4. Amazing Adaptations
(2) Reading Skulls

*Animal **skulls** contain valuable information about how wildlife has adapted to living in their **habitats**. (Field Trip / 60 minutes)*

Connecting with Science Standards			
Strand/Category	***Grade***	***Standard(s)***	***Benchmark(s)***
Life Science	4/5	Form, structure, function	Food webs, senses, behavior

Goal: By studying animal skulls, students will be able to identify local wildlife, understand what and how they eat, describe how they use their senses, determine when they are most active, and discuss how they defend themselves.

Objectives:

- Understand and identify skulls of **carnivores, herbivores** and **omnivores**.
- Define and identify ***nocturnal*** and ***diurnal*** animals.
- Understand and explain how an animal uses its sense of smell.
- Learn how an animal hears by studying its auditory bones.
- Define and distinguish ***predators*** from ***prey.***

Materials:

- Replicas or actual skulls of mule deer, raccoon, muskrat, bobcat, coyote, cottontail rabbit, wood rat.
- Animal photos/posters for each corresponding skull
- Student worksheets
- Pencils

Background

Animal skulls are great tools for teaching about the diversity of wildlife and the special role each animal plays in its natural environment at Bottomless Lakes.

Many interesting relationships between animals are revealed by studying their skulls. Skulls also give us clues about how the animal is adapted for survival in its environment.

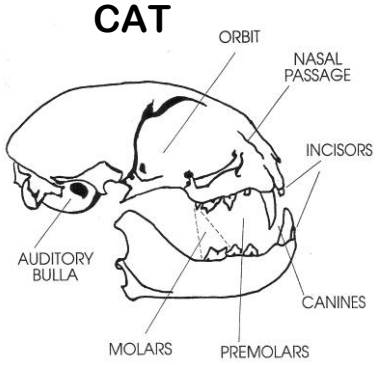
Teeth, eye sockets, nasal passages, auditory bones, horns/antlers, and the individual plates of the skull tell us what it eats, when it is most active, how it sees and smells, whether it's predator or prey, its age and sometimes even its sex.

The following diagrams and explanations will help you become better-acquainted with the different characteristics of skulls.

Christopher Leinonen

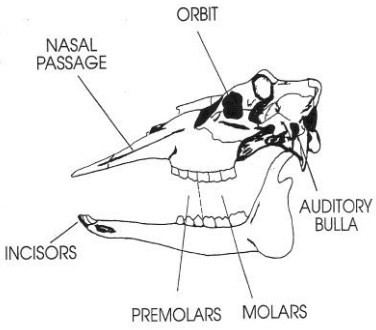
Teeth
The teeth in an animal skull can tell us whether the animal was a *carnivore*, *herbivore* or an *omnivore*.

CAT



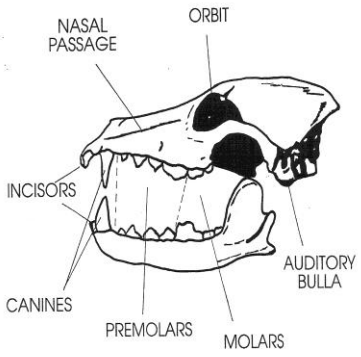
Carnivore: (meat eater – bobcat, mountain lion)
Carnivores have comparatively small, less developed *incisors*. *Incisors* play a minor role for carnivores, such as for grooming. The *canines* are large, long and pointed for piercing and holding prey. Cheek teeth (*pre-molars* and *molars*) are sharp and pointed for cutting and tearing flesh. Some of these upper teeth overlap lower teeth, providing a scissor-like shearing action to cut meat. These teeth are referred to as *carnassials*. With overlapping cheek teeth and long canines, carnivores do not have the ability to move the lower jaw from side to side in a chewing motion. Carnivores are predators (they kill and eat other animals) and tend to bite, tear and gulp food without any chewing action. The meat-eater's teeth tend to be clean and white because they are not stained by chemicals in plant material.

DEER



Herbivore: (plant eater - mule deer, jackrabbit)
*Herbivore*s have large, well developed *incisors* for cutting plant material. Their *canines* resemble *incisors* in form and function. Most ruminant (cud chewing) *herbivores* (deer, sheep, cattle, etc.) do not have upper *incisors* or *canines*. Instead, they have a hard upper *palate* that serves as a "cutting board" for the lower *incisors* to cut through plant stems. This arrangement permits the rapid ingestion of large amounts of plant material. Ruminant animals often seek cover after eating to regurgitate and chew their cud while watching for predators. *Herbivore* cheek teeth are large and wide with high, sharp crowns for grinding and chewing plant material. Instead of overlapping, the cheek teeth make surface contact to create a grinding action. Unlike predators, *herbivores* have side-to-side movement of the lower jaw and are able to chew food. This chewing, grinding action causes their teeth to wear with age. *Herbivore* teeth are often stained from substances in plants.

COYOTE



Omnivore: (plant and meat eater – coyote, gray fox, raccoon)
As might be expected, *omnivores* have a combination of *carnivore* and *herbivore* teeth characteristics. *Omnivores* have fairly large and well developed *incisors* for cutting plant material. The *canine teeth* are long and pointed for catching and killing prey. Cheek teeth are a combination of sharp, scissor-like *carnassials* for shearing meat, and teeth with more rounded *cusps* for grinding and crushing plant material. There is surface contact between some upper and lower *molars*. *Omnivores* (except some primates) do not have side to side lower jaw movement. Rather than chewing, their cheek teeth perform both shearing and crushing actions. Many *omnivores* are either predominately meat-eaters or predominately plant-eaters. The cheek teeth of these animals can usually tell us their predominant feeding strategy. For example, the coyote is an *omnivore* that is predominately a meat eater and has cheek teeth very similar to a *carnivore*. However, the coyote's most *posterior molars* have rounded *cusps* for grinding and crushing plant material.

Reading Skulls Background Information

Nasal Passage	Eyes
The relative size of the *nasal passage* on a skull is an indication of the animal's sense of smell. The thin bony structures inside the *nasal passage* (nasal turbinates) provide the framework for membranes which sense odor. The greater the size of these structures the greater the sense of smell. The short *nasal passages* of cat skulls tell us that cats do not have a very good sense of smell compared to many other animals and rely more on other senses to locate prey. Conversely, the long *nasal passage* of a coyote indicates that coyotes have a very keen sense of smell and that this sense is important to the coyote's survival.	The size of the *orbits* (eye sockets) in relation to the overall size of the skull, is generally proportional to the sharpness of the animal's eyesight. The larger the *orbits*, the better the eyesight of the animal. As an example, mountain lions (and most cats) have very large *orbits* and hence, very acute vision. The large eyes of cats, and many other *nocturnal* animals, play a role in their keen night vision.

Auditory Bullae

The *auditory bullae* ("bully") are the bony portions of a skull that encase structures of the inner and middle ear. In general, the larger, more inflated, this structure the greater the sense of hearing. Cats have comparatively large, inflated *auditory bullae* and very acute hearing. Although their hearing is much better than a human's, deer and elk have a relatively poor sense of hearing as compared to that of a cat.

Characteristics for Survival

All of the characteristics discussed here are elements of survival. The particular combination of characteristics that an animal has determines how that animal survives. Ruminant *herbivores*, such as deer and elk, are able to ingest large amounts of food and retreat to cover to regurgitate and chew this food (chew their "cud") while hiding from predators. These *herbivores* are equipped to detect predators with keen senses of hearing and smell along with *monocular vision* which provides for a wide field of vision. When predators attack, the *herbivores* best defense is their fleetness of foot.

Carnivores that would prey upon these *herbivores* are equipped with large *canine teeth* to capture and kill them. These predators have *orbits* forward on their skulls and thus *binocular vision*, which permits better depth perception. *Omnivores*, with the ability to eat both meat and plants, have a wider choice of food sources than strict *carnivores* or *herbivores*.

An example of one of the most successful animal survivors is the coyote. Coyotes are currently found in all the contiguous United States, throughout Canada, north to near the Arctic Circle and south to the Panama Canal. Within this extensive range of climates, this animal is found in remote wilderness and in large urban areas. Because it is an *omnivore* and can eat almost anything, coyotes are highly adaptable to just about any setting. Their excellent senses of sight, hearing and smell help them find food and avoid danger (coyotes living in mountain lion country are often preyed upon by these big cats).

Bobcat

Mule deer

Coyote

Photos by Robert Shantz

Predator and Prey Characteristics

Predators are animals that eat other animals and prey are animals that are eaten by other animals. Predators can also become prey. Predators are always *carnivores* or *omnivores*, whereas prey may be *carnivores*, *herbivores* or *omnivores*. When examining skulls to determine predators, we look for the teeth characteristics of a *carnivore* or an *omnivore*. If the teeth characteristics of a skull are strictly those of an *herbivore*, we consider the animal to be a prey species.

There is another skull characteristic that is very useful in determining predator/prey classification. This is the location of the *orbits* (eye sockets.) Most all predators have the eyes located in a forward position on the skull. Forward eye placement provides the animal with a greater degree of *binocular vision*. *Binocular vision* means that both eyes focus on an object providing the animal with a greater ability to judge distance (depth perception).

Binocular vision is an advantage when attacking prey and an important element of a predator's survival. *Herbivores* are strictly prey and most have *orbits* located on the side of the skull. This placement limits *binocular vision*, but enhances the animal's field of view or peripheral vision. These *herbivores* have *monocular vision* which means that they can see an object with only one eye. With *monocular vision*, each eye has a field of view of almost 180 degrees. Therefore, by using both eyes, these animals almost have a 360 degree field of view.

This field of vision provides the animal with a greater ability to locate predators and is an important element of their survival. In some *herbivores,* there is some overlap in the field of view and these animals may have partial *binocular vision*.

Procedure I - Chew On This: Carnivore, Herbivore or Omnivore?

1. Choose one skull to represent a carnivore, an herbivore and an omnivore. Best options are as follows:

Carnivore	*Herbivore*	*Omnivore*
Bobcat	*Mule deer*	*Coyote*
Mtn lion	*Jackrabbit*	*Gray fox*
		Raccoon

2. Ask the following questions with the appropriate skull. Do no identify the animal at first – students will have their chance to do so after all three skulls have been examined.

Carnivore skull(bobcat or mountain lion)

Q: Why are the *canine teeth* so long and pointed?
A: The canine teeth are used for piercing and holding other animals.

Q: Why are the *incisors* (smaller teeth in front) relatively small and short?
A: Incisors play a minor role for this animal – such as grooming.

Q: Why are the cheek teeth (*pre-molars* and *molars*) sharp? Why do they overlap?
A: The molars are used for cutting and shearing meat in a scissor-like action.

Q: Can this animal *chew?*
A: The long canine teeth and the type of lower jaw prevent this animal from having side-to-side movement of the lower jaw. This animal bit, sheared and gulped its food.

Q. Is this animal a carnivore, herbivore or omnivore?
A: This animal is a CARNIVORE. Carnivores kill and eat other animals.

Herbivore Skull (mule deer, pronghorn, jackrabbit)

Q: Compared to the first skull, are these *incisors* larger or smaller?
A: The incisors are relatively large and well developed.

Q: What are these *incisors* used for?
A: They are used as blades for cutting plant parts and stripping away leaves.

Q: Do these *canines* look like the *canines* in the first skull?
A: No. They resemble and function as incisors – no need for long, pointed canine teeth.

Q: Do the cheek teeth (*molars* and *pre-molars*) look like the first skull?
A: No, they are large, high and wide for grinding and crushing plant materials.

Q: Do the upper and lower cheek teeth overlap?
A: No. The upper/ lower molars fit together to provide grinding and crushing surfaces.

Q: Could this animal chew?
A: Yes - it could move its lower jaws in a side-to-side, chewing motion.

Q: Notice there are there no upper *incisors* or *canines*. Why not?
A: Most ruminant (cud chewing) animals (deer, sheep, cattle.) have a hard palate that serves as a "cutting board" for the lower incisors to cut grass and other plant materials and to strip leaves off branches.

Q: Is this animal a carnivore, herbivore or omnivore?
A: This animal is an HERBIVORE. Herbivores eat plants.

<u>Omnivore skull:</u> (coyote, gray fox, raccoon)

Q: Why are the *canine teeth* long and pointed?
A: *The long, well developed canines are used for capturing and killing other animals.*

Q: How do the *incisors* compare to the first two animals?
A: *The incisors are relatively large for cutting plants and stripping leaves.*

Q: How do the cheek teeth compare?
A: *This animal has both high crowned cheek teeth with sharp edges for shearing meat, and cheek teeth with wider crowns to crush bone and plant parts. Look closely at the back molars. They look very similar to ours. Humans eat both meat and plants.*
Q: Why don't we have long *canines*?
A: We do not kill and capture animals with our teeth.

Q: Is this animal a carnivore, herbivore or omnivore?
A: This animal is an ***OMNIVORE.*** *Omnivores* eat both plants and animals.

3. Now that skulls have been separated into carnivore, herbivore, and omnivore, allows students the opportunity to identify the skulls.

4. Discuss with students predators and prey and discuss which skulls may represent a predator and/or prey animal. *Caution:* some animals may be predators of smaller animals, but may in turn become prey for larger animals. For example, bobcats and coyotes both prey on smaller animals, but are often preyed upon themselves by mountain lions. Some predatory animals will also scavenge carrion – the carcasses of dead animals (i.e., bears and coyotes).

***Extension* – Mystery skulls**

Students will apply their knowledge of the primary characteristics of an animal skull that were used to determine if the animal is a *carnivore*, *herbivore* or *omnivore*.

1. Set-up numbered stations using skulls that were not used initially.

2. Divide students into equal-numbered teams with one group at each skull location. Distribute worksheets (and pencils, if necessary).

3. Ask students to examine the skull at their location and record their observations on the worksheets by skull number.

4. Teams rotate to the next skull location until they have visited all stations.

5. When worksheets are completed, ask for volunteers or call on students to share with the class their answers.

6. Proceed through the answers for each animal represented. Show photos/posters of each animal as it is identified.

AMAZING ADAPTATIONS / Reading Skulls
Vocabulary

Carnivores: any animal with a diet consisting mainly of meat, whether it comes from animals living (predation) or dead (scavenging).

Diurnal: active during the daytime and sleep at night.

Habitats: an ecological or environmental area that is inhabited by a particular animal or plant species. It is the natural environment in which an organism lives, or the physical environment that surrounds a species population.

Herbivores: an animal that is adapted to eat plants and not meat. Herbivores form an important link in the food chain as they transform the sun's energy stored in the plants to food that can be consumable by carnivores and omnivores up the food chain. As such, they are termed the primary consumers in the food cycle (chain).

Nocturnal: active at night and sleep during the daytime.

Omnivores: an animal that eats both plants and animals as its primary food source. They are opportunistic, general feeders not specifically adapted to eat and digest either meat or plant material exclusively.

Predator: an animal that hunts, feeding on its prey.

Prey: an animal taken by a predator as food.

Skull: the bony skeleton of the head of vertebrates

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Teacher Evaluation

Your feedback will help make the Outdoor Classroom Program a long-lived success. Please help us improve this activity and the BWBL curriculum by taking a few minutes to provide some constructive answers to the questions below.

Date of field trip:_____ Location of field trip: _____

School/City: _____ Grade: _____ # students: _____

Your name: _____ Your phone or email: _____

1. In what capacity did you use this activity? (please check one) ____ field trip _____ classroom (pre- or post-field trip)
2. Who led the activity? (please check one) ____you _____another teacher _____agency staff
3. Please rate your overall impression of this activity.

1 2 3 4 5 6 7 8 9 10 (please circle one)
Poor Good Excellent

4. How well do you think it met the stated Goals/Objectives on the front page of the activity?

1 2 3 4 5 6 7 8 9 10 (please circle one)
Poorly Fairly well Right on target

5. How well did it compliment/support classroom study?

1 2 3 4 5 6 7 8 9 10 (please circle one)
Poorly Fairly well Right on target

E1. What do you believe your students gained from this activity in terms of learning?

E2. How did you assess learning from this activity?

E3. What would you suggest as a practical assessment for future revisions of this activity?

E4. What else would you suggest to improve this activity and/or the BWBL curriculum?

Please fax this completed form to (505) 476-3361, Attn: Outdoor Classroom Program

AMAZING ADAPTATIONS
Mystery Skull Worksheet

Team/Name _____ **Date:** _____

SKULL NUMBER _____

Please answer these questions by studying the following things about each skull:

1. Teeth

Is there side to side movement of lower jaw? Yes___ No___

How would this help the animal?

What is this animal? Carnivore ___ Herbivore ___ Omnivore___

2. Hearing

What is the size of auditory bullae? Large ___ Small ___

How does this help the animal?

3. Smell

What is the size of the nasal passage? Large ___ Small ___

How does this affect the animal's sense of smell?

4. Eyesight

What is the size of the eye orbits? Large ___ Small___

Where are the eyes placed? Forward ___ On the side ___

How do these things help the animal?

5. What type of animal is this? Predator ___ Prey ___ Both ___

6. Which animal is this?

Muskrat ___ Wood rat ___ Cottontail Rabbit ___ Raccoon ___