

Eastern hellbenders once swam in at least 570 streams in the eastern and central U.S., says Bill Hopkins, an ecologist at Virginia Tech. However, numbers of the craggy, beady-eyed amphibians have plummeted in recent decades, with only about 126 streams now harboring healthy populations—and scientists did not know why.

Hopkins' team recently studied one of the reasons for the decline, as stated in the article below. For eight years, they snooped on 182 nests, checking them every few days during the breeding season. In 60 percent of those nests, not a single larva survived, most commonly because of whole-clutch cannibalism: the male had gobbled up hundreds of eggs! See the Science article attached below

A. Imagine you are an ecologist working to find some more ways to save the declining population of Hellbenders further. How would you design your conservation project? What research and scientific questions do you need to ask?

B. What types of information might you use to design your experiment or conservation project? What criteria would you use to judge the accuracy and authenticity of the evidence you gather?

C. How would you present your findings and results? How would you acknowledge differing points of view?

While hundreds of Hellbender eggs are created daily, but there is an issue – almost none of them end up hatching. Unlike most other species this is mostly not because of an increase in predators, deforestation, climate change, or any other reason but because of the Hellbender males gobbling up their children. If I was a ecologist working to find a way to save the declining population of the Hellbenders further I would use the scientific method to help me understand how to stop Hellbender males from eating their own offspring. The scientific method consists of asking questions, conducting background research, formulating hypotheses, conducting objectives to answer the hypotheses, and drawing conclusions.

To start off with, I would ask the following questions:

Central Question (The main question scientists ask, which is the goal or main question ones experiment is aiming to solve): How can we stop Hellbender males from eating their own offspring? To answer this question, I would ask further questions and conduct background research.

Questions (Further more in-depth questions I have about the central questions):

- Why do Hellbender males resort to eating their own offspring?
 - Are they unaware of that those eggs are in-deed their offspring?
 - Do they not have access to enough food, making them eat their own offspring?
 - Answering this question would help me understand the main incentive the Hellbender males have for eating their own offspring, allowing me to determine other ways to give them that incentive without them eating their own offspring.
- What resources do I have acces to as an ecologist?
 - Do I have a monetary budget?
 - Do I have access to other specialists in the field?
 - Do I have access to any other resources?
 - Answering this question would help me set constraints and limitations when I formulate my hypotheses and in other areas of the scientific method.

- Do Hellbender males eating their own offspring cause more harm than good?
 - Are there any positive reasons that these males eat their own offspring eggs?
 - Do Hellbenders affect other species and organisms?
 - What niche (unique role in a community) do Hellbenders serve?
 - Answering this question would help me understand if this problem is really in fact a problem, and if there are no unseen positives or negatives to Hellbender males eating their own offspring.
- Is this practice of Hellbender males eating their own offspring recent?
 - Has this practice been going on for a long time?
 - If it started in recent years, WHY?
 - Is Hopkins team the first team of scientists who have ever discovered this?
 - Is there proof that this practice started in recent years?
 - Answering this question would help me understand if this practice has naturally been done by the Hellbender males or is a recent issue.
- Have there been any other scientists that have solved a similar or the same problem I hope to tackle?
 - Did Hopkins Group or any other scientist go further into their research?
 - Has there been any further research done since their group?
 - How has the field and research about the Hellbender and more specifically the Hellbender males eating their offspring evolved since Hopkins group.
 - Answering this question would help me understand previous solutions and/or research done and the positives and negatives about it. Allowing me to construct a solution or conserved effort that tries to solve the negatives of the previous solutions and improve the positives.

Once I ask my questions I would conduct background research to answer these questions. To ensure my background research is accurate I would use peer-reviewed scientific journals and government databases. For example, when conducting my background research I would answer the question of whether or not other scientists have solved a similar or the same problem I hope to tackle by looking at scientific journals and seeing if any scientists published papers about their findings. Nonetheless, I may have further questions from the databases and papers, as such I would attempt to contact the authors of the sources with my further questions.

After conducting background research, I would formulate my hypotheses. Assuming that this practice is a recent practice; the reason why Hellbenders do it is unknown but there has been a decrease in their prey and food sources, and they do not know that it is their offspring; I have very limited resources and funding as an ecologist; and there have not been any other scientists who have tried to solve the problem since the Hopkins group – I may formulate the following hypotheses:

1. If a Hellbender male has access to other sources of food sources like crayfish, then there would be a 63% decrease in cannibalism by Hellbender males.
2. If there is a 33% decrease in the fishing of certain food sources for the Hellbender like Crayfish, then there would be a 40% decrease in cannibalism by Hellbender males.
3. If there is a 82% decrease in BPAs in the habitat of the Hellbender males, then there would be a 78% decrease in cannibalism by Hellbender males.

Next, I would conduct the following objectives to help confirm my hypotheses:

Hypotheses: I would test these hypotheses with three objectives.

1. If a Hellbender male has access to other sources of food sources like crayfish, then their would be a 63% decrease in canabalism by Hellbender males.
2. If there is no fishing of certain food sources for the Hellbender like Crayfish, then their would be a 40% decrease in cannibalism by Hellbender males.
3. If there is a 82% decrease in BPAs in the habitat of the Hellbender males, then there would be a 78% decrease in canabalism by Hellbender males.

Objective 1: Food Source

I would set up two aquariums. The first aquarium is three Hellbender males and 25 fake eggs that would act like Hellbender eggs this aquarium would serve as the control group. The next aquarium would have the same three Hellbender males and 25 fake eggs that would act like Hellbender eggs, but there would also be five Crayfish. This objective would test hypothesis 1 because after a week, if the difference in the eggs eaten from the control aquarium and the other aquarium is a 63% decrease, then hypothesis 1 is affirmed.

Objective 2: Fishing

I would select two habitats, one where there are Hellbender males, Hellbender eggs, and crayfish and there is fishing for crayfish, another where there is Hellbender males, Hellbender eggs, crayfish but fishing is not allowed to catch crayfish. This objective would test hypothesis 2 because after a week, if the difference in the eggs eaten from the habitat where fishing is allowed and the habitat where fishing is not allowed is a 40% decrease, then hypothesis 2 is affirmed.

Objective 3: BPA's

I would select two more habitats, both where there are Hellbender males and Hellbender eggs, but both of the habitats would need to have similar BPA levels. Then, I would decrease one of the habitats BPA levels by 82% over a period of three months by decrease pollution and chemical and waste dumping. This objective would test hypothesis 3 because after a week, if the difference in the eggs eaten from the habitat with a 83% decrease in BPA's and the habitat with no decrease in BPA's is a 78% decrease, then hypothesis 3 is affirmed.

Furthermore, after conducting all of my objectives I would draw conclusions and if my hypotheses were proven false I would create new hypotheses. If all my hypotheses are affirmed, then I would draft up a manuscript – a paper consisting of an introduction, abstract (summary of hypotheses, experiments, and results), objectives, figures, conflicts of interest, conclusion, and more – and get it peer reviewed and published into a journal.

Once I hopefully publish my paper into a journal, I would present my findings to stakeholders (people affected by the issue). In this case, possible stakeholders are the following: fisherman, companies, people with interest in Hellbenders, and more. I would gather my data and explain it to my stakeholders. To effectively explain it to them I would translate it into whatever language was easiest for them, and make it as short and sample as possible. I would also conduct a socratic seminar (a type of seminar popularized by Greek Philospher Socratis) where counterarguements and alternate viewpoints would be discussed.

Nevertheless, one possible concern presented by the stakeholders may be how Crayfish are popular fished animals, how could their fishing be stopped. While that is a valid concern, I would attempt to compromise with them by letting Crayfish be fished in habitats where Hellbender males are not present,

and they would be offered compensation for complying by the US Fish & Wildlife Service and other international organizations.

If the hypotheses are affirmed, then I believe that stopping fishing of Crayfish in habitats where Hillbender males are present and decreasing BPAs in Hillbender habitats is a valuable start to conservation efforts for Hillbenders. Furthermore, I believe that the use of the scientific method, inclusion, diversity, and communication with stakeholders could be applied to a variety of different problems.

I would design a conservation project that would keep the male and female eastern hellbringers together for mating but then after mating they would be separated. This would most likely not be automated because we cannot tell if the hellbringers are on the same side or different sides. Since it is not automated we would need humans to pick them up and move them to a different section for the female to lay the eggs so that the male hellbringer does not eat the female hellbringers eggs. The male and female would be selected based on their health, their viability, and their diseases. This process is known as selective breeding. Before I could construct this project I would need to ask myself a few important questions. One question I could ask myself is, who would be able to design this machine for me? Another question I could ask myself could be, should I dive in headfirst or should I take precautions and make a prototype first.

To design my conservation project, I would first need to visit one of the 126 remaining streams that these hellbringers thrive in and then I would need to capture a few dozen of these hellbringers and bring them back to my facility alive. Then I would have to research these animals more to find out how to selectively breed them and how to keep them content. I would also need to know how to build this machine in the first place. To complete these tasks, I would hire professionals to capture the hellbringers, bring them back and keep them content, monitor their health, build the machine, and to actually maintain and run the machine. To make sure that everything is being done correctly I could hire two crews to monitor the workers to make sure they are doing their job. One crew for the morning and another crew for the evening.

To present my machine to the government to get it approved I would probably should a documentary of why their numbers are so low and how I plan to fix that. Then I would show them the machine and explain how it works and the reason that it exists. After that I would show them a chart that shows how over time, the number of streams that contain healthy hellbringers that thrive have gone from 570 all the way to 126. To make sure they know I am not bias to my own machine, I would bring representatives from preserves that have the same mission as me to show the government how good this machine could actually be and how it could save these creatures from extinction.

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According to Hopkins' team there has recently been a massive decline in the species called eastern hellbenders. If I was given the task to stop this raging decline in population this is what questions I would ask and what I would do. First I would ask if the stream that Hellbender gives birth correlates to the declining population of the species. Another question I would ask is why does the male hellbender find the need to eat its own babies and is there sufficient food source in a hellbenders habitat.

Me and my team would first try to gather information about the hellbenders and why it is dying out. We would try to find information specifically on why the male hellbender finds the need to eat its child, and is there a sufficient food source for the male hellbender to eat from. I would also try to gather information on the habitat and environment of the hellbender. I would also find out if my information is reliable, to find out if my information is reliable I would only use websites that end in .org and .gov and I would also use the National Geography and United States Environmental protection agency which would have a lot of useful information about the subject. Once we have enough information we could start working on one of our solutions. One solution we could use is eliminating cannibalistic hellbenders because if you eliminate all cannibalistic hellbender the population would start increasing. Mr. Hopkins study showed that 60% of all nests had no larva that survived and If you eliminate all the cannibalistic hellbender then the 60% would start decarsing. To find out if my solution works I would test it in a single stream and after a few months I would check if the hellbenders population is thriving and if it is then I would know that my solution worked. If this solution works the next step I would do is trying to make it publicly known because hellbender are a very fascinating and cool creature and sure that if someone

heard about their population decreasing they would try to help but if the solution did not work then I would try to find some flaws with my solution and why the solution did not work will also find out how to make my solution better. One way I could make the decaring population more publicly known is by creating a website with all types of information about hellbender and also all information we gathered. I would also start a social media account with types of pictures and information about the species. I could also make a donation link on the website to people who could help fund my solution. I would also ask any environmental organization to help donate to the cause. Another Solution I could try to use is when we find eggs of a hellbender we could take the eggs into a facility to nurture the baby until it is strong enough to go back into the wild. This solution would be good because we would not need to kill any hellbenders and it will also help increase the population. To make sure that this solution works I would do the same thing as the first solution by testing it in a single stream and checking back after a few months to see if the population is thriving.

Before trying the solution I would discuss both solutions with my team,a group of environmentalists and the government to see if they have any recommendations or if they see any flaws with my solution.

In conclusion I would create two solutions and discuss them with a group of people to try to evaluate my solution and present it in a neatly made slideshow with links that goes to my social media page and my website. I hope both of my solutions make the number of streams hellbenders are populated close to the number of 570 streams.

Eastern Hellbenders is a species of Salamanders. Eastern Hellbenders once swam in at least 570 streams, but now the population of the creatures have plummeted. There are only about 126 streams remaining with healthy populations of Eastern Hellbenders. If the decreasing population continues the Eastern Hellbenders may go extinct, but there is a massive cause to this problem. The eggs of Eastern Hellbenders are victims of cannibalism to living Eastern Hellbenders. While brainstorming a solution to this threatening problem, I need to assess questions that relate to the problem. Why are Eastern Hellbenders resorting to cannibalism as a source for food? Is there a necessary value of biodiversity in the areas of plummeting Eastern Hellbender populations? Are humans playing a role in the decline of the Eastern Hellbender population? What materials and technology would help me design a solution? All the questions listed above are needed to be assessed to help design a solution. With all these questions yet to be answered, it will help me think about how to design a conservation project to increase the population of Eastern Hellbenders. I would design my conservation project to be strong enough to withstand the strength and intelligence of the Eastern Hellbenders. I would design my prototype with durable material.

Before we start creating a solution, we always need to get a further understanding of the topic. I will set up waterproof cameras with vision sensors which will alert the camera whenever an Eastern Hellbender is moving in the sight of the camera. I will make a CAD model of the Eastern Hellbenders, so the camera can use that data to start recording whenever it sees the salamander. This can really help save the battery of the camera and vision sensor for longer battery and quality clips. Once the lab is done, I can design my conservation project. One reason why they are resorting to cannibalism is because of the lack of food in their habitat. For the conservation project, I will need the help of many volunteers and we will add different types of dead fish inside the stream. We will place a fish dispenser near the nests. Whenever the vision sensor and camera spots an animal, it will dispense fish for them to eat. The process will take a long time and won't be the best, but it works and will help increase the population of the Eastern Hellbenders. The information about the biodiversity of the streams really helped. I felt that there wasn't much to eat in the streams, so the Eastern Hellbenders had to resort to cannibalism of the eggs. They also had to eat a lot of eggs because the eggs are sized at a small portion and they needed enough food to fill the salamanders up. My evidence is authentic and accurate as it comes from a large group of people that were also fascinated by this problem and wanted to learn the causes of this problem. The article was posted by a trustworthy source.

I would present my findings to the local fish and wildlife conservation group. I would help lift up the exposure of the topic. I would start off by spreading the news to locals and hopefully it will get up to the local government. There are also many opportunities in the STEM field for kids. I would choose to present my topic to Ecybermission or Step Up Loudoun, where many science experts would get to listen to this problem and may build exposure off this problem so that it can escalate and the solution can be brought to many others around the nation. I am a listening person and I feel that my solution isn't the best solution, so I would implement other perspectives to create a better and more efficient solution. "It is always better to work as a team than as a single individual".

