Great Lakes Fishery Commission

November 2023

Thank you to Michigan State University Extension (Tracy D'Augustino, Alcona) for working closely with us to create these lesson plans and ensure alignment with Next Generation Science Standards. These lesson plans are currently being tested in classrooms during the 2023-2024 school year. If you would like to participate in testing, we would appreciate your feedback! To supplement the lessons, we can provide additional outreach materials for your classroom. Please contact Ross Shaw at rshaw@glfc.org for more information.

Finalized lessons should be completed by fall 2024 and will include links to an updated (2024) version of the Great Lakes Fishery Commission's *Predator in Paradise* video. At that time a K-3 set should also be released.

Questions and feedback regarding the lessons can be directed to Lauren Holbrook at lholbrook@glfc.org.

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Great Lakes Invaders: Learning about (sea) lampreys 4-5

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, jawless 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 the 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?

Video clips and related activities are provided to deepen student understanding of sea lamprey characteristics and preferred habitats, the devastation sea lampreys brought to the Great Lakes, how the sea lamprey control program works, and how a group of researchers in the small town of Millersburg, Michigan 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 methods 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
- Describe the life cycle of a sea lamprey
- Identify characteristics of adult sea lampreys and explain how they help adults survive
- Identify characteristics of larval sea lamprey and explain how they help larvae survive
- Describe the importance of a sea lamprey's sense of smell
- Explain how stream characteristics affect sea lamprey spawning around the Great Lakes

- Explain one reason why it is important to control sea lamprey populations in the Great Lakes
- Describe one current method for controlling Great Lakes sea lamprey
- 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 invasive sea lamprey

Curriculum alignment (to NGSS 3-5 Standards)

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction**.**
4-LS1-2. Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways.
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

Classroom time required

Four time blocks of varying lengths:

Session 1: Getting to know sea lamprey (video, map activity, internal/external char.) – 90+ minutes
Session 2: Learning about control and fishy pheromones (video, Swimming Noses activity) – 45 minutes
Session 3: Designing and evaluating sea lamprey control methods – 100 minutes
Session 4: Small town, big impact (group project, student action plan) – 95 minutes

Materials needed

Please note*: All items labeled as* ***printable*** *can be found at the end of the lesson plan in the "Printable Materials" section.*

Session 1

- *Predator in Paradise* video link: https://youtu.be/YIPrj8mtPXM
  - It is also included where needed below, but a free DVD can be requested from the GLFC
- Great Lakes map (click here to access one of the entire U.S.)
- Websites needed to help students complete map (links below; mainly Google Maps)
- Sea lamprey-producing streams map (printable, or project on classroom screen)
- Markers or colored pencils
- Adult and larval sea lamprey images (printable)
- T Chart for comparing adult and larval sea lampreys (printable)
- Full color sea lamprey life cycle image to be displayed on screen (or printable)

Session 2

- *Predator in Paradise* video link.
- Containers to hold various scents (opaque if needed)
    - For example: 35 mm film storage canisters, condiment cups with lids, or baggies
- Essential oils and cotton balls OR natural scents OR tea bags (see text below for detail)
- Nest and tributary images for scent activity (printable; 8 nest images provided and 20 streams images – 4 streams for each of the 5 Great Lakes)
- Swimming noses activity recording sheet (printable)
- Repellant video link (included where needed below)

Session 3

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

Session 4

- Computers
- MSUE Action Plan template (printable)
- Poster board
- Markers

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 adult and larval sea lamprey image comparisons (or can have printed copies for the students)

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

3. **30 minutes** - Adult and Larval comparison

Materials:

- *Predator in Paradise* video link
- Great Lakes map (1 per student; or click here to access map of the entire U.S.)
- Websites needed to help students complete map (links below; mainly Google Maps)
- Sea lamprey-producing streams map (printable; or project on classroom screen)
- Markers or colored pencils
- Adult and larval sea lamprey images (printable)
- T Chart for comparing adult and larval sea lampreys (printable)
- Full color sea lamprey life cycle image to be displayed on screen (or printable)

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.*
- Review sea lamprey life cycle by projecting on screen or printing handouts.

2. **Sea lamprey Invasion (map activities)**
    a. Provide each student with a black and white map of the Great Lakes region.
        i. Students will use different color markers to 1) identify specific locations around the Great Lakes, and 2) include information about the movement of sea lamprey into the Great Lakes.
            1. **Black** = Lake name (for each of the Great Lakes) and the Atlantic Ocean
                a. Students can shade in the lakes and ocean light blue first
                b. H.O.M.E.S. acronym (Huron, Ontario, Michigan, Erie, Superior)
            2. **Brown** = Label the 8 Great Lakes states
                a. Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York
            3. **Gray** = Invasion route from the Atlantic (via Atlantic Ocean → Hudson River → Erie Canal → Lake Ontario)

a. http://www.canals.ny.gov/maps/index.html
b. Uncheck 'locks' box in column on right to view canal itself
c. Scroll down (on map) to where the Hudson River empties into the Atlantic Ocean in New York City (zoom in/out as needed)
d. Follow the river up to where it meets the Erie Canal
e. Show students where the canal connects with Lake Ontario
f. Can discuss the need (pros/cons) for canals here, if desired (shipping/transporting goods into and out of the Great Lakes)

4. **Red** = Dates of invasion for each lake
   a. Re-watch video clip [7:00-8:05]
5. **Orange** = Niagara Falls/Welland Canal location
   a. First have students try and figure this out on their own
   b. Then, display Google Maps on screen for Niagara Falls
   c. Zoom in and out to give students a better perspective of where the falls are in relation to the two lakes
   d. Display Google Maps on screen for the Welland Canal
   e. Zoom in and out to show students the path of the canal as it connects Lake Ontario and Lake Erie and where it is in relation to Niagara Falls
6. **Green** = Hammond Bay Biological Station (Millersburg, MI)
   a. Can use a map of Michigan or Google Maps (zoom in and out to get a better perspective)
7. **Yellow Star** = Draw on Great Lake that is closest to you!

b. Using the 'sea lamprey stream producer map' (either projected on a screen or as handouts given to individuals) have students label four known sea-lamprey producing streams that are tributaries to the Great Lake they live closest to (**Purple**). And with a DOT, mark where the tributary meets the Great Lake.
   i. Students can be encouraged to look for a couple streams they are familiar with and a couple they are not.
   ii. Questions: *Has anyone ever heard of one of these rivers or creeks? Fished in one? All of these rivers have had sea lamprey in them in the past and likely still have sea lamprey larvae in them today.*

c. Using the 'sea lamprey stream producer map' have students mark (with shading) key regions around the Great Lakes that sea lampreys prefer for spawning (**Blue**).

d. Ask students to brainstorm with a partner: Why might sea lamprey prefer these streams for spawning over others around the Great Lakes?
   i. Have groups share, round robin, one reason at a time until there are no new ideas, making a list on the board/computer/overhead. *Project sea lamprey life cycle on screen as needed or use handouts*.
      1. Have students think about the needs of each sea lamprey life cycle stage (key examples: *water temperature; stream bottom-type for nest-building and subsequent larval burrowing; food availability/nutrition; water quality)*. If students do not come up with answers you will need

to ask prompting questions like, “Do you think water temperature influences where sea lampreys spawn?” (*Water that gets too warm in the summer months cannot support sea lampreys*) and “What do larval lampreys need in order to grow?” (*food, appropriate stream bottom-type*), etc.

e. Ask the class: Based on your brainstorming, in which lake(s) would you expect to find more sea lampreys? Why? And in which lake(s) would you expect to find the lowest numbers of sea lampreys? Why?
    i. *Sea lamprey numbers were historically, and still are today, highest in Lakes Huron, Michigan, and Superior, due to high quality spawning streams (habitat) located around those lakes as well as good nutrient availability. High quality spawning habitat would include streams with good water flow as well as a gravel/rocky substrate for nest building and soft sand or muddy substrate downstream for larvae to burrow into. Additionally, even with good spawning habitat, if a stream’s temperature gets too warm it will not support sea lamprey (note from the provided map that there are a lower number of ideal streams in southern Lake Michigan and Lake Erie, which are further south than other Great Lakes).*
    ii. *Lake Erie and Lake Ontario have smaller sea lamprey populations as they typically are warmer (especially Lake Erie), and stream spawning habitat is not ideal in many of the tributaries to these lakes.*

3. Larval vs. Adult: Similarities and Differences

***Please note**: Sea lamprey life cycle can be displayed on screen during this activity if it is helpful.*

a. Provide each student with the image depicting an adult and larval sea lamprey.
    i. Why might some characteristics be the same while others are different? *Think about where each stage lives (stream bottom vs. open water) and what is needed for each (larvae are blind as there is no need for vision when buried under stream sediment and they have an oral hood for filter feeding microorganisms from the water; post-metamorphosis, sea lampreys develop fins for swimming in open water and suction mouths for feeding on fish blood).*
b. Have students work in small groups or pairs to identify similarities and differences using the images of a larval and an adult sea lamprey.
c. Students can use different colored crayons to mark similarities and differences.
d. Students can draw or list the similarities and difference between the larval and adult sea lamprey in the T Chart (provided below).
    i. Similarities:
        1. Similar body shape (streamline, “snake-like”)
        2. Mouth at one end, tail at the other
        3. Seven gill pores
    ii. Differences:
        1. Larvae – lack suction mouth, teeth, tongue (have an oral hood, a hole basically, for filter-feeding microorganisms from of the water)

2. Larvae – lack developed fins (larvae do not really swim, they float through the water carried by the current and then bury themselves in the stream bottom sediment)
3. Larvae – blind (do not need eyes when buried under the sediment)
4. Larvae – smaller, grow slowly
5. Adults – suction mouth, teeth, rasping tongue (need this for parasitizing/feeding on other fish)
6. Adults – developed fins (important for swimming)
7. Adults – eyes, one on each side of the head
8. Adults – larger, grow faster (feeding on other fish)

Session 2

1. **15 minutes** - Watch *Predator in Paradise* (Start: 10:05 – End of video)
2. **25 minutes** - Swimming noses
3. **5 minutes** - Alarm response video

Materials:

- *Predator in Paradise* video link
- Containers to hold various scents (opaque if needed)
    - For example: 35 mm film storage canisters, condiment cups with lids, or baggies
- Essential oils and cotton balls OR natural scents OR tea bags
- Nest and tributary images for scent activity (printable)
- Swimming noses activity recording sheet (printable)
- Repellant video link (included where needed below)

1. Watch *Predator in Paradise* Part 2

Video Discussion questions

- What types of control methods are predominantly used to control sea lamprey? *Lampricides and barriers (dams) are the main two methods used. A third method of control currently in development is trapping. Traps are strategically placed near barriers to capture sea lampreys from the streams.*
- What is the most effective method of sea lamprey control? *Lampricide, TFM.*
- What makes TFM a good lampricide? *It is selective, that is, it harms sea lamprey, but not other aquatic organisms in the system.*
- 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.*

2. Swimming noses (scent activity): Learning more about attractant pheromones

a. Ask students to name the 5 senses. *Taste, touch, smell, sight, and hearing*.
   i. What sense do humans, as a whole, rely on the most? *Eyesight*.
   ii. What sense do students think sea lampreys rely on the most? *Smell*.
   iii. So, what smells do you think sea lamprey are attracted to? *Sea lamprey pheromones*!
   iv. Ask students, "How well do your noses work? Do you think you could make your way to the right stream like a sea lamprey?

b. Sea lampreys use their noses to find certain things such as good spawning streams. Can your nose lead you to the correct destination?
   i. Before activity prepare 'scent sets' (you will need three identical baggies or containers for each student group, possibly labeled in a nondescript manner) and several additional "lone scents."
      - Option 1 – place a drop of Essential oil on a cotton ball and place it in a small baggie or condiment cup with lid.
      - Option 2 – use cinnamon, oregano, basil, onion powder, garlic powder, evergreen pine needles (crushed), wintergreen, vanilla, baby powder etc. placed in identical small containers, like film canisters, with a cotton ball on top so that when canisters are opened the items are not visible.
      - Option 3 – use tea bags of different scents placed in a bag or cup
   ii. Disperse or hide one container from each 'scent set' and the lone scents around the inner portion of the classroom (pair with an image of a stream flowing into the Great Lakes, printable – the stream names are real tributaries to the five different Great Lakes that are known to have sea lamprey larvae).
   iii. Disperse the second vial from each 'scent set' around the outer edge of the classroom (pair with an image of a sea lamprey nest, printable).
   iv. Divide class into small groups and give each group the final (3rd) matching scent container from their 'scent set.'
   v. Students in each group will take turns smelling "their" scent. Then each group will have to find their scent from among the scents that are dispersed throughout the inner portion of the classroom (this represents a sea lamprey finding a spawning stream by using its nose to recognize pheromones released by larval lampreys living upstream).
   vi. Once they have found their spawning stream, the groups must find their actual nest by sniffing out the scents labeled with nest images around the outer edge of the classroom (this represents a sea lamprey finding a good spawning location once it swam upstream into a tributary). Groups will fill out a "Swimming noses activity recording sheet" as they go through this activity.

Follow up questions

- What was it like being forced to rely on your sense of smell? What do you think might happen if a sea lamprey couldn't smell properly? *They might pick a poor spawning stream,*

which may not have good spawning habitat, which could result in less success for their offspring. They also may be unable to find a mate.

3. **Repellants: Alarm response**
    a. Explanation: As you have just learned, smelling is important to sea lampreys. Their smelling organ is 2-3 times larger than their brain; hence they are nicknamed "swimming noses."
    b. Now that you understand attractant pheromones that help sea lampreys find spawning streams and mates, we will talk about the opposite scenario.
    c. What would you do if you walked into a room that smelled like rotting trash or dead fish? Would you sit and eat your lunch? Or would your run the other way? Well, just like with you, there are scents that sea lampreys don't like. These pheromones, called repellants, trigger an alarm response in sea lampreys.
    d. Now watch a short video clip depicting the sea lamprey response after exposure to the scent of dead sea lampreys (a strong repellant, wouldn't you agree?).

Video Discussion questions

- Describe the sea lamprey alarm response. *Sea lamprey jump out of the water and try to quickly swim away from the scent of dead lamprey when it is poured into the water*.
- How might researchers use a sea lamprey's sense of smell to develop control methods? *Through what is called '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.*

Session 3

1. **10 minutes** – Review
2. **45 minutes (or more)** – You be the scientist (brainstorm and create potential control method)
3. **45 minutes** – Sharing and brainstorming feasibility

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 call kill up to 40 lbs. worth of other fish in its lifetime. Sea lampreys brought great devastation to the Great Lakes fishery and economy upon invasion.

- What are the main methods used by the Sea Lamprey Control Program? *Lampricides (mainly TFM), barriers, and traps (in development).*
- Why are sea lampreys nicknamed swimming noses? *They have a strong sense of smell and use it to find spawning streams and mates.*
- How are scientists using a sea lamprey's sense of smell in control efforts? *Through what is called '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.*

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 barrier or more effective trap), or completely unique. Discuss aloud if desired.
        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 present their models/drawings with the class and after all have shared, brainstorm 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 and send them back to us in case we want to use some of the ideas!) ☺

Session 4

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

Materials:

- Computers
- MSUE Action Plan template (printable)
- Poster board
- Markers

1. **Hammond Bay Biological Station: Local discoveries, basin-wide impact**
    a. Background: *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, Michigan (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.*
    b. 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.
        i. Resource: Northeast Michigan Great Lakes Stewardship Initiative is a website where students can read about projects that have been (and are currently being) implemented by students in northeast Michigan.
    c. Have students create a poster based on their findings and share with the class the discoveries they have made. As a final point, have them come up with at least one science-based idea that they (as an individual) or the class could implement to protect our natural resources ('next steps'). Students can fill out an MSUE Action Plan template (printable).
    d. **Optional**: Further this activity by having students implement their ideas.

Unit wrap-up discussion or writing activity (choose any or all questions)

Have students:

- Explain two unique characteristics of a sea lamprey
- Describe how sea lampreys entered the Great Lakes
- Describe the life cycle of a sea lamprey
- Identify characteristics of adult sea lampreys and explain how they help adults survive
- Identify characteristics of larval sea lamprey and explain how they help larvae survive
- Describe the importance of a sea lamprey's sense of smell
- Explain how stream characteristics affect sea lamprey spawning around the Great Lakes
- Explain one reason why it is important to control sea lamprey populations in the Great Lakes
- Describe one current method for controlling Great Lakes sea lamprey
- Describe how the research facility in Millersburg, Michigan used science to protect the Great Lakes from invasive sea lamprey

Assessment

1. Map activity (**4-ESS2-2**)
2. Adult and larval sea lamprey comparison activity (**4-LS1-1**)
3. Smelling activity (**4-LS1-2**)
4. Rubric for illustration of sea lamprey control method. (Standards **3-5-ETS1-1** and **3-5-ETS1-2**.)
5. Protecting the Earth's resources (**5-ESS3-1**)
6. Student answers to the unit wrap-up discussion or writing assignment serve as a summative assessment for this unit.

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 and/or within limited budget.	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 it 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 components.	

Critical vocabulary (*all definitions taken from dictionary.com, unless otherwise noted*)

- **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** – an organism that lives on or in an organism of another species, known as the host, and from which it obtains nutrients.
- **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.

Websites

- Great Lakes Fishery Commission: glfc.org
- U.S. map: http://www.coloringcastle.com/pdfs/us_states/united_states_blank.pdf
- NY Erie Canal map: http://www.canals.ny.gov/maps/index.html
- Welland Canal on Google Maps: https://www.google.com/maps/place/Welland+Canal/@43.1306294,-79.477514,10.25z/data=!4m5!3m4!1s0x89d3362fe75943ff:0x117550872a77b659!8m2!3d43.0573207!4d-79.2112601
- Niagara Falls on Google Maps: https://www.google.com/maps/place/Niagara+Falls/@43.0892706,-79.1046814,14z/data=!4m5!3m4!1s0x89d34307412d7ae9:0x29be1d1e689ce35b!8m2!3d43.0828162!4d-79.0741629
- NEMIGLSI: http://www.nemiglsi.org/
- *Sea Lamprey - From Crisis to Control* GLFC outreach video: https://www.youtube.com/watch?v=JVlHApc3h1c

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.

Printable Materials

THE GREAT LAKES

Tributaries in Which Sea Lampreys Have Been Found

Lake Superior (CAN)

East Davignon Creek	1	Michipicoten River	33
West Davignon Creek	2	Dog River	34
Little Carp River	3	White River	35
Big Carp River	4	Pic River	36
Cranberry Creek	5	Little Pic River	37
Goulais River	6	Prairie River	38
Bostons Creek	7	Steel River	39
Haviland Creek	8	Pays Plat River	40
Unnamed	9	Gravel River	41
Stokely Creek	10	Little Gravel River	42
Unnamed	11	L.Cypress River	43
Tier Creek	12	Cypress River	44
Harmony River	13	Jackpine River	45
Sawmill Creek	14	Jackfish River	46
Jones Landing Creek	15	Nipigon River	47
Tiny Creek	16	Big Trout Creek	48
Chippewa River	17	Otter Cove Creek	49
Unnamed (1009)(48-1)	18	Black Sturgeon River	50
Unnamed (S-49)	19	Big Squaw Creek	51
Unger Creek	20	Wolf River	52
Unnamed	21	Coldwater Creek	53
Batchawana River	22	Pearl River	54
Unnamed (52-2)	23	D'Arcy Creek	55
Digby Creek	24	Blende Creek	56
Carp River	25	MacKenzie River	57
Pancake River	26	Current River	58
Westman Creek	27	Neebing-McIntrye Floodway	59
Agawa River	28	Kaministikwia River	60
Sand River	29	Cloud River	61
Baldhead River	30	Pine River	62
Gargantua River	31	Pigeon River	63
Old Woman River	32		

Lake Superior (US)

Waiska River	1	Sturgeon River	47
Sec. 11SW Tributary	2	Pilgrim River	48
Pendills Creek	3	Trap Rock River	49
Grants Creek	4	McCallum Creek	50
Naomikong Creek	5	Traverse River	51
Ankodosh Creek	6	Little Gratiot River	52
Roxbury Creek	7	Eliza Creek	53
Galloway Creek	8	Gratiot River	54
Tahquamenon River	9	Smiths Creek (Bear Creek)	55
Betsy River	10	Boston-Lily Creek	56
Three Mile Creek	11	Salmon Trout River	57
Little Two Hearted River	12	Mud Lake Outlet	58
Two Hearted River	13	Graveraet River	59
Dead (Blind) Sucker River	14	Elm River	60
Sucker River	15	Misery River	61
Carpenter Creek	16	East Sleeping River	62
Sable Creek	17	West Sleeping River	63
Hurricane River	18	Firesteel River	64
Sullivans Creek	19	Ontonagon River	65
Seven Mile Creek	20	Potato River	66
Mosquito River	21	Floodwood River	67
Miners River	22	Cranberry River	68
Munising Falls Creek	23	Little Iron River	69
Anna River	24	Union River	70
Furnace Creek	25	Black River	71
Five Mile Creek	26	Montreal River	72
Au Train River	27	Washington Creek	73
Rock River	28	Bad River	74
Deer Lake Creek	29	Fish Creek (Eileen Twp.)	75
Laughing Whitefish River	30	Red Cliff Creek	76
Sand River	31	Raspberry River	77
Chocolay River	32	Sand River (Bayfield)	78
Carp River	33	Cranberry River	79
Dead River	34	Iron River	80
Harlow Creek	35	Reefer Creek	81
Little Garlic River	36	Fish Creek (Orienta Twp.)	82
Garlic River	37	Brule River	83
Iron River	38	Poplar River	84
Salmon Trout River	39	Middle River	85
Pine River	40	Amnicon River	86
Huron River	41	Nemadji River	87
Ravine River	42	St. Louis River	88
Slate River	43	Sucker River	89
Silver River	44	Gooseberry River	90
Falls River	45	Split Rock River	91
Six Mile Creek	46	Arrowhead River	92

Lake Michigan

Brevort River	1	Bear Creek	63
Paquin Creek	2	Door County #23 Tributary	64
Davenport Creek	3	Ahnapee River	65
Hog Island Creek	4	Three Mile Creek	66
Sucker Creek	5	Kewaunee River	67
Black River	6	East Twin River	68
Mile Creek	7	Fischer Creek	69
Millecoquins River	8	Burns Ditch	70
Rock River	9	Donns Creek	71
Crow River	10	Trail Creek	72
Cataract River	11	State Creek	73
Point Patterson Creek	12	Galien River	74
Hudson Creek	13	St Joseph River	75
Swan Creek	14	Rogers Creek	76
Seiners Creek	15	Brandywine Creek	77
Milakokia River	16	Black River	78
Bulldog Creek	17	Allegan 5 Creek	79
Gulliver Lake Outlet	18	Allegan 4 Creek	80
Marblehead Creek	19	Allegan 3 Creek	81
Manistique River	20	Kalamazoo River	82
Southtown Creek	21	Gibson Creek	83
Thompson Creek	22	Pine Creek	84
Johnson Creek	23	Pigeon River	85
Deadhorse Creek	24	Grand River	86
Gierke Creek	25	Black Creek	87
Bursaw Creek	26	Muskegon River	88
Parent Creek	27	Duck Creek	89
Poodle Pete Creek	28	White River	90
Valentine Creek	29	Flower Creek	91
Little Fishdam River	30	Stony Creek	92
Big Fishdam River	31	Pentwater River	93
Sturgeon River	32	Bass Lake Outlet	94
Ogontz River	33	Pere Marquette River	95
Squaw Creek	34	Lincoln River	96
Hock Creek	35	Cooper Creek	97
Whitefish River	36	Gurney Creek	98
Rapid River	37	Manistee River	99
Tacoosh River	38	Bowen Creek	100
Days River	39	Betsie River	101
Escanaba River	40	Platte River	102
Portage Creek	41	Crystal River	103
Ford River	42	Good Harbor Creek	104
Sunny Brook	43	Leland River	105
Bark River	44	Leo Creek	106
Cedar River	45	Boardman River	107
Sugar Creek (Ruleau Creek)	46	Mitchell Creek	108
Arthur Bay Creek	47	Acme Creek	109
Rochereau Creek	48	Yuba Creek	110
Johnson Creek	49	Elk Lake Outlet	111
Bailey Creek	50	McGeach Creek	112
Beattie Creek	51	Loeb Creek	113
Springer Creek	52	Monroe Creek	114
Menominee River	53	Jordan River	115
Little River	54	Porter Creek	116
Peshtigo River	55	Boyne River	117
Oconto River	56	Horton Creek	118
Pensaukee River	57	Bear River	119
Suamico River	58	Wycamp Creek	120
Ephraim Creek	59	Big Sucker Creek	121
Hibbards Creek	60	Big Stone Creek	122
Whitefish Bay Creek	61	Carp Lake River	123
Lily Bay Creek	62		

Lake Huron (CAN)

St. Marys River	1	Timber Bay Creek	32
Root River	2	Manitou River	33
Garden River	3	Blue Jay Creek	34
Echo River	4	Kaboni Creek	35
Bar River	5	Chikanishing River	36
Desbarats River	6	French River	37
Stoby Creek	7	Key River	38
Sucker Creek	8	Still River	39
Unnamed	9	Magnetawan River	40
Twotree River	10	Naiscoot River	41
Richardson Creek	11	Shebeshekong River	42
Watson Creek	12	Boyne River	43
Gordon Creek	13	Squirrel Creek	44
Browns Creek	14	Musquash River	45
Koshkawong River	15	Simcoe/Severn System	46
Unnamed	16	Coldwater Creek	47
Unnamed	17	Sturgeon River	48
McBeth Creek	18	Hog Creek	49
Thessalon River	19	Lafontaine Creek	50
Livingstone Creek	20	Nottawasaga River	51
Mississagi River	21	Pretty River	52
Blind River	22	Silver Creek	53
Lauzon River	23	Beaver River	54
Spragge Creek	24	Bighead River	55
Unnamed	25	Bothwell's Creek	56
Serpent River	26	Sydenham River	57
Spanish River	27	Sauble River	58
Kagawong River	28	Saugeen River	59
Silver Creek	29	Nine Mile River	60
Sand Creek	30	Maitland River	61
Mindemoya River	31	Bayfield River	62

Lake Huron (US)

Mission Creek	1	Elliot Creek	32
Frechette Creek	2	Greene Creek	33
Ermatinger Creek	3	Grass Creek	34
Charlotte River	4	Grace Creek	35
Little Munuscong River	5	Black Mallard Creek	36
Big Munuscong River	6	Mulligan Creek	37
Carlton Creek	7	Seventeen Creek	38
Canoe Lake Outlet	8	Ocquesc River	39
Bear Lake Outlet	9	HBBS Creek	40
Carr Creek	10	Johnny Creek	41
Joe Straw Creek	11	Schmidt Creek	42
Saddle Creek	12	Nagels Creek	43
Huron Point Creek	13	Trout River	44
Albany Creek	14	Swan River	45
Trout Creek	15	Grand Lake Outlet	46
Beavertail Creek	16	Middle Lake Outlet	47
Prentiss Creek	17	Long Lake Creek	48
McKay Creek	18	Squaw Creek	49
Flowers Creek	19	Devils River	50
Ceville Creek (Pearson Creek)	20	Black River	51
Hessel Creek (Mackinac Creek)	21	Mill Creek	52
Steeles Creek	22	AuSable River	53
Nunns Creek	23	Tawas Lake Outlet	54
Pine River	24	East AuGres River	55
McCloud Creek	25	AuGres River	56
Carp River	26	Rifle River	57
Martineau Creek	27	Saginaw River	58
266-20 Creek	28	Rock Falls Creek	59
Beaugrand Creek	29	Elm Creek	60
Little Black River	30	Mill Creek	61
Cheboygan River	31	Cherry Creek	62

Lake Erie (CAN)

St. Clair River	1		
Thames River	2		
East Creek	3		
Catfish Creek	4		
Silver Creek	5		
Big Otter Creek	6		
South Otter Creek	7		
Clear Creek	8		
Big Creek	9		
Forestville Creek	10		
Normandale Creek	11		
Fishers Creek	12		
Youngs Creek	13		

Lake Erie (US)

Black River	1		
Pine River	2		
Belle River	3		
Clinton River	4		
Chagrin River	5		
Grand River	6		
Wheeler Creek	7		
Ashtabula River	8		
Conneaut Creek	9		
Raccoon Creek	10		
Crooked Creek	11		
Canadaway Creek	12		
Halfway Brook	13		
Cattaraugus Creek	14		
Delaware Creek	15		
Buffalo River	16		

Lake Ontario (CAN)

Niagara River	1		
Ancaster Creek	2		
Grindstone Creek	3		
Bronte Creek	4		
Fourteen Mile Creek	5		
Sixteen Mile Creek	6		
Credit River	7		
Humber River	8		
Rouge River	9		
Petticoat Creek	10		
Duffins Creek	11		
Carruthers Creek	12		
Lynde Creek	13		
Oshawa Creek	14		
Farewell Creek	15		
Bowmanville Creek	16		
Wilmot Creek	17		
Graham Creek	18		
Wesleyville Creek	19		
Port Britain Creek	20		
Gage Creek	21		
Cobourg Brook	22		
Covert Creek	23		
Grafton Creek	24		
Shelter Valley Creek	25		
Colborne Creek	26		
Salem Creek	27		
Proctor Creek	28		
Smithfield Creek	29		
Trent River(Canal System)	30		
Moira River	31		
Salmon River	32		
Napanee River	33		

Lake Ontario (US)

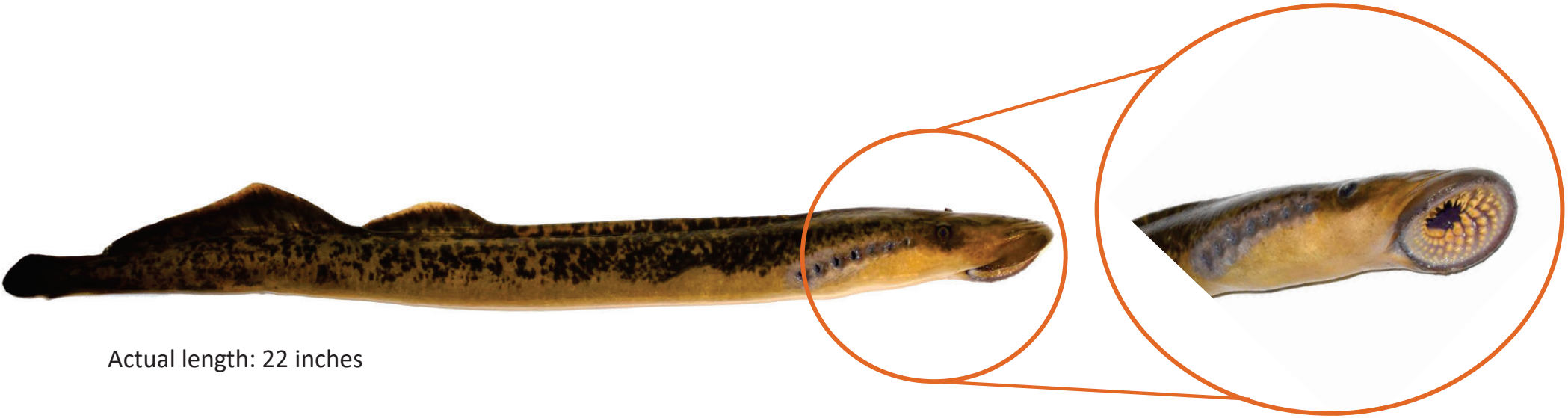
Johnson Creek	1	Oswego River	18
Oak Orchard Creek	2	Catfish Creek	19
Salmon Creek	3	Butterfly Creek	20
Northrup Creek	4	Little Salmon River	21
Larkin Creek	5	Sage Creek	22
Irondequoit Creek	6	Snake Creek	23
Forest Lawn Creek	7	Grindstone Creek	24
First Creek	8	Salmon River	25
Third Creek	9	Deer Creek	26
Sodus Creek	10	Little Sandy Creek	27
Wolcott Creek	11	Blind Creek	28
Red Creek	12	Lindsey Creek	29
Blind Sodus Creek	13	Skinner Creek	30
Sterling Creek	14	South Sandy Creek	31
Nine Mile Creek	15	Sandy Creek	32
Eight Mile Creek	16	Stony Creek	33
Rice Creek	17	Black River	34

SEA LAMPREY CONTROL CENTRE
SAULT STE. MARIE, ONTARIO

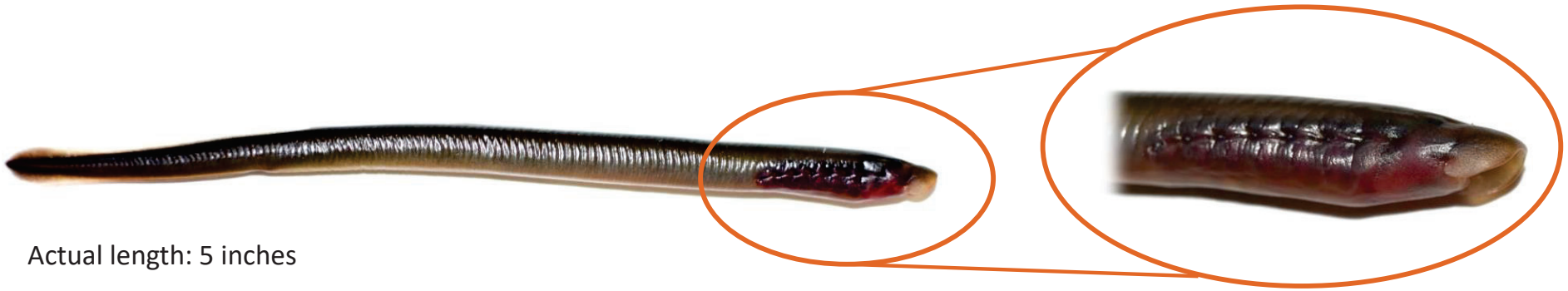
created by: Kevin Tallon

data supplied by:
Sea Lamprey Control Centre
Marquette Biological Station
Ludington Biological Station

Compare and contrast: Adult and larval sea lampreys



Actual length: 22 inches



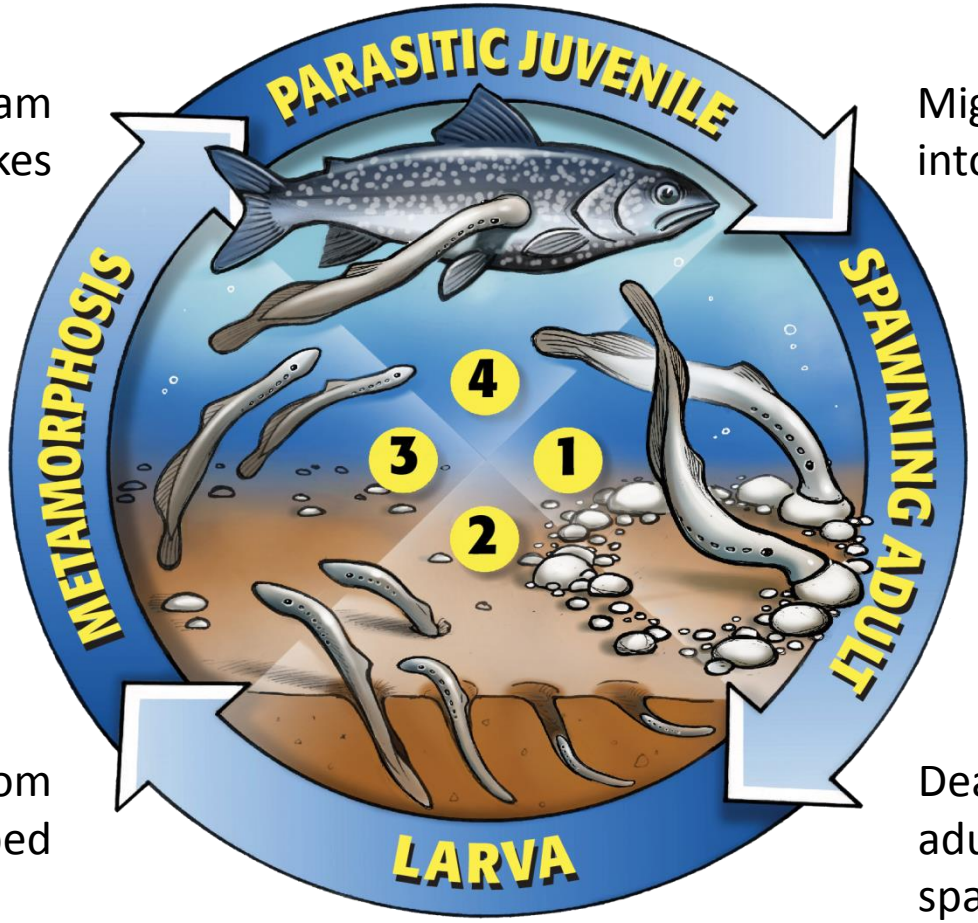
Actual length: 5 inches

Compare and contrast: Adult and larval sea lampreys

Adults	Larvae

SEA LAMPREY LIFE CYCLE

12-18 MONTHS
One summer, fall, and winter feeding on blood of host fish



Migration of adults into streams

MARCH-JULY

Death of adults after spawning

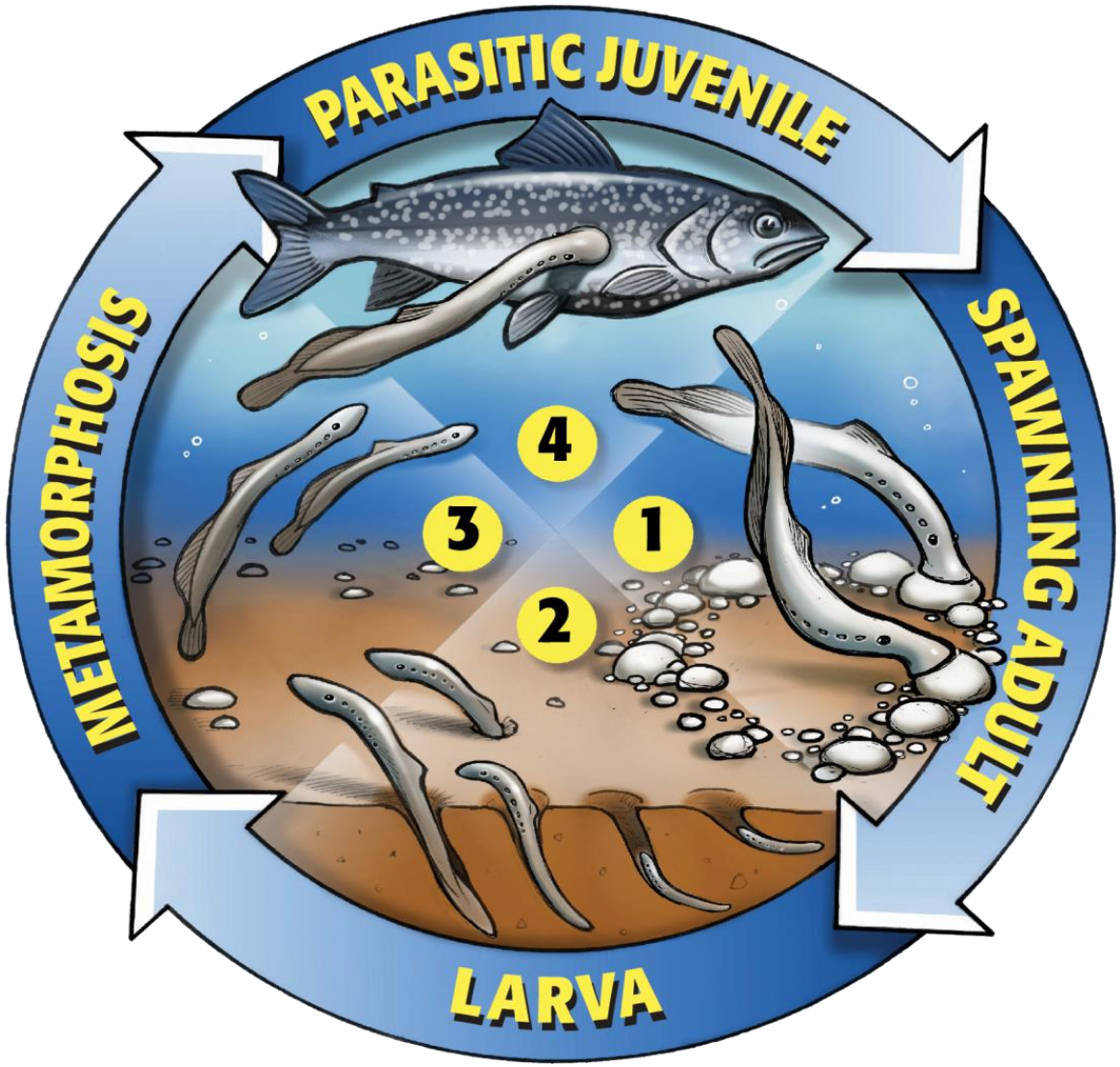
3-10+ YEARS

Emergence from stream bed

JUNE-MARCH

Downstream migration to lakes

SEA LAMPREY LIFE CYCLE



SEA LAMPREY NEST #1

SEA LAMPREY NEST #2

SEA LAMPREY NEST

#3

SEA LAMPREY NEST

#4

SEA LAMPREY NEST

#5

SEA LAMPREY NEST

#6

SEA LAMPREY
NEST
#7

SEA LAMPREY
NEST
#8

BIG GARLIC RIVER

(LAKE SUPERIOR)

OCQUEOC RIVER

(LAKE HURON)

ST. MARYS RIVER

(DRAINS LAKE SUPERIOR INTO LAKE HURON)

MANISTEE RIVER

(LAKE MICHIGAN)

RIFLE RIVER

(LAKE HURON)

GRAND RIVER

(LAKE MICHIGAN)

SALMON RIVER

(LAKE ONTARIO)

CATTARAUGUS CREEK

(LAKE ERIE)

CHEBOYGAN RIVER (LAKE HURON)

DETROIT RIVER (LAKE ERIE)

MANISTIQUE RIVER

(LAKE MICHIGAN)

LITTLE OTTER CREEK

(LAKE ERIE)

BLACK RIVER

(LAKE ONTARIO)

AU GRES RIVER

(LAKE HURON)

CARP RIVER

(LAKE SUPERIOR)

TAHQUAMENON RIVER

(LAKE SUPERIOR)

OSWEGO RIVER

(LAKE ONTARIO)

OAK ORCHARD CREEK

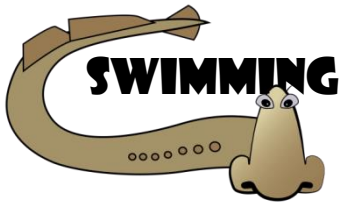
(LAKE ONTARIO)

ASHTABULA RIVER

(LAKE ERIE)

BEAR RIVER

(LAKE MICHIGAN)



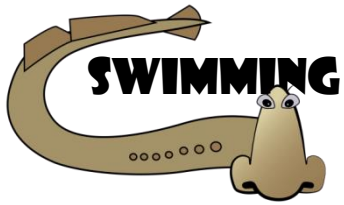
SWIMMING NOSES

Name: _____

Group #: _____

Stream name: _____

Nest #: _____



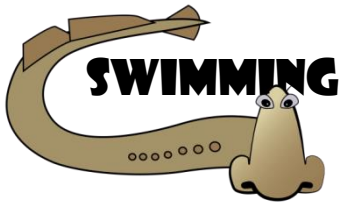
SWIMMING NOSES

Name: _____

Group #: _____

Stream name: _____

Nest #: _____



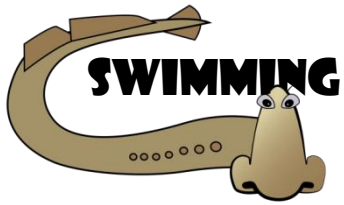
SWIMMING NOSES

Name: _____

Group #: _____

Stream name: _____

Nest #: _____



SWIMMING NOSES

Name: _____

Group #: _____

Stream name: _____

Nest #: _____

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