



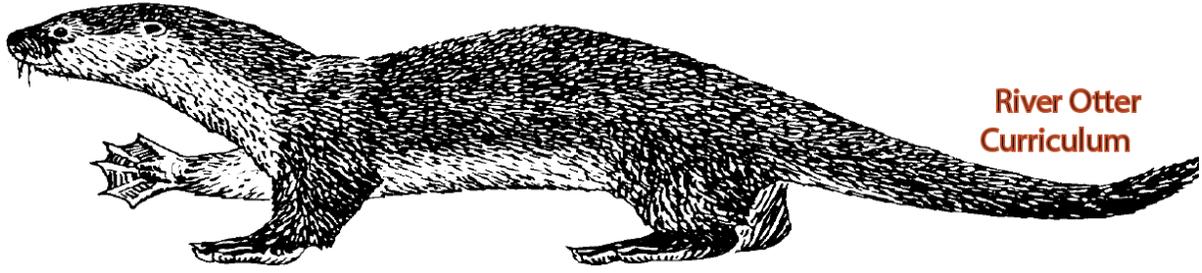
RUNNING WITH RIVER OTTERS
A River Otter Curriculum Commissioned by
Amigos Bravos, July 2013

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Running with River Otters: K-12 Curriculum

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Introduction

This curriculum was commissioned by Amigos Bravos and the Friends of the River Otter, a group of individuals and organizations that support the conservation and reintroduction of river otters in New Mexico. The curriculum contains 10 lessons, with 5 written for grades K-5 and 5 for grades 6-12. It also provides extensions and linkages between lessons. Lessons are aligned to New Mexico state standards and benchmarks, with a primary emphasis on science, visual arts, and language arts. Specific background and relevant content are provided in each lesson. Lessons are intended to be used sequentially, so that material builds on itself, starting with a simple understanding and appreciation of river otters, and moving into more complex ideas of habitat, ecological relationships, and species reintroduction. An appendix provides supplemental materials and templates for ease of copying. A materials trunk is also available to use with the curriculum from the Upper Gila Watershed Alliance.

Range of the River Otter

Otters live on just about every continent in the world. The North American river otter (*Lutra canadensis*) was once present throughout most of North America. While exact numbers are not known, accounts of river otters are found throughout the United States during times of European settlement. In the 1700s and 1800s, people trapped river otters, along with beavers and mink, for their lush fur. Large scale trapping as well as water pollution (from mining and settlement) resulted in their decline. The last known river otter in New Mexico was found dead in a trap along the Gila River in 1953. Today, the river otter has recolonized or been reintroduced to many areas of the continent (Figure 1), including parts of northern New Mexico.

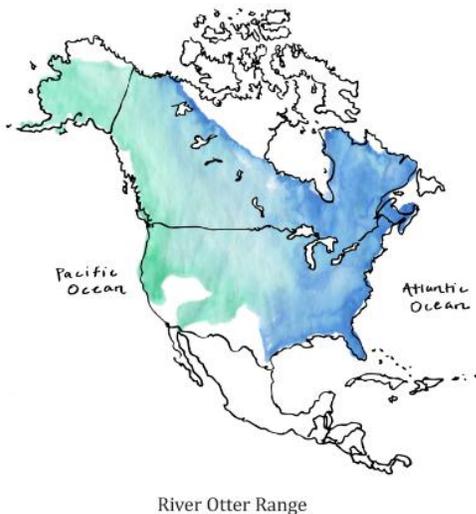


Figure 1. Map of North America, showing range of North American river otter (*Lutra canadensis*). The range map shows the current range of river otters. However, much of the inter-mountain west, the river otter is considered threatened or endangered. It is a federally listed as a threatened species in Colorado, Nebraska, and South Dakota. It is protected in Kansas and Wyoming, and until recently, had been extirpated from New Mexico.

Reintroduction of the River Otter

River otters are present in stories and culture from many parts of the United States. They are playful swimmers and sliders as well as top predators in river ecosystems. These semi-aquatic animals are thought to play an important role in the maintenance of trophic levels within river systems. Many western states have successfully introduced river otters, including Utah, Colorado, Arizona, and northern New Mexico. Efforts to reintroduce the river otter to the Gila River met opposition because of the large number of endangered fish species in the river. River otters eat fish, so there is natural concern that they could adversely affect species recovery. However, most assessments find that the river otter is not only *unlikely to hurt* the endangered fish, either because of these fish's habitat preferences or their small size, but also *may help* these fish by eating larger predatory fish, such as suckers or bass.

Matrix of Activities by Grade

The curriculum provides 5 activities for each grade grouping (K-5 and 6-12). Some activities will require multiple sessions to complete. Each grade grouping has one field-based activity. The rest are classroom based. For grades 4-5, some of the activities designed for grades 6-8 may also be appropriate, depending on the structure and composition of a classroom. Similarly, some of the activities designed for grades 4-5 may be extended or adapted to older grades. The Self-Portrait as Otter activity was written for Grades K-12.

Activity	Grades K-5	Grades 6-12
Word Paint Otter	X	
Self Portrait as Otter	X	X
Habitat Hunt	X (Field activity)	
Cog and Wheel Game	X	
Diorama	X	
Otter Stories		X
Reading the River		X (Field Activity)
Habitat Mosaics		X
Cog, Wheel, and Carnivore		X
Neighbors to the North		X

Curriculum Trunk

The curriculum trunk includes books, specimens, a DVD and color plates that are associated with and provide additional resources to the curriculum.

Materials directly associated with activities in the curriculum:

- *River Otter at Autumn Lane: A Smithsonian's Backyard Book* by Laura Gates Galvin and Christopher Leeper
- *Playful Slider: The North American River Otter* by Barbara Juster Esbensen
- *Otter and Odder* by James Howe

- *Mixed Media Self-Portraits* by Cate Coulacos Prato
- River otter skull replica
- River otter and beaver hand puppets
- Color plates of river otters
- Color plates for self-portrait activity
- Color cards for Habitat Hunt, Cog and Wheel, Reading the River, and Cog, Wheel and Carnivore activities

Additional materials that support the curriculum (but are not directly linked to an activity):

- *Otters Under Water* by Jim Arnosky
- Seasons of the Otter DVD
- River otter track replicas
- River otter track molds

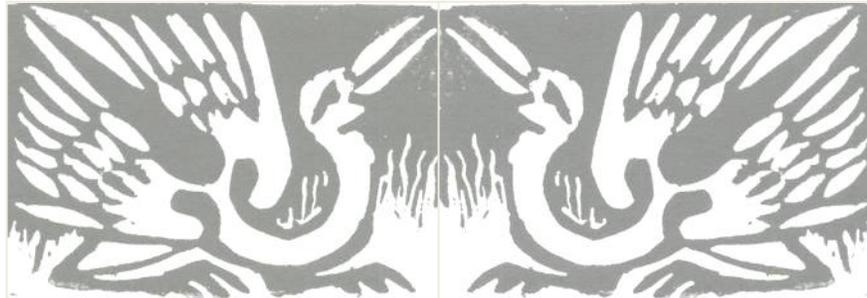
For More Information

To learn more about river otters and their restoration, please contact:

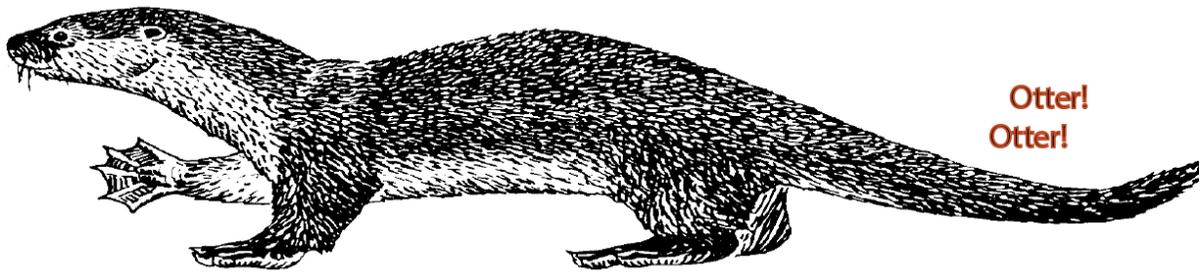
New Mexico Friends of River Otters
 c/o Amigos Bravos
 P.O. Box 238
 Taos, NM 87571
 Telephone: 575.758.3874
 Email: bravos@amigosbravos.org
 Website: http://www.amigosbravos.org/river_otter.php

Upper Gila Watershed Alliance
 PO Box 383, Taos, NM 88038
 Telephone: 575.590.5698
 Website: <http://ugwa.org/>
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Crane Collaborations



Lesson 1: Otter! Otter! Word Paint Otter

Description

Otters are playful, curious creatures. In this activity, students will read about the characteristics and natural history of otters and humans' interpretation of their character traits. They will then make a word poem and painting of an otter. As an extension to this activity, students may make a collage of otters, showing their playful and social nature.

Objective

To develop an appreciation for the North American River Otter. To make connections between oneself and another species.

Materials

- A copy of Smithsonian Institution's *River Otter at Autumn Lane* (in trunk)
- Paper, waterproof pens, watercolor paints, watercolor paint brushes, and water
- River otter templates (in appendix)

Background

Otters are curious, playful creatures that have captured the imagination of many. As an animal totem, they represent joy, playfulness, and sharing. One author has written that otters "remind us that everything is interesting if we look at it from the right angle." He goes on to tell this story of a river otter in Ontario, Canada:

front foot



hind foot



Otter! Otter! Word Paint Otter

Grades: K-3 with 4/5 extension

Time: 30-45 minutes

Subjects: Language Arts K-4; Visual Arts K-5

Terms: Natural History, Habitat, Reproduce, Den, Cubs, Shelter, Bottom-dwelling, Hibernate

Once on a canoe trip, a river otter popped up about ten feet from the front of the canoe. It raised itself up out of the water and peered over its nose as if curious as to who would be up so early and coming into its playground. It would dive and disappear and then reappear off to one side or the other, as if trying to size up the situation from every angle. When its curiosity was satisfied, it dived and disappeared, going about its own activities (Animal Totems, p. 293).

The book, *River Otter at Autumn Lane* introduces some of the life history traits and habitat requirements of the North American River Otter.

Habitat

- Shelter: River Otters live in dens underground. The dens usually have at least two entries: from the water and from the ground surface. River otters usually occupy existing dens made by other animals, including beaver. Sometimes they occupy the hollows underneath trees.
- Reproduction: River otters typically have anywhere from 2-3 (and sometimes up to 5) young each spring. The mother builds a nest of dried leaves for the young. The mother otter raises cubs, and even chases the male otter out of the den when the young are born. (The father is allowed to rejoin the den when the cubs become active and move about.) After about 3 months in the den, the mother leads her cubs out of the den and to the river, where she teaches them to swim.
- Food: River otters eat crayfish, as shown in the book. They also eat many different kinds of fish, especially slow moving fish such as channel catfish. Other foods sometimes include frogs and garter snakes. One study found that while otters primarily eat fish, they do not do well on a fish-only diet. The diversity of types of food (coming from invertebrates, amphibians, small reptiles and mammals in addition to fish) is an important part of their diet, too.

Natural History

- River otter is strong and fast. It moves sleekly through water but can be clumsy on land because of its short legs.
- River otters dry themselves on leaves or grass when they leave the water.
- River otters must learn to swim and find food from their mothers. River otters catch food in the water but sometimes eat it on land.
- River otters often play with each other. They are social animals, often playing with other members of their family.
- River otters do not hibernate in winter. They may spend more time in their dens, but they seek out deep areas of water for swimming and finding food.

River otters are social animals. They are often called gregarious because of the charismatic and playful nature. After students complete their word otter, have them create an otter collage. Using the same materials with additional templates, have students create a habitat for their otter (the river, the river bed, the den), using images from *River Otter at Autumn Lane* or other books or images found on the internet or in the trunk materials. Then have them copy the template using construction paper or paints to make several river otters.

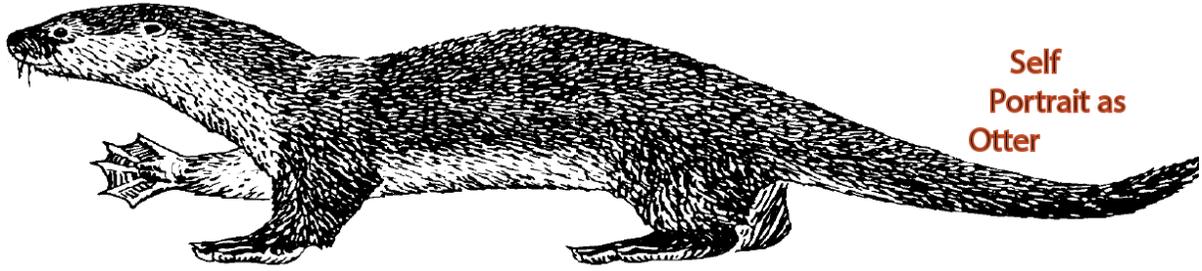
Example



Additional Extension

River of Words is an international poetry and art contest to promote ecoliteracy. It has become the largest poetry and art contest in the world. The competition is open to any student ages 5 to 19, who has not yet completed high school. Each year, approximately 100 winners are chosen and presented awards in San Francisco. One of the exciting opportunities the competition provides is not only to submit students work and promote the idea of each student as a budding artist, but also to see work from students around the world. In past years, work has been submitted from school children, 4-H clubs, refugee camps, scouts, as well as summer and after-school camps and programs.

The word paint otter activities provide an opportunity for students to learn about otters, their associated habitat, and to develop art and literacy skills. This directly aligns with the goals of the River of Words competition. For submission details, see visit their website at www.riverofwords.org.



Lesson 2: Self Portrait as Otter

Description

In the previous activity, students developed word paintings of otters and identified at least one word that describes the river otter and also describes them. In this exercise, students will learn about otter biology while also creating self-portraits that symbolize the otter as well as themselves.

Objective

To learn basic biology of the river otter. To develop an appreciation for the North American River Otter and make connections between oneself and another species. To apply math concepts to the creation of a life-size representation of a river otter.

Materials

- Otter biology materials: otter skull replica; otter tracks; pencil and paper for charts
- Self portrait materials: Large sheets of paper and pencils; Mirror; Options for self-portraits: Watercolors or acrylic paints and brushes or collage materials (tissue paper, fabric scraps, old magazines or newspapers, found objects); River otter template grids



Self Portrait as Otter

Grades: K-12 with grade modifications

Time: 3-4 30-minute segments

Subjects: Biology, Visual Arts, Math (grades 4-5)

Terms: Self-portrait, symbolic self-portrait, genus, species, whiskers, rhinarium, webbed feet

Background

Self-portrait as a method. A self-portrait is a representation of the artist and can be made using any art media, including drawing, painting, sculpture, photography, or collage. Portrait comes from the Latin *portray*, which means to represent. Self-portraits bring self-awareness to artists because they require the artist to learn about themselves and how to express some aspect of themselves to others through art. In *symbolic self-portraiture*, the artist creates an image of him or herself as something else. This could be another person, an object, or a place. By creating a self-portrait of oneself as an otter, students can begin to identify with the otter and start to make a connection to it.

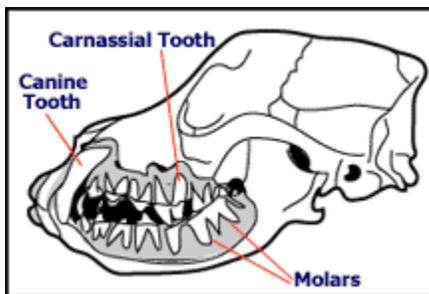
Otter Biology

Kingdom	Phylum	Class	Order	Family	Genus	species
Animalia	Chordata	Mammalia	Carnivora	Mustelidae	<i>Lontra</i>	<i>canadensis</i>

Mammalia. Otters belong to the Class Mammalia. Mammals are a broad group that includes coyotes, mule deer, cattle, javelina, mice, and even whales. As a Class, mammals give birth to live young, nurse their young with milk, and generally have fur (though some mammals have lost most of their hair). Both reptiles and mammals are amniotes, meaning they have amniotic fluid that feeds the developing embryo. Mammals are different from reptiles in the ways listed above (live young, milk, fur), as well as because they have specialized teeth for the kinds of food they eat. Deer and horses, for example, are ungulates, and have specialized teeth for grinding grasses.

Carnivora. Otters belong to the Order Carnivora. Carnivores are most widely known as meat eaters with strong jaws and sharp teeth for tearing and shearing meat. While many meat eating animals have sharp teeth, most carnivores retain four “carnassial” teeth (Figure 1), which are used for shearing meat. Carnivores are the dominant predators on most continents (except Antarctica). Carnivora is a diverse order, including bears, coyotes, wolves and wild dogs; mountain lions and other cats; seals and sea lions; and raccoons.

Figure 1. Skull of a dog showing canines, molars and carnassial teeth



Mustelidae. Otters are part of the Family Mustelidae, along with weasels, skunks, badgers and wolverines. The mustelid family is one of the most diverse and largest. Species from this family are found in almost every habitat type, from desert to forest to tundra. They may live in fresh or salt water and may be terrestrial, arboreal, aquatic, or semi-aquatic. Mustelids are voracious hunters

with a strong sense of smell so that they can track and find prey. Many mustelids have scent glands which they use to mark territories and sometimes as defense (think *skunk*). Mustelids have what is called a “double coat,” with a soft underlayer and wiry longer guard hairs. This double coat makes them water resistant, which is important for swimming and for staying active in winter. This double fur has also attracted many hunters and fur-traders. Fur trading caused the large scale decline of many mustelids, including the river otter in North America.

Lontra canadensis. The North American River Otter’s scientific name is *Lontra canadensis*. The long, sleek body of the river otter makes it particularly fast and agile hunter in the water. They are considered semi-aquatic because they spend a significant portion of their lives both in the water and on land. While most other species in the mustelid family are solitary (meaning they live alone), river otters are social animals, and can be found alone or in family groups. The river otter is also mostly active at night.

Body features:

- Length: about 1.25 meters (or approximately 4 feet, 1 foot of which is tail)
- Weight: Males: 9 kg (or almost 20 pounds); Females: 8 kg (or about 17.5 pounds)
- Webbed Feet: River otters have webbed feet for swimming and claws for digging.
- Whiskers: River otters have a short face full of whiskers.
- Scent Glands: Like other mustelids, male river otters have large scent glands. In river otters, they are located in the hind feet of males.
- Rhinarium: River otters have relatively large rhinaria (or noses) in proportion to the rest of their face when compared to people.

Threats to the river otter. Like many in the mustelid family (such as minks or beavers), people hunted river otters extensively for their fur in the 1700s and 1800s. River otters have been reintroduced to some areas and have recovered naturally in some areas. Other threats to the river otter come from degradation of river habitat, alteration to water flows (such as through dams or diversions), and poor water quality. River otters were completely *extirpated* from New Mexico in 1953, meaning all the river otters were killed or died out in the state. However, in 2004, there was a sighting of river otters in San Juan County, in the northwest corner of New Mexico. Some believe river otters are now moving back and forth between water ways in Colorado and New Mexico. Since 2006, 33 river otters have been re-introduced into the Upper Rio Grande. They have been spotted along the Rio Grande as far south as the Cochiti Dam.

Procedure: Otter Biology

Use the background above as well as books and specimens to talk about the specific features of the river otter. Have students make a chart of the otter’s body features as compared to their own (see chart template). Grades K-1 can do this as a class with one big chart.

Procedure: Self-Portrait

- i. Have students share and present their word paint otters with each other. Have students tell each other the characteristic or word they most identify with themselves and the otter.
- ii. Introduce the idea of a self-portrait. Show some examples of famous self-portraits.
- iii. Next introduce the idea that some artists have experimented with self-portraiture that combines human and animal traits (symbolic self-portraiture). Emphasize that this requires some understanding of both the characteristics of the person as well as the biology and natural history of the animal. Show some examples of self-portraits as animals.
- iv. Review some of the traits of the river otter. Use a river otter template to label specific otter features, including the rhinarium (nose), short legs, webbed feet, lots and lots of whiskers, small ears, dark brown fur, scent gland in hindfeet of males.
- v. Make a self-portrait, with modifications appropriate to each grade.

Grades K-1: Self-Portrait as Otter : Exploration

For Grades K-1, the main goal is to have students learn body features and adaptations of the river otter and to relate these or other characteristics to themselves.

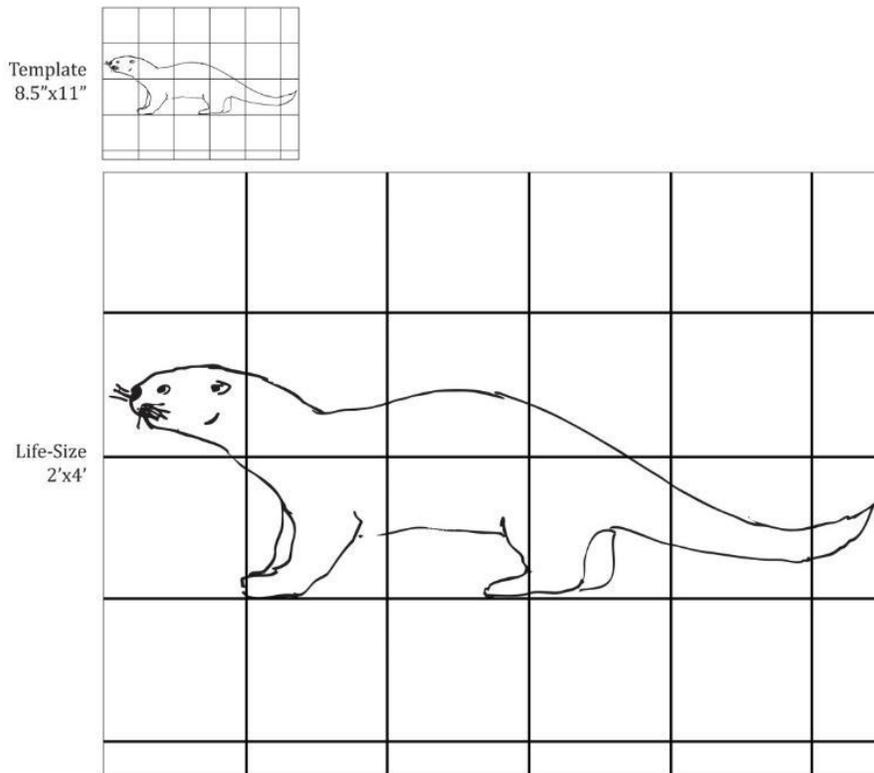
Present students with the template grid of a river otter. This can be printed at life size or can be printed on 8.5x11 or 11x17 paper. Have students paint the river otter while adding in characteristics of themselves. For example, students could make a river otter with glasses or with green eyes. The river otter might have a pink sweater or be wearing headphones. Have students look in the mirror to see expressions they want to show on their self-portrait. Ask students to think about the characteristics attributed to river otters and the expressions they might wear (for example, playful or mischievous). After drawing their self-portrait in pencil, have students paint their otter or create an otter collage. Ask students to describe what they have in common with the otter and how they showed this through their art.

Grades 2-3: Self-Portrait as Otter : to Scale

For Grades 2-3, the main goal is to have students learn body features, while also appreciating the scale and proportions of the river otter. Through the symbolic self-portrait, students will also learn to appreciate the otter and begin to connect to it themselves.

Working with the template grid, have students draw a life size river otter. To do this, they will need to create a grid on a paper (or strips of paper) at least 4-feet in length and 2 feet in height. They will need to draw and transfer the river otter from the smaller grid to the larger grid (Figure 2).

Figure 2. Sample of template and enlargement to life size.



After students have drawn the river otter to scale, they can add their own self-portrait features. What would they change? Would they make it blue because both the otter and student love water? Would they add glasses or a ponytail or a soccer jersey? Have students complete their self-portrait either by painting or using collage techniques.

Questions to consider: How would they change the nose or ears to make them in human proportions? Would they be bigger or smaller? How does their self-portrait reflect what is common between themselves and the otter? How did they represent this through their portrait? What characteristics of the river otter make it very adaptable for swimming? (webbed feet, body shape and long tail, dense and oily fur).

Grades 4-5: Self-Portrait as Otter: Measure and Compare

For Grades 4-5, the main goal is to have students learn body features, while also appreciating the scale and proportions of the river otter and understanding its proportions in comparison to themselves. Through the symbolic self-portrait, students will also learn to appreciate the otter and begin to connect to it themselves. Follow the steps for Grades 2-3 to make a life size otter and self-portrait. Then continue below:

Measure and compare: The proportions of otters’ body features are different from human features. Measure and compare the differences between otter/human ears, noses, legs, faces, torsos. Use the grid to measure each feature of the river otter. Use a ruler or tape measure for each feature of humans.

Questions to consider: How do these differences make river otters more adaptive to their environment? What specific features are adaptations to water? How does this fit in with their classification as a mustelid or a carnivore? How does their self-portrait reflect what is common between themselves and the otter? How did they represent this through their portrait?

Grades 6-12: Self-Portrait as Otter: Reflective Study

For Grades 6-12, the main goal is to have students learn the biology of the river otter.. Through the symbolic self-portrait, students will also learn to appreciate the otter and begin to connect to it themselves.

As a class, share the self-portrait plates included in the appendix or have students research their own. Have students choose from at least two types of representation shown in the self-portrait examples to develop their “style” as a portrait. Also discuss the meanings and symbolism of color. Have students select colors that represent the otter and themselves. Either select a medium or have students select the medium they will use to represent themselves. Use the *Mixed Media Self-Portrait* book from the trunk as a guide. Students may use the template provided, but more likely will want to draw their own self-portrait.

When the self-portraits are complete, have students generate an artists’ statement that reflects their goals as an artist, what is common between the artist and themselves, and how they chose to represent this portrait both in media and color.

Color Symbolism

Blue Steady, secure, power, solitude, peaceful, calming, sad	Green Money, nature, peacefulness, hope, renewal, healing, envy, illness
Red Success, celebration, beauty, courage, luck, anger, injury, embarrassment	Purple Royalty, spirituality, wisdom, magic, vision, bravery, sentimental
Yellow Happiness, sunny, cheerful, friendly, intellect, warmth, caution, cowardly	White Purity, spirituality, fresh, hope, good, cleanliness, fear
Gray Stability, security, strength of character, maturity	Black Sophistication, power, mystery, formality, evil

River Otter Sample Chart

	River Otter	Me
Scientific name	<i>Lontra canadensis</i>	<i>Homo sapiens</i>
Length/Height	1.25 m (4 feet)	4 feet, 1 inch
Weight	9 kg (20 pounds)	55 pounds
Hair color	Dark brown	Black
Teeth / Diet	Big canines, Carnassial teeth, carnivorous diet	Small canines, omnivorous diet
Special features	Scent glands in hind feet of males; webbed feet; large rhinarium, whiskers	No scent glands; bipedal for standing and walking; rely on sight for food more than smell (and no whiskers)
Movement in water	Paddling with hind legs with tail undulation. More agile in water.	Swimming with arms and legs.
Movement on land	Walking and galloping. Sliding on snow.	Walking and running. Slides on snow with a sled. More agile on land.

Sample Self Portrait



Curiosity: Designer
Protection: Care for the Earth

Additional Extension

River of Words is an international poetry and art contest to promote ecoliteracy. It has become the largest poetry and art contest in the world. The competition is open to any student ages 5 to 19, who has not yet completed high school. Each year, approximately 100 winners are chosen and presented awards in San Francisco. One of the exciting opportunities the competition provides is not only to submit students work and promote the idea of each student as a budding artist, but also to see work from students around the world. In past years, work has been submitted from school children, 4-H clubs, refugee camps, scouts, as well as summer and after-school camps and programs.

The word paint otter and self-portrait as otter activities provide an opportunity for students to learn about otters, their associated habitat, and to develop art and literacy skills. This directly aligns with the goals of the River of Words competition. For submission details, see visit their website at www.riverofwords.org.

Self Portrait Resources (As background for teachers or for use by 5th grade or above)

Just Like Me: Stories and Self Portraits by Fourteen Artists, by Harriet Rohmer.

Mixed Media Self Portraits: Inspiration and Techniques by Cate Coulacos Prato. (In trunk)

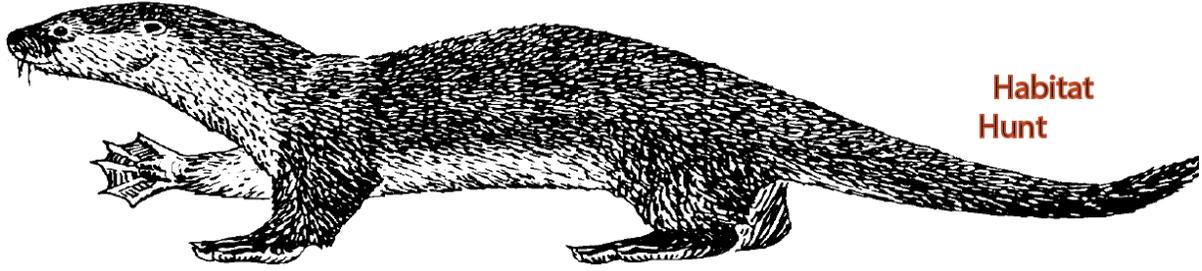
500 Self Portraits by Julian Bell.

Otter Resources

Hans Kruuk. 2006. *Otters: ecology, behaviour and conservation*. Oxford University Press.

George McKay. *The Encyclopedia of Mammals: A Complete Visual Guide*

John H. Murray. 1987. *Wildlife in Peril: The Endangered Mammals of Colorado*. Boulder, CO: Roberts Rhinehart, Inc. Publishers.



Lesson 3: Habitat Hunt

Description

In the first two activities, students have learned some of the biology, natural history, and character of the North American River Otter. In this activity, students will begin to learn about the river habitat that supports river otters in much of North America. This is a field activity that can be done along any stretch of a river or creek.

Objective

To understand the term habitat. To learn and identify specific habitat requirements for river otters.

Materials

- Habitat Hunt search pages (from appendix)
- Clipboards and pencils
- Optional: *River Otter at Autumn Lane* or *Playful Slider* from trunk materials
- Extension materials: Copy of *Otter and Odder* by James Howe from trunk; watercolor paints and paper; crayons

Background

In general, animals require shelter, reproductive resources, and food in their habitat.

- Shelter: River Otters live in dens underground. The dens usually have at least two entries:



Habitat Hunt

Grades: K-3 with 4/5 extension

Time: Approximately 30 minutes plus travel time

Subjects: Biology; visual and performing arts for extensions

Terms: Natural History, Habitat, Reproduce, Den, Cubs, Shelter, Bottom-dwelling, Hibernate

from the water and from the ground surface. River otters usually occupy existing dens made by other animals, including beaver.

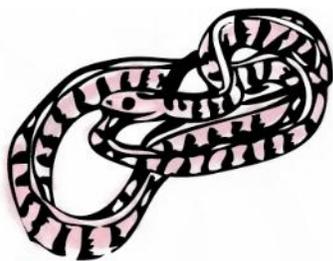
- **Reproduction:** River otters typically have 2-3 young each spring. The mother builds a nest of dried leaves for the young. The mother otter raises cubs, and even chases the male otter out of the den when the young are born. (The father is allowed to rejoin the den when the cubs become active and move about.) After about 3 months in the den, the mother leads her cubs out of the den and to the river, where she must teach them to swim.
- **Food:** River otters eat crayfish, as shown in *River Otter at Autumn Lane*. They also eat many different kinds of fish, especially the slow moving bottom-dwelling fish such as channel catfish. Other foods sometimes include frogs and garter snakes.

Habitat Hunt

The habitat hunt is designed for students to search out elements of river otter habitat. Most of the search items represent either food or shelter, but there is also the possibility of looking for reproductive resources such as leaves and dens. It is important to note that for the river otter, water is a primary source of food as well as space for swimming and other behaviors that are important to the otter.

Procedure

- This is a field-based activity, which can be used at a nearby creek or along any stretch of the Gila River.
- At the site or prior to visiting, review habitat requirements of animals in general (food, shelter, reproductive resources) and for the river otter in particular.
- Go over the Habitat Hunt sheet making sure each item is clear. Use the explanations on the next pages to help students understand what they are looking for.
- Have students identify the name of the species or type of resources (or both) (this can vary by grade), and then the relationship to the river otter habitat. Have students imagine, "if you were an otter, what would you do if you saw this? How would you use it?" Younger students can answer "Food!" or "Homes!" While older students can give more detailed answers.
- Ask students to find each item on the habitat hunt page.
- Questions to consider: what were the hardest part of the habitat to find? What does this tell you about the habitat?



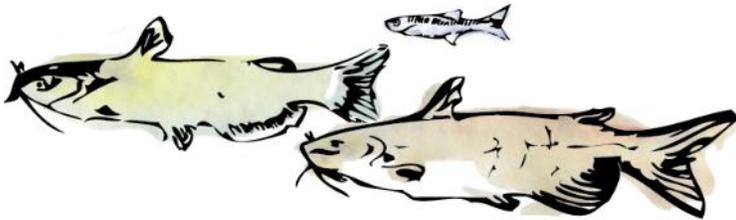
Western garter snake. Snakes are not a primary food source for otters, but they do sometimes eat them.



Chiricahua leopard frog. This frog is an endangered species and is not likely to be found. In the assessments for reintroduction of river otters, this species was not considered to be likely to be impacted. Amphibians in general are an occasional food source for river otters.



Crayfish. Invertebrates are also a food source for river otters. Otters find crayfish and other invertebrates such as clams and snails by overturning rocks under water. Like garter snakes and amphibians, they are not a primary food source for the river otter, but they are important in making a well-rounded diet.



Fish. The primary food source for river otters. In general, river otters catch larger, slower moving fish, including suckers and catfish. But anything is fair game when it comes to the voracious river otter! Pictured here are channel catfish and spinedace. Spinedace is listed as a threatened species under the endangered species act. There is some concern that river otters, if introduced, might impact the recovery of this and other endangered fish species, though most river otters feed on larger prey species such as larger fish or crayfish.



Willow leaves. Leaves are used by river otters to make their dens. Willows in particular are a kind of riparian vegetation common along the Gila River that provide good habitat for many of the prey/food the river otter eat. They are also important daytime refuges for young river otters to hide from predators.



North American Beaver. River otters do occasionally eat beaver kits, so they can be considered a source of food. But the primary relationship is that beavers provide homes for the otters.

The River Otter Ecology Project describes the relationship in this way: "The thing is - a landscape that suits beavers becomes one that suits otter so the two, while not friends, are almost inseparable." They describe the arrival of a river otter to a pond inhabited by a beaver family:

“Each May when otters that visit the beaver pond they are greeted with a series of very loud tail slaps until they saunter nonchalantly away. . . The father beaver soon chased that otter away and sent the waters echoing with a total of nineteen memorable tail slaps! Since that time I have never observed more than one or two at a time and they seem most likely to occur in the spring. We know that otters like to rest and den in abandoned beaver lodges and on two separate occasions I saw eager otters try to enter the beaver lodge only to be roundly chased out by mom beaver or one of the yearlings.”

<http://www.riverotterecology.org/otter-blog.html>



Space, including rocks, logs, river water, variation in river water, and potential den opening under the root of a tree. These are all important components of a river otter’s habitat. Rocks and logs can provide space for resting or for digging under to find food. Logs in water can alter the flow of water, creating a diversity of habitats for fish. Roots from trees provide potential space for a river otter den. And river water itself is an essential component of the river otter habitat for swimming, finding food, and . . . just being an otter!

Additional Extension

With 4th or 5th graders, read the book *Otter and Odder*. Have students link the natural history concepts they have been learning to the story. What characters are present? What are the specific characteristics of the different animals? How does this relate to what students know about their natural history? How does it cross over into human values that draw from animal traits? Review different literary techniques to telling a story and ask students to create their own otter story using one of these techniques. Have students illustrate their story by experimenting with the art techniques used in *Otter and Odder*.

- i) Tragedy: In many tragedies, such as Greek myths, the main character has a fatal flaw which leads to a tragic event. Usually, the character has good intentions. In *Otter and Odder*, the story could be a tragedy with the flaw being that otter and fish fall in love even though otters normally are predators of fish. But the story is not a tragedy in the end, so it ends happily (in a tragedy the otter would potentially eat the fish).
- ii) Parable: Parables are stories that teaches a lesson or moral. *Otter and Odder* could be considered a parable in that the lesson is that the way of love is more important than the specific ways of an individual species.

iii) Other story themes that students could apply to otters or otter restoration: i) “Overcoming the Monster” where an underdog overcomes a larger or more powerful creature; ii) “Journey and Return” in which characters set out to find something and return home in the end to tell the story; iii) “Quests” in which there is a mission to accomplish something noble or good.

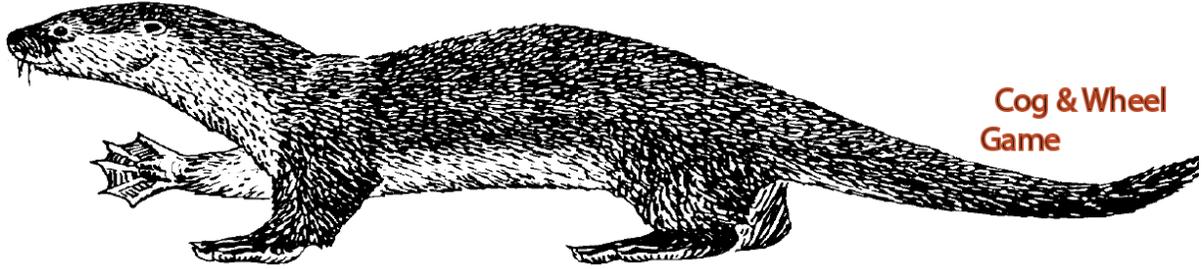
Additional Extension

Have students act out the *Otter and Odder* book as a class play. You may use the beaver and otter hand puppets and make paper fish, turtle and crayfish puppets. Or assign roles to each student and have them make their own costumes. Potential characters include:

Lead Roles: River Otter, Myrtle the Fish, Beaver, Narrator

Supporting Roles: duck, crayfish, turtles, river chorus (made of birds, snails, school of fish)

Have students write their own play adaptation of the story or use the script included in this curriculum (in the appendix).



Lesson 4: Cog and Wheel Game

Description

In this activity, students will learn about food webs and ecological relationships within the river otter habitat. They will portray components of the food web or river otter habitat through a physical activity, with modifications for grades K/1, 2/3 and 4/5.

Objective

To understand the components of a food web. To learn basic ecological relationships, such as commensalism and predation. To apply these concepts to an ecological system that includes river otters.

Materials

- K/1: String or yarn and game cards
- 2/3: String or yarn and game cards
- 4/5: String or yarn, game cards, paper and pens for charting population changes, space for playing game (large indoor area or preferably outside area)

Background

Aldo Leopold was a conservation leader who lived and worked in New Mexico for part of his career. The Aldo Leopold Wilderness Area was named for him. He is well known for his writings on conservation, including this quotation from his book titled *The Round River*:

“If the land mechanism as a whole is good, then every part is good, whether we understand it or not. If the biota in the course of aeons, has built something we do not understand, then who but a fool would discard seemingly useless parts? *To keep every cog and wheel is the first precaution of intelligent tinkering.*”



Cog & Wheel Game

Grades: K-5, also with 6-12 application (see Cogs, Wheels and Carnivores)

Time: 30 minutes for grades K-3; 45-60 minutes for grades 4-5

Subjects: Science

Terms: food chain, commensalism, competition, predation, predator/prey, carrying capacity, limiting factors

This idea, of keeping every cog and wheel, assumes that we do not fully understand the relationships between organisms sufficiently, nor can we know all the ramifications of our actions on a particular environment. In this activity, students will begin to learn about the connections between different cogs and wheels by learning about components of an ecosystem as well as the ecological relationships of a food web in that system. While these basic components and relationships are generally understood for the river otter, we have clearly tinkered with otters system too much, leading to its decline or extirpation in its former range.

Basic ecological relationships help describe the interactions between different types of organisms. Some of the basic ecological relationships for river otters are described below.

Commensalism: One species benefits from the relationship, while the other species does not benefit or suffer from the relationship. An example of commensalism is between beavers and river otters. Beavers create favorable habitat conditions for river otters (including creation of dens as well as slowing and deepening of water for river otter fishing). River otters do not harm nor help the beaver's habitat.

Competition: Two different species (or different individuals of the same species) need the same type of resource (food, water, space, an individual for mating) and compete with others for this same resource. Many species within the same ecosystem compete for food. River otters may compete with raccoons and bobcats, which eat similar food to the otter. However, these relationships are largely neutral.

Predation: When one species eats another species. These relationships are also called predator/prey relationships, where the predator is the species doing the eating and the prey is the species being eaten. River otters are predators to fish, crayfish and other aquatic animals, garter snakes and amphibians. River otters are prey to coyotes and mountain lions.

Carrying capacity and limiting factors: For the 4/5 game, students will explore these relationships in more depth and will chart out population fluctuations over time. The term *carrying capacity* refers to the number of individuals in a population that a single habitat can support. When carrying capacity is exceeded, a population begins to decline because it cannot meet all its needs (such as food, water, or shelter) for survival and reproduction. Sometimes *limiting factors* affect the number of individuals in a single population so that it doesn't reach carrying capacity. Limiting factors can include predation, parasites or disease, pollution, seasonal variation (an extreme winter or drought), and habitat degradation. Historically, the river otters decline was from extreme predation (by people). Populations of river otters currently are limited by pollution and habitat degradation as well as from more natural influences such as predation and disease.

Procedure

Grades K/1: Basic Food Chain Game

Review a list of animals found in the river otter habitat (use the cog and wheel cards as prompts). Ask students to stand in a circle with a ball of yarn. Have the first student hold a ball of yarn and call out the animal that he/she can remember or wants to be (e.g., bobcat). Have the "bobcat" student hold one end of the ball of yarn and throw the rest of the ball to another student across the circle. Have the student who catches the ball of yarn call out an animal that either is eaten by or eats the previous student's animal (e.g., "crayfish") and explain why they called out that animal

("because bobcats eat crayfish"). Repeat this process, having each new student call out an animal that is eaten by or eats the previous animal. Students may repeat animals more than once. When all the students have caught the yarn, they will have created a food web.

Extension: Have students use the cog and wheel cards to draw a food web.

Grades 2/3: Food Chain Game with Ecological Relationships

Before beginning, review with students a list of animals found in the river otter habitat (use the cog and wheel cards as prompts). Also review basic ecological relationships between organisms (commensalism, mutualism, predation, competition, and parasitism) (also found on cards). Then ask students to follow the procedure described for grades K/1. In addition to having students call out an animal, also ask them to call out the relationship to the animal that preceded them in the food web or to the river otter (such as competition or commensalism).

Extension: Have students use the cog and wheel cards to draw a food web and show relationships.

Grades 4/5: Food Chain Game (Adapted from Project Wild's Oh, Deer! Game)

For grades 4 and 5, follow the steps for grades 2 and 3 first, as a review of habitat requirements (primarily focused on food for this game). Next have students count off by 4s (have students count "1" "2" "3" "4" and then repeat this sequence until each student has a number). It does not matter if there are an equal number of any group. Ask students to organize themselves as follows: "1s" will be river otters. Line them up at one end of a room or outdoor space. "2" "3" and "4" will be habitat requirements. Pass out cards so that each student knows what kind of habitat he or she will be. Ask the river otter to decide what it will look for. Line these students at the opposite end of the room or outdoor space. Have each line with their backs facing the other line.

Begin the first "round" by asking students to assume their postures and display their cards. The river otters need to seek out the type of habitat they had decided to look for (food, water, or shelter). Water and food may move about, but space should remain in place.

When the students are ready, say, "Otter!" When the river otter students see the type of habitat they are looking for, they should go to it. Capturing that habitat component means their needs have been met and they can successfully reproduce. If a river otter fails to find its particular habitat component, it will die and become part of the "habitat" team. If no river otters required a specific type of habitat (for example, no one chose to look for space), then those components of the habitat remain standing.

At the end of the round, record the number of river otters that remained.

Continue to play for 15 more rounds, recording the number of river otters at the end of each round. Chart out the patterns of the river otter population cycle and discuss: What is realistic about this exercise? What was less realistic? What happened when there were a lot of river otters? What might happen if there is not enough space or food or water?

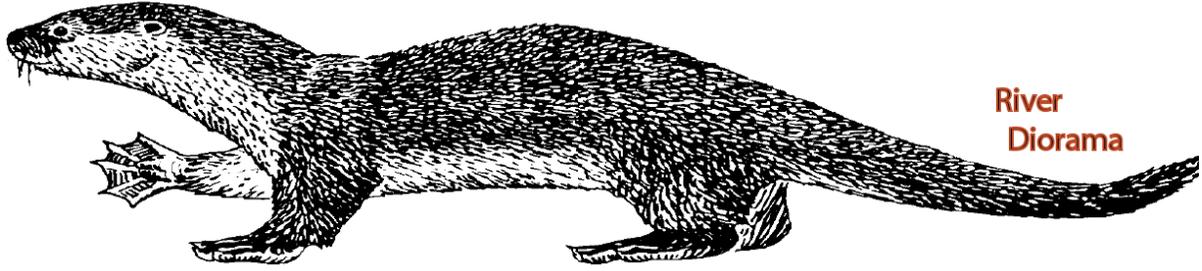
Variations: After several rounds, you can introduce a competing animal card, such as a raccoon or bobcat, which might eat similar foods, or you can introduce a predator card, such as the coyote.

For competitors, the game would start with river otters and competitors seeking their habitat requirements as above. However, in the end, you would chart out river otters as well as raccoons or bobcats and see what variations occur within the populations.

For predators, have one student begin in a designated predator den to the side of the line. They can only eat one river otter at a time and must take it fully back to the den before seeking additional prey. River otters may run away from predators. Have students observe how this affects the river otters ability to acquire other components of its habitat, such as food.

Introduce the idea of carrying capacity and limiting factors to students. Ask students to identify the limiting factors they experienced in their game. Have students analyze their charts to see if they can identify a carrying capacity for the population of otters in the game.

Read the quote from Aldo Leopold about “intelligent tinkering.” Ask students to reflect what they feel they know well about river otters and those parts of the system that they do not know as well. What would the precaution of “keeping every cog and wheel” in place require to sustain a healthy river and river otter population? What does Aldo’s quote really call for?



Lesson 5: River Diorama

Description

In this activity, students will apply what they have learned thus far about river otters and healthy otter habitat to the creation of a three dimensional diorama of the Gila River.

Objective

To learn and apply specific habitat requirements for river otters to a three-dimensional model of the river otter.

Materials

- Shoeboxes (have each student supply a shoebox)
- Brown and blue construction paper
- Other colored paper as accent
- Scissors, glue and tape
- Watercolor paints or colored paper for river bed
- Collected or found objects (can include plant materials, small rocks for boulders, sand, sticks or twigs)
- Optional: self-drying clay for 3-dimensional otter figures

front foot



hind foot



River Diorama

Grades: K-5

Time: 1-2 hours

Subjects: Visual Arts; Science

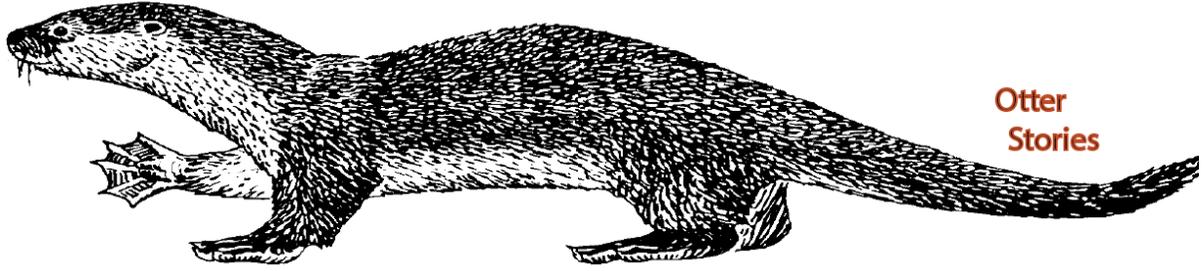
Terms: habitat, riffle and pool, cottonwood, willow, riparian den

Procedure

- i. Introduce the activity and have students collect or bring in materials in advance (or plan to do the activity outside where they can collect some natural elements for their model).
- ii. Start by having students tape their shoebox so the lid or flap is secured and on the bottom of the box.
- iii. Have students line the inside of their box with blue for the sky and background and brown for the ground plane.
- iv. Next have students draw in the river. The river should take up a lot of space on the diorama. Have students use colored construction paper or paints to make the river.
- v. Next, ask students to include the following elements of otter habitat in their diorama. They may create these elements with found objects from nature (twigs, sand, rocks), or they may make them out of paper (or a combination):
 - a. Cottonwood tree(s)
 - b. Willows
 - c. Riffles and pools
 - d. A den or shelter for resting
 - e. At least one food source
 - f. A beaver den
 - g. A river otter with young (can be 3D with clay or out of paper)
- vi. When students have completed their diorama, have them share their work with each other. Ask students to explain how they used materials to show different aspects of the river otter habitat and what specifically they included in their model.
- vii. Questions to consider: If you wanted to reintroduce the river otter to the Gila, what would you need to do to restore or add back to the river to make it a good place for river otters to live?

Possible Extensions for Grades 3/4/5

Ask students to use cartoon call-out boxes on white paper to label their diorama and explain the relevance of each element of the habitat to the river otter or overall system function. Have students use habitat cards to create appropriate labels for the diorama.



Lesson 6: Otter Stories

Description

In this activity, students will learn some basics about otter biology and the life story of an otter called M31. Students will then read a book called *Otter and Odder* and create their own story about an otter. This activity draws on the otter biology presented in Lesson 2. Refer to lesson 2 for background and templates.

Objective

To learn basic biology of the river otter. To use language arts skills to develop an appreciation for the North American River Otter and make connections between oneself and another species.

Materials

- Copies of the story of M31 (in Appendix, Lesson 6)
- Notebook paper for M31 “field notes”
- Otter biology materials: otter skull replica; otter tracks; pencil and paper for charts (in trunk)
- Copies of chart and otter templates (in Appendix, Lesson 2)
- Copy of *Otter and Odder* by James Howe (in trunk)
- Paper, watercolors and crayons

front foot



hind foot



Otter Stories

Grades: 6-12

Time: 3-4 1-hour segments

Subjects: Biology, Visual Arts, Language Arts

Terms: Carnivore, carnassial, rhinarium, extirpated, parable

Background

Review the otter biology background on pages 11-12 of Lesson 2: *Self-Portrait as Otter*.

Procedure

- i. Have students read the story of M31. Have students create an M31 field notebook in which they take notes and make sketches of the otter while they read.
- ii. Next have students look at specimens and natural history profile to learn specific biology and features of the river otter. Have students make a chart and draw and label specific features of the river otter (see chart and templates in the appendix for Lesson 2).
- iii. Now read *Otter and Odder* with the students. Discuss the story in light of the natural history and the adaptations of the story teller.
- iv. Have students take the ideas of a parable and write their own story that features a river otter. The character may take on human traits but must also be based in the natural history of the river otter in some way.
- v. Have students use similar art techniques (watercolor and crayon) from *Otter and Odder* (or use their own techniques) to create at least one illustration that helps tell their story.
- vi. Have students share their illustrations with each other, sharing the life history traits they drew for the otter as well as the storyline for their parable.



Mr. M31 at night

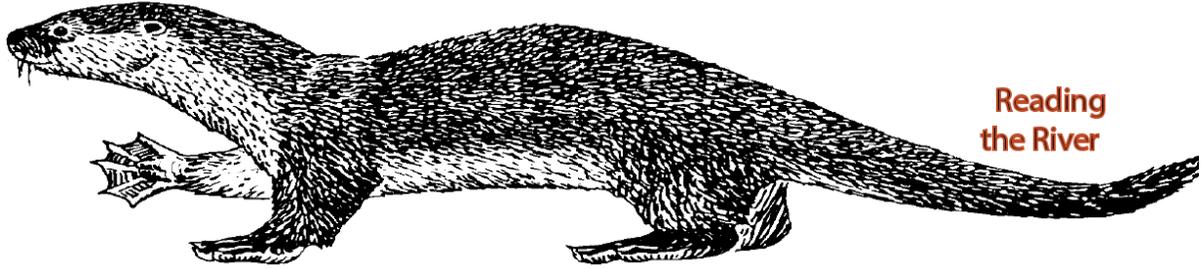
Additional Extension

River of Words is an international poetry and art contest to promote ecoliteracy. It has become the largest poetry and art contest in the world. The competition is open to any student ages 5 to 19, who has not yet completed high school. Each year, approximately 100 winners are chosen and presented awards in San Francisco. One of the exciting opportunities the competition provides is not only to submit students work and promote the idea of each student as a budding artist, but also to see work from students around the world. In past years, work has been submitted from school children, 4-H clubs, refugee camps, scouts, as well as summer and after-school camps and programs.

The Otter Stories activities provide an opportunity for students to learn about otters, their associated habitat, and to develop art and literacy skills. This directly aligns with the goals of the River of Words competition. For submission details, see visit their website at www.riverofwords.org.

Otter Resources

John H. Murray. 1987. *Wildlife in Peril: The Endangered Mammals of Colorado*. Boulder, CO: Roberts Rhinehart, Inc. Publishers.



Lesson 7: Reading the River

Description

In this activity, students will learn to “read” the landscape by looking for specific clues along the river and learning what these clues tell us about river health and otter habitat.

Objective

To understand the process of reading a landscape. To learn and identify specific habitat requirements for river otters and to look for clues about these habitat requirements in the landscape.

Materials

- Copies of clue cards (in Appendix)
- Clipboards, paper and pencils

Background

Reading. Reading is a process of looking at symbols to get information. Symbols or letter make up words. Words compose sentences. And sentences convey ideas and information. People who study the environment use a similar process of *reading* to learn about the landscape and the specific information that can be found in it. By looking for specific clues, naturalists can learn a lot about a habitat or ecosystem. They can tell if it is healthy or what animals might have been there, even if they haven’t seen the animals directly. These clues help to tell if an ecosystem is healthy or if it is missing critical pieces. Reading the landscape is a skill that can be learned, just like reading a book.

front foot



hind foot



Reading the River

Grades: 6-12

Time: 1-2 hours plus travel time

Subjects: Biology and Earth Sciences

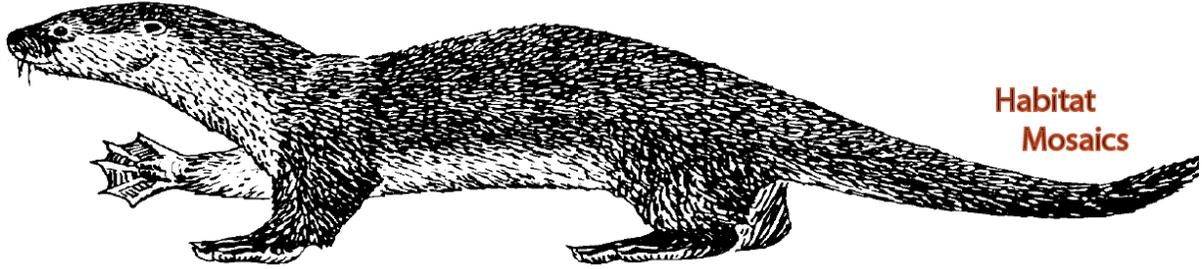
Terms: habitat, macroinvertebrates, sediment, channel cut, riffle, pool, run

The more you practice, the better you get.

Procedure

- i. This is a field-based activity, which can be used at a nearby creek or along any stretch of the Gila River.
- ii. At the site or prior to visiting, review habitat requirements of animals in general (food, shelter, reproductive resources) and for the river otter in particular.
- iii. Have students work in pairs or teams of 3 and assign each group a set of clue cards.
- iv. Instruct students to look for as many clues as possible. When they find a clue:
 - a. Have one student read the clue aloud
 - b. Have one student make a sketch of the clue object
 - c. Have one student make a broader scale sketch of the surrounding area

Questions to consider: What was the hardest part of the habitat to find? What does this tell you about the condition of the river as a whole? If you wanted to reintroduce the river otter to this river, what would you need to restore or add back to the river in order to make it a good place for river otters to live?



Lesson 8: Habitat Mosaic

Description

In this activity, students will learn about the processes that form the upper, middle, and lower courses of a river. Students will make a memory map of the Gila River and create a habitat mosaic of the different elements of the river that support river otters.

Objective

To learn river processes and functions at different points along the river course. To understand how these different habitats relate to river otters. To begin to see the river otter habitat as a mosaic of different but related components.

Materials

- Plates or slides of river process
- Map of the Gila River (in trunk) or access to Google Earth
- Paper for notes and memory mapping
- Template for habitat mosaic
- Tissue paper in yellows, greens, browns, and 2-3 shades of blue

Background

Erosion: The wearing away of a material by a force. In rivers, there can be 4 sources of erosion: i) abrasion by sand or stone, which wears the banks away; hydraulic action, where water itself moves into cracks in rocks or the river bank and makes those cracks wider; attrition, in which rocks move along the water course and through bouncy and hitting other rocks, become worn away and smooth; and corrosion, in which water breaks apart the softer parts of rock (such as sandstone). Erosion in the upper water course of a river is usually vertical (meaning the river is eroding rock

front foot



Habitat Mosaic

Grades: 6-12

Time: 1-2 45 minute segments

Subjects: Earth Science, Biology

Terms: Erosion, abrasion, hydraulic action, attrition, corrosion, transportation, debris, deposition, sediment, spurs, v-shaped valley

hind foot



downwards). In upper stretches of river, the river is not very windy. In the middle course of the river, erosion is mostly lateral (meaning the river erodes rocks or soil from the sides). The river is less steep in the middle course and is more windy or bendy.

Transportation: Material (rocks or debris) carried from one place to another. With transportation, material may be large rocks or it may be very fine debris or anything in between. When fine particles such as clay or silt are transported through the river, it can make the river look cloudy.

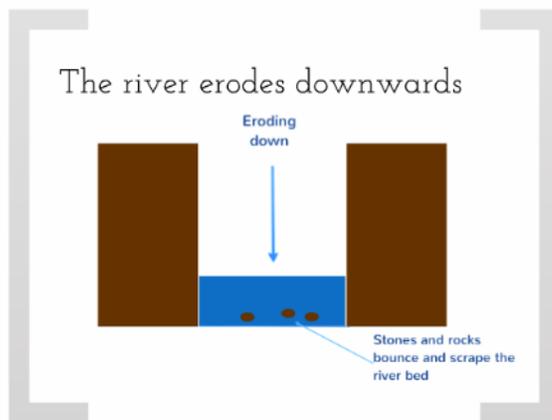
Deposition: Where material (rocks, debris, sediment) gets placed in the river. When a river reaches flatter land, the water does not move as quickly or with as much force. The river no longer has the energy to carry all the material it was transporting, so it “deposits” it. This process is called deposition, and the deposited material is called sediment.

Upper Course

Characteristics of the upper course of a river: i) steep, v-shaped valley; ii) narrow and shallow channel; iii) presence of spurs, waterfalls or gorges.

V-shaped valleys: how do they form? At the early stages of the river (in its formation as well as in its upper reaches), a river erodes downwards through rock. This leads to a steep-sided valley (Figure 1). Over time, weather wears the rock down on the sides, and the rocks slide down the slopes (Figures 2-3). This creates a v-shaped valley (Figure 4).

Figure 1. Rivers erode downwards through rock.



Figures 2-3. Weathering of rock and collapse of material into river bed.

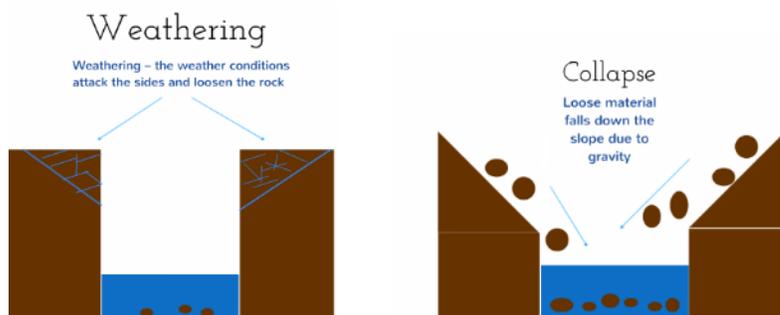
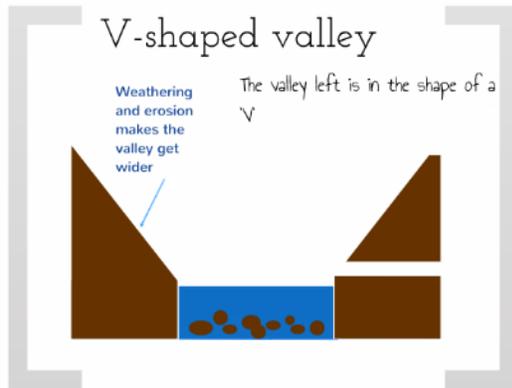
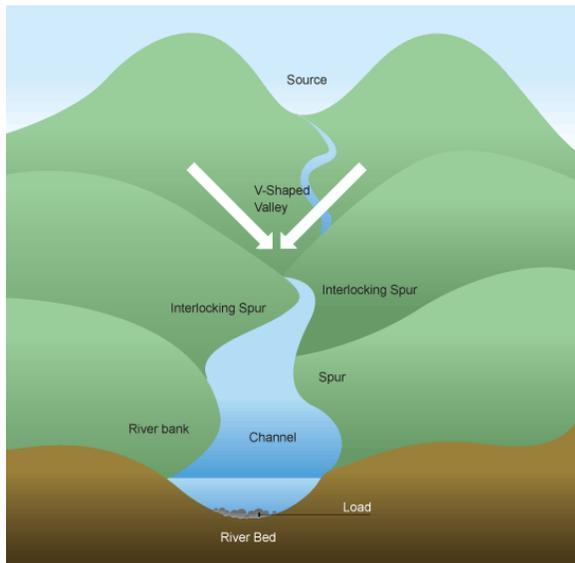


Figure 4. Formation of V-shaped valley



Young rivers do not have a lot of energy. The water does not have enough force to break rocks away and must go around hard rocks and boulders on the valley's sides. The river twists and turns around these rocks. This results in *interlocking spurs* that form the river banks (Figure 5).

Figure 5. Schematic of upper course of river



Procedure

- i) Introduce the basic geological processes for rivers, including river formation in the upper river course and erosion, transportation and deposition concepts.
- ii) Ask students to draw pictures or each of the 4 types of erosion that happen in rivers.

- iii) Next ask students to identify the types of “work” (erosion, transportation, deposition) that are done in the different courses of the river (upper, middle and lower). Their answers should be:

Upper Course : Erosion

Middle Course : Transportation

Lower Course : Deposition

iv) *Memory mapping*

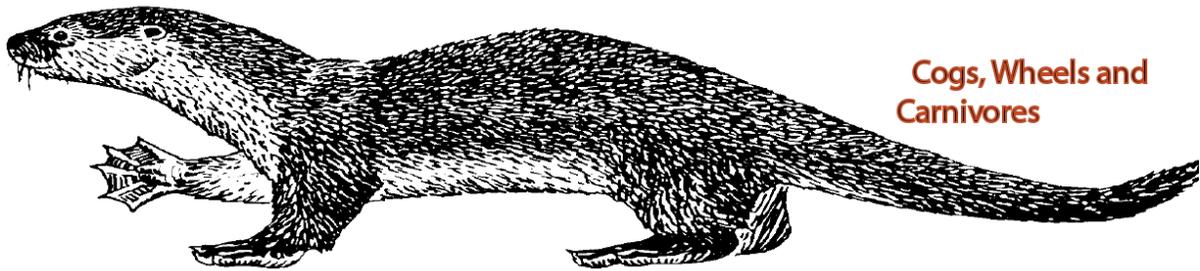
- a. Prepare a map station of the Gila River that shows the different zones as well as basic features of the river (including topography, channel, v-shaped valleys, interlocking spur, source). You may use a large topographic map from the trunk materials, or use Google Earth for students to scan the Gila from the headwaters to its basin.
- b. Break students into teams of 3-5
- c. Have students split the river into 3 zones: upper, middle, and lower Gila River.
- d. Working in teams, have each person look at the map of the Gila River and then draw and diagram as much as they can. Each team member will have 1 minute to look at the map and 1 minute to draw and diagram. Then the next team member will add to the diagram until as much as recorded and transferred as possible.
- e. Still working in groups, ask students to analyze the river course:
 - How steep are the slopes?
 - How wide is the channel?
 - What is the bed load like?
 - Where has the most erosion happened here?
 - How fast is water moving?
- f. Then have students reflect and share the diagrams and make any corrections or additions necessary.

v) *Mosaic Habitat of the River Otter*. The river otter is a semi-aquatic predator that can thrive where there is enough clean water and food. Healthy riparian systems, with an abundance of riparian and streamside vegetation such as willows, generally make good habitat for otters. Otters need slow-moving water and deep pools, riparian plants, and abundant food. They can live in rivers with relatively low flow (as low as 10 cubic feet per second) as long as other habitat conditions are present, such as pools, water depth, and access to shoreline.

- a. Explain to students that they are both figuratively and literally creating and identifying a mosaic of habitat types necessary for the river otter. The figurative element of the assignment is that they are creating a visual mosaic with tissue paper. The literal element is that the habitat is a mosaic, with many varying parts. For example, river otters are part of a food web that includes macroinvertebrates (which fish and crayfish eat, and which the otter in turn feeds on), and macroinvertebrates mostly live in riffle areas of the river. Yet if only riffle or fast moving water were present in the river, the deeper areas for finding slow moving fish would be missing from their habitat. It is this *mosaic* of habitats that is necessary to support the full life history of the river otter.
- b. Ask students to brainstorm as many different elements of the habitat mosaic.

- c. Still working in groups, ask students to make a color key for the different kinds of otter habitat found along the upper and middle reaches of the Gila River in New Mexico.
- d. Have students cut small squares of tissue for each of the color-coded habitat types found on the Gila River.
- e. Next ask students to place squares of tissue paper where these habitat components are located. Have students use more squares in areas where a particular component of the habitat is abundant (and fewer squares where it is present but less abundant).





Lesson 9: Cogs, Wheels, and Carnivores

Description

In this activity, students will learn the ecological role of large animals and carnivores within river ecosystems. Students also will learn how river otters contribute to the overall function of trophic systems in the river.

Materials

- Cog and Wheel cards from Lesson 4
- Paper and pencils
- Colored pencils optional (for trophic diagrams)

Background

In Lesson 4's "Cog and Wheel" activity, students are introduced to the idea that individual species play ecological roles that we should respect and preserve. To more or less extent, we understand these roles to be significant in ecological processes, but we do not always fully understand the impacts when a species is eliminated from the system. Aldo Leopold's thinking was that it was ethically and ecologically responsible to maintain and restore all parts to a system, especially since we do not always fully understand the complex relationships of organisms.

front foot



hind foot



Cog, Wheel & Carnivore

Grades: 6-12

Time: 2 45-minute segments

Subjects: Earth Science, Biology

Terms: Cog & wheel, ecological process, riparian corridor, predation, species abundance, competition, top carnivore, trophic level

In the case of the river otter and other species with similar ecological niches, we know that large animals affect river corridors at a system-level, and we know that large carnivores contribute to healthy ecosystems. Specifically:

- River otters can alter riparian corridors by altering the physical characteristics of a place, by burrowing or wallowing or using dams or other refugia along river corridors. Figure 1 shows different levels of disturbance caused by low to high use by large animals.
- River otters can affect other animal populations through predation by altering the abundance of a species (or numbers of individuals in a specific population)
- River otters can affect other animals through competition for resources
- River otters have been a part of the ecological web for many North American rivers. Their existence as top carnivores in river systems suggest an important role in the trophic levels of the overall system (Figure 2). Research from river otter reintroduction in Missouri has shown that otters eat a diversity of foods, including a number of types of species (or guilds) that each feed on invertebrates and/or algae. This study suggests that removal of river otters from the system would result in a “trophic cascade,” in which there are potentially negative consequences to the overall system. In short, the presence or absence of river otters is thought to have a significant positive or negative impact, respectively, on overall biodiversity of a system. By feeding on large fish and large crayfish, river otters help reduce the overall biomass of smaller crayfish. Presence of river otters and their trophic role could help reduce the incidence of algae blooms or other negative effects (Figure 3).

Figure 1. These diagrams show different scenarios for river corridors. A) shows a river corridor that is highly managed by people with few to no large animals. B) is an intermediate level of animal influence, and C) shows a high level of large animal influences. Note that in C) there are many small patches of habitat or vegetation, with a more diverse river channel. (Modified from Robert J. Naiman and Kevin H. Rogers, “Large Animals and System-Level Characteristics in River Corridors: Implications for River Management.” *Bioscience* 47(8):521-529.)

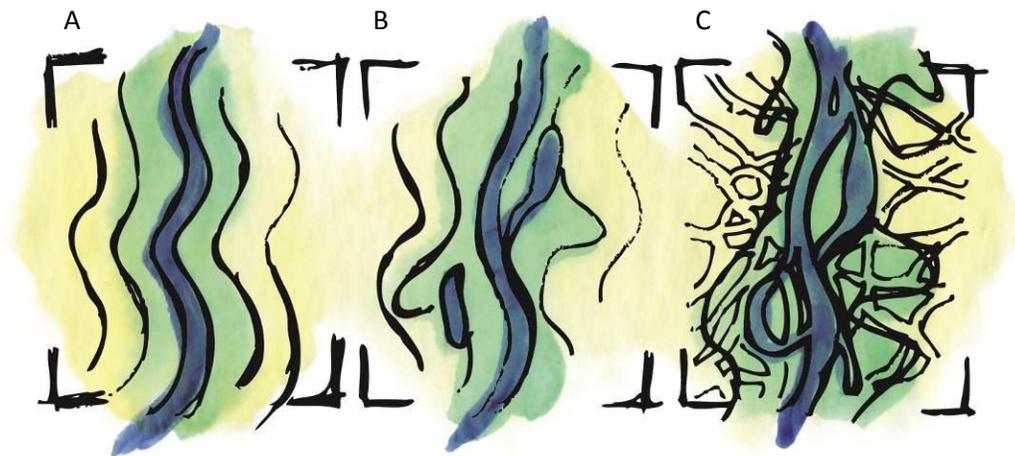


Figure 2. A trophic diagram for riparian ecosystems. River otters are considered a top predator in river systems.

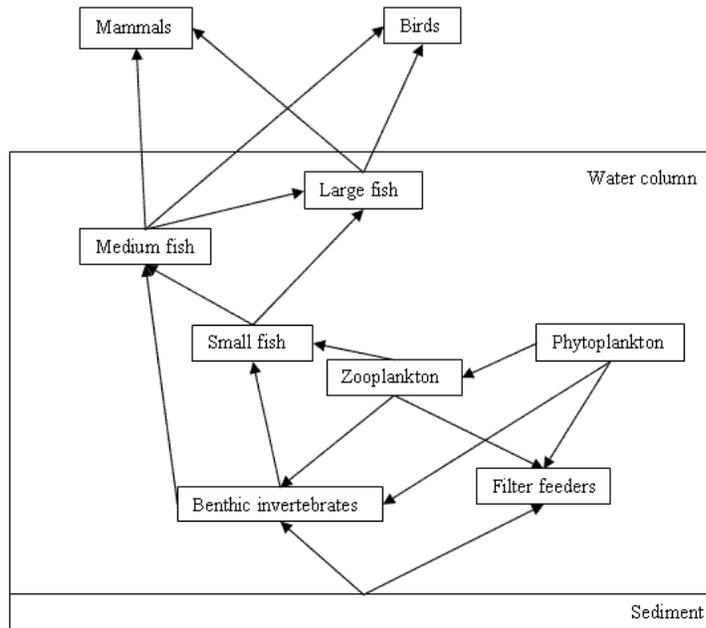
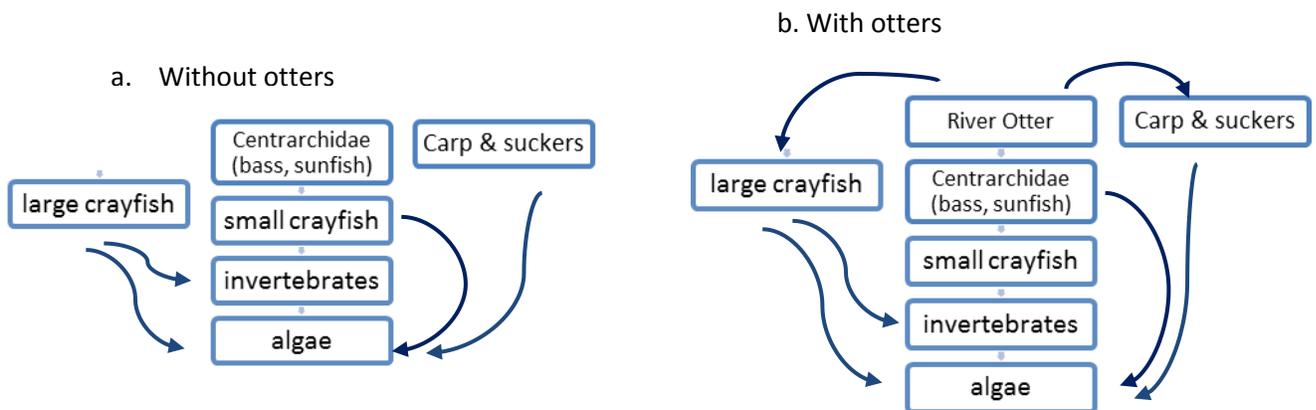


Figure 3. Trophic interactions with (B) and without (A) river otters. These diagrams come from a study of river otters in Missouri. Note that when river otters are added, they eat large crayfish, bass & sunfish, as well as carp and suckers (Gittleman & Gomper 2005).



Procedure

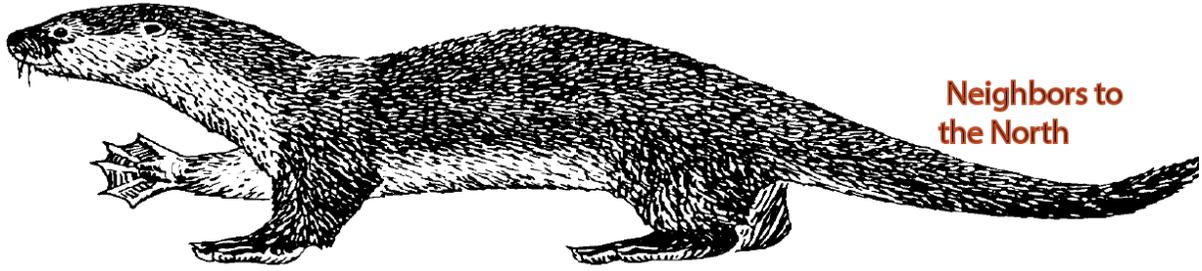
- i. Present and discuss the background information on the role of large animals and carnivores of river systems.
- ii. Have students brainstorm the roles large animals and carnivores might play in these systems.
- iii. Create a general trophic diagram for riparian systems (Figure 2) with students as a group.
- iv. Have students draw a trophic diagram of the existing Gila River that includes plants, herbivores, and carnivores (but not river otters). Ask students to include those species they know exist. Help students fill in any gaps in their diagrams, using Figure 3.
- v. Ask students to add the river otter to their trophic diagram. What role does it play? How would its reintroduction affect other species? Discuss the idea that top carnivores have significant contributions not only to the physical environment (see Figure 1), but also to the ecological balance of the river system (Figure 3).
- vi. Ask students to reflect on how the presence or absence of river otters might affect their habitat mosaic (Lesson 8). What would they need to change if river otters were not present? If they were reintroduced?
- vii. Optional synthesis: Using the Cog and Wheel game cards, have students follow the directions for Grades 4/5 in Lesson 4. Modify the game to include or exclude the river otter. What are the differences?

Sources:

Gittleman, John L. and Matthew E. Gomper. 2005. "Plight of Predators: The Importance of Carnivores for Understanding Patterns of Biodiversity and Extinction." Pp. 370-388 in: Pedro Barbosa and Ignacio Castellanos (Eds.), *Ecology of Predator-Prey Interactions*. Oxford University Press.

Miller, B. et al. 2001. "The Importance of Large Carnivores to Healthy Ecosystems." *Endangered Species Update* 18(5):202-210.

Robinson, C.T., K. Tocknew and J.V. Ward. 2002. "The fauna of dynamic riverine landscapes." *Freshwater Biology* 47: 661-677.



Lesson 10: Neighbors to the North

“To me, the otter is emblematic of the water, and particularly symbolic of rivers. . . The two seem inextricably intertwined – each evokes the other. To have the otters back in this state’s water is as important a statement of philosophy as it is of biology. We are saying we have made a commitment to keeping our rivers wild. The otter reminds us of the importance of water in a water-scarce state (Murray 1987, pp. 44-45).”

Description

This activity will introduce students to the process and complexity of species reintroductions. Students will learn about successful reintroductions of the river otter to Colorado and northern New Mexico. They also will learn about reintroduction efforts for the southern Gila.

Materials

This lesson builds on Lessons 6-9 for grades 6-12. Students will understand the concepts of river otter restoration better if they have first completed these activities.



Neighbors to the North

Grades: 6-12

Time: 2-3 45-minute sessions

Subjects: Biology

Terms: Species, reintroduction, endangered, threatened, listed, restoration

Background

Why restore river otters? As described in previous lessons, river otters were once widespread in the North America. Trapping and loss of suitable habitat are factors that have led to their decline. They were extirpated from New Mexico in 1953. One reason for restoring species to an ecosystem is that of ethics: we should support and protect all living creatures. We live in an age of diminished biological diversity. Where opportunities exist to successfully reintroduce species, we have a moral obligation to take them. A second reflects the ideas of Aldo Leopold described in the “Cog and Wheel” activity: that individual species play an ecological role in supporting ecosystem diversity and function. To more or less extent, we understand these roles to be significant in ecological processes, but we do not always fully understand the impacts. Aldo Leopold’s thinking was that it was ethically and ecologically responsible to maintain and restore all parts to a system, especially since we do not always fully understand the complex relationships of organisms.

Colorado River Otter Reintroduction

In Lesson 6, students learned about the restoration of the river otter to Colorado waters (see Deep Streams, the River Otter: the Story of M31). River otters were common in Colorado in the 1800s. Like much of the western United States, settlement in Colorado resulted in changes to rivers and the decline of river otters. Some of the impacts of settlement on otters were trapping, changes to flows of water, and water pollution from mining. By the 1900s, there were no known river otters remaining in Colorado. However, in the 1970s, the Parks and Wildlife Department in Colorado began reintroduction of the species. In 1976, wildlife staff captured more than 100 otters from other states and released them into several rivers, including the Upper Colorado River, Dolores River, and South Platte River. In 2002, the status of the Colorado population was changed from endangered to threatened. The otters still require protection and management in some parts of the state, but are doing well and are considered self-sustaining in the Green, Gunnison, Piedra, and Colorado rivers. In Rocky Mountain National Park, otter populations have been considered at or near carrying capacity (the highest number of otters that can be sustained with food and habitat).

In 2013, a new sighting of river otters was recorded on the Boulder Creek in Boulder, Colorado. Staff from Boulder Open Space and Mountain Parks had placed motion-sensitive wildlife surveillance cameras along the Boulder Creek. On two nights in April, the camera captured a river otter eating a fish not far from Boulder’s downtown (Figure 1). River otters had not been recorded in Boulder for more than 100 years. The sightings reflect the ability of otters to move great distances and recolonize areas on their own, as long as there are healthy populations elsewhere and habitat to support them. The Boulder river otter was spotted at a beaver lodge, with an existing beaver “ramp” for water entry, further supporting the commensalist relationship between beavers and river otters. Most river otters previously have been found on the western slope of Colorado and not in the Front Range, where Boulder is located. The otter has been captured on film twice, with other reported but unconfirmed sightings from the same area.

Figure 1. Caught on camera: the river otter was discovered in the Boulder Creek, arriving from parts unknown. Photo courtesy *Daily Camera*.



New Mexico Reintroductions

Like Colorado, river otters were documented in much of New Mexico during the 1800s. Reliable reports suggest that they were present in the upper and middle Rio Grande, and the Mora, Gila and Canadian Rivers. They may also have been in the San Juan River. Also like Colorado, the river otter was trapped along with beaver. By the late 1800s, river otters were heavily depleted from New Mexico's rivers. The last documented river otter in New Mexico was in the Gila River in 1953. This otter was found dead in a beaver trap, and no river otters have been confirmed since.

Taos Pueblo Restoration. In 2008, 10 river otters were reintroduced to the Upper Rio Grande, at the Rio Pueblo de Taos. River otters were captured and transported from Washington State to Taos Pueblo. As of 2010, 33 otters had been reintroduced. Since the 2008 reintroduction, otters have been found along much of the Rio Grande, extending as far south as the Cochiti Dam.

Restoration in the Gila. After successful efforts with reintroduction of river otters at Taos Pueblo, the New Mexico River Otter Working Group began efforts to reintroduce otters to the Gila River, with plans to reintroduce the otters starting in 2010. These efforts met some of the same concerns expressed during initial reintroductions in Taos Pueblo (see youtube video, under procedure, step 2). In addition to the ecological benefits described in Lesson 9, other benefits include human enjoyment and potential influences on non-native species. In New Mexico, crayfish are not a native species. River otters enjoy eating crayfish, and at times have consumed exclusively crayfish when they are readily available. It is possible that river otters could help eliminate a non-native species, thereby allowing other species to thrive in their place. Concerns are generally over the food habits of the river otter and can be grouped as follows:

- Concerns by Anglers: Fishermen (and women) have expressed concern that river otters, river carnivores, will compete with anglers for prized fish species and diminish or deplete their numbers. However, most fishermen seek trout or other game species that tend to live at the headwaters of the river. In contrast, river otters tend to feed in areas with slow-moving, deeper water where large suckers and carps are found. These fish are larger, slower, and easier to catch in the deeper waters than trout. River otters also eat crayfish (sometimes almost exclusively in their diet) as well as other invertebrates, amphibians, and sometimes small mammals. Their diet tends to be varied and based on what is readily available.
- Concerns about endangered fish species. The Gila River is considered one of America's "Most Endangered Rivers" according to American Rivers, and is home to several endangered fish species. Two species of concern (species whose populations are low, but are not listed by the state or federal government as threatened or endangered) are the Rio Grande cutthroat and the Gila trout. As described above, these are not the fish of choice for river otters, because of their location in the headwaters and the relative difficulty in catching them. In addition, river otters do not tend to eat fish smaller than four inches because they are hard to catch. So other endangered fish, such as the spinedace and loach minnow, which are 2-3 inches in length are unlikely to be eaten by river otters. Other river otter food preferences, such as for the non-native carp and bass, may in fact help these small, endangered fish, by reducing the number of fish predators in the river. In addition, otters do not tend to deplete a single prey species. They feed on what is abundant and readily easy to catch, also shifting their diet according to seasonal variability of prey species. Concern still exists where some species are very low, and it is this issue that resulted in the halting of reintroduction in the Gila. http://azstarnet.com/news/science/environment/nm-pulls-the-plug-on-gila-river-otters/article_3d05fc55-e3d7-570c-95c6-2e673564ae35.html

Procedure

- i) Introduce the idea of species reintroduction. Explore both the ethical and ecological reasons for reintroduction (review Lesson 9).
- ii) Have students read and discuss the news releases for both Boulder Creek and the Upper Rio Grande. Have students watch the 5-minute video and take notes as below:
 - a. *Steps described for reintroducing the river otter* (assessing suitable river habitat; identifying areas where river otters can be captured and relocated (Washington State); keeping river otters at appropriate temperatures/keeping quiet to reduce stress during transport; moving otters into "otter pods" and fed trout before releasing)
 - b. *Concerns about reintroducing river otters* (keeping otters safe in transport and relocation; concerns of fisherman that river otters will compete for food).
 - c. *Ways these concerns were addressed* (keeping transport cold and quiet; education that river otters tend to eat larger, slower fish and not the favored trout of fisherman)

- iii) Next introduce students to the attempts to reintroduce river otters to the Gila. Have students read the Arizona Sun article and discuss concerns about reintroduction.
- iv) Break students into teams and have them develop arguments for or against reintroduction into the Gila. Have students debate the issues using specific historical or biological concepts or facts from previous lessons, articles in this lesson, or the youtube video, to support their argument. Then have the students try to reach consensus (total agreement) as to the future of the river otter in the Gila.

Sources:

Brennan, Charlie. "Boulder confirms first North American River Otter sighting in a Century: Caught on camera, a carnivore more common in a bygone era." *Daily Camera*, April 2, 2013. Accessed from the web at: http://www.dailycamera.com/news/boulder/ci_22928891/boulder-confirms-first-northern-river-otter-sighting-century

Bureau of Land Management. 2010. "More River Otters Released in Upper Rio Grande." Accessed from the web at: http://www.blm.gov/nm/st/en/info/news_releases0/2009/october/more_river_otters.html

Colorado Parks and Wildlife. "River Otter." Accessed from the web at: <http://wildlife.state.co.us/WildlifeSpecies/SpeciesOfConcern/Mammals/Pages/RiverOtter.aspx>

Murray, John H. 1987. *Wildlife in Peril: The Endangered Mammals of Colorado*. Boulder, CO: Roberts Rhinehart, Inc. Publishers.

Pittenger, John S. 2009. *Biological Assessment for Repatriation of River Otter (Lontra Canadensis) to the Gila River, New Mexico*. Prepared for the Upper Gila Watershed Alliance. December 10, 2009.

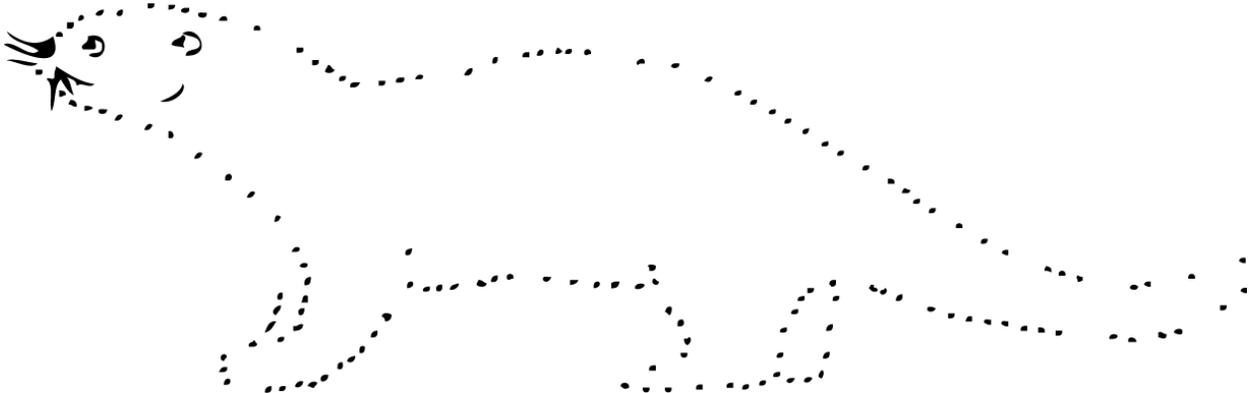
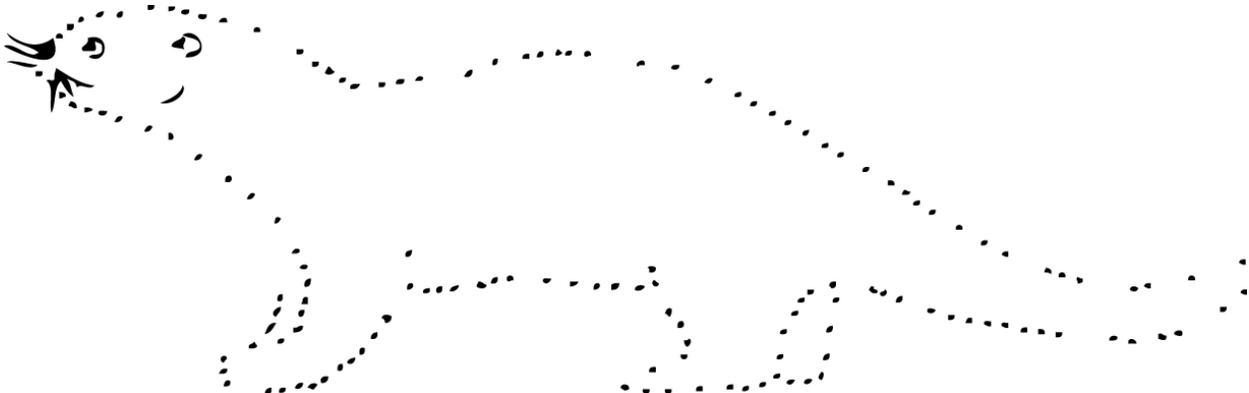
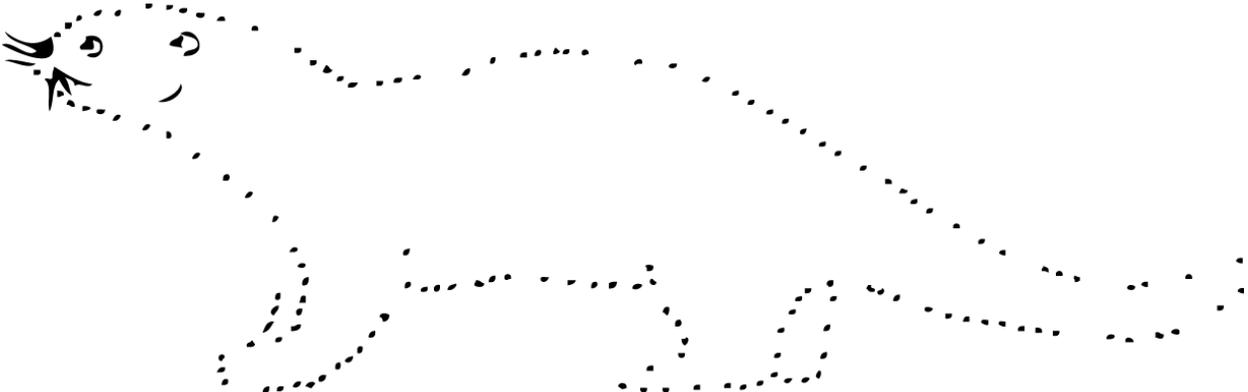
Savage, Melissa and Jon Klingel. Nd. *The Case for River Otter Reintroduction in New Mexico: A Report to the River Otter Working Group*. The Four Corners Institute, Santa Fe, New Mexico. Available at: <http://www.amigosbravos.org/docs/projects/riverotter/Case.Otter.Restoration.pdf>

Appendix

Templates, Game Cards, and Other Supplemental Materials for
Running with River Otters Curriculum

Lesson 1: Otter! Otter! Word Paint Otter

Otter Templates



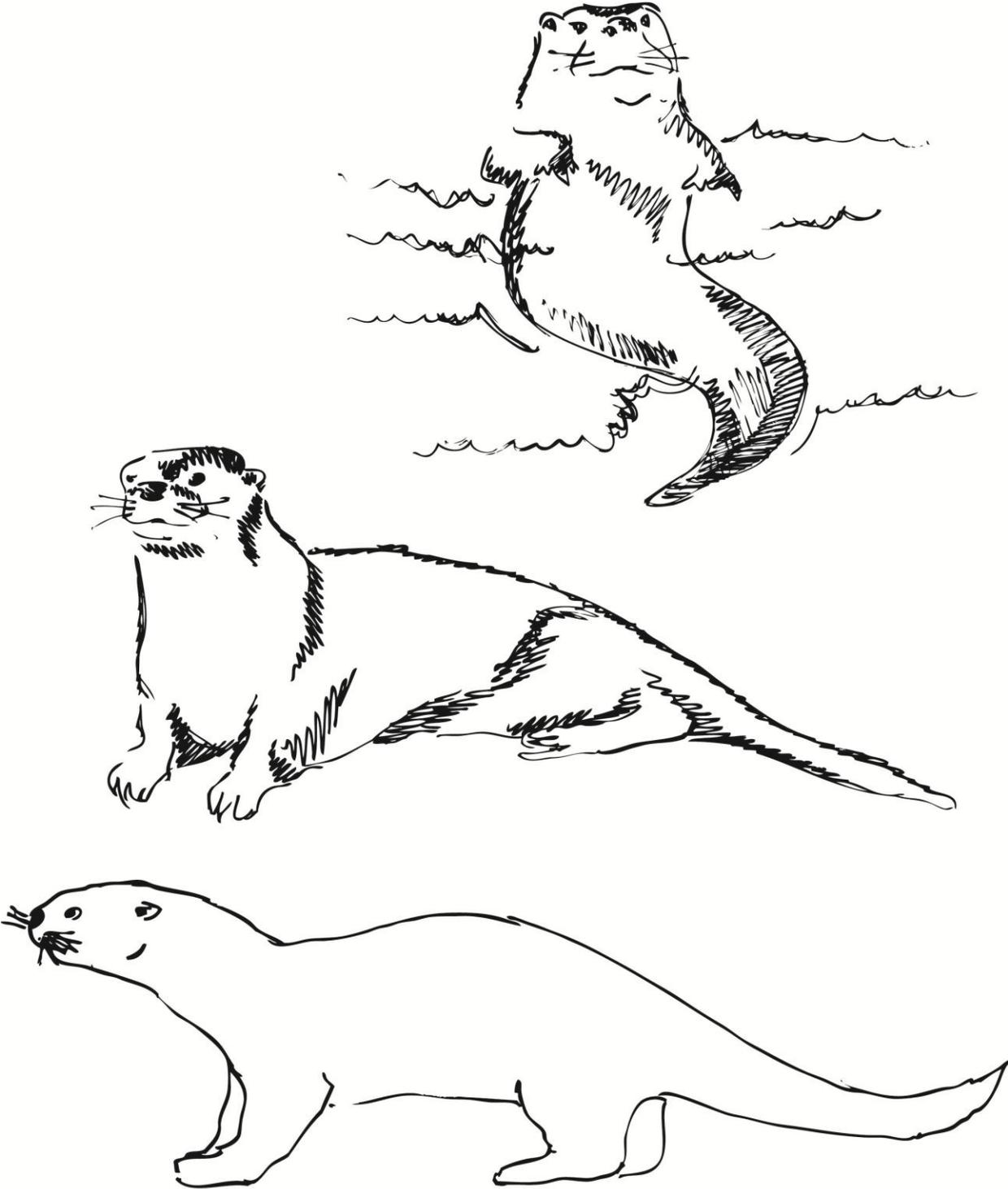
Lesson 2: Self Portrait as Otter

Chart Template

	River Otter	Me
Scientific name (<i>Genus species</i>)		
Length/Height		
Weight		
Hair color		
Teeth / Diet		
Special features		
Movement in water		
Movement on land		

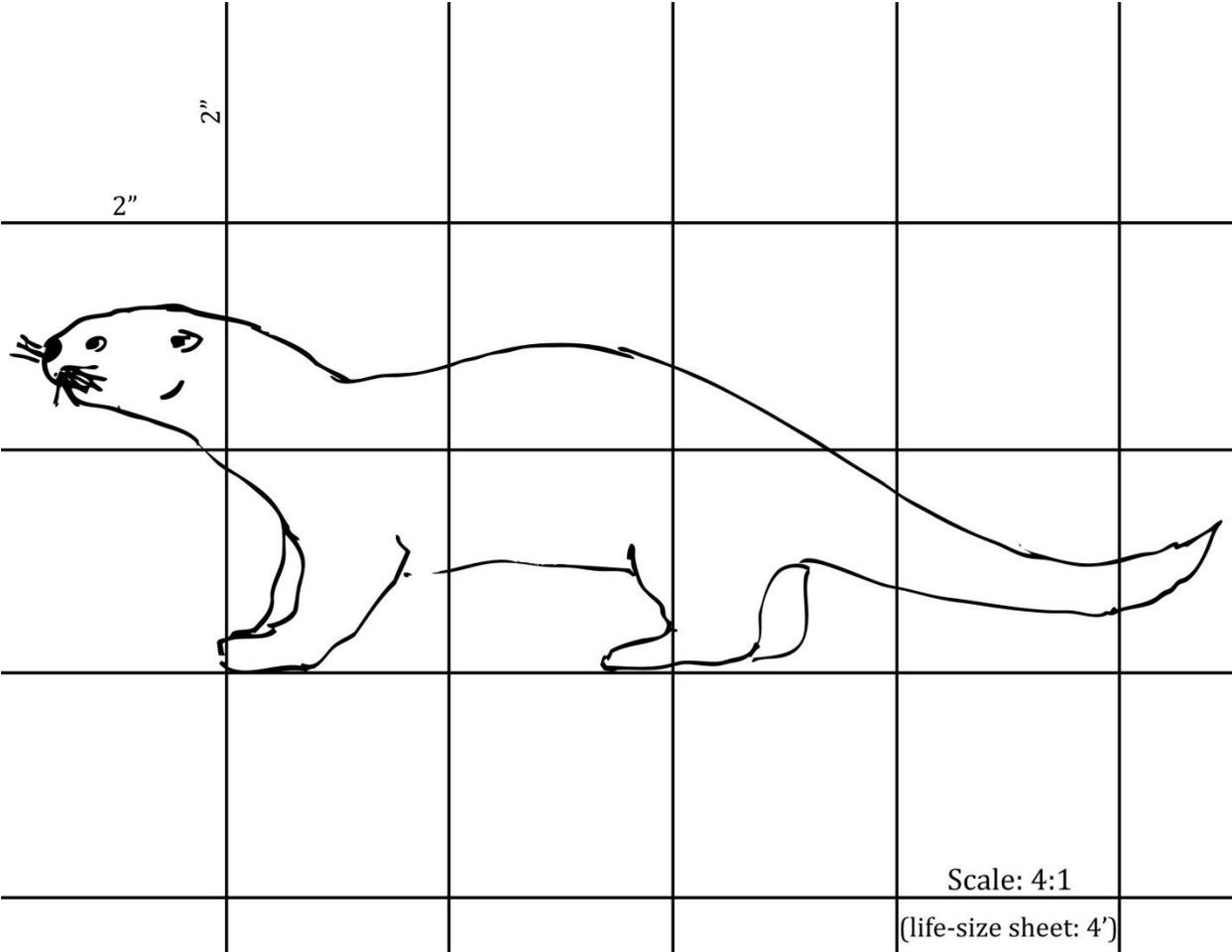
Lesson 2: Self Portrait as Otter

River Otter Templates



Lesson 2: Self Portrait as Otter

River Otter Template with Grid

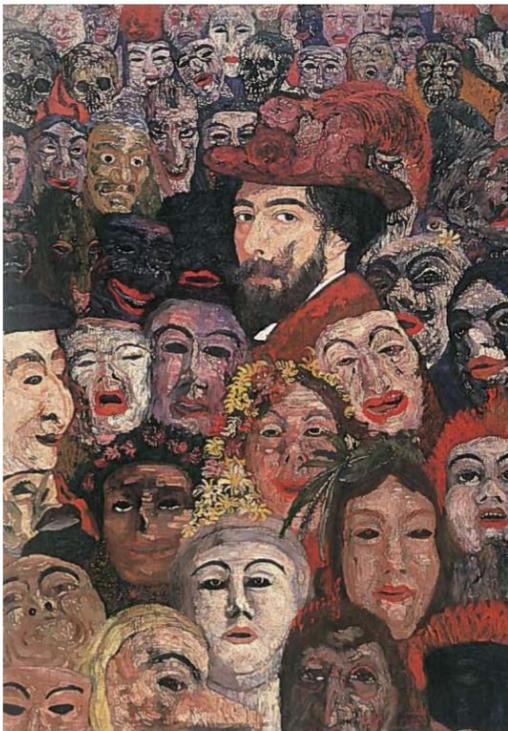


Lesson 2: Self Portrait as Otter

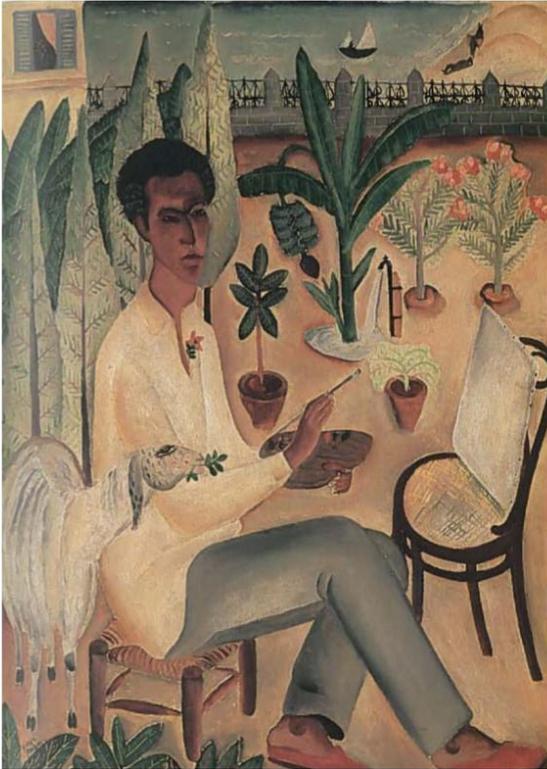
Sample Self Portraits



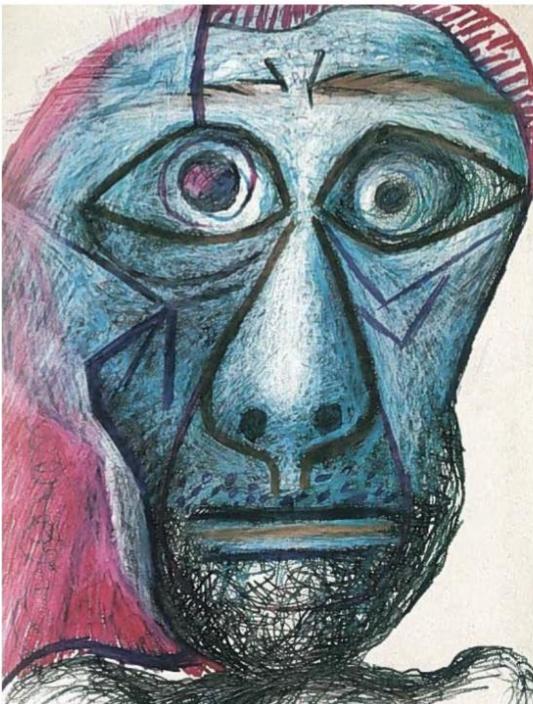
ROSALBA CARRIERA (1675-1757)
Self-Portrait as Winter, 1731
Pastel on paper (500 Self-Portraits)



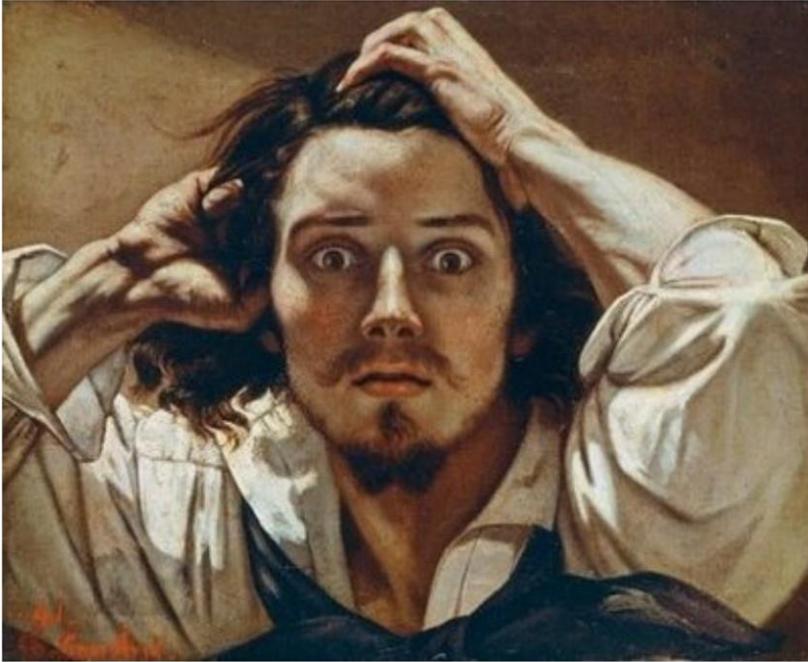
JAMES ENSOR (1860-1949)
Self-Portrait with Masks, 1899
Oil on canvas (500 Self-Portraits)



REUVEN RUBIN (1893-1974)
Self-Portrait, 1924
Oil on canvas on board (500 Self-Portraits)



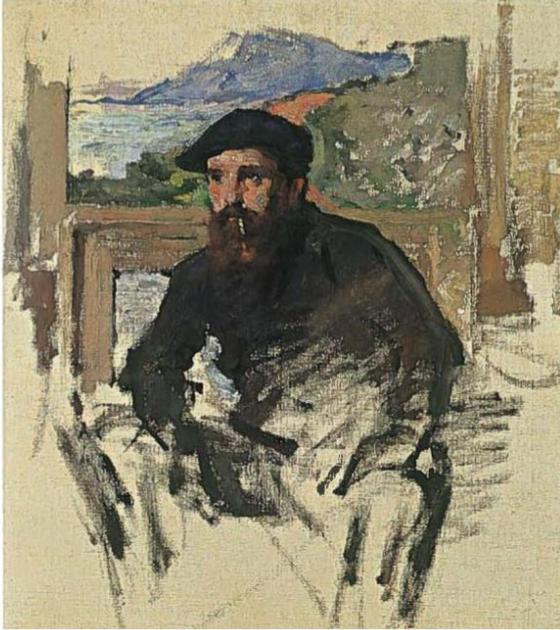
PABLO PICASSO (1881-1973)
Self-Portrait, 1972
Wax crayon on paper (500 Self-Portraits)



GUSTAVE COURBET

Self-Portrait: The Desperate Man

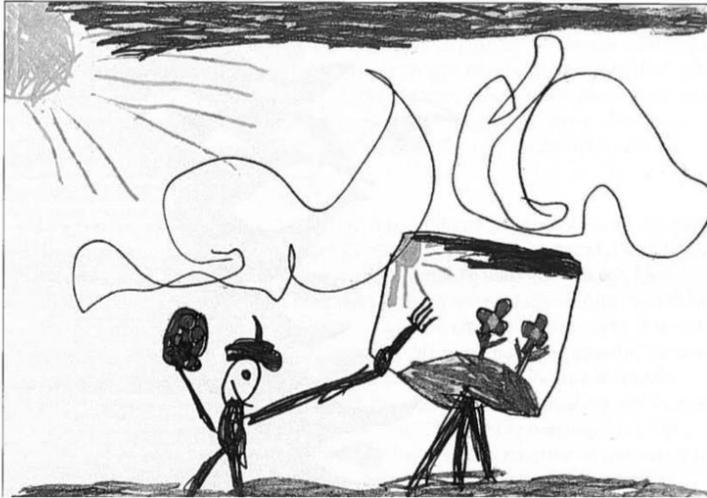
Oil on canvas (500 Self Portraits)



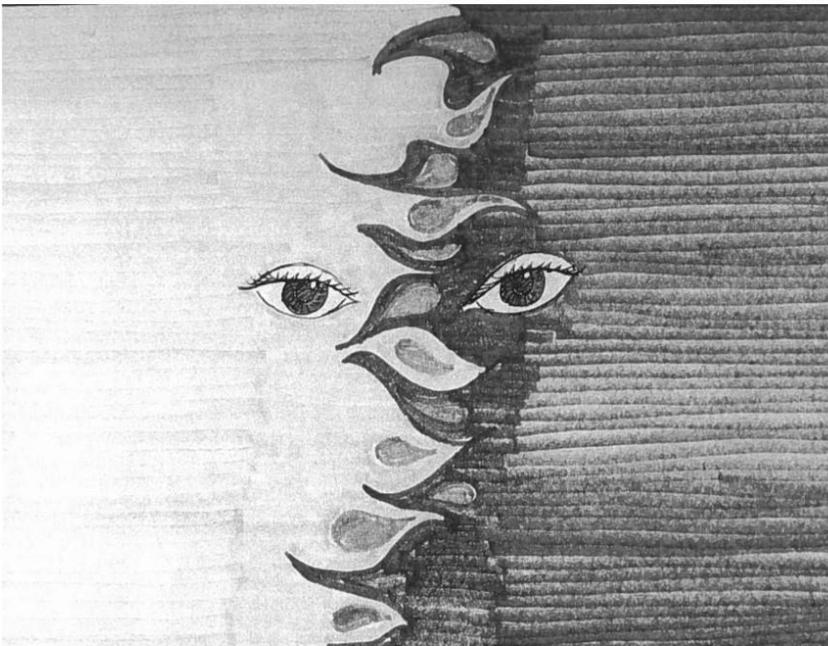
CLAUDE MONET (1840-1926)
Self-Portrait, c. 1878
Oil on canvas (500 Self-Portraits)



HENRI ROUSSEAU (1844-1910)
Self-Portrait, c. 1904
Oil on canvas (500 Self-Portraits)



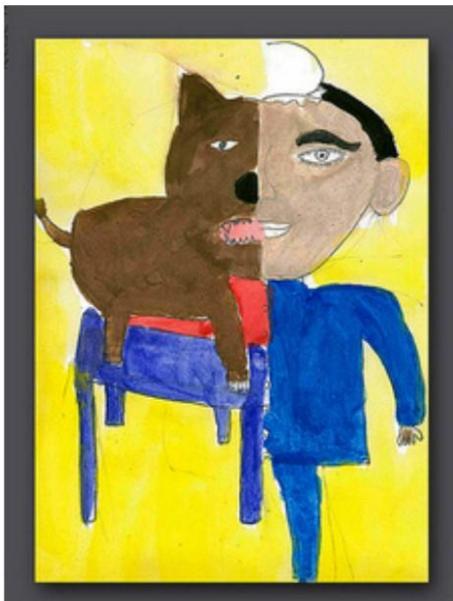
ERLING M.
An Artist, Kolbotn, Norway
Color Pencil (Visual Communication)



ANONYMOUS 18 YEAR OLD
Self-Portrait
(Visual Communication)



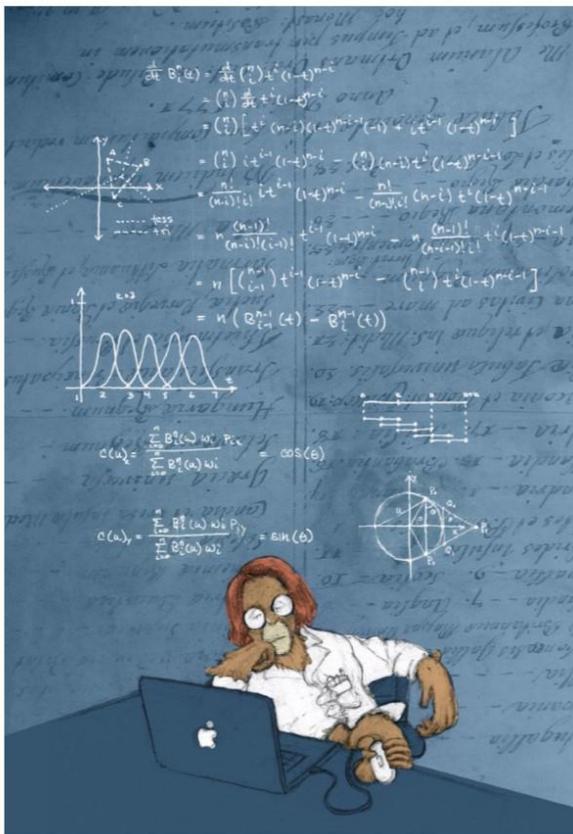
ANONYMOUS
Womatsil, Australia
Collage
(Animalselfportrait.blogspot.com)



ANONYMOUS
Half Animal Half Person
El Marino Elementary
(ospace.otis.edu)



ALSO ALSO
An Animal Self-Portrait
 Pen and Ink , Digital
 (also also.net)



ALSO ALSO
An Animal Self-Portrait
 Pen and Ink , Digital
 (also also.net)



ALSO ALSO
An Animal Self-Portrait
Pencil (also also.net)



Me and My Dog: A Self-Portrait
Photograph (Flickr: Otters holt photo-stream)

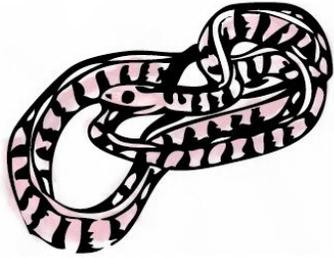


Matte Stephens

"The far-sighted otter. Its actually kind of a self-portrait. I lam far-sighted, I like to swim, and I love seafood."

Matteart.blogspot.com

Lesson 3: Habitat Hunt



Name _____
What if you were an otter? _____



Name _____
What if you were an otter? _____

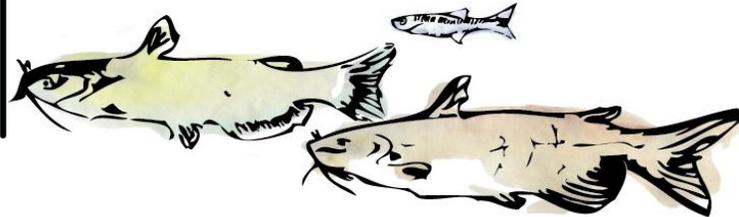


Name _____
What if you were an otter? _____

HABITAT HUNT



Name _____
What if you were an otter? _____



Name _____
What if you were an otter? _____



Name _____
What if you were an otter? _____



Name _____
What if you were an otter? _____

Lesson 3: Habitat Hunt

Otter and Odder Play Script

(Adapted from the book by James Howe)

Narrator: The river sparkled the day Otter found love. He was not looking for it (love, that is). He was looking for dinner.

[Enter Otter swimming and looking for fish, stage left. Enter Myrtle, stage right]

[Otter meets Myrtle mid-stage, looking nose to nose]

Narrator: But when Otter gazed into those eyes, he knew that we had found what he had not been looking for.

Otter: Impossible. I am in love with my food source.

Otter: What's your name?

Myrtle: Gurgle

Otter: Oh, hello, Myrtle [looking lovingly at Myrtle]

Narrator: And so it was that Otter fell in love with a fish. Myrtle (or Gurgle, if you prefer) had not been looking for love, either. She had been looking to stay alive.

Myrtle: Please don't eat me (said with eyes pleading to Otter)

[Otter gazes lovingly at Myrtle. Otter grasps Myrtle with his arms]

Narrator: All she wanted was a loosening of his grip, a slippery escape, a return to the safety of family and home. But then in his eyes she saw the sparkling river reflected and a tender and lonely heart revealed. And the stirrings of her own hear – her fish-not-wanting-to-be-dinner hear – awakened something new and surprising.

[Otter and Myrtle playing together]

Narrator: From that moment on, Otter and Myrtle were rarely apart. They swam together. They played hide-and-seek together. They told each other stories – hers of the depths of the river, his of the banks and beyond. In a perfect world, it would now be written, *And they lived happily ever after*. In a perfect world, an otter could fall in love with a fish and a fish with an otter and that would be that. But it is not a perfect world, alas, and so *that* was not *that*.

[Exit Otter and Myrtle. Enter the river chorus]

Turtle: Have you heard about Otter?

Crayfish: He was always odd.

Duck: Now he is odder.

School of Fish: He has lost his mind.

Turtle: It isn't right

Crayfish: It isn't natural

School of Fish: It isn't the way of the otter.

Narrator: Day after day, night after night, Otter hear the talk

[Chorus continues low chatter, with river chorus moving backstage. Otter re-enters stage.]

Otter: What is right? What is natural? What is the way of the otter?

[Myrtle re-enters stage.]

Otter (to Myrtle): What is the way of the otter?

Myrtle (looking down): The way of the otter is why I can no longer swim with you or play with you.

[Duck, leans in to otter to check his breathing]

Otter (in a whisper): Do you no longer love me?

Myrtle: I am no longer sure a fish can love an otter, when the way of the otter is to eat fish. [Myrtle swims away from Otter.]

Otter: I must eat

Myrtle (looking backwards at Otter): But must you eat my friends? My family?

Narrator: Otter had no answer. Feeling an old loneliness return, he watched Myrtle swim away. In a tragic tale, it would now be written, *And so their love could never be*. But this is not a tragic tale. It contains hope. And so the ending is yet to be written.

[River chorus steps forward]

Turtle: Otter has come to his senses.

Crayfish: Now he will forget all about this falling-in-love-with-fish nonsense

Otter (thinking): They're right. It is impossible. You cannot love your food source.

[Exit river chorus]

Narrator: But when he warmed his face in the morning sun, he imagined Myrtle beside him.

Otter: Is it the way of the otter to be alone?

Narrator: One morning, Otter floated his way to Beaver's house.

[Beaver standing stage right, nibbling on a stick]

Beaver: Good morning! Care for a bit of birch bark?

Otter (wrinkling nose): Otters don't eat bark, but thank you for your kindness.

Beaver: Ah, how about an apple then?

Otter (shaking head no)

Beaver: Apples are awfully tasty. Tastier, I find, than fish.

Otter (looking Beaver in the eye): Have you ever eaten fish?

Beaver: No, but I suppose I might if I ever fell in love with an apple.

Otter: Are you saying?

Beaver: I am saying . . . that there is the way of the otter and the way of the heart. It is up to you to decide which to follow.

Otter (taking a bite of apple and bark): Thank you. (Otter swims away).

[Exit Beaver.]

Narrator: That night Otter was considering the stars when he heard a familiar *splash*.

[Enter Myrtle]

Myrtle: Beaver told me I would find you here (she says as she swims up to Otter). My family would like you to play with us tomorrow.

Otter: I would love to. Perhaps we could have dinner together. Have you ever eaten the bark of the aspen tree?

Myrtle: I could try it

Otter: It's quite tasty. . . Much tastier than fish.

[Enter river chorus]

Narrator: It wasn't long before the talking began again.

Turtle: It isn't right

Crayfish: It isn't natural

Duck: It isn't the way of the otter.

[Otter and Myrtle swimming and playing together.]

Narrator: But Otter and Myrtle did not listen. They swam together. They played hide-and-seek together. They discussed the mysteries of life and love with Beaver while dining on plankton and apples. . . And now it can be written:

[All together]: *And they lived happily ever after.*

Lesson 4: Cog and Wheel Game (Also Lesson 8: Cog, Wheel & Carnivore)

Game Cards



River Otter

Eats: fish, crayfish

Relationship to River

Otter: Self



River Otter

Eats: fish, crayfish

Relationship to River

Otter: Self



River Otter

Eats: fish, crayfish

Relationship to River

Otter: Self



River Otter

Eats: fish, crayfish

Relationship to River

Otter: Self



Beaver

Eats: Woody plants

Relationship: to River Otter:

Commensalism (beaver helps river otter through habitat creation)

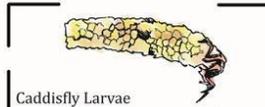


Mountain Lion

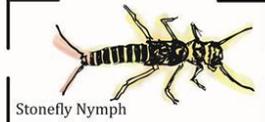
Eats: Mammals, especially deer

Relationship: to River Otter:

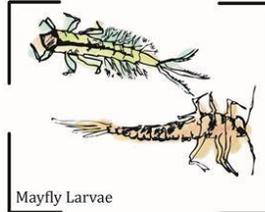
Predation (Mountain lions sometimes eat river otters)



Caddisfly Larvae



Stonefly Nymph



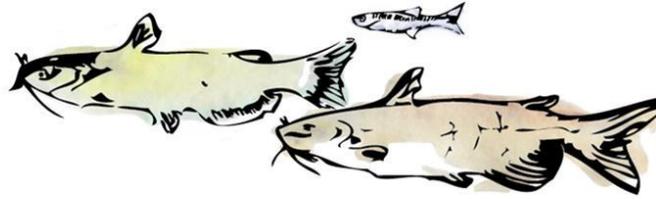
Mayfly Larvae

Macroinvertebrates

Eat: plankton

Relationship to River Otter:

Food Web (Eaten by fish, which river otter eats)



Fish

Eat: Macroinvertebrates, plants, algae, small aquatic animals

Relationship to River Otter: Predation (river otter eats fish)



Crayfish

Eats: plants, algae, small aquatic animals

Relationship to River

Otter: Predation (river otter eats crayfish)



Frog

Eats: insects

Relationship to River

Otter: Predation (river otter eats amphibians)



Raccoon

Eats: Crayfish, frogs,
small aquatic animals

Relationship to River
Otter: Competition
(competes for food)



Bobcat

Eats: crayfish, frogs,
small aquatic animals

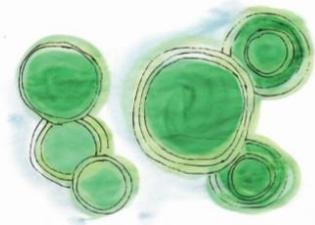
Relationship to River
Otter: Competition
(competes for food)



Coyote

Eats: Small mammals

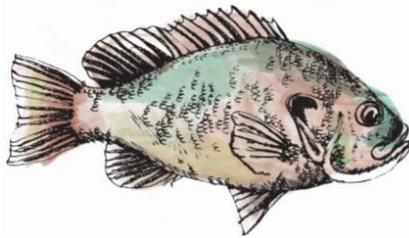
Relationship to River
Otter: Predation
(coyotes eat river ot-
ters)



Algae

Eats: Makes its own food through photosynthesis

Relationship to River Otter: Food chain (crayfish eat algae and river otters eat crayfish)



Bass

Eats: crayfish, smaller fish

Relationship to River Otter: Prey (River Otters will eat Bass and other Large Fish)

Lesson 6: Otter Stories

Deep Streams The River Otter

Excerpted from, John H. Murray. 1987. *Wildlife in Peril: The Endangered Mammals of Colorado*. Boulder, CO: Roberts Rhinehart, Inc. Publishers.

He swam in a slow and easy motion, with strong regular kicks of his thick webbed hind feet and even strokes of his smooth, round tail, which he used as a rudder to guide himself through the water. He was cruising upstream on the North Fork of the Colorado River in Rocky Mountain National Park, pushing steadily against the current with only his eyes, nose, and ears showing, beaverlike, above the surface. All his lines were sculpted and swept back, like a piece of wood that has been in the water a very long time, a once-tangled branch from which everything irrelevant has been removed, so that only the simplest forms, the core beauty, remains. It was a lovely slender body with a short muzzle, a broad and flattened head, a muscular neck and trunk, and a powerful tapered tail trailing behind it to a point. Everything about him was made for the water, from the head curved like a river stone, to the tiny ears flattened into the dense fur, to the fur itself – a luxurious dark brown coat so fluid and fine that it seemed he wore the very element in which he swam. Only his stiff white whiskers protruded visibly outward from the thick muscular contour of his body, and they offered only passing resistance to the current. To the water he was just another wave gliding through the ever flowing continuum.

To the biologist from Colorado State University studying the North For river otter transplant, he was M31 (male number 31), one of over twenty otters being monitored in the Kawuneeche Valley and its environs. Originally brought to Colorado in 1983, M31 had been surgically implanted with a small three-ounce radio transmitter and then been released into the wild. On a floppy disk back in Fort Collins, all of M31's vital information and sightings were recorded. He had been captured in Minnesota as a juvenile and shared the river with otters from Wisconsin, Michigan, Minnesota and Washington. Like most, he was a widely ranging free spirit, and had been radio tracked as far east as the headwaters of the North Inlet, just below the feeder stream from Lake Nanita, and among virtually all of the western and northern tributaries of the North Fork. Using an omnidirectional whip antenna, the biologist and his assistants, working from vehicles, on foot, and the air, had patiently tracked M31 and his cousins for three years.

It was an hour before daybreak and the full August moon, still high among the spire-topped spruce and fir, brightened the winding course of the river. In the deep pools where the clear snowmelt gathered behind the rock falls or the log jams, the water was so still that the tall stars could twinkle upon it and the ghostly clouds gliding over the moon. In other places, the splashing water scattered the light into a myriad of steel-like slivers glimmering on the surface of the stream. It was in the pools that the fishing was best for the otter, where the trout gathered and the suckers scavenged and the frogs jumped in now and then.

It had been three days since the hailstorm, and the river was once again clear and moving slowly well below its banks – so clear, that in one deep pool the otter dove to retrieve an aluminum fly box that had fallen to the bottom. On a spruce deadfall still dragging half-green boughs in the water he tried to open it with his dexterous paws, but could not find its secret and left it there, gleaming like a treasure chest in the moonlight. A little farther on he left the water and loped across a grass meadow with the peculiar gait of an otter to an enormous boulder left perched on the gravel by a glacier that retreated long ago. It was marked with fresh and old otter scent, as well as

the scent of mink, weasel, bobcat, coyote, and mountain lion. After leaving his scent he returned to the river, spooking a cow moose and her calf along the way, who snorted as he passed.

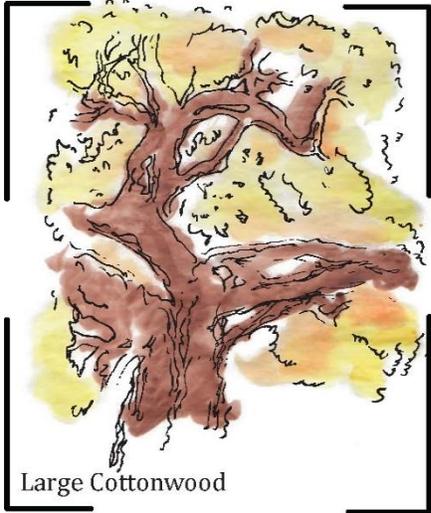
On either side of the river the mountains rose as steeply as the neck of a horse, looming darkly over the narrow valley. Several of the cataracts and waterfalls streaming down their sides from the high lakes could be heard, surging against the silence. Down lower, in the lodgepole stands and sedge parks, the owls could be heard as they hunted, and the bleats and grunts of the grazing elk. Farther up the valley, near the remote headwaters of the North Fork, there was a treeless gray mass of bedrock and tundra, a formidable mountain as rounded and battered as the canine tooth of an old bear, with a few white patches of lingering snow scattered here and there. A few of the otter released into the valley had already crossed over this mountain and colonized the northern waters. A few more had died from various causes. Most had stayed in and around the valley where they had been released. Even when the big snows came in December, the otters could still fish, seal-like, from holes dug in the ice.

As the otter approached the footbridge over the river to the Never Summer Ranch, once a private inholding in Rocky Mountain National Park, but now a historical exhibit of a classic early twentieth century dude ranch, he slowed and submerged silently. Four body lengths ahead, where the riffle swirled around the rock pilings, he could see a small school of brown trout holding on the gravel bottom, just as the leading edge of the moon shadow cast by the bridge, rising occasionally to take a passing insect. With a quick whip of his tail he accelerated forward and grabbed the last one tightly in his jaws as the other shot upstream. He brought the trout ashore, still flapping wildly, tore it apart on a flat rock and devoured its edible parts, leaving only the head, the back, and the tail for the ravens to find in the morning. Near the spot he scent-marked a familiar boulder and then stood on his hind legs, using his tail for support, and held his front paws against his chest. He was just a half mile below the Timber Creek Campground and could smell the sharp scent of woodsmoke from an early campfire and hear the clang of a coffee pot on a metal grill. He reentered the water and continued to rest and sleep during the hot part of the day, keeping to the far side of the river, where blue-winged teal could sometimes be found with their summer broods.

A mile farther on, the otter entered a beaver-pond complex. He stayed on the west side of the valley, carefully avoiding those ponds where several fly fisherman were casting quietly. It was becoming light now, and the last clouds of mist were drifting off the water into the aspen groves as small scattered herds of mule deer browsed through the underbrush. The trout were rising on all seven ponds. The otter caught two more trout and passed through three large beaver ponds before he reached his destination, an abandoned beaver lodge. He chased the muskrats from their nest and settled into his favorite daybed for a long rest. Within minutes, he was fast asleep, his nose, eyes, and paws twitching as he dreamed such dreams as otters dream. A half mile to the east, on the side of the road, one of the biologist's field assistants put down the H antenna with which she had identified the otter's general location, and wrote in her spiral notebook: "M31. August 24. 0622. Clear skies. Air temperature 34 Fahrenheit. No wind. Beaver Pond Complex, Above Timber Campground."

Lesson 7: Reading the River

Field Cards



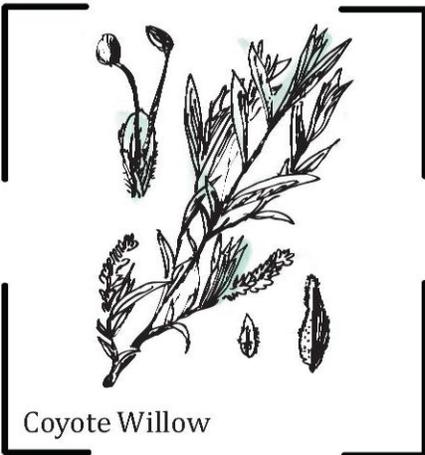
Large Cottonwood

Look for a large cottonwood. Cottonwoods grow where water is plenty. They are common along most of New Mexico's rivers. Cottonwoods provide many important benefits. They provide shade, shelter, and food for many animals. They also can shade the river itself. These shaded areas provide important habitat for fish species that depend on a specific temperature. Can you name 2 different kinds of animals that rely on the cottonwood that the river otter also relies on for its habitat?



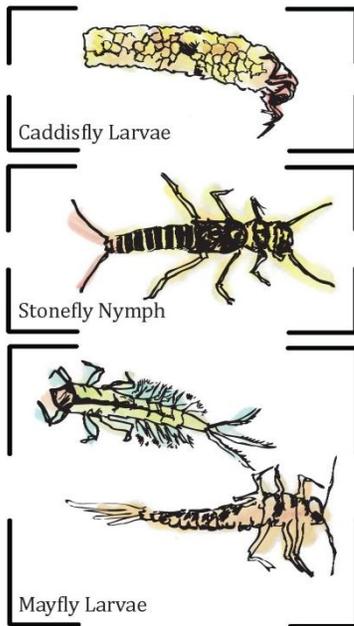
Gila Woodpecker

Look for signs of a Gila woodpecker. Gila woodpeckers, among many birds, nest in the cavities of old cottonwood trees. While Gila woodpeckers eat many insects, they also eat the galls (egg sacs) of aphids found on cottonwood tree leaves. Can you see any galls? Do you see any holes in the trees that might have been made from a woodpecker beak? Acorn woodpeckers are also common where there are groves of oak trees. They place the acorns into the oak tree, leaving pockets of holes and a stash of nuts. Look for signs of these too. In general, woodpeckers are signs of a healthy ecosystem, where there is enough food and habitat for diverse life.



Coyote Willow

Look for riparian vegetation. Riparian vegetation includes many of the willows and low growing shrubs that grow along river banks. They are signs of healthy river systems. They are also one of the most important factors in creating a healthy river habitat for otters. Riparian vegetation does many things that otters need. These plants can provide cover to hide from predators, eat food, and move about safely. Riparian vegetation also fosters shade and muddy areas where food sources can live. Healthy riparian zones also create conditions important for beaver activity, and beavers are important in creating positive river otter habitat.



Caddisfly Larvae

Stonefly Nymph

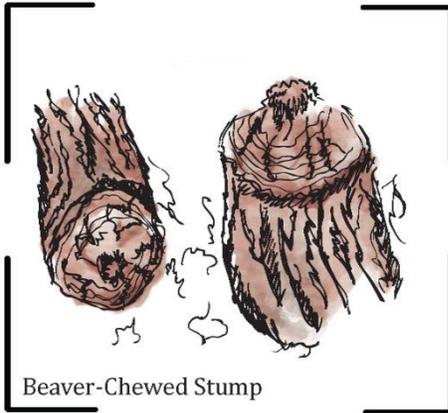
Mayfly Larvae

Look for aquatic macroinvertebrates. Find softball sized rocks in the river's edge. Turn them over and look for signs of life under the rocks. Do you see any larvae, such as the mayfly or stonefly larvae? Do you see a small larva covered with small stones? This is the caddisfly larva. Larva are important sources of food for many invertebrates and fish. They are also important indicators of water quality in rivers. If you find larvae of mayfly, stonefly, or caddisfly, the water quality is fairly good in the river. River otters also eat dragonfly larvae and other insects during summer months.



Snail

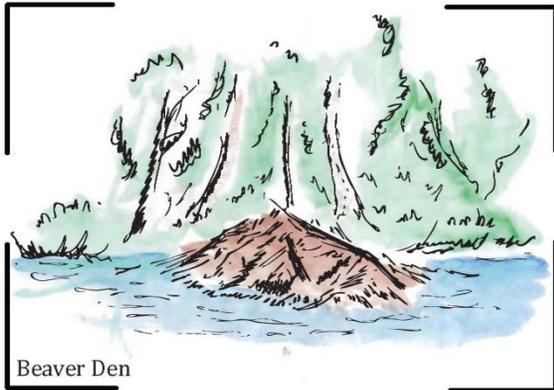
Look for leeches or snails along rocks or river's edge. Just like the larvae described above, snails and leeches can help us read the river. They can tell us that the water quality might not be clean or in good condition. These animals are tolerant of much poorer water conditions along a river and indicate that there might be a problem either from a pollution source or degraded stream banks.



Beaver-Chewed Stump

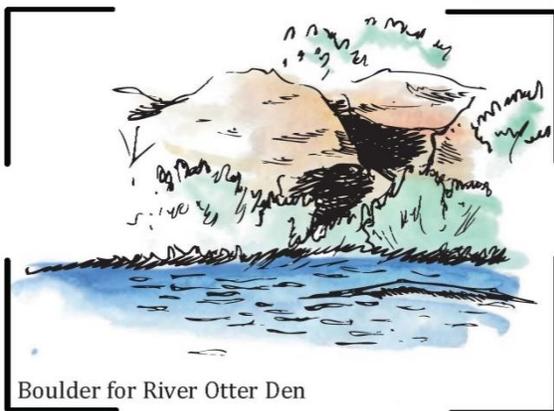
Look for a tree stump that has been chewed.

What kind of animal might have done this? The tree could have been cut down by a beaver. Beavers cut trees for food and to make their dens. Beavers will eat small trees or branches whole but will sometimes leave larger debris. Beavers are important for river otters because they create many of the necessary habitat conditions for river otters.



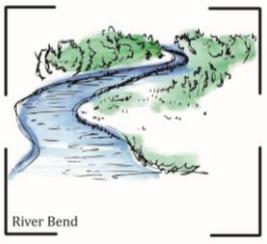
Beaver Den

Look for a beaver den. When beavers abandon their dens, these can be occupied by river otters. Sometimes, otters will hang around beaver dens that are still occupied. On occasion, river otters will eat young beaver kits. In California, river otters have been chased off from beaver dens. Male beavers slap their tails repeatedly at the water, telling the river otter he or she is not welcome there. Beaver dens can also be important in creating other habitat conditions for river otters. This includes creating deeper water where the river otter might find fish as well as deeper water for swimming and feeding during cold and winter months.



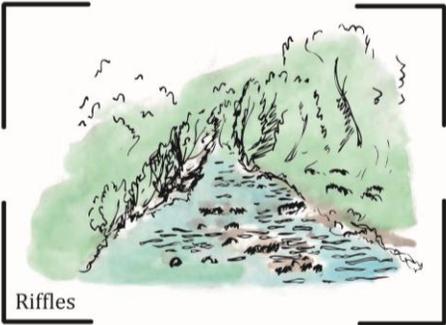
Boulder for River Otter Den

Look for large boulders with holes behind them. These are potential areas for river otter dens. River otters have been found along the Rio Chama in northern New Mexico in hollowed areas behind large boulders. Other important features include logs, stumps, and fallen trees. Dens are important areas not only for raising young but also for resting during the day. River otters might use several den locations during the day for rest and cover.



River Bend

Look for a bend in the river. Observe which side of the river is moving more quickly. Also look to see if one side of the river has deeper water in it. Generally, the river flows faster on the outside of a bend in the river. Bends are also called meanders. Water generally moves more slowly on the inside of the river and sand can build up there, sometimes creating a sandbar.



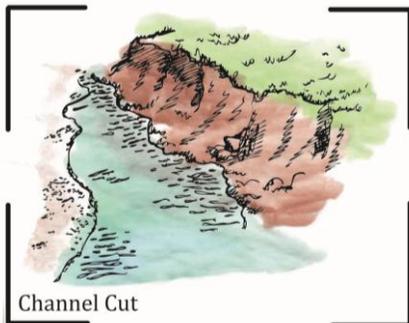
Riffles

Look for alternations between riffles and pools in the river. Riffles are areas of rough water. Generally there are small or medium sized rocks and the water moves quickly and roughly through riffles. Pools are areas of deeper, slow moving water. These areas usually alternate in rivers. Riffles and pools create different kinds of habitat for aquatic life, including macroinvertebrates and fish. Fish that feed on larvae can be found along protected edges of rocks in riffle areas, whereas larger fish that feed on smaller fish might be found in pools. River otters use all areas of a river, but rely on the deeper waters for their main food source (fish).



River Run

Look for a river run. A river run is a straight portion of the river where water moves relatively smoothly and evenly. What might a river otter do in these stretches of a river?



Channel Cut

Look for a channel cut in the river. When water moves very quickly through a river, it can “cut” the riverbank, causing some of the soil along the edge to fall into the river as sediment. This can decrease the water quality. It can also alter the habitat conditions most suited to river otters. Aside from water quality, the shoreline habitat is very important in providing adequate habitat for the river otter. Riparian plants cannot grow on steep channel cuts, yet these plants provide hiding places for otters when they are feeding, denning or moving about on land.



Raccoon Tracks

Look for sign of raccoons. Raccoons are common animals along the riverbanks because they eat crayfish and frogs. Their tracks are often easy to find because they walk along the muddy banks looking for aquatic food. Their front feet leave prints like little hands. These paws make it easier for raccoons to eat a diversity of foods, including crabs and crayfish which need to be pried from their shells.



Bobcat Tracks

Look for sign of bobcats. Bobcats can be found along rivers because they feed on many of the animals that visit the river. This includes squirrels, rabbits, and small water birds. In general, otters and bobcats do not compete with each other for food or habitat and neither preys on the other. In California, a bobcat was startled to find a river otter along the water's edge. They both stared at each other for a while before the river otter dove back into the water. Cats have retractable claws, so their tracks do not have marks.

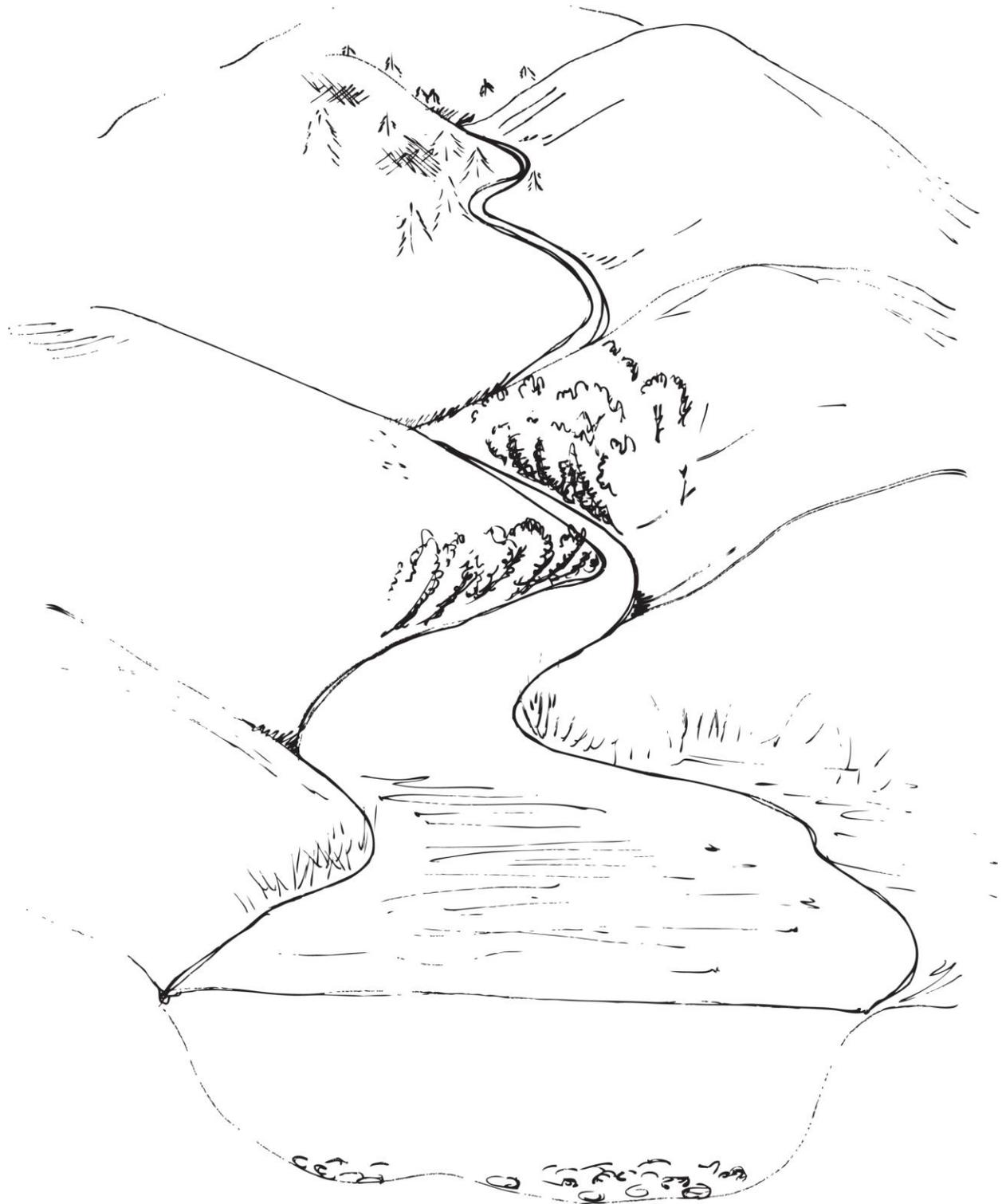


Coyote Tracks

Look for sign of coyotes. Coyotes, along with dogs and mountain lions, are predators of the river otter. While you will not find sign of the river otter in its scat, you can sometimes tell what coyotes have eaten by reading their "scat," or poop. See if you can find tracks or scat from the coyote and learn what it has eaten.

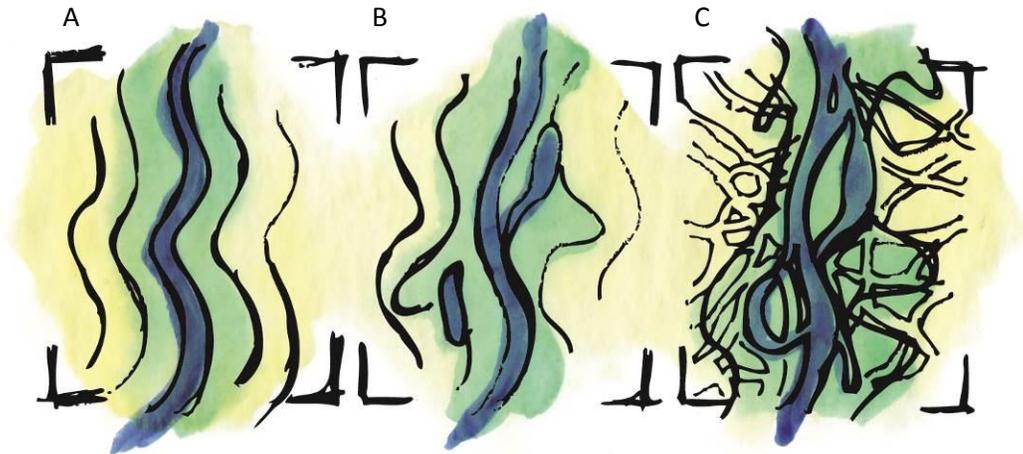
Lesson 8: Habitat Mosaic

Mosaic Template

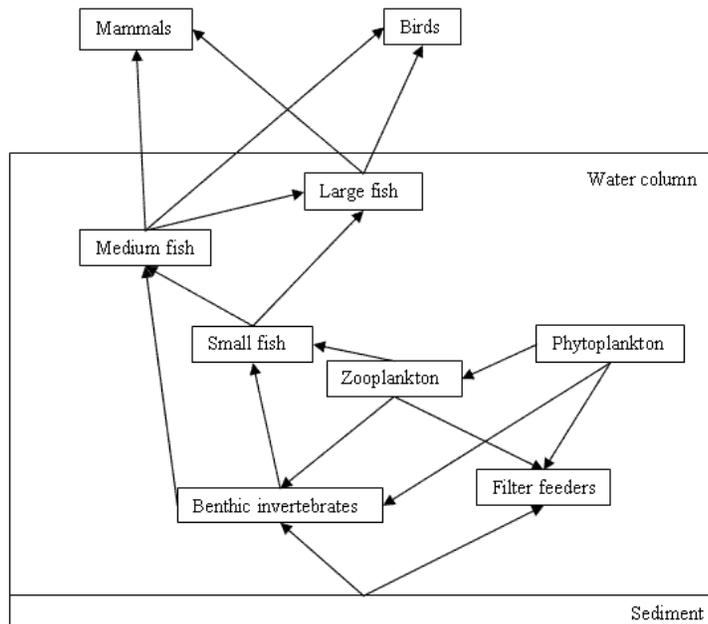


Lesson 9: Cog, Wheel and Carnivore

Influence of animals on river corridors and mosaic patterns

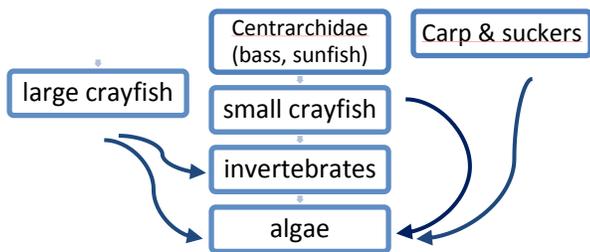


A trophic diagram for riparian ecosystems. River otters are considered a top predator in river systems.



Trophic Interactions without (a) and with (b) river otters

a. Without otters



b. With otters

