. This is done by first writing the number of incisors on one side of the upper jaw over the number of incisors on one side of the lower jaw. Next, repeat the process for canines, premolars, and finally the molars. In order to get a total number of teeth for a skull, the values for both the upper jaw and lower jaw are added up and multiplied by two (to account for the other side of the skull). See example below:

one side of upper jaw	{	3	1	3	3	= 42 total teeth
one side of lower jaw	{	3	1	4	3	
		incisors	canines	premolars	molars	

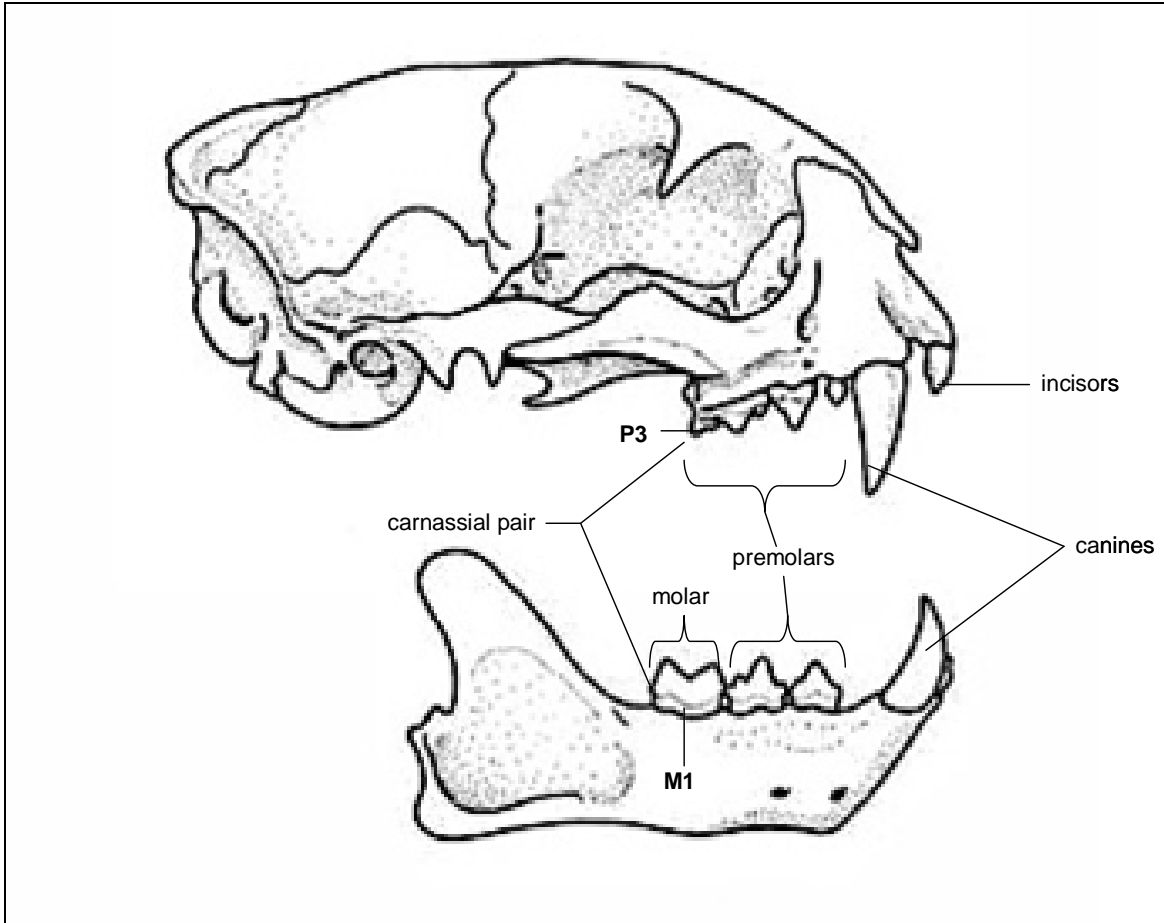
Lesson on Carnivore skulls:

Family Felidae:

This family is characterized by having very few teeth and a short, blunt face. The canines are long and sharply pointed, and the carnassial pair is very well developed. The upper molar is tiny and peg-like, and is not visible in the diagram below.

Dental Formula:

3	1	2/3	1	= 28 to 30 total teeth
3	1	3	1	



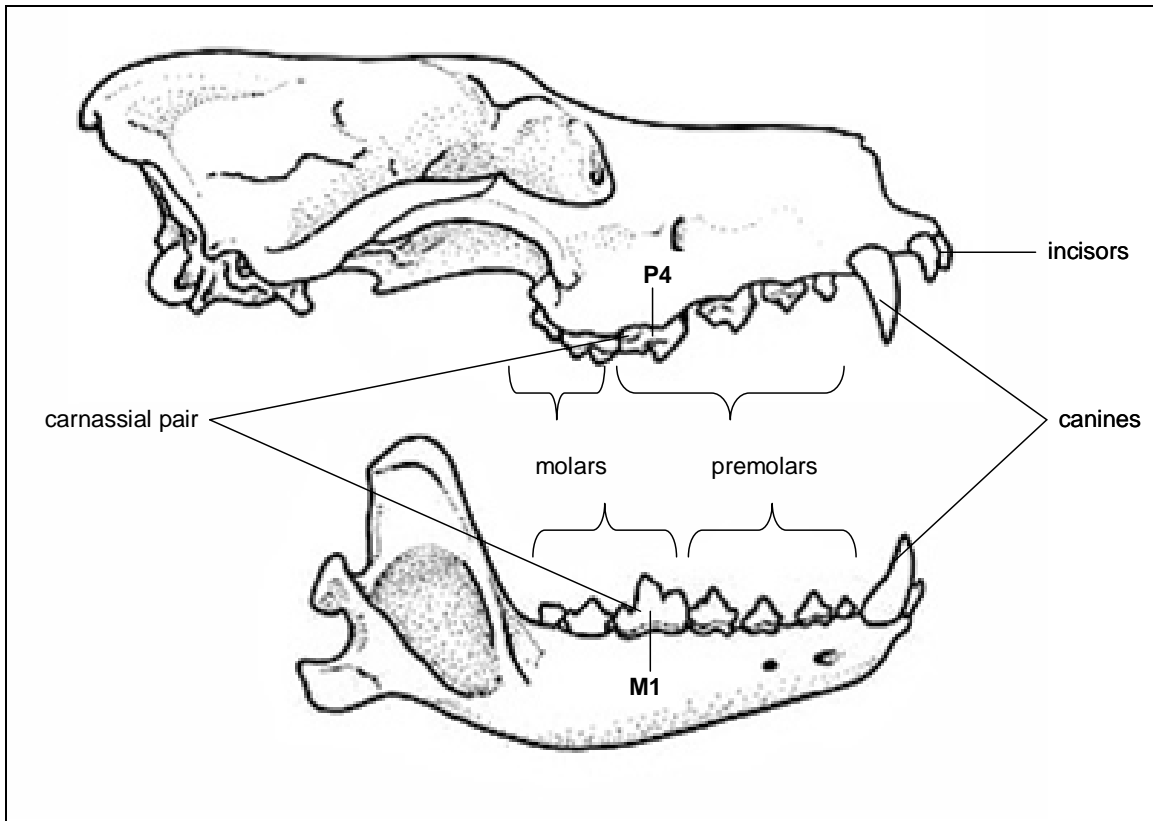
Felid skull diagram recreated from Lawlor 1979. P4 points to premolar 3 (or the last upper premolar) on the upper jaw, and M1 points to molar 1 on the lower jaw; the two teeth that make up the carnassial pair.

Family Canidae:

This family is characterized by having a long skull with a long, narrow nose. Canids have more teeth, and they are less specialized for killing prey and shredding flesh compared to Felids.

Dental Formula:

$\frac{3}{3}$	$\frac{1}{1}$	$\frac{4}{4}$	$\frac{2}{3}$	= 42 total teeth (usually)



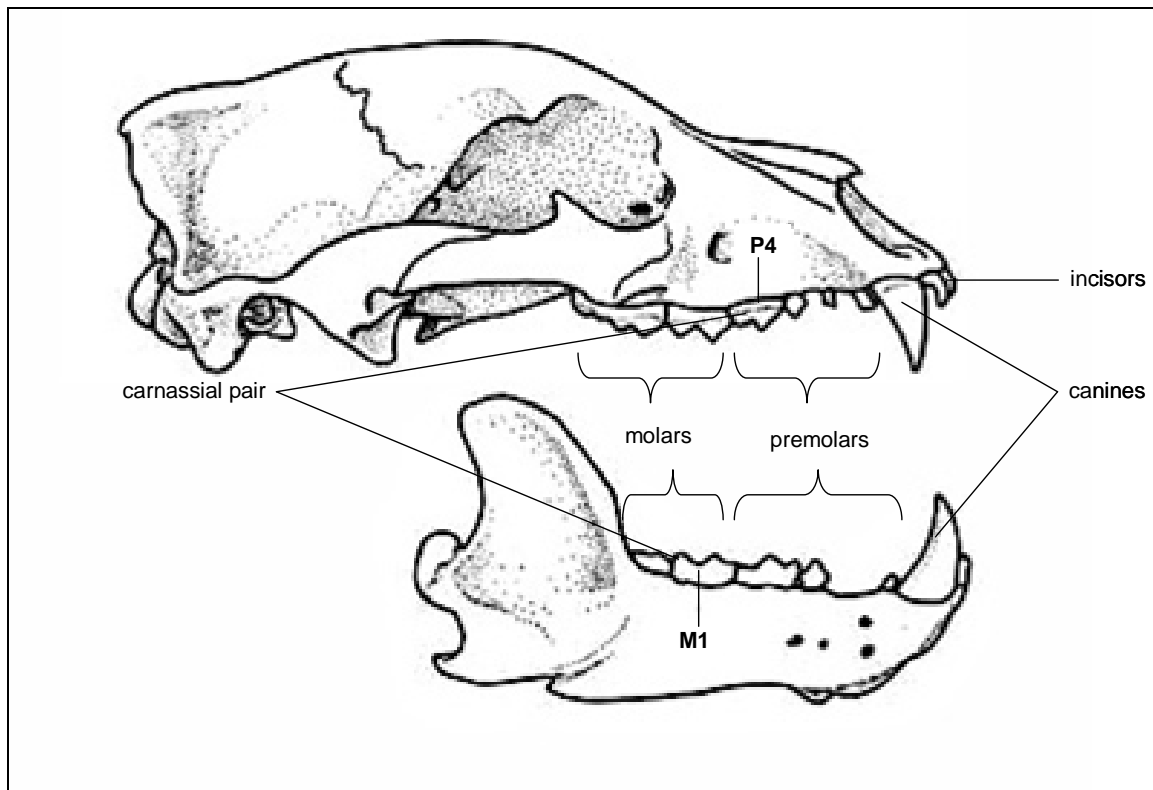
Canid skull diagram recreated from Lawlor 1979. P4 points to premolar 4 on the upper jaw, and M1 points to molar 1 on the lower jaw; the two teeth that make up the carnassial pair.

Family Ursidae:

This family is characterized by having a long, massive skull with a long, narrow nose. The carnassial pair is greatly reduced in comparison with Felids and Canids, having very flattened molar crowns and is reflected in a more omnivorous diet in bears. The three premolars are greatly reduced in size and are often absent.

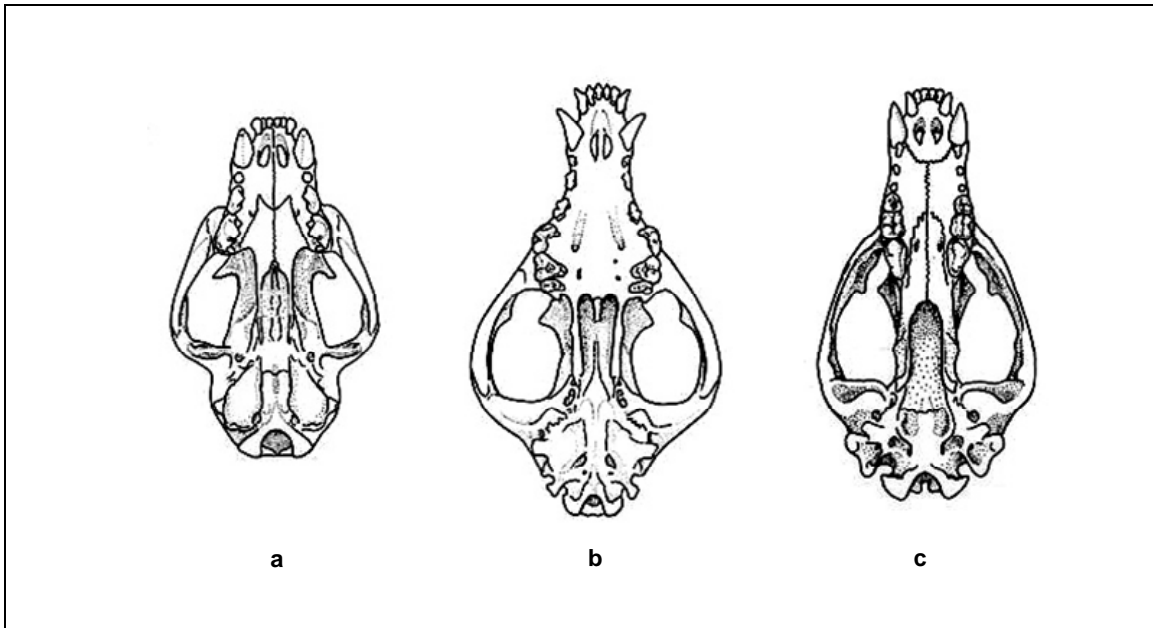
Dental Formula:

$\frac{3}{3}$	$\frac{1}{1}$	$\frac{4}{4}$	$\frac{2}{3}$	= 42 total teeth
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Ursid skull diagram recreated from Lawlor 1979. P4 points to premolar 4 on the upper jaw, and M1 points to molar 1 on the lower jaw; the two teeth that make up the carnassial pair, which is greatly reduced in bears and signals a more omnivorous diet.

Felid, Canid, and Ursid skulls together for comparison:



Felid (a), Canid (b), Ursid (c) upper jaw and skull viewed from below recreated from Lawlor 1979. Note the difference in skull shape, nose length, and relative molar size and shape. All of these characteristics are critical for identifying the differences between these three families.

Engage:

Start a dialogue with visitors about the influence apex predators have on the ecosystem after completing the “Oh Deer” activity. The activity should clearly demonstrate that without apex predators, the herbivore population continues to increase until all of the resources are consumed (an ecosystem collapse). What would this collapse do to other species, such as song birds? The introduction of apex predators should reveal the impact predators have on an ecosystem as the number of deer in the population is regulated and thus the resources continue to be available once a puma is added. The activity should help the audience comprehend that apex predators are indispensable to an ecosystem, and having one piece (species) missing from the puzzle (ecosystem) can have devastating results.

Preparation:

The “Oh Deer” activity requires little preparation. A clear understanding of the rules of the game and the expected outcomes for each part of the game are necessary, but no materials are needed. This activity will be performed only if a classroom or another group of at least 20 children (age 7-18) are present.

Step-by-Step Procedure for Activity*I. Presentation on Apex Predators and five Arizona species*

1. Open with a brief introduction to the five apex predators of Arizona and discuss the role of apex predators in the ecosystem. Posters and specimens will be incorporated into the presentation as needed.
2. Apex predators: Explain what an apex predator is and what role they play in the ecosystem while referring to food web diagram on poster. Discuss the flow of energy through an ecosystem while referring to trophic levels and pyramid diagram on poster. Point out how only 10% of the energy at each trophic level is available to the next level, and where the other 90% of the energy is consumed (heat, tissue maintenance, reproduction, movement etc.). Give details on ecosystem collapse in the absence of apex predators highlighting the diagram of an ecosystem with and without pumas. Talk about a case study in Yellowstone National Park with the reintroduction of gray wolves and the subsequent restoration of an entire ecosystem.

Make the point that increased herbivore populations pose a threat both to the ecosystem and to people (highway collisions). Every year there are approximately 1.5 million vehicle collisions with deer at a cost of \$1.1 billion in property damage and more than 150 deaths according to the Insurance Institute for Highway Safety. However, there has been an annual rise in the number of collisions with deer according to State Farm Insurance, with a 6% increase from 2005 to 2006 which equates to over 10,000 more accidents in a single year.

3. Mexican Gray Wolf: Highlight the natural history of the Mexican gray wolf, and explain the history of eradication and reintroduction effort on the Arizona/New Mexico border. Note the current legal status of the Mexican wolf and what to do in the event of a wolf encounter.
4. Bears: Highlight general natural history of bears, and then focus on differences between grizzlies and black bears. Discuss the historical range and extirpation of grizzlies from Arizona, and the history of black bears in Arizona with a concentration on black bears today. Explain what to do in an encounter with either a grizzly or a black bear, and note the important differences in dealing with both.
5. Cats: Highlight general natural history of large felines, and then focus on differences between jaguars and pumas. Discuss the history of jaguars in the Southwest and the potential impact the new US/Mexico border fence will have on jaguar persistence in Arizona. Give the history of puma management in Arizona, and the future the puma faces in the Southwest. Explain what to do and what not to do in an encounter with a wild mountain lion.
6. Specimens: Discuss the importance of dentition for determining diet, and point out differences in tooth morphology between taxonomic groups (bears, cats, dogs). Invite visitors to touch skins and skulls and see the animals up close. Once at the tables, demonstrate differences in tracks and explain the art of tracking (see tracking reference). Encourage participants to make track stamps in substrate provide and with ink (to take home).
7. Field Methods: Discuss the importance of field research in designing management and conservation plans for apex predators. Focus on the information provided by radiotelemetry and show equipment while explaining how radiotelemetry works.

II. "Oh Deer" Activity

1. Split the audience into two groups (25% of the group are deer, 75% of the group are resources which are food, water and shelter)
2. Have the two groups face away from each other, and as individuals decide what they want to be (resource group) and what they want to acquire (deer group).
3. Once everyone is ready, have both groups turn to face each other, and the deer need to run over to the resource that matches them, i.e. Has the same hand signal as them (if they wanted water, they need to run to a person in the resource group that is water). They need to grab that resource and bring it back to the deer group's side. Once there, the resource becomes a deer. Repeat until all the resources are gone (simulating an ecosystem collapse).
5. Now, choose a person to play a mountain lion, and have the rest of the people reset in their original groups. Play the game again, but the lion is able to tag the deer (simulating the lion eating the deer, and the rest of the deer decomposing to replenish the producers) as they travel to and from resources. The impact of lion on the ecosystem should be apparent when the resources

are more regulated and the population fails to crash (simulating ecosystem regulation by an apex predator).

Images, Worksheets, Weblinks, etc.

Four posters to support our presentation; one poster introducing apex predators and their role in the ecosystem with an explanation of breakdown of ecosystem function with the removal of apex predators, one poster focusing on the Mexican wolf's history, natural history, and reintroduction, one poster focusing on the large cats of Arizona: the jaguar and puma with information on history, natural history, and current challenges faced by both species, and finally a poster on the ursids of Arizona including historical information on the grizzly bear's presence in Arizona and natural history of both the grizzly and American black bear.

Items for Discussion

We have a several questions we can ask the audience to encourage participation and evaluate our content delivery. These include:

1. How do apex predators help maintain a healthy ecosystem?
2. What happens to herbivore populations when predators are removed?
3. What happens when there are too many herbivores?
4. How can one species of herbivore impact another species of herbivore?
5. What happened to the grizzly bear in Arizona, and do you think anything should be done do restore the grizzly to Arizona?
6. What should you do if confronted by a mountain lion?
7. How could the border fence affect jaguars in Arizona? ...What other species might be affected?

Assessment

Our workshop did meet our goals for outreach and education, and the arrangement of hands-on materials appeared to attract some visitors to approach our table and interact with us. The rest of the visitors had to be encouraged to approach our table by starting a conversation. The ability to have visitors touch specimens including skins and skulls was critical in alluring visitors to listen to our overall message about the role of apex predators in the ecosystem. Visitors were very engaged in learning about these magnificent animals despite inherent fears associated with top carnivores. We feel our message clearly supports the need to have these predators present in our ecosystems. Our posters acted as excellent support props when we were referring to change in historic ranges of species and being able illustrate ecological concepts.

Goal A: To get the audience to understand the role apex predators play in a functioning ecosystem and the devastating ecological effects of removing them; hopefully instilling a desire to conserve and protect carnivores.

Our workshop met this goal effectively with real world examples including the Yellowstone ecosystem and diagrams on our apex predator poster. Demonstrating the natural beauty of Arizona's apex predators hopefully helped instill a greater desire to protect carnivores and other wildlife.

Goal B: Introduce the audience to the history, natural history, and future of Arizona's apex predators.

Many visitors were surprised to learn that grizzly bears were once present in Arizona, and some were also unaware of the presence of Mexican wolves and jaguars in our landscape. We were able to share a lot of natural history and history about Arizona's apex predators, and had ample opportunity to raise concerns for the future of these animals in Arizona. Our workshop led to many conversations about the impact the border wall, ranching, hunting, and habitat fragmentation have on carnivores in Arizona.

Goal C: Get the audience to recognize differences and similarities between apex predators found in southwest.

When presenting information on the natural history of apex predators, we were able to discuss differences between the two bear species including physical and behavioral characteristics. We spent time comparing skulls from canids, felines, and ursids; comparing sensory adaptations, diet, and size. We also discussed the behavioral adaptations pumas possess that have enabled them to survive predator persecution when other species have not.

Goal D: To instill a general respect, appreciation, a sense of wonder for large carnivores and biological diversity.

The skins, skulls, and tracks were critical in achieving this goal because visitors were able to pick up and feel parts of these animals. Visitors were fascinated by these specimens, and generally amazed that we have such an incredible diversity of wildlife in our state.

Goal E: To foster a sense of humans belonging in the environment, and realization that their actions influence the natural world.

Many visitors asked "what can I/ we do?" giving us a clear indication that we had reached them and that they saw the importance of our message. The border fence really seemed to be an issue that ignited a sense of duty for visitors to take action against a barrier for jaguars and other wildlife. We were able to give people advice on groups to contact, such as the local Sierra Club about the border fence, having handouts with this type of information would have been helpful, and may have encouraged more people to follow though after returning home.

Beyond the Activity

(Further activities which relate to and extend the complexity of the experiment)

This activity could prompt more thorough discussions on the ecological role of carnivores, environmental consequences of their extirpation, and factors that prohibit functional carnivore populations. Such questions could include but are not limited to: What could be done to restore/protect other apex predators in Arizona? If scientific data supports reintroducing grizzlies into Arizona, what other barriers could prohibit them from being reintroduced (social, monetary, etc.)?

More broadly, this activity could promote discussions on ecology and ecosystem processes including energy flow, nutrient cycling, and ecosystem services. Human impacts on all of these topics would be an important additional discussion.

This could also promote a section on comparing similarities between human/carnivore conflicts worldwide, conservation of prey species, and phylogenetics of the Order Carnivora. We could also discuss the benefits carnivores provide to humans beyond their ecological function (spiritual, aesthetic, etc.)?

Resources

Web Resources

(Web addresses with information on the topic of the activity)

General Information on Apex Predators

IUCN's Redlist of threatened/endangered species: <http://www.iucnredlist.org>

Carnivora Species Information: <http://www.lioncrusher.com/animalinfo.asp>

Lords of Nature Film Website: <http://lordsofnature.org/>

Tracking

Tracking: <http://www.princeton.edu/~oa/nature/tracking.shtml>

Learn to track: <http://42explore.com/animaltracks.htm>

Canines

USFWS Mexican Wolf Program: <http://www.fws.gov/southwest/es/mexicanwolf>

Lobos of the Southwest: <http://www.mexicanwolves.org/>

AZGFD Mexican Wolf Management: http://www.azgfd.gov/w_c/es/wolf_reintroduction.shtml

Defenders of Wildlife Wolf Page:

http://www.defenders.org/programs_and_policy/wildlife_conservation/imperiled_species/wolves

Felines

Defenders of Wildlife Jaguar Page:

http://www.defenders.org/wildlife_and_habitat/wildlife/jaguar.php

AZGFD Jaguar Management: http://www.azgfd.gov/w_c/es/jaguar_management.shtml

Mountain Lion Foundation: <http://www.mountainlion.org/index.asp>

AZGFD Urban Puma Page: http://www.azgfd.gov/w_c/urban_lion.shtml

Ursids

Defenders of Wildlife Grizzly Bear Page:

http://www.defenders.org/wildlife_and_habitat/wildlife/grizzly_bear.php?ht

USFWS Grizzly Bear Page:

<http://www.fws.gov/mountain-prairie/species/mammals/grizzly/index.htm>

AZGFD Urban Black Bear Page: http://www.azgfd.gov/w_c/urban_bear.shtml

Additional References

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Key Words/Glossary

Apex predator – animal at the top of the food chain

Canid/Canine – member of the dog family Canidae (includes wolves, foxes, coyote)

carnassial pair – the fourth upper premolar (P4) and the first lower molar (M1) make up a pair of teeth that act like a pair scissors for the species in the Order Carnivora

Carnivore – a mammal in the order Carnivora

carnivore – an animal that eats other animals

ecological release – restrictions of a species' niche are reduced due to the removal of a competitor

Felid/Feline – member of the cat family Felidae (includes puma, jaguar, bobcat)

herbivore – an animal that eats primary producers (plants)

Mesopredator – secondary consumer, generally a medium sized mammal (ex. coyote)

niche – the ecological role of a species in a community

omnivore – an animal that eats both plants and animals

Primary producer – An organism that makes its own energy (the role of plants in an ecosystem)

Primary consumer – An organism that gets its energy from eating a producer (the role of herbivores in an ecosystem)

Top-down regulation – the apex predator (TOP of the food chain) regulate the populations of prey (DOWN lower on the food chain).

Trophic level – Sections of a food chain/web that represent the flow of energy through an ecosystem.

Ursid – A member of the bear family Ursidae (includes grizzly, black bear, polar bear)

English to Spanish Phrases for the Workshop

Carnivore – *carnivoro*

Top carnivore – *predadores*

Predator – *de predador*

Mexican wolf – *lobo Mexicano*

Bear – *oso*

American Black Bear – *oso negro Americano*

Grizzly Bear – *el oso pardo*

Jaguar – *el tigre or jaguar*

Mountain Lion – *puma*

Important to the ecosystem - *importante para el ecosistema*

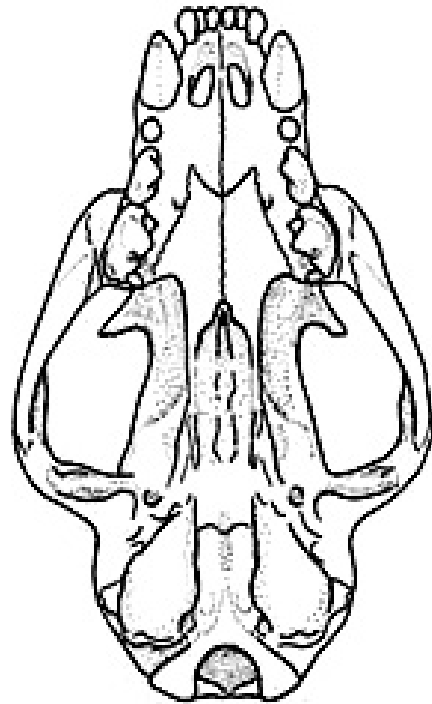
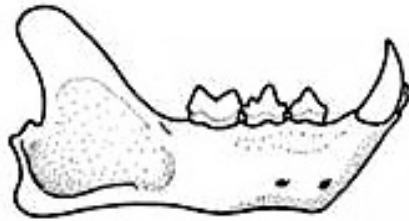
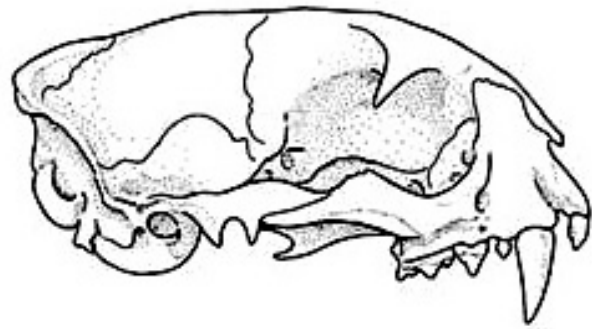
Predators are very important to the ecosystem - *Los depredadores son muy importantes para el ecosistema*

Acknowledgements

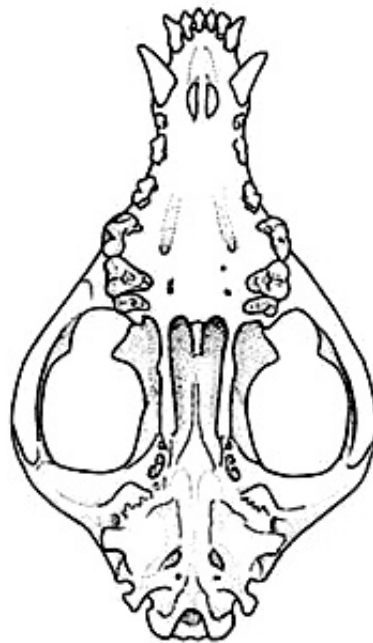
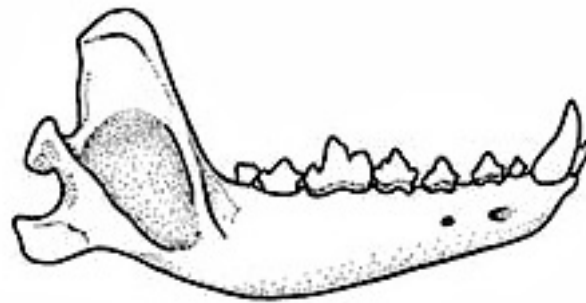
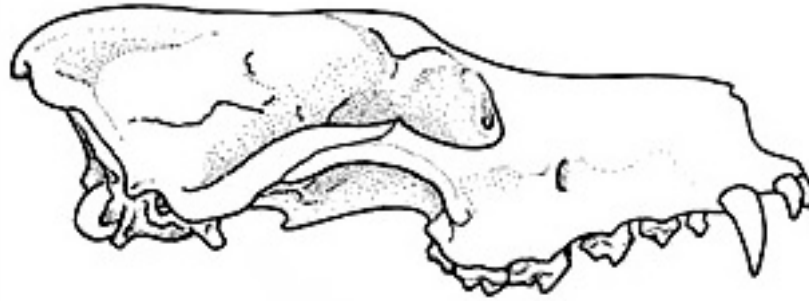
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Appendices

Appendix 1. Unlabeled Felid skulls recreated from Lawlor 1979 (not to scale).



Appendix 2. Unlabeled Canid skulls recreated from Lawlor 1979 (not to scale).



Appendix 3. Unlabeled Ursid skulls recreated from Lawlor 1979 (not to scale).

