Great Lakes Invaders: Learning about (sea) lampreys 6-8

Introduction

Sea lampreys are prehistoric fish that feed on the blood and bodily fluids of other fish. They invaded the upper Great Lakes through shipping canals in the early 1920s and quickly became, and remain, one of the worst invaders to have entered the Great Lakes basin. Sea lampreys have had an enormous, negative impact on the Great Lakes fishery, inflicting considerable damage. Before the sea lamprey invasion, Canada and the United States harvested about 15 million pounds of lake trout in the upper Great Lakes each year. In the late 1940s, sea lamprey populations exploded and by the early 1960s, the amount of lake trout caught had dropped dramatically, to about 300,000 pounds, only 2% of the previous average catch. Sea lampreys fed on lake trout, lake whitefish, and ciscoes - fish that were the mainstays of a thriving Great Lakes fishery. During the time of highest sea lamprey abundance, up to 85% of fish that were not killed by sea lampreys were marked with sea lamprey attack wounds. The once thriving fisheries were devastated, and along with them, the hundreds of thousands of jobs related to the region's economy. This lesson will introduce students to this primitive fish and Great Lakes invader.

The lesson consists of materials that will allow students to explore the following questions:

- What is a sea lamprey?
- How did sea lampreys enter the Great Lakes?
- Why are sea lampreys a problem?
- What is the life cycle of a sea lamprey?
- What is being done by the Great Lakes Fishery Commission (GLFC) and partners to protect the Great Lakes from sea lamprey?

After each section of video, related activities are provided to deepen student understanding of specific sea lamprey characteristics, the devastation sea lamprey brought to the Great Lakes, how the sea lamprey control program works, and how a group of researchers in the small Michigan town of Millersburg were able to make ground-breaking strides in the battle to control sea lamprey.

Information is also provided to 1) engage students in an exploration of current control methods and 2) encourage students to design their own new and innovative control method(s) given specific criteria and constraints.

Learning outcomes

Following this lesson, students will:

- Explain two unique characteristics of a sea lamprey.
- Describe how sea lampreys entered the Great Lakes.
- Identify one reason why it is important to control sea lamprey populations in the Great Lakes.
- Describe one current method of sea lamprey control in the Great Lakes and how it impacts the sea lamprey population.
- Illustrate and explain a new, potential method for controlling sea lamprey in the Great Lakes.
- Describe how the research facility in Millersburg, MI used science to protect the Great Lakes from the invasive sea lamprey (optional activity).

Curriculum alignment (to NGSS MS Standards)

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.
MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. *
*Included despite the grade level as the final (optional) activity in this lesson falls under this standard

Classroom time required

Three or four time blocks of varying lengths (as several activities, including the entirety of Session 4 can be optional):

Session 1: Getting to know sea lamprey (video, creating a "Wanted" poster) – 95 minutes
Session 2: Learning about control (videos, pheromones, "selling your method," sea lamprey tag) – 100 minutes
Session 3: Designing and evaluating sea lamprey control methods – 75-100 minutes
Session 4: Optional project (creating an action plan for protecting Earth's resources) – 95 minutes

Materials needed

Session 1

- *Predator in Paradise* video link: https://www.youtube.com/watch?v=IVwf2VfnMfU or a DVD can be requested from the GLFC, free of charge
- Sea lamprey brochures (request from GLFC)
- 'Wanted' poster template (see below)
- Markers or colored pencils for designing 'Wanted" posters
- Printed sea lamprey and native fish labels for tag game (downloadable PDF; could be printed as stickers or laminated and attached with tape to students)
- Gym or outdoor space
- Notepad and pencil for recording data
- Optional Expanded Research would require computer/internet research time

Session 2

- *Predator in Paradise* video link: https://www.youtube.com/watch?v=IVwf2VfnMfU or a DVD can be requested from the GLFC, free of charge
- Attractant and repellant video links (included where needed below)
- Sea lamprey life cycle projected on screen during part of "selling your method" activity
- At least 4 sets of the GLFC fact sheets (downloadable PDF; teacher can choose to print all fact sheets, or just those most relevant)
    - Pheromones information is included in these sheets (Fact Sheet #5)
- Poster board for group project "selling your method"
- Markers for group project
- Printed sea lamprey and native fish labels (see below; reuse from Session 1)

- Sea lamprey control cards for repeating tag game (see below)
- Gym or outdoor space
- Notepad and pencil for recording data

Session 3

- Medium for designing a sea lamprey control method (paper and markers, modeling clay, paint, computer program, etc.)

Session 4 (Optional day)

- Computer access for group project research
- True Science Leaders Action Plan, by Michigan State University Extension (see below)

Additional resources

- Sea lamprey activity booklets and tattoos (free; request from the GLFC)

Technology resources

- Computer and screen for showing video to students and for online research
- Overhead screen for projecting images as needed through lesson

Pre-Activities:

Following the videos or at the start of each session have students review key terms like invasive, spawning, parasitic, metamorphosis, life cycle, and sea lamprey (definitions provided at the end of the lesson plan).

Activities

Session 1

1. **15 Minutes** – Watch *Predator in Paradise* (Start: 0.00 – End: 10:05) and discuss
2. **45 minutes** – Sea lamprey invasion data discussion and 'Wanted' poster and Optional: Extended Research
3. **35 minutes** – Sea lamprey tag game (Round 1), data collection

Materials:

- *Predator in Paradise* video link
- Sea lamprey brochures
- 'Wanted' poster template
- Markers or colored pencils for designing 'Wanted" posters
- Printed sea lamprey and native fish labels for tag game
- Gym or outdoor space
- Notepad and pencil for recording data
- Access to graph paper or computer graphing program (individual or class activity)

- Optional Expanded Research would require computer/internet research time

1. Watch *Predator in Paradise* Part 1

Video Discussion questions

- What is a sea lamprey? *Parasitic, prehistoric fish that is native to the Atlantic Ocean, but has invaded the Great Lakes.*
- How did sea lampreys get into the Great Lakes? *From the Atlantic Ocean, sea lampreys made their way into Lake Ontario in the mid-1800s through small shipping canals, such as the Erie Canal. Then, once the Welland Canal, which bypasses Niagara Falls, was renovated in 1919 sea lampreys were able to swim into Lake Erie and eventually, the rest of the Great Lakes by the late 1930s.*
- Why are people concerned about sea lampreys? *While not an issue in their native range of the Atlantic Ocean where they live with - and feed on - larger marine fish, sea lampreys harm native Great Lakes fish by feeding on their blood, which typically kills them (only about 1 in 7 Great Lakes fish will survive a sea lamprey attack). Since their invasion, sea lampreys have had a dramatically negative impact on commercial and recreational fishing as well as tourism and the economy.*

2. Sea lamprey 'Wanted' posters

a. After students have viewed the first portion of *Predator in Paradise* video, hand out sea lamprey brochures from the Great Lakes Fishery Commission.

b. Give students a few minutes to examine the GLFC's sea lamprey brochure and then discuss as a class (making sure to note the life cycle, mouth images, and graph titled "A success story . . .")

i. Ask students: How did sea lamprey affect the Great Lakes when they invaded? What were some of the immediate consequences? *Native fish dying, fisher-men and -women losing their livelihood.* What is the long-term impact of the sea lamprey invasion? *If sea lampreys were allowed to live uncontrolled in the Great Lakes, most, if not all, native fish would die off. The alternative: sea lampreys must be controlled by humans (as they have no natural predators in the Great Lakes).*

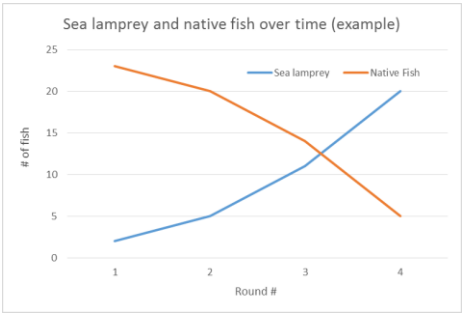
c. Allow students more time to read the brochure and then create their own version of a sea lamprey 'Wanted' poster. Students can be asked to include information about sea lamprey anatomy as well as key points about the damage that sea lamprey cause to other Great Lakes fish and the Great Lakes Fishery. (*For example, labeling the mouth, fins, gills, nostril as well as explaining key facts such as 1 sea lamprey kills up to 40 lbs. of Great Lakes fish in its life time; sea lamprey are only in their parasitic phase for 12-18 months; 1 in 7 fish survives a sea lamprey attack, etc*.)

Optional: Expanded Research - *Expand this activity to include research time and students can make most-wanted posters for a variety of invasive Great Lakes species and hang them around the classroom or school to inform others!*

3. **Sea lamprey tag game and data collection: Part 1** (Gym or outdoor space and notepad for recording data)

   ***Please note:** Chinook salmon will be considered "native" fish during this game, but they are actually a non-native fish in the Great Lakes and were intentionally introduced (1967), in part, as an indirect result of the sea lamprey invasion. They are not considered invasive as they do not harm other fish (as sea lamprey do), but nonetheless, are not truly native to the Great Lakes.

   a. Explain that students will have a chance to be a sea lamprey or a native fish species and pass out the fish cards.
   b. Depending on class size, 1 or 2 sea lamprey cards should be handed out (1 if class is 15 or under; 2 if 15 or over).
   c. Record the number of sea lamprey vs. native fish before starting game.
   d. Have the sea lamprey(s) gather in the middle of the room while the native fish group line up against one wall.
   e. When ready, have the native fish try and 'swim' (run) from one side of the room to the other without getting "attacked" (tagged) by a sea lamprey.
   f. Tagged students now become sea lamprey along with the original one(s).
   g. Record the new number of sea lampreys and new number of native fish.
   h. Repeat the game, but with this increased number of sea lampreys.
   i. Record the number of total sea lampreys after the second game, as well as the number of native fish left.
   j. Repeat again until the majority of students are sea lampreys, making sure to record results after each game.
   k. Repeat game again if desired.
   l. Once back in the classroom show data to students and have them use graphing paper or a computer graphing program to graph the change in the number of sea lamprey(s) and native fish over time for one game (expectation: *as sea lamprey numbers increase, native fish numbers decrease*; see below for example graph). This could be done individually, or as a class with the teacher displaying the graph on a screen.
   m. Connect this back to the initial sea lamprey invasion in the Great Lakes. [*It has been estimated that there were roughly 2.5 million sea lampreys in the lakes after their invasion – and before sea lamprey control began. As each sea lamprey kills up to 40 lbs. of Great Lakes fish in its lifetime, that means up to 100,000,000 lbs. of Great Lakes fish were dying each year due to the invasive sea lamprey.*]



Session 2

1. **15 minutes** – Watch *Predator in Paradise* (Start: 10:05 – End of video)
2. **20 minutes** – Pheromones: Attractants and Repellants, videos, and discussion
3. **40 minutes** – "Selling your method"
4. **25 minutes** – Sea lamprey tag game (repeat) with sea lamprey "control cards"

Materials:

- *Predator in Paradise* video link
- Attractant and repellant videos (included where needed below as well)
- Sea lamprey life cycle projected on screen during part of "selling your method" activity
- At least 4 sets of the GLFC fact sheets (downloadable PDF; teacher can choose to print all fact sheets, or just those most relevant)
    - Pheromones information is included in these sheets (Fact Sheet #5)
- Poster board for group project "selling your method" (or video camera)
- Markers for group project
- Printed sea lamprey and native fish labels for tag game
- Sea lamprey control cards for tag game
- Gym or outdoor space
- Notepad and pencil for recording data
- Graphing paper or computer graphing program as used in Round 1 of the tag game

1. Watch *Predator in Paradise* Part 2

Video Discussion questions

- What types of control methods are predominantly used to control sea lamprey? *Barriers/dams, Traps, Lampricides.*
- What is the most effective method of sea lamprey control? *Using the lampricide, TFM.*
- What makes TFM a good lampricide? *It is selective, that is, it harms sea lampreys, but not other aquatic organisms in the system*.

2. **Pheromones: Attractants**
    a. What are pheromones (they were briefly covered in the *Predator in Paradise* video)? *Pheromones are "any chemical substance released by an animal that serves to influence the physiology or behavior of other members of the same species" (dictionary.com). Some pheromones are called attractants because upon release by an individual they attract other members of the species. For sea lamprey, it is known that adult males release a scent that attracts females to the nest when it is time to spawn. Also, larval sea lampreys are known to release a scent that attracts adults to rivers for spawning.*
    b. View short video of a sea lamprey moving up the river to where an attractant pheromone is being released through a white tube.

Video Discussion questions

- How can pheromones help with sea lamprey control? *By using the scents that attract sea lamprey as bait (think: mouse traps) we can potentially capture more sea lamprey from the Great Lakes in our traps.*
- One nickname given to sea lampreys is "swimming noses," why does this make sense given the information you just learned? *Sea lamprey use their sense of smell more than any other sense in order to survive. Their sense of smell helps them find good spawning habitat, a mate, and likely many other things necessary to survival.*

Pheromones: Repellants

a. Some pheromones are called repellants because upon release they cause other members of the species to be repelled. In particular, researchers have found that the scent released by dead lamprey is a repellant and leads to an alarm response from any living sea lamprey in the area.
b. View this video from Michigan State University researchers to see the response from sea lamprey exposed to the scent of dead lamprey. (WOW! Right?!)

Video Discussion questions

- How is this video evidence that researchers found an effective repellant for sea lampreys? *Think about the fight or flight response -- when the repellant was added to the tank of sea lampreys, the fish jumped out of the water and tried to quickly swim away from the scent of dead lampreys (e.g. flight).*
- How might researchers use a sea lamprey's sense of smell to develop control methods? *Push-pull control: researchers hope to use the repellant scent to keep sea lampreys out of certain streams while simultaneously using attractant scents to lure sea lampreys into traps more efficiently.*

3. **"Selling your method": Evaluating each method of sea lamprey control**
    a. Divide class into 4 groups, each group will be responsible for presenting (via a poster or short video) the reasons why their assigned method of control is important.

b. Assign each group a method of control (1 - barriers/dams; 2 – traps; 3 – lampricides; 4 – pheromones/repellants*).
   *While pheromone attractant and repellant scents are not considered a main part of the current sea lamprey control program there is hope they will be in the future and are included in this activity because they can generate good discussion, are important to be aware of, and are an exciting possibility as we look to the future of sea lamprey control.
c. Provide each group with a GLFC sea lamprey fact sheet folder and have students in each group work together to learn more about their assigned method of control.
d. Students should then be given poster board and markers to create posters, using both words and drawings, about the method of control they were assigned and then present them to the class (or access to a video camera for recording a short, informative video).

Wrap up questions:

- Discuss which life stage each method targets? *The sea lamprey life cycle should be projected on-screen during this discussion. Traps and barriers mainly target adults moving into streams to spawn while lampricides target larval lamprey living buried in stream sediment. However, researchers are working to use innovative traps to catch out-migrating newly transformed (metamorphosed) parasitic sea lamprey as well.*
- Are these methods ever used in combination? How might this be a greater benefit? *Yes, the sea lamprey control program is considered an "integrated control program" as it uses multiple methods in combination in order to be more successful. Dams block sea lampreys from getting into higher reaches of rivers, but they also pool adults below them, forcing these adults to spawn in a less suitable area and with many others. This may lead to lower spawning success and those larvae that successfully hatch will be pooled in a smaller area than they might otherwise have been, making lampricide treatment less expensive and potentially more effective. Additionally, dams may have traps built into them allowing sea lampreys to be pulled out of the system.*
- Which method might be longest-lasting? *Points to keep in mind: dams deteriorate over time without proper (expensive) upkeep; traps must be maintained and updated; while it does not appear to be the case, there was concern that larval sea lamprey might develop a resistance to TFM over time.*

4. Sea lamprey tag game and data collection: Part 2

a. Set up for tag game as described in Part 1
b. Change: After determining which students will be native fish and which will be sea lamprey(s), each sea lamprey must draw a "control card" before the start of the game and follow the directions given (for the entirety of the game). Then, at the start of each subsequent round, the new sea lampreys must each draw a card and follow the directions. Students can read their cards aloud or keep them a secret, depending on teacher preference.
c. Card possibilities (10 total; print multiples if needed): The cards drawn will relate to sea lamprey control and likely hinder the activity of the sea lamprey. For example:

i. BAFFLING barriers – You were unable to get over a barrier in the river and therefore could not get to good spawning habitat. This doesn't kill you and you were still able to feed on native fish, but it does hinder your reproductive success. As a result, you must hop on one foot when trying to tag others during the game.
ii. TEMPTING traps – You found a sea lamprey trap and swam on inside. You were still able to feed on native fish during an early stage of your life cycle, but now there's no spawning for you. As a result, you must count to 5 after the start of the game before you can start tagging the native fish (your classmates).
iii. PESKY pheromones – You followed attractant pheromones right into a sea lamprey trap. You were still able to feed on native fish during an early stage of your life cycle, but now there's no spawning for you. As a result, you must try and tag the native fish (your classmates) with only your left hand (keep your right hand behind your back as you run).
iv. ABRUPT Angler – A quick-moving angler caught a lake trout with you attached! Now you're stuck in a boat. As a result, you can tag only 2 native fish (classmates) maximum per round of the game.
v. TRICKY traps – The sea lamprey that might have been your parents got caught in sea lamprey traps and were never able to reproduce/spawn. As a result, you must switch and become a native fish species instead.
vi. LETHAL lampricide – The river you lived in as a larval lamprey was treated with TFM and you didn't make it to adulthood. As a result, you must sit out this round.
vii. RASCALLY repellants – As you swam upstream to spawn you came to a fork in the river and encountered a repellant scent coming from one branch of the river. To avoid the "smell of death" you chose the branch heading west. Unfortunately, this leads to terrible spawning habitat. You did still have a chance to feed on fish during your life cycle, but now your chance of reproduction is low. As a result, you must try and tag native fish (classmates) with one eye closed during the entire round.
viii. One BAD day – You were enjoying lovely meal on a walleye when suddenly the walleye was caught by an angler! You managed to escape by detaching quickly from the walleye, but in the rush you bumped the side of the boat hard and hurt yourself. Now you're having trouble catching another fish (meal). As a result, you can only try and tag native fish (classmates) wearing a blue item of clothing.
ix. NO nose – Your nasal (olfactory) organ is injured and you can't smell very well. Unfortunately for you, you struggle through the different stages of your life cycle and are never able to find a good spawning stream. As a result, you can only tag native fish (classmates) that are wearing a yellow item of clothing.
x. KRAZY Kid – A 5-year-old with amazing reflexes was wading through the exact stream you were exiting as a young, newly transformed (metamorphosed) parasitic sea lamprey. The child reaches in and grabs you from the water before you even know what happened. You become a preserved specimen at

Hammond Bay Biological Station where the child's mother works. As a result, you must sit out this round.

d. *Important note*: If all sea lampreys pick cards that cause them to be completely unable to function (or they are told to switch to a native fish species) during any given round, then you can just ask students to predict what would happen during the tag game (with no sea lamprey present) and then start the round over again. Have someone record numbers of sea lamprey and native fish after each round and then graph the results back in the classroom; compare to the graph made during Part 1.

Wrap up Questions

- What happened when the sea lampreys were "being controlled"? Did it change the outcome of the game as compared to Part 1? How so?
- How does controlling invasive sea lampreys help the Great Lakes?

Session 3

1. **10 minutes** – Review
2. **1 hour 30 minutes (or more)** – You be the scientist (brainstorm and create potential sea lamprey control method)

Materials:

- Medium for designing a sea lamprey control method (paper and markers, modeling clay, paint, computer program, etc.)

1. **Review key points from previous days**
   - What is an invasive species? ***Invasive species*** *- As per* ***Executive Order 13112*** *an "invasive species" is defined as a species that is: 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions.* (*https://www.invasivespeciesinfo.gov/whatis.shtml)*
   - Why are sea lampreys a problem in the Great Lakes? *They feed on the blood and bodily fluids of other Great Lakes fish such as lake trout, walleye, whitefish, perch, lake sturgeon, and salmon. One sea lamprey will kill up to 40 lbs. worth of other fish in its lifetime. Sea lampreys brought great devastation to the Great Lakes fishery and economy.*
   - What are the main methods used by the Sea Lamprey Control Program? *Lampricides (including TFM), barriers, and traps (though traps are mainly used for assessment purposes).*
   - Why are sea lampreys nicknamed swimming noses? *They have a strong sense of smell and use it when finding spawning streams and then a mate.*
   - How are scientists using a sea lamprey's sense of smell in control efforts? Push-pull control: *Using the repellant scent to keep see lamprey out of certain areas, such as streams that have no traps or are difficult to treat with lampricide and then pull them into other areas where*

traps are located and the Sea Lamprey Control Program is better able to treat with lampricide.

2. **You be the Scientist**
    a. Have students silently brainstorm other methods that might help us control the sea lamprey population. It can be a variant of something already done (like a new type of trap), or something completely unique.
        i. Optional: Give students criteria/constraints for their project, such as:
            1. Control method can have little to no impact on other organisms or the environment.
            2. Control method must be reasonably feasible from a financial perspective.
    b. Provide each team or individual with a copy of the rubric or other scoring criteria. Then allow students time to sketch and/or create one of their ideas.
        i. Students should identify key parts and explain how it works as well as state how the shape (or purpose if it is something like a chemical) of the object they created helps it function as needed to solve a given problem.
        ii. Have students share their models/drawings with the class and after all have shared, brainstorm/evaluate* how well each is likely to meet the criteria and constraints of the problem, keeping in mind the desire to maintain both biodiversity and ecosystem services. (Teachers, please feel free to scan these in and send them back to us, in case we want to use some of the ideas!) ☺
        iii. Evaluations can be done individually, with teacher-created evaluation sheets, or as a class in a group discussion.

Session 4 (optional)

1. **5 minutes** - Background
2. **45 minutes** – Group research
3. **45 minutes** – Student sharing and 'next steps'

Materials:

- Computer access for group project research
- True Science Leaders Action Plan

1. **Background - Hammond Bay Biological Station: Local discoveries, basin-wide impact**
TFM, the most effective method of sea lamprey control (that allows the control program to get rid of ~90% of sea lampreys on an annual basis) was first tested at Hammond Bay Biological Station (HBBS) in the 1950s. Early researchers and technicians knew they had to find a chemical that would selectively kill sea lamprey larvae without harming other organisms in the environment. The hard-working biologists and technicians at HBBS tested over 5,200 chemicals before finding TFM and, in turn, success. In the small town of Millersburg, MI (pop. size of 206 as

of 2010) a discovery was made that would have a lasting impact on Great Lakes fisheries. The researchers used their scientific knowledge and skills to help protect our natural resources and the environment. Without TFM, the Great Lakes fishery, ecosystem, and economy would be dramatically different.

2. **Student group research**
   Students: Work in groups to research ways individuals, schools, and communities are working to protect the Earth's resources and environment, much like the small community of Millersburg, MI did in the 1950's.

3. **Student sharing**
   a. Have students share with the class the discoveries they have made. As a final point, have them come up with at least one idea that they (as an individual) or the class could implement that would use science ideas to protect our natural resources ('next steps').
      1. Students can fill out an Action Plan sheet
   b. **Optional**: Further this activity by having students implement their ideas.

Unit wrap-up discussion (could be a writing activity if more appropriate)

Have students:

- Explain two unique characteristics of a sea lamprey.
- Describe how sea lampreys entered the Great Lakes.
- Identify one reason why it is important to control sea lamprey populations in the Great Lakes.
- Describe one current method of sea lamprey control in the Great Lakes and how it impacts the sea lamprey population.

Assessment

1. Student answers to the unit wrap-up discussion or writing assignment serve as a summative assessment for this unit.
2. Sea lamprey most wanted posters and tag game (**MS-LS2-4**.)
3. Sea lamprey control methods "selling your method" activity (**MS-LS2-5**)
4. Rubric for illustration of new sea lamprey control method (**MS-ESS3-3**)
5. Group evaluation of each student's designed control method (**MS-LS2-5**)
6. Protecting the Earth's resources (**5-ESS3-1**)

Rubric: Illustration of sea lamprey control method

Criteria	3 pts.	2 pts.	1 pt.	Total
Feasibility **(Potential restrictions:** Control/reduce sea lamprey populations with little to no impact on other organisms or the environment)	The idea could potentially control/reduce sea lamprey populations with no impact on other organisms or the environment. The idea targets a particular stage, or stages, of development (e.g., a unique barrier or trap design that targets newly-metamorphosed sea lamprey).	The idea could potentially control/reduce sea lamprey populations with little impact on other organisms or the environment. The idea targets a particular stage, or stages, of development (e.g., new type of lampricide that targets a different life stage than TFM).	The idea looks like might control/reduce sea lamprey populations but will have a negative impact on other organisms or the environment (e.g., TNT).	
Creativity and Originality	Idea/illustration is unique and indicates a high level of thought (e.g., idea is plausible and shows that the student is thinking deeper, not just going off of ideas they already heard; see example above).	Idea/illustration is mostly unique, indicating a moderate level of thought (see example above).	Idea/illustration is somewhat unique, indicating some level of thought, but may not be very realistic (see example above).	
Craftsmanship/Skill	Illustration indicates that the student took significant time to create it and includes detailed descriptions of its components.	Illustration indicates that the student took some time to create it and includes some descriptions of its components.	Illustration indicates that the student completed it quickly and includes little to no descriptions of the its components.	

Critical vocabulary

- **Invasive species** - As per **Executive Order 13112** an "invasive species" is defined as a species that is: 1) non-native (or alien) to the ecosystem under consideration and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. Invasive species can be plants, animals, and other organisms (e.g., microbes). Human actions are the primary means of invasive species introductions. (*https://www.invasivespeciesinfo.gov/whatis.shtml)*
- **Metamorphosis** – a profound change in form from one stage to the next in the life history of an organism, as from the caterpillar to the pupa and from the pupa to the adult butterfly.
- **Parasite** – and organism that lives on or in an organism of another species, known as the host, from the body of which it obtains nutriment.
- **Pheromone** – any chemical substance released by an animal that serves to influence the physiology or behavior of other members of the same species.
- **Larvae** – the young of any invertebrate animal.
- **Spawning** – the mass of eggs deposited by fishes, amphibians, mollusks, crustaceans, etc.
- **Filter feeding** – A method of feeding occurring in some aquatic animals, such as planktonic invertebrates and whalebone whales, in which minute particles are filtered from the surrounding water.

- **Biodiversity -** The number, variety, and genetic variation of different organisms found within a specified geographic region.
- **Ecosystem Services -** the important benefits for human beings that arise from healthily functioning ecosystems, notably production of oxygen, soil genesis, and water detoxification.

All definitions taken from dictionary.com, unless otherwise noted

Websites

- Great Lakes Fishery Commission: glfc.org
- GLFC sea lamprey activity booklet: http://www.glfc.int/pubs/pdfs/kids%20activity%20booklet_single%20page_with%20new%20logo.pdf
- Northeast Michigan – Great Lakes Stewardship Initiative (NEMI-GLSI): http://www.nemiglsi.org/
- SeaGrant: https://www.michiganseagrant.org/; https://www.seagrant.wisc.edu/; and others around the Great Lakes region

Comments

- Feel free to contact us with any comments – or for materials, such as sea lamprey brochures.

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- This lesson plan was developed through the Great Lakes Fishery Commission, with assistance from Tracy D'Augustino through Michigan State University Extension.

WANTED

THE INVASIVE SEA LAMPREY, A PESKY FISH THAT INVADED THE GREAT LAKES AND ENJOYS DRINKING FISH BLOOD FOR DINNER!


Lake whitefish


Lake whitefish


Lake whitefish


Lake sturgeon

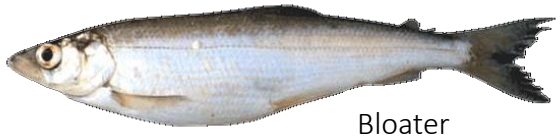

Lake sturgeon

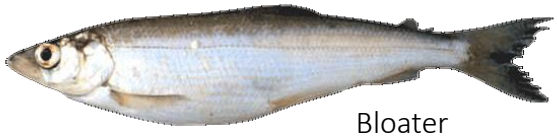

Lake sturgeon


Walleye


Walleye


Walleye


Bloater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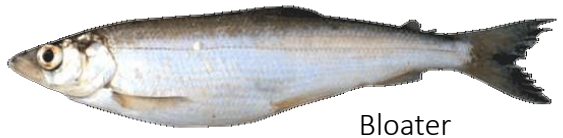

Bloater


Northern pike


Northern pike


Northern pike

Images courtesy of Wisconsin Sea Grant: http://www.seagrant.wisc.edu/home/Default.aspx?tabid=604

Rainbow trout

Rainbow trout

Rainbow trout

Chinook salmon

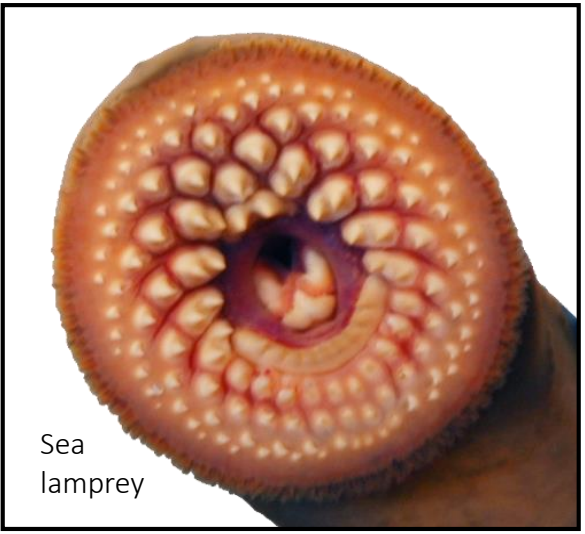
Chinook salmon

Chinook salmon

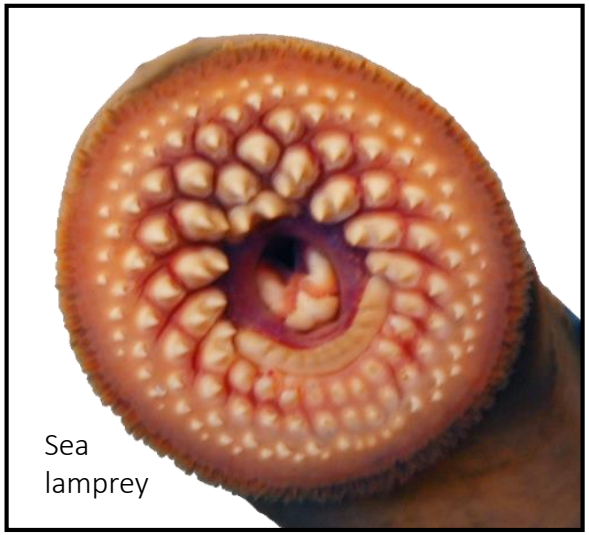
Lake trout

Lake trout

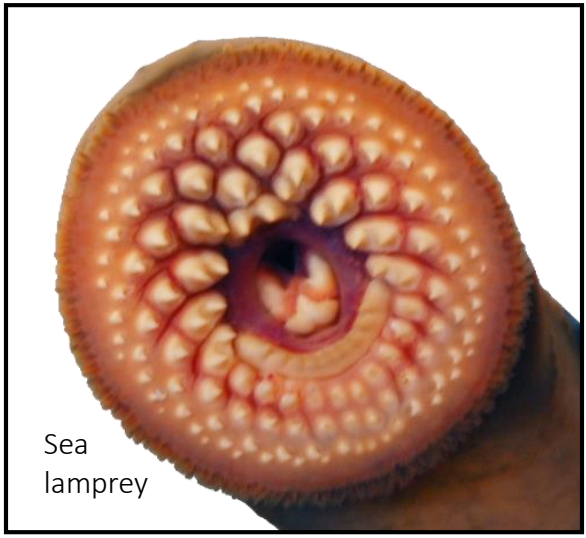
Lake trout



Sea lamprey



Sea lamprey



Sea lamprey

All images (except sea lamprey) courtesy of Wisconsin Sea Grant: http://www.seagrant.wisc.edu/home/Default.aspx?tabid=604

BAFFLING barriers!

You were unable to get over a barrier in the river and therefore could not get to good spawning habitat. This doesn't kill you and you were still able to feed on native fish, but it does hinder your reproductive success. As a result, you must hop on one foot when trying to tag others during the game.

TEMPTING traps!

You found a sea lamprey trap and swam on inside. You were still able to feed on native fish during an early stage of your life cycle, but now there's no spawning for you. As a result, you must count to 5 after the start of the game before you can start tagging the native fish (your classmates).

PESKY pheromones!

Pesky pheromones – You followed attractant pheromones right into a sea lamprey trap. You were still able to feed on native fish during an earlier stage of your life cycle, but now there's no spawning for you. As a result, you must try and tag the native fish (your classmates) with only your left hand (keep your right hand behind your back as you run).

ABRUPT angler!

A quick-moving angler caught a lake trout with you attached! Now you're stuck in a boat. You did get to feed for part of your life cycle, but now you're done. As a result, you can tag only 2 native fish (classmates) maximum per round of the game.

TRICKY traps!

The sea lamprey that might have been your parents got caught in sea lamprey traps and were never able to reproduce/spawn. As a result, you must switch and become a native fish species instead.

LETHAL lampricides!

LETHAL lampricide – The river you lived in as a larval lamprey was treated with TFM and you didn't make it to adulthood. As a result, you must sit out this round.

RASCALLY repellants!

As you swam upstream to spawn you came to a fork in the river and encountered a repellant scent coming from one branch of the river. To avoid the "smell of death" you chose the branch heading west. This lead you to poor spawning habitat. You did have a chance to feed on fish during your life, but now your chance of reproduction is low. As a result, you must try and tag native fish (classmates) with one eye closed during the entire round.

One BAD day!

You were enjoying a lovely meal on a walleye when suddenly the walleye was caught by an angler! You managed to escape by detaching quickly from the walleye, but in the rush you bumped the side of the boat hard and hurt yourself. Now you're having trouble catching another fish (meal). As a result, you can only try and tag native fish (classmates) wearing a blue item of clothing.

NO nose!

Your nasal (olfactory) organ is injured and you can't smell very well. Unfortunately, this means that you struggle through the different stages of your life cycle and are never able to find a good spawning stream. As a result, you can only tag native fish (classmates) that are wearing a yellow item of clothing.

KRAZY kid!

A 5-year-old with amazing reflexes was wading through the exact stream you were exiting as a young, newly transformed (metamorphosed) parasitic sea lamprey. The child reaches in and grabs you from the water before you even know what happened. You become a preserved specimen at Hammond Bay Biological Station where the child's mother works. As a result, you must sit out this round.

True Science Leaders Action Plan

Remember **STAR**—**S**pecific, **T**ime-framed, **A**chievable, **R**eviewable

What are my next best steps…(include publicize in local media)

Why it is important…(potential impact)

How will I know I've achieved it…(follow up)

I want to...

When do I want to achieve it…(list dates)

Who can help me...

How can they help me...

What resources do I need…(space, helpers, budget, materials)

DM 1/17