



GO FURTHER!

Paddlefish

Imagine a quiet day on the river, when suddenly a huge, prehistoric-like fish pulls hard on your line. Named for its long, flat rostrum (beak), the paddlefish might break your gear and your previous ideas about water creatures.

Compare a fossil fish from the Cretaceous Period to a paddlefish from the Missouri River today. You would find many similarities. It has tiny eyes and smooth skin without scales. Its skeleton is cartilage like a shark. And it may be huge—as long as 7 ft 1 in (2.16 m) and weighing 90 kg (198 pounds).

Of course, there are differences. The jaws of its ancient ancestor were adapted for foraging in the muddy bottoms of lakes and rivers, but the modern paddlefish is a filter feeder. Tiny zooplankton fill its diet.

How do they find their tiny prey? Like the platypus (a mammal), the paddlefish has tiny electroreceptors in the rostrum. It can sense electrical signals as the zooplankton move and follow them for food.

We call the paddlefish an ancient fish. But of course, it's just as modern as all the other fish in our lakes and rivers. Its traits haven't changed because they are well-suited for the environment in which it lives.

Imagine the environment at the bottom of the upper Missouri River. Develop a hypothesis (an educated guess) about how each trait below might give a paddlefish an edge in survival.

Large body size _____

Cartilage skeleton _____

No scales _____

Flat rostrum (snout) _____

Tiny eyes _____

Long lifespan _____

Ability to sense electrical signals from small prey _____



JOIN THE CONSERVATION TEAM

Today's American paddlefish is considered threatened because its numbers have fallen. Its cousin, the Chinese paddlefish, is extinct. Paddlefish survived and even thrived for hundreds of thousands of years because adults had few predators. But in modern times their most dangerous predators, humans, have become their most dangerous threat. Female paddlefish have as many as 300,000 eggs (roe) which are eaten as caviar.

Conservation teams have two important jobs:

- To carefully track the numbers (and total biomass) of the paddlefish population to make sure that there are enough to continue their species, and
- To restock paddlefish so that the population remains stable and fishing can continue.

Step 1: Keeping Track

The goal of conservation is to have a sustainable population. Where fishing is allowed, natural reproduction must be balanced with fishing. Restocking from hatcheries can help to keep the numbers stable.

Since paddlefish mature very slowly and do not begin to have fry until they are about 12 years old, conservation scientists must monitor populations over long periods of time.

In the northern areas along the Missouri River, there is a short fishing season and strict limits on how many fish can be caught. Biologists use tags to determine what proportion of the population is being removed by fishing. (This is called the exploitation rate.)

Look at the results at one site along the Mississippi. Beginning in 2014, scientists put tags on hundreds of paddlefish. When a tagged fish was caught, the tag was returned to the researchers. This is just a small sample of the fish population. But these data can help estimate how many of the total population are being caught.

Polyodon spathula, of the Mississippi River

	2014–2015	2015–2016
<i>Tags applied to fish</i>	301	307
<i>Tags harvested</i>	10	20

 How many fish were tagged the first year? _____

What fraction of the tagged fish were caught in the first year? _____

If there were about 3000 fish total in that area of the river, what would be the best prediction of how many fish died or were taken by fishers? _____

How many of the total tagged fish were left in the wild after 2016? _____

In addition to fishing, what other factors might explain changes in the number of fish? _____

Step II: Restocking— Helping Nature

A restocking project begins by collecting eggs right after they are fertilized. They are placed in special hatching jars that support the development of roe (fish eggs).

One spawning crew collected 250,000 eggs from fish in the Missouri River in North Dakota. These eggs were kept in special aquaria (“hatching jars”) that hold up to 50,000 eggs each. The jars create an environment much like the river bottom. The picture on the right shows hatching jars from the Garrison Dam. The number of eggs or fry are estimated by weight.

What is the average hatching rate for the eggs?

After three weeks the baby fish (called “fry”) are moved to a long, rectangular tanks called a raceway. In the first week there (week 4 of their lives), 16 ounces of food are needed to support the fish. That number increases by 25 percent (5/4) each week. For column 4 of the chart estimate the amount of food needed in the raceway for week 6 (3 weeks after moving there).



The raceways are outside, so there some loss from predators like raccoons and large birds. At the end of the summer it’s time to stock the paddlefish in the wild. Only about 1/10 of the fish that hatched

survived this long. Some were not strong enough to live; others were killed by predators. In the last column “Released” predict the total number from each group left.

Hatching Jar	Number of eggs at start of project	Number that hatched	Food needed in raceway Week 3	Food needed in raceway Week 6	Number of fish released
1	50,000	29,500	16 ounces		
2	50,000	28,000	16 ounces		
3	50,000	32,100	16 ounces		
4	50,000	30,500	16 ounces		
5	50,000	29,900	16 ounces		

THINK!


 Asian carp are an invasive species that arrived in the United States about 20 years ago. They are filter feeders that eat lots of plankton. What effect might this have on paddlefish? _____

Paddlefish tend to move long distances up and down large rivers to gather at spawning sites. How might dams cause them problems? _____

Given what you know about a paddlefish's diet, why do you think that fishermen don't bother with bait or lures? _____

Paddlefish don't have any scales, sharp fin rays, or even any hard bones. What problems could this cause the fry? _____

GOING FURTHER

 Trace the route of paddlefish as they move through the waters of the Missouri river. Think about all of the challenges and hazards that the fish encounter as they look for good sources of food and environments for spawning. Write a short story about the life of a paddlefish fry in its first year.



<https://moenvironment.org/missouri-river-dams/>

Teacher Page

These activities ask students to think both qualitatively and quantitatively about paddlefish and about conservation efforts in general. Students can begin to think about the balance between conservation and maintaining a healthy population of fish for sportsmen. The lesson begins with questions about the adaptations of the organism that require students to develop educated guesses based on a model of natural selection. Each trait of the paddlefish has survival advantage.

Suggested Answers:

- Large body size: *Adult paddlefish have few predators.*
- Cartilage skeleton: *Cartilage is lighter than bone and more flexible.*
- No scales: *They don't have scale protection, so (must have) other kinds of protection from parasites.*
- Flat rostrum (snout): *It is adapted to explore muddy bottoms of rivers and lakes*

- Tiny eyes: *Good vision isn't necessary in muddy river bottoms*
- Long lifespan: *Ability to migrate, large size means reproducing females have few predators.*
- Ability to sense electrical signals from small prey: *The water is muddy; this is a good way to find prey.*

Keeping Track

What fraction of the tagged fish were caught? *3.99 in the first year, 4.03 in the second year.*

How many tagged fish were left in the wild after 2016? *291 + 287*

Why is counting the number of tagged fish caught a good way to estimate the total number of fish? *We assume that the fraction of fish with tags caught is the same as the fraction of all fish caught.*

Think!

Asian carp are an invasive species that arrived in the United States about 20 years ago. They are filter feeders that eat lots of plankton. What effect might this have on paddlefish? *The fish occupy similar niches or roles in the community. Asian carp reproduce more quickly.*

Paddlefish tend to move long distances up and down large rivers to gather at spawning sites. How might dams cause them problems? *The dams may isolate the paddlefish in areas where there are too many fish or too few plankton.*

Given what you know about a paddlefish's diet, why do you think that anglers hoping to catch one don't bother with bait or lures? *They do not eat bugs or worms, which are used as bait for other fish.*

Paddlefish don't have any scales, sharp fin rays, or even any hard bones. What problems could this cause the fry? *They are relatively unprotected until they are quite large.*

Hatching Jar	Number of eggs at start of project	Number that hatched	Food needed in raceway Week 3	Food needed in raceway Week 6	Number of fish released
1	50,000	29,500	16 ounces	25 ounces	2950
2	50,000	28,000	16 ounces	25 ounces	2800
3	50,000	32,100	16 ounces	25 ounces	3210
4	50,000	30,500	16 ounces	25 ounces	3050
5	50,000	29,900	16 ounces	25 ounces	2990

What is the average hatching rate for the eggs? *3/5 or 60 percent.*

For column 4 of your chart estimate the amount of food needed in the raceway for week 3. *25 ounces*

Label the last column "Released" and predict the total number. *Column 5 is 10 percent or 1/20 of number hatched.*

Go Further

Trace the route of paddlefish as they move through the waters of the Missouri river. Think about all of the challenges and hazards that the fish encounter as they look for good sources of food and environments for spawning. *While student answers will vary, they should include dams, pollution, predators (including humans), and competition from other species for food.*

Integrate

Search for great literature to integrate with your STEM lessons at <https://www.nsta.org/recommends/>.

Award-winning science and STEM books are reviewed at <https://www.nsta.org/publications/ostb/> and <https://www.nsta.org/publications/stembooks/>

Sample Standards**CCSS.MATH.CONTENT.5.NF.B.6**

Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

CCSS.ELA-Literacy.W.4.2

Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Write arguments to support claims with clear reasons and relevant evidence. (MS-LS2-4)

NGSS Life Science Middle SCHOOL

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)