Against the Current

Metamorph Films

Classroom Discussion Guide

Middle School Version (6-8)

Content created for **Schoolyard Films, Inc.** by Cypress Curriculum Services, LLC

Film Overview

For over 70 years, the upstream reach of Montana's North Fork Fridley Creek was severed from the Yellowstone River. To maintain productive grazing fields, ranchers constructed a canal to divert water from the creek for flood irrigation, resulting in the loss of spawning and rearing grounds for the Yellowstone cutthroat trout, Montana's state fish. But the valley did not just lose a fish; it lost the health of an entire stream ecosystem. Thankfully, there were those who noticed. The creek was reconnected in 2005 and through the flow of water—the lifeblood of the stream—the ecosystem is healing and the Yellowstone cutthroat trout has returned.

“Against the Current” tells the story of competing water interests between agriculture and wildlife, and how one group came together to find a sustainable solution for all. Set on the Ox Yoke Ranch in Paradise Valley, Montana, this 19-minute film highlights a successful collaboration between the Murphy Family, Trout Unlimited, the Gallatin Valley Land Trust, and the State of Montana, to restore the connection of Fridley Creek. As students learn about the restoration of this small creek, they will develop a broader understanding of connections between land, water, fish, and humans. As Montana biologist Pat Byorth eloquently states, "Our fate is tied to the fate of the rivers."

Teachers can use this guide to supplement study of the Montana Essential Learning Expectations and Florida Sunshine State Standards for Science, specifically on content standard topics such as scientific investigation, structure and function of living things, the processes and diversity of life, interactions between living organisms and their environments, and the impact of scientific knowledge and technology on communities, cultures and societies.

Key Terminology

Be sure that students are comfortable with these terms either before the film, or as part of discussion after the film. If the students are doing writing prompts, provide these terms as a "word bank" to help guide their writing.

adaptation, biomes, class, cold-blooded, community, competition, dichotomous key, diversity, ecosystems, environment, environmental impact, evolution, food chain, food pyramid, food web, glaciation, invertebrate, kingdom, mutualism, natural selection, parasitism, piscivorous, population, predator, prey, primary consumer, producer, range, secondary consumer, technology

National Standards Correlations

Discussion Guide Element	Unifying Concepts and Processes	Science in Personal and Social Perspectives	Life Science	Science and Technology
Discussion Question #1		●	●	
Discussion Question #2		●	●	
Discussion Question #3		●	●	
Discussion Question #4		●	●	●
Discussion Question #5	●		●	
Discussion Question #6			●	
Activity #1: Construct a Food Web for the North Fork Fridley Creek	●		●	
Activity #2: Build Your Own Key	●		●	

State Science Standards Correlations

Discussion Guide Element	Montana: Essential Learning Expectations (ELE) for Science	Florida: Sunshine State Standards
Discussion Question #1	S3.4.gr6-8.A, D	SC.7.L.17.3
Discussion Question #2	S3.4.gr6-8.A, D	SC.7.L.17.3
Discussion Question #3	S3.4.gr6-8.A, D S5.4.gr6-8.A-C	SC.7.L.17.3
Discussion Question #4	S5.4.gr6-8.A-C	SC.8.N.4.1 SC.7.L.17.3
Discussion Question #5	S3.4.gr6-8.D	SC.7.L.15.3 SC.7.L.17.1 SC.7.L.17.2 SC.7.L.17.3
Discussion Question #6	S3.4.gr6-8.A	SC.7.L.17.2 SC.7.L.17.3
Activity #1: Construct a Food Web for the North Fork Fridley Creek	S3.2.gr6-8.C	SC.7.L.17.1 SC.7.L.17.2 SC.7.L.17.3
Activity #2: Build Your Own Key	S3.5.gr6-8.A-C S5.2.gr6-8.A-B	SC.6.L.15.1

Discussion Questions/Writing Prompts

Use the following questions as springboards—either to stimulate a classroom discussion or as writing prompts. Either way, the goal is to foster discussion on the level of synthesis and analysis. Below each question, you will find possible areas of discussion to guide the teacher.

1. In the film, the biologist states that, "Our fate is tied to the fate of the river." What do you think he means by this? How might the people of Montana be connected to the Yellowstone River's future?
   - *Prompt students to consider how animals meet their needs to survive and compare these needs with those of humans. Identify shared basic needs between humans, trout and other animals that live near or in the streams and rivers. Explain that an unhealthy or changed environment can make it more difficult for animals (including humans) to obtain their basic needs for survival.*

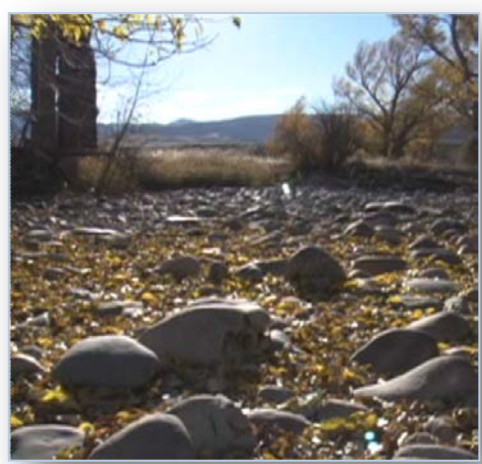
2. Scientists estimate that the Yellowstone cutthroat trout currently occupies half of its historical range. This decline of Montana's state fish is largely due to impacts by humans. Can you give examples of human activities that have contributed to the decline of the Yellowstone cutthroat trout?
   - *Students may identify disturbances to the population that fall into three main categories: habitat degradation, introduction of non-native fishes, and over fishing. Specific examples would include agricultural activities, livestock grazing, mining, timber harvest, and over fishing.*

3. What specific activities on the Murphy Family's ranch were causing harm to local trout populations?
   - *Make sure students understand that agriculture involves diversions of water from streams (for irrigation and water supply for livestock).*
   - *While not specifically addressed, other common impacts from ranching activities include shoreline disturbance (erosion) from livestock, and increased nutrient inputs to streams from animal waste and fertilizers.*

4. What are some environmental problems in your area right now and what are the impacts to the environment? What technology is used to help solve the problem?
   - *Collect responses from students and write on the board. Possible issues for discussion include statewide problems such as mining, coal fires, tire burning in plants, invasive non-native organisms (plants, animals, pathogens), climate change, and mercury pollution. Students may also focus on local issues such as the need for recycling or threatened ecosystems.*
   - *For each problem, ask students to consider technologies that they know are being used to address the issue. Then ask students to brainstorm other technology applications that may be used. Encourage students to think creatively.*

5. The lake trout (*Salvelinus namaycush*) is a large, fish eating (piscivorous) trout species. It can live up to 40 years and commonly reach 50cm in length. Lake trout are not native to the Yellowstone region. Humans introduced them to Yellowstone Lake on purpose in the 1990's. Since then, scientists have observed significant declines in the Yellowstone cutthroat trout in the lake and in upstream tributaries. Why do you think the introduction of lake trout has had such an impact on cutthroat trout?
    - *Students may need additional background information to give specific examples, but should be encouraged to propose likely impacts to the cutthroat trout based on their understanding of species interactions. Students should be able to identify predation and competition for resources (space, food) as primary causes for cutthroat decline.*
    - *Discuss the specific impacts to cutthroat trout by presenting the following information.*
        - *With the introduction of lake trout in Montana, Yellowstone cutthroat populations were suddenly exposed to a new, voracious predator. Migrating cutthroat trout are not adapted to the presence of large predator fish and become easy prey for the larger, longer-lived lake trout.*
        - *A single lake trout, which begins eating cutthroats at four years of age, will eat up to 50 cutthroats a year. This has a direct impact on the number of reproducing adults in the cutthroat trout population.*
        - *Non-native lake trout compete with native cutthroats for food (leeches, amphipods, midges). With less food resources, the cutthroat trout are less likely to reach adulthood and produce offspring.*
        - *Unlike the cutthroat trout, the lake trout does not migrate upstream to spawn. If the cutthroat trout are significantly reduced, the upstream food web is disturbed. Many species (grizzly bears, osprey, eagles, and otters) rely heavily on the Yellowstone cutthroat trout for food in the upper reaches of the Yellowstone.*
        - *Another predator will miss the cutthroat. Stream trout fishing is very popular in Montana, bringing in over $30 million in revenues to the state. As cutthroat trout continue to decline, fishing will be more limited to lake and large river fishing.*

6. Can you identify common biotic and abiotic factors in Montana stream ecosystems? Describe how these biotic and abiotic factors influence Yellowstone cutthroat trout populations.



    - *BIOTIC: Students may identify "living things" or name specific organisms common to stream ecosystems (e.g., dragonfly) as biotic factors. While these are biotic components of the ecosystem, ask students to consider interactions that a trout would have with its environment that involve other living things. General examples include competition with other* *organisms for food and space, both interspecific and intraspecific; predation; parasitism. Discuss predation both from native predators (e.g. grizzly bear, American white pelican) as well as from recently introduced species (e.g. lake trout). An important example of parasitism is Myxobolus cerebralis. Originally introduced from Europe, this non-native parasite causes whirling disease and seriously threatens cutthroat trout populations throughout the region.*

- *ABIOTIC: Students should identify a variety of factors including water temperature, water flow rates, water pH, substrate type (loose sediment, rocky bottom, etc), and nutrient levels. Facilitate discussion regarding the effects of changing these abiotic factors on trout population dynamics.*

Suggested Activities for Further Study

Activity One: Construct a Food Web for the North Fork Fridley Creek

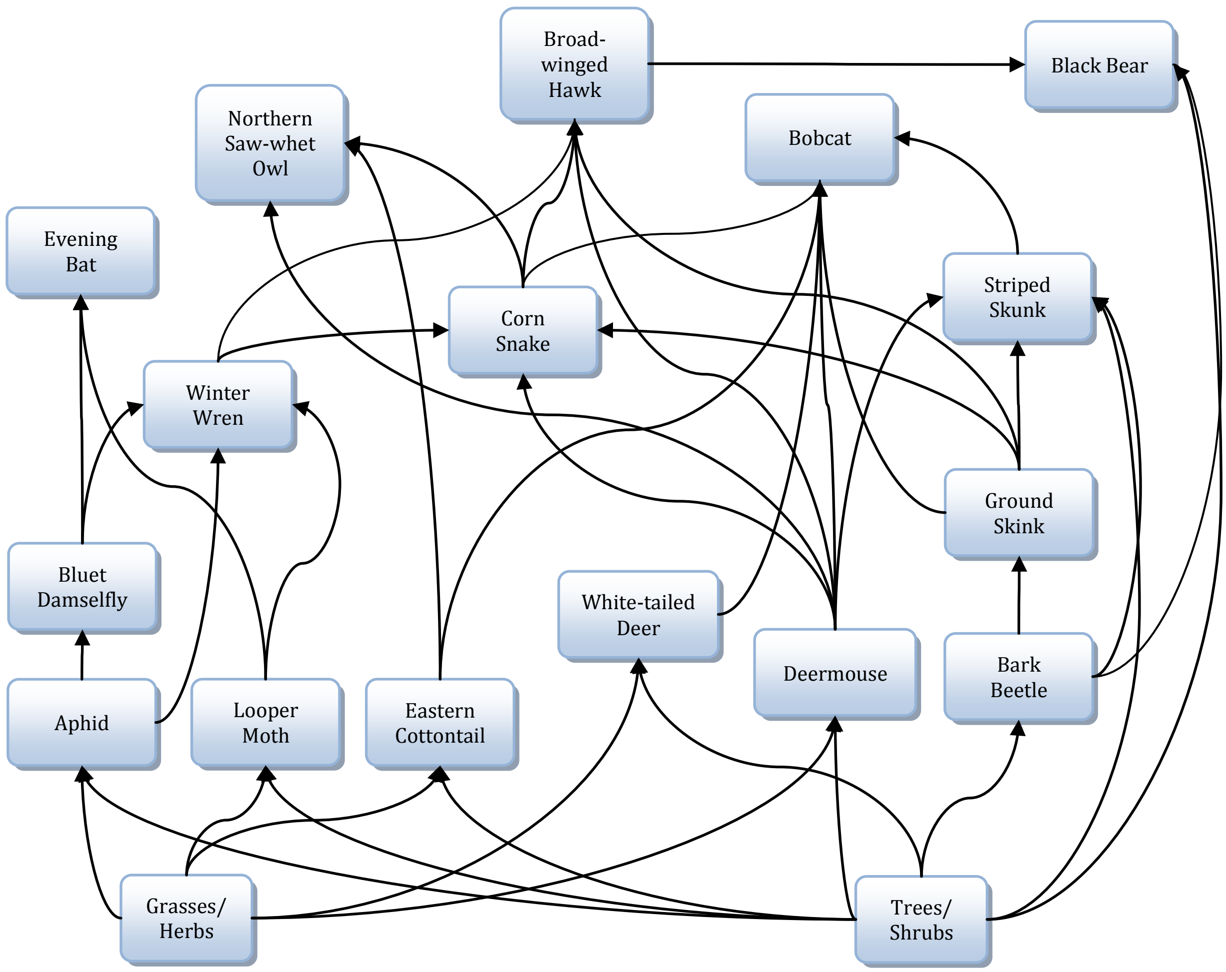
In this classroom activity, students will construct a food web for a Montana stream ecosystem.

a) Begin by dividing the class into small groups. Using the species list provided below, assign equal numbers of animal species to each group. Instruct each group to utilize various reference resources to research the diet of their assigned animal species.

   Note to the teacher: Adequate resources and time to do the research are key to the successful completion of this activity. In an ideal situation, there would be one or more class periods for library research alone. If this is not possible, you may wish to gather resources ahead of time for students to use in class.

b) After students have completed their research, use large group instruction to lead the class in creating a food web, preferably on a dry-erase board. Building the web is easier if species are added in the following trophic order: herbivores, omnivores, carnivores. Advanced classes may include scavengers and decomposers (fungi). It is not necessary to label the trophic groups on the board. Also, be sure to point arrows from prey to predator to show the direction of energy flow.

Here is an example of a simple food web for the Smoky Mountains:



Smoky Mountain Food Web

c) Once the food web is constructed, crosschecked, and neatened, ask students to copy the food web onto their own paper. Students should then group sections of the food web into trophic levels: producers, primary consumers, secondary consumers, higher order consumers, scavengers, and decomposers.

d) If there is access to presentation software, give students an additional class period to design the food web using graphic organizational software. Their presentations could then be offered to the rest of the school or community as an informative display or presentation, along with the film "Against the Current."

Common Animal Species of Fridley Creek

American Dipper - *Cinclus mexicanus*
American Rubyspot - *Hetaerina americana*
Arctic Grayling - *Thymallus arcticus*
Belted Kingfisher - *Megaceryle alcyon*
Brook Stickleback - *Culaea inconstans*
Brook Trout - *Salvelinus fontinalis*
Coeur d'Alene Salamander - *Plethodon idahoensis*
Common Stonefly - *Plecoptera* spp.
Grizzly Bear - *Ursus arctos*
Harlequin Duck - *Histrionicus histrionicus*
Leech - *Helobdella stagnalis*
Mayfly - *Caudatella* spp.
Mottled Sculpin - *Cottus bairdii*
Mountain Marshsnail - *Stagnicola montanensis*
Mountain Whitefish - *Prosopium williamsoni*
Northern Leopard Frog - *Rana pipiens*
Pale Snaketail - *Ophiogomphus severus*
Pilose Crayfish - *Pacifastacus gambelii*
Raccoon - *Procyon lotor*
Rainbow Trout - *Oncorhynchus mykiss*
Rhyacophilan Caddisfly - *Rhyacophila angelita*
Rocky Mountain Duskysnail - *Colligyrus greggi*
Rocky Mountain Tailed Frog - *Ascaphus montanus*
Trout Perch - *Percopsis omiscomaycus*
Tule Bluet - *Enallagma carunculatum*
Virile Crayfish - *Orconectes virilis*
Water Shrew - *Sorex palustris*
Western Pearlshell - *Margaritifera falcata*
Wood Duck - *Aix sponsa*
Yellowstone Cutthroat Trout - *Oncorhynchus clarkii bouvieri*

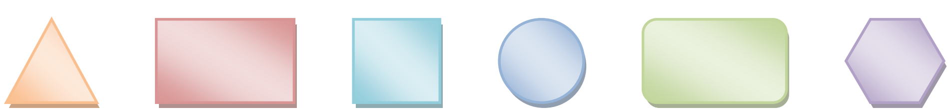
Activity Two: Build Your Own Fish Key

In this activity, students will identify and describe similarities and differences among 12 fish species common in Montana. Using detailed observations of morphological characteristics of these fish, students will then create a simple dichotomous key to identify each species. Once complete, students will trade keys to test whether the key works and whether they can identify one of the 12 fish.

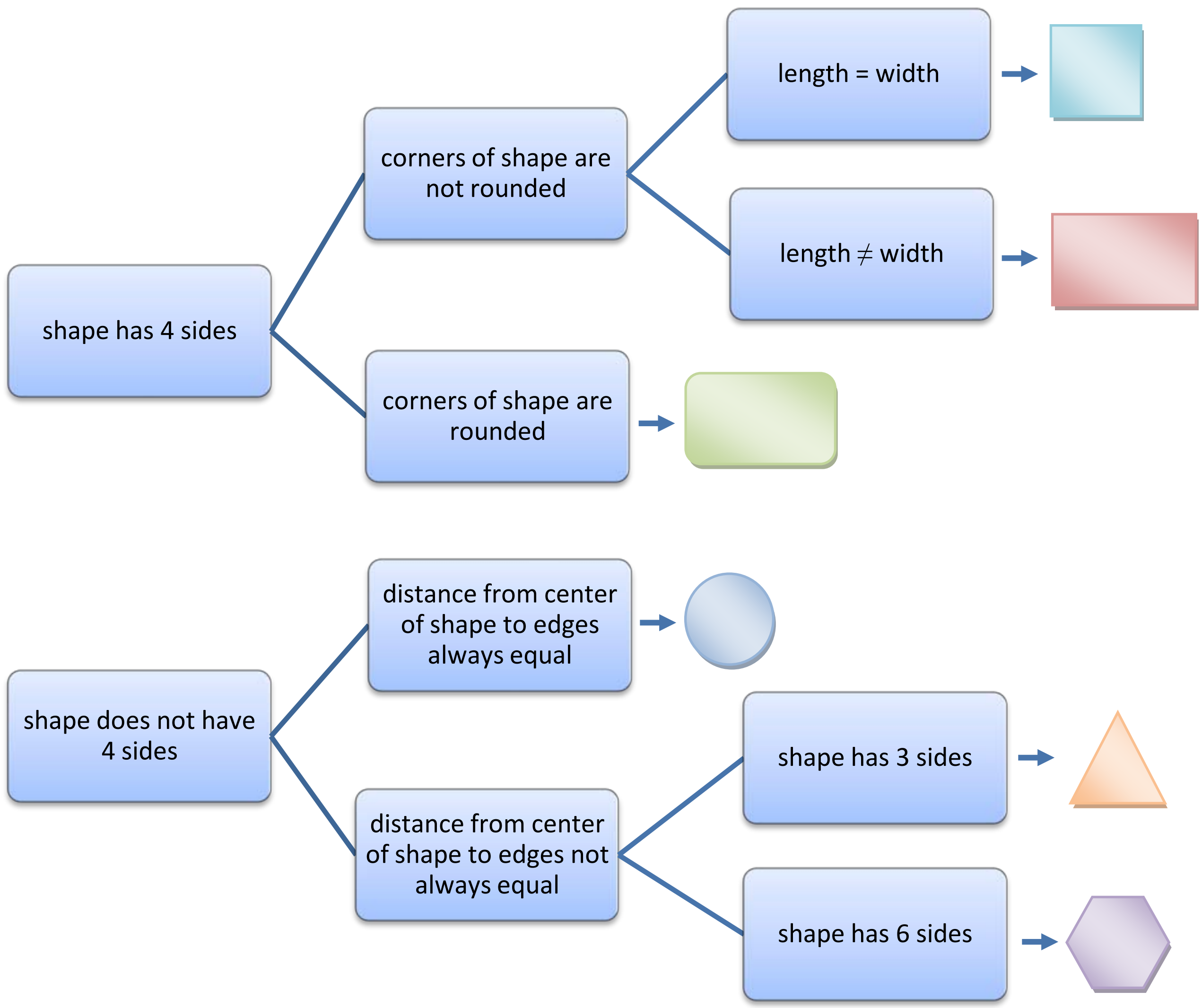
Begin this activity with a review of basic terminology of external fish anatomy using the diagram below. Once students are introduced to structure terms, review the concept of dichotomous keys, verify that students understand how to read a key, and then provide tips on constructing their own key (see tips below).

A dichotomous key is a tool for identifying unknown organisms. *Dichotomous* means dividing into two parts. Dichotomous keys are composed of a series of paired statements about the organism you are trying to identify. Each set of statements offers two choices to describe the organism. Just like meeting a fork in the road, you must decide which statement is true for your organism then proceed forward on the chosen path to the next set of statements. When you finally choose a statement that ends with a name for an organism (rather than leading to another set of statements), you have found your organism-- that is, if you answered the questions correctly.

Here is an example using the following simple shapes:



Before writing your key, it is helpful to sort your shapes with a tree diagram. Try to identify unique characteristics that are easy to describe and will be interpreted by all observers the same way. Write two statements that describe the first two groups of shapes. In the example below, shapes with four sides are separated from other shapes. It is important to note that there are many ways to group items in a key. As the author of your key, it is up to you to decide the most effective way to set species apart. After dividing the set of objects into two groups, look at each subset and determine how these shapes can be further divided. Repeat this process until all shapes are described.



Now write your diagram in the format of a dichotomous key. Start at the left and move right as shown below.

1	a. Shape has 4 sides	go to #2
	b. Shape does not have 4 sides	go to #4
2	a. Corners of shape are not rounded	go to #3
	b. Corners of shape are rounded	*rounded rectangle*
3	a. Length = width	*square*
	b. Length ≠ width	*angular rectangle*
4	a. Distance from center of shape to edges always equal	*circle*

	b. Distance from center of shape to edges not always equal	go to #5
5	a. Shape has 3 sides	*triangle*
	b. Shape has 6 sides	*hexagon*

What is the best way to divide your species into groups? Not all characteristics are useful for dichotomous keys. There are many "right ways" to set apart species in a key. Here are some features related to external fish anatomy that you might use:

- presence/absence of certain fins
- length to width ratio
- presence of barbels
- relative length of upper and lower jaw (lower jaw longer, lower jaw shorter, jaws same length)
- presence/absence of distinct lateral line
- distinctive spots on body (must indicate where on body)
- shapes of certain fins (often the caudal fin) -- forked, rounded, triangular, etc.
- presence/absence of spinous dorsal fins

There are many other characteristics to look for, so use your observation skills and compare!

Avoid the following characteristics when describing similarities and differences between species.

- length of fish (this changes with the animal's age)
- general color (color often varies with fish, color is hard to describe, and some people are colorblind)
- statements that are opinions (e.g., "fish is cute")
- guesses about fish behavior or ability based on physical appearance (fast swimmer, aggressive)

Now try to build your own key for 12 fish species commonly found in Montana.

Step 1) Review the terms used to describe the external anatomy of fish using the illustration provided (*Fish Anatomy*)

Step 2) Examine the 12 fish illustrations and begin considering how they might be divided. Length and width scales (centimeters) are provided to estimate *relative* dimensions of features. Remember that absolute lengths and widths are usually inappropriate for dichotomous keys.

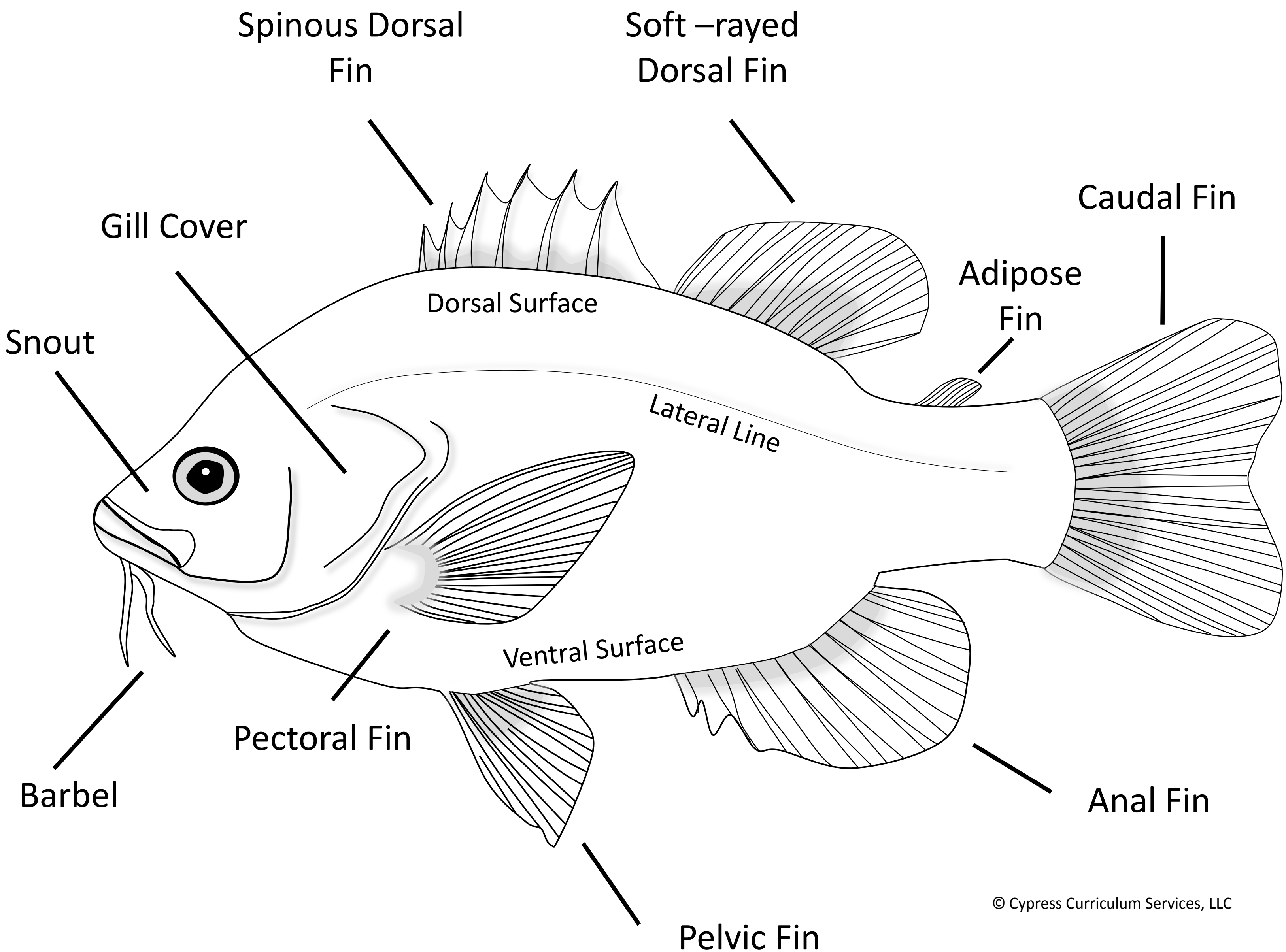
Step 3) Sketch a tree diagram to arrange your species into groups.

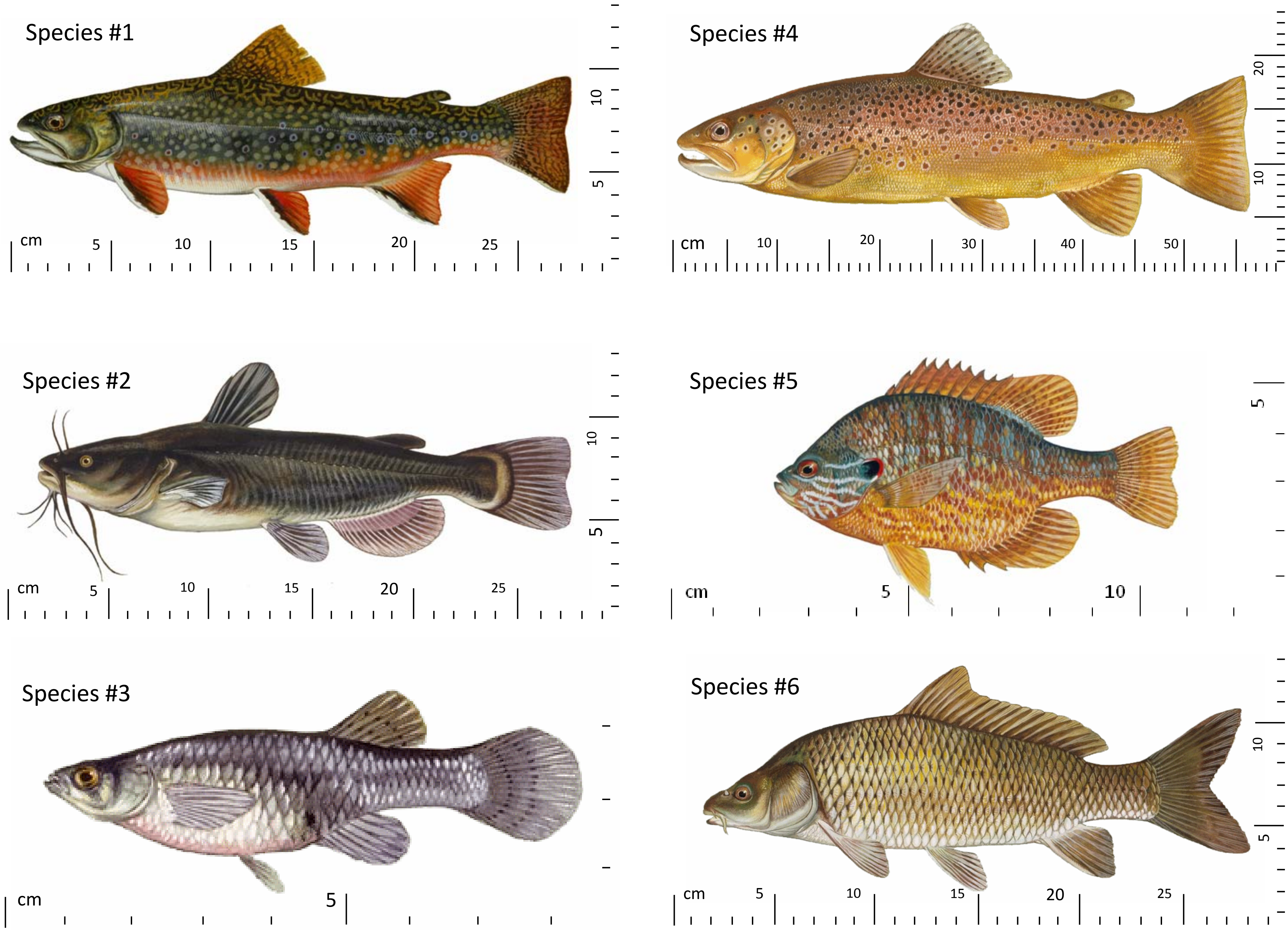
Step 4) Once you are satisfied with your tree diagram, begin writing your key using the same structure presented in your diagram. Each pair of statements should be descriptive but brief.

Step 5) Test your key! Ask other students to identify one of the species using your key. If the key does not work, do some troubleshooting to determine which set of statements is causing the problem. Was an "opinion statement" used? Is the statement not specific enough?

Step 6) Once the key is completed, your teacher will provide a species list so you can see the common and scientific names of the 12 species. The species list also includes a type of tree diagram called a cladogram, which shows the evolutionary relationships between the 12 species. Two branches that separate from a common box are most closely related to one another. Look at the most closely related species. Can you see common characteristics? Did you pick any of these characteristics when creating your dichotomous key?

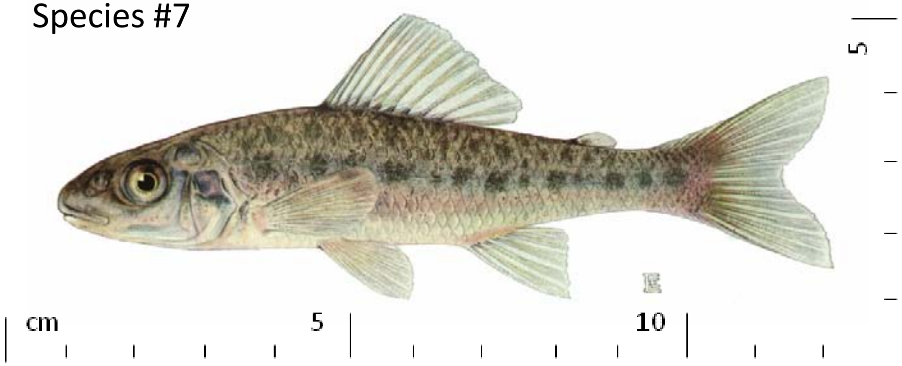
FISH ANATOMY



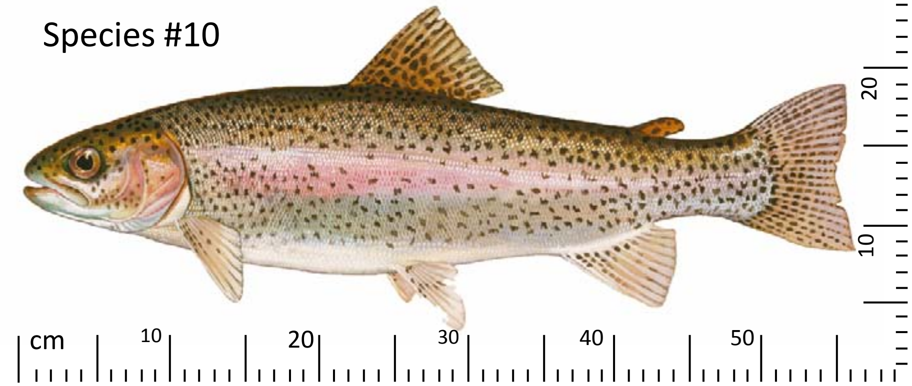


Illustrations courtesy USFWS

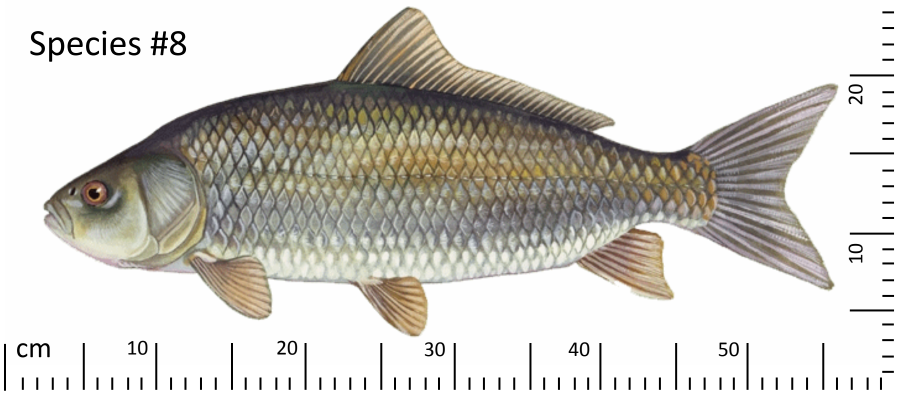
Species #7



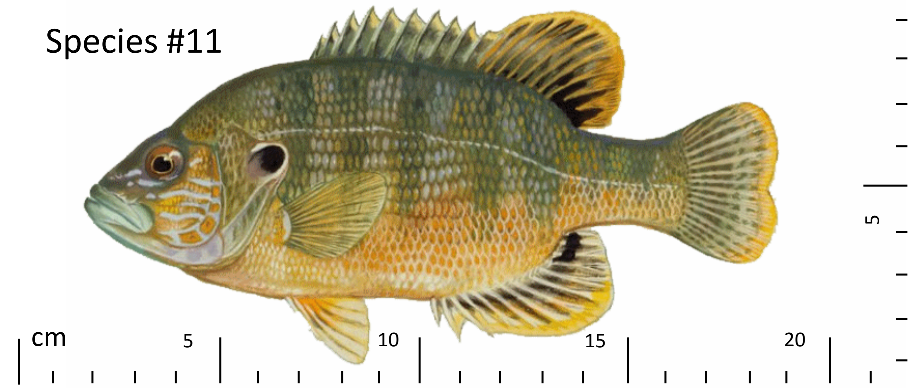
Species #10



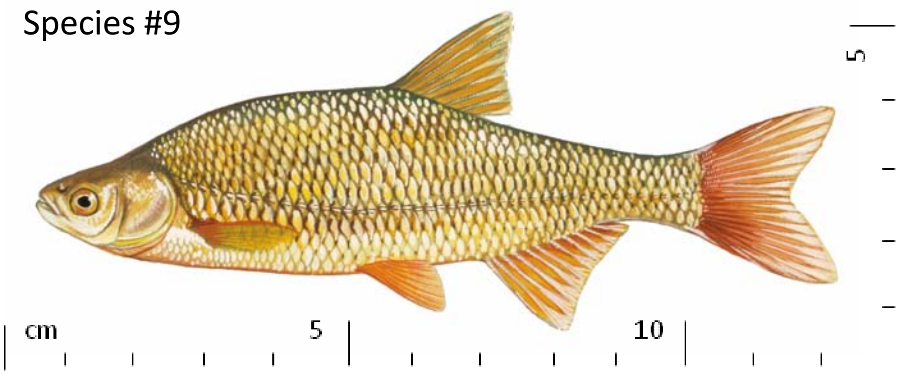
Species #8



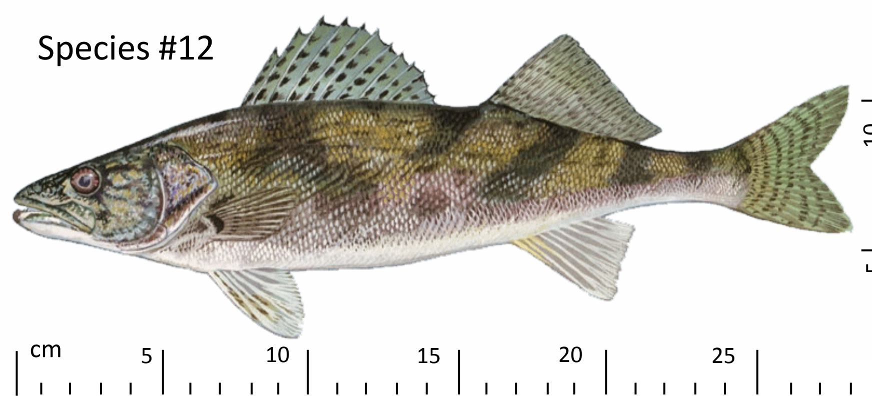
Species #11



Species #9



Species #12



Illustrations courtesy USFWS

Species Key

Species #1 Brook Trout
Salvelinus fontinalis
Non-native

Species #2 Black Bullhead
Ameiurus melas
Non-native

Species #3 Western Mosquitofish
Gambusia affinis
Non-native

Species #4 Brown Trout
Salmo trutta

Species #5 Pumpkinseed
Lepomis gibbosus
Non-native

Species #6 Common Carp
Cyprinus carpio
Non-native

Species #7 Trout-perch
Percopsis omiscomaycus

Specie #8 Bigmouth Buffalo
Ictiobus cyprinellus

Species #9 Golden Shiner
Notemigonus crysoleucas

Species #10 Rainbow Trout
Oncorhynchus mykiss

Species #11 Green Sunfish
Lepomis cyanellus

Species #12 Sauger
Sander canadensis

Classification Tree