SCIENCE 3D

HELLBENDERS

In this packet, sample student answers are provided in red and notes to teachers are in blue.

In this **Science Mission**, students will use data from the field, including eDNA (environmental DNA), to create hypotheses about the presence of hellbenders and changes in their populations. Then, they will explore how different types of data and information are needed to support claims. Finally, students will integrate the data they have analyzed to make recommendations on how to restore hellbender populations.

ACTIVITY I: WHERE ARE THE HELLBENDERS?

Hellbenders used to be found in many rivers, but their populations are now in trouble in most places. Because they hide under rocks, it takes a lot of time to find them. But, organisms constantly have bits of tissue, like skin, slough off their bodies. Bits of their DNA are found in their waste products. By taking samples of the water and using a series of chemical reactions and a machine, the team can see if there is hellbender DNA in the water. Use the data from these environmental DNA (eDNA) surveys to make predictions about hellbenders' well-being in five rivers.

Table 1. Results from eDNA surveys of 5 rivers in Ohio and Pennsylvania where Hellbenders were once found

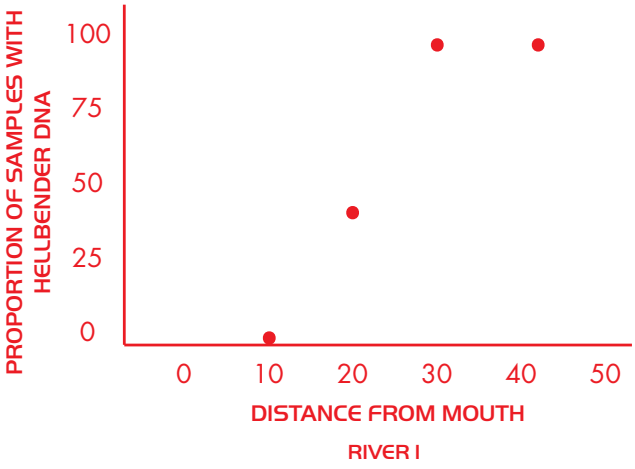
River number	Distance from river mouth (km)	Oxygen	Water quality	Number of large rocks	Proportion of samples where hellbenders were detected
1	40	High	Good	Many	100
1	30	High	Good	Many	100
1	20	High	Moderate	Many	40
1	10	High	Poor	Many	0
2	50	High	Good	Few	20
2	35	Moderate	Poor	Many	0
2	25	High	Good	Few	20
2	5	High	Good	Many	60
3	20	High	Good	Many	100
3	15	Moderate	Moderate	Many	20
3	5	Low	Moderate	Many	0
3	2	Moderate	Poor	Few	0
4	45	High	Good	Many	20
4	35	High	Good	Many	0
4	25	High	Good	Many	0
4	15	High	Good	Many	0
5	60	High	Moderate	Many	0
5	40	Moderate	Low	Many	0
5	20	Moderate	Low	Few	0
5	10	Low	Low	Few	0

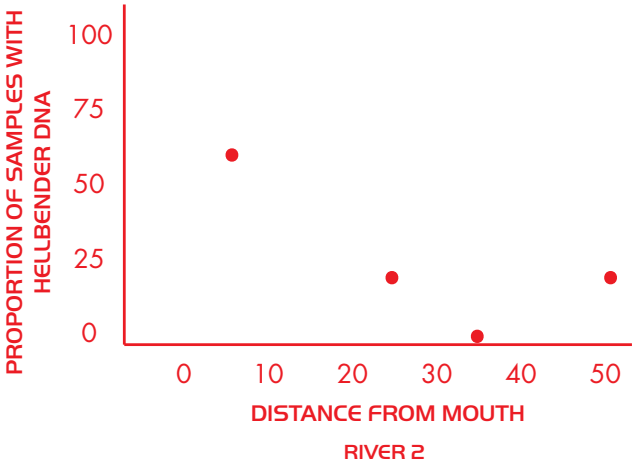
Have the students form small groups and assign each group a river to work on for the next two activities. Do not assign river 5 to a group.

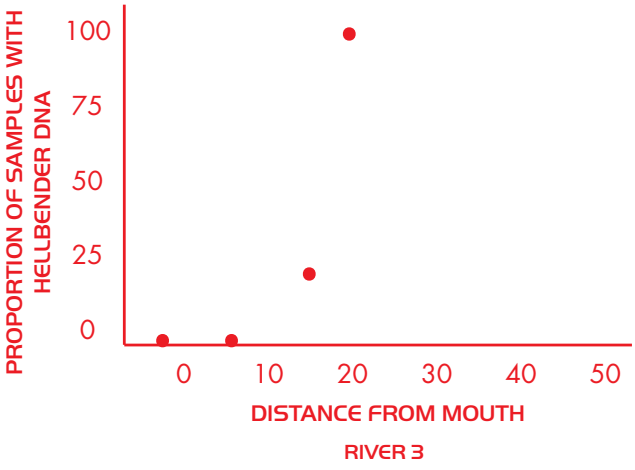
My River Number:_____

1. **Create** a graph that shows the proportion of samples with hellbender DNA at each distance from the mouth of the river.

Data could be represented such as with bar graphs, or scatter plots as shown in the examples below. Students should space data so that it reflects distance from the mouth and not just categories.







2. Use evidence from the table and graphs to **describe** the patterns you see. **Describe** why you think you see these patterns. (HINT: Think about how water quality may change over many years or how pollution may flow in rivers.)

River 1: The presence of hellbenders is high upstream where water quality is good and there are a lot of rocks. It appears that pollution or poor water quality downstream has caused hellbenders to disappear or drop in numbers because there are plenty of rocks for them there too.

River 2: Far from the river mouth there are some hellbenders. Water quality is good, but there are not enough rocks. In the middle distance, conditions are not good. At 35 km from the mouth something bad is going on. There are many rocks but water quality and oxygen are low, and there are no hellbenders. Conditions get better downstream where there are more hellbenders.

River 3: There are a lot of hellbenders upstream but none downstream. This is because water quality goes down and there isn't enough habitat or clean water closest to the mouth.

River 4: Hellbenders are gone except for a few in the furthest places upstream. This is confusing since the water quality and habitat are good. Maybe the river was polluted and has been cleaned up. Maybe something else killed the hellbenders or too many were collected to be pets. Perhaps there are too many predators or not enough prey.

3. Do you think the hellbender population in the river is healthy? Why or why not?

Answers will vary but should be based on the evidence that was provided in question number 2.

4. Does the eDNA give you enough information to know if the hellbender population is breeding successfully? Why or why not?

This is not enough evidence to know if they are breeding. Information in the video and reader show that hellbenders can live a long time. So, adult hellbenders may still be in a river but not able to reproduce successfully.

5. For each site in your river, **predict** where you think hellbenders are reproducing and where they are not reproducing. **Describe** why you made your predictions.

Good answers will provide evidence from the table to support their predictions. The actual predictions are not as important as having sound evidence or logical reasons for the predictions. River 4 especially may have different answers since hellbenders are rare but conditions are good.

ACTIVITY 2: HELLBENDER REPRODUCTION

The hellbender team decided to survey the rivers using the borescope and turning over rocks to look for signs of hellbender reproduction.

Table 2. Results from reproduction surveys of the rivers in Ohio and Pennsylvania where Hellbender eDNA was tested

River number	Distance from river mouth (km)	Proportion of samples where hellbenders were detected	Number of adult hellbenders	Number of hellbenders < 3 years old	Number of nests
1	40	100	14	20	4
1	30	100	10	22	3
1	20	40	2	12	1
2	50	20	2	0	0
2	25	20	0	0	0
2	5	60	6	4	1
3	20	100	18	26	5
3	15	20	6	0	0
4	45	20	1	0	1

1. Why do you think the team didn't survey all the locations where eDNA was sampled?

If there was no DNA, it is very unlikely that there are hellbenders present. It would be a waste of time.

2. **Describe** the additional information that visual surveys provided that you did not get from eDNA. **Describe** whether eDNA and visual surveys provided the same results at all sites.

Visual surveys provide evidence for reproduction including the size/age of hellbenders and whether there are nests.

River 1: Visual surveys add the information that hellbenders are not just present but reproducing at each of the sites they were found.

River 2: Visual surveys suggest that there is no reproduction occurring at sites 50 km and 25 km from the river mouth. Visual surveys did not find any hellbenders 25 km from the river mouth even though eDNA detected them. They may be very rare at this site.

River 3: Visual surveys confirm the presence of hellbenders at the sites where they were found and shows they are reproducing 50 km from the river mouth but probably are not near the river mouth.

River 4: Visual survey suggest that hellbenders are still in the river. They are rare but are trying to reproduce.

3. Were your predictions about where hellbenders were reproducing supported? Why do you think hellbenders are doing well or poorly in the places you studied?

Answers will vary; good answers will provide explicit evidence from the data tables and information given in the reader and video to support their arguments.

4. **Draw** a picture of your river. Include a picture of the habitat and the hellbenders that live there. Include any potential threats to the health of hellbenders.

Drawings should represent threats (pollution, deforestation, dredging) and good habitat features (intact forests, no pollution, a lot of rocks) to reflect rivers in good shape or poor shape.

5. **Compare** and **contrast** the results from your river to river 5. Explain why you think you see the patterns that you see.

Answers will vary based on the river selected but should focus on differences in water quality (oxygen, pollution) and habitat available (large rocks).

ACTIVITY 3: RETURN OF THE HELLBENDERS

Now that we know more about the abiotic conditions in the rivers and the population status of hellbenders, it is time to start making decisions about how to restore populations of hellbenders. You need to make recommendations to the team at The Wilds on how to restore hellbender populations.

Use the following terms to fill out Table 3 and help prioritize your actions.

Population Status: Good, Of Concern, Critical, Extinct
Abiotic Status: Good, Of Concern, Critical
Actions Needed: Protection, Environmental cleanup, Population restoration, Not worth investment
Rank Priority: From 1 (highest priority) to 5 (lowest priority)

Table 3. Decision support table for restoring Hellbender habitats

River	Population Status	Abiotic Status	Actions Needed	Rank Priority
1	Of concern or good	Of concern	Environmental cleanup, population restoration, protection	1
2	Of concern	Of concern	Environmental cleanup, population restoration, protection	2-4
3	Critical	Of concern or critical	Environmental cleanup, population restoration	2-4
4	Critical	Good	Population restoration	2-4
5	Critical	Critical	Not worth investment or environmental cleanup	5

Note: Ranks for priorities may vary somewhat based on student suggestions. You could expand the lesson by having groups or individual students make arguments about why they ranked the rivers in the order they chose.

1. Choose one of the rivers you have ranked as worthy of conservation investment. Write two paragraphs describing how you would restore the system (including the river and the hellbenders) and how you would study the system to make sure that your plan works.

Answers will vary based on the river selected but should focus on differences in water quality (oxygen, pollution) and habitat available (large rocks).

Extend the lesson: Have your students write a short essay about or debate the following scenario.

You received a call from a colleague in New York. They have found a stream that used to have hellbenders, but there are now none left. The stream has been cleaned up and the conditions are perfect for hellbenders now. Your colleague wants to know if they should use hellbenders in a head-start program from rivers in Ohio or if they need to find hellbenders from a river that flows into the one they want to restore. If they get the hellbender eggs from the other New York river to create a head start program, it will take years to start restoring the population. What do you recommend to your colleague? Support your answer with evidence from the readings and investigations.

Students may debate the tradeoff between time and costs of starting a new program with getting local animals. However, offspring tend to inherit traits from their parents, so hellbenders from other streams may not be adapted to live in new conditions. It is better to get *head-start* hellbenders from a stream that has the same population or is in the same area.