

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 you 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 can 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 repellent 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=JVHApC3h1c>

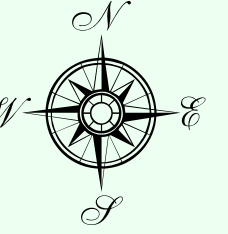
Comments

- Feel free to contact us with any comments – or for materials, such as sea lamprey brochures.
Lauren Holbrook
Communications Associate, Great Lakes Fishery Commission
lholbrook@glfc.org
- 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
 - West Davignon Creek
 - Little Carp River
 - Big Carp River
 - Cranberry Creek
 - Goulais River
 - Bostons Creek
 - Haviland Creek
 - Unnamed
 - Stokely Creek
 - Unnamed
 - Tier Creek
 - Harmony River
 - Sawmill Creek
 - Jones Landing Creek
 - Tiny Creek
 - Chippewa River
 - Unnamed (1009/48-1)
 - Unnamed (S-49)
 - Unger Creek
 - Unnamed
 - Batchavana River
 - Unnamed (S2-2)
 - Digby Creek
 - Carp River
 - Pancke River
 - Westman Creek
 - Agawa River
 - Sand River
 - Baldhead River
 - Gargantua River
 - Old Woman River

- Michipicoten River
- Dog River
- White River
- Pic River
- Little Pic River
- Prairie River
- Steel River
- Pays Plat River
- Gravel River
- Little Gravel River
- L. Cypress River
- Cypress River
- Jackpine River
- Jackfish River
- Nipigon River
- Big Trout Creek
- Oter Cove Creek
- Black Sturgeon River
- Big Squaw Creek
- Wolf River
- Coldwater Creek
- Pearl River
- D'Arcy Creek
- Blende Creek
- MacKenzie River
- Current River
- Neebing-McIntyre Floodway
- Kaministikwia River
- Cloud River
- Pine River
- Pigeon River

- Lake Superior (US)**
- Waiksa River
 - Sec. 11SW Tributary
 - Pendills Creek
 - Grants Creek
 - Naomkong Creek
 - Ankodosh Creek
 - Roxbury Creek
 - Galloway Creek
 - Tahquamenon River
 - Betsy River
 - Three Mile Creek
 - Little Two Hearted River
 - Two Hearted River
 - Dead (Blind) Sucker River
 - Sucker River
 - Carpenter Creek
 - Sable Creek
 - Hurricane River
 - Sullivans Creek
 - Seven Mile Creek
 - Mosquito River
 - Miners River
 - Munising Falls Creek
 - Anna River
 - Furnace Creek
 - Five Mile Creek
 - Au Train River
 - Rock River
 - Deer Lake Creek
 - Laughing Whitefish River
 - Sand River
 - Chocalay River
 - Carp River
 - Dead River
 - Harlow Creek
 - Little Garlic River
 - Garlic River
 - Iron River
 - Salmon Trout River
 - Pine River
 - Huron River
 - Ravine River
 - Slate River
 - Silver River
 - Falls River
 - Six Mile Creek

- Sturgeon River
- Pilgrim River
- Trap Rock River
- McCallum Creek
- Paquin Creek
- Little Gratiot River
- Eliza Creek
- Gratiot River
- Smiths Creek (Bear Creek)
- Boston-Lily Creek
- Salmon Trout River
- Mud Lake Outlet
- Graveraet River
- Elm River
- Misery River
- East Sleeping River
- West Sleeping River
- Firesteel River
- Ontonagon River
- Potato River
- Floodwood River
- Cranberry River
- Little Iron River
- Union River
- Black River
- Montreal River
- Washington Creek
- Bad River
- Fish Creek (Eileen Twp.)
- Red Cliff Creek
- Raspberry River
- Sand River (Bayfield)
- Cranberry River
- Iron River
- Reefer Creek
- Fish Creek (Orienta Twp.)
- Brule River
- Poplar River
- Middle River
- Amnicon River
- Nemadji River
- Tacosh River
- Days River
- Escanaba River
- Portage Creek
- Ford River
- Sunny Brook
- Bark River
- Cedar River
- Sugar Creek (Rouleau Creek)
- Arthur Bay Creek
- Rochereau Creek
- Johnson Creek
- Bailey Creek
- Beattie Creek
- Springer Creek
- Menominee River
- Little River
- Peshigo River
- Oconto River
- Pensaukee River
- Suamico River
- Ephraim Creek
- Hibbards Creek
- Whitefish Bay Creek
- Lily Bay Creek

Lake Michigan

- Bear Creek
- Door County #23 Tributary
- Ahnapee River
- Three Mile Creek
- Kewaunee River
- Black River
- Fischer Creek
- Salmon Trout River
- Burns Ditch
- Donns Creek
- Trail Creek
- State Creek
- Galien River
- St. Joseph River
- Rogers Creek
- Brandywine Creek
- Black River
- Allegan 5 Creek
- Allegan 4 Creek
- Allegan 3 Creek
- Kalamazoo River
- Gibson Creek
- Pine Creek
- Pigeon River
- Grand River
- Black Creek
- Muskegon River
- Duck Creek
- White River
- Flower Creek
- Stony Creek
- Pentwater River
- Bass Lake Outlet
- Para Marquette River
- Lincoln River
- Cooper Creek
- Garney Creek
- Manistee River
- Bowen Creek
- Betsie River
- Platte River
- Crystal River
- Good Harbor Creek
- Leland River
- Leo Creek
- Boardman River
- Mitchell Creek
- Arthur Bay Creek
- Yuba Creek
- Elk Lake Outlet
- McGeach Creek
- Loeb Creek
- Monroe Creek
- Jordan River
- Porter Creek
- Boyne River
- Horton Creek
- Bear River
- Wycamp Creek
- Big Sucker Creek
- Big Stone Creek
- Carp Lake River

Lake Huron (CAN)

- St. Marys River
- Root River
- Garden River
- Echo River
- Bar River
- Desbarats River
- Stoby Creek
- Sucker Creek
- Unnamed
- Twotree River
- Richardson Creek
- Watson Creek
- Gordon Creek
- Browns Creek
- Koshkawong River
- Unnamed
- McBeth Creek
- Thessalon River
- Livingstone Creek
- Missisagi River
- Blind River
- Lauson River
- Spragge Creek
- Unnamed
- Serpent River
- Spanish River
- Kagawong River
- Silver Creek
- Sand Creek
- Mindemoya River

- Timber Bay Creek
- Manitou River
- Blue Jay Creek
- Kaboni Creek
- Chikanishing River
- French River
- Key River
- Still River
- Magnetawan River
- Naiscoot River
- Shebeshekong River
- Boyne River
- Squirrel Creek
- Musquash River
- Simcoe/Severn System
- Coldwater Creek
- Sturgeon River
- Hog Creek
- Lafontaine Creek
- Nottawasaga River
- Pretty River
- Silver Creek
- Beaver River
- Highland River
- Bothwell's Creek
- Sydenham River
- Sauble River
- Saugen River
- Nine Mile River
- Maitland River
- Bayfield River

Lake Huron (US)

- Mission Creek
- Frechette Creek
- Ermatinger Creek
- Charlotte River
- Little Munusong River
- Big Munusong River
- Carlton Creek
- Canoe Lake Outlet
- Bear Lake Outlet
- Carr Creek
- Joe Straw Creek
- Saddle Creek
- Huron Point Creek
- Albany Creek
- Trout Creek
- Beavertail Creek
- Prentiss Creek
- McKay Creek
- Flowers Creek
- Ceville Creek (Pearson Creek)
- Hessel Creek (Mackinac Creek)
- Nunns Creek
- Pine River
- McCloud Creek
- Carp River
- Martineau Creek
- 266-20 Creek
- Beaugrand Creek
- Little Black River
- Cheboygan River

- Elliot Creek
- Greene Creek
- Grass Creek
- Grace Creek
- Black Mallard Creek
- Mulligan Creek
- Seventeen Creek
- Oqueoc River
- HBBS Creek
- Johnny Creek
- Schmidt Creek
- Nagels Creek
- Trout River
- Swan River
- Grand Lake Outlet
- Middle Lake Outlet
- Long Lake Creek
- Squaw Creek
- Devils River
- Black River
- Mill Creek
- Ausable River
- Tawas Lake Outlet
- East AuGres River
- AuGres River
- Rifle River
- Saginaw River
- Rock Falls Creek
- Elm Creek
- Mill Creek
- Cherry Creek

Lake Ontario (CAN)

- Niagara River
- Ancaster Creek
- Grindstone Creek
- Bronte Creek
- Fourteen Mile Creek
- Sixteen Mile Creek
- Credit River
- Humber River
- Rouge River
- Petticoat Creek
- Duffins Creek
- Caruthers Creek
- Lynde Creek
- Oshawa Creek
- Farewell Creek
- Bowmanville Creek
- Wilmot Creek
- Graham Creek
- Wesleyville Creek
- Port Britain Creek
- Gage Creek
- Cobourg Brook
- Covert Creek
- Grafton Creek
- Shelter Valley Creek
- Colborne Creek
- Salem Creek
- Proctor Creek
- Smighfield Creek
- Trent River (Canal System)
- Moira River
- Salmon River
- Napanee River

Lake Ontario (US)

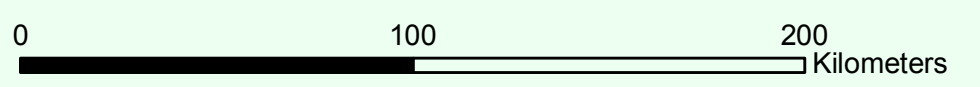
- Johnson Creek
- Oak Orchard Creek
- Salmon Creek
- Northrup Creek
- Larkin Creek
- Irondequoit Creek
- Forest Lawn Creek
- First Creek
- Third Creek
- Sodus Creek
- Wolcott Creek
- Red Creek
- Blind Sodus Creek
- Sterling Creek
- Nine Mile Creek
- Eight Mile Creek
- Rice Creek
- Oswego River
- Catfish Creek
- Butterfly Creek
- Little Salmon River
- Sage Creek
- Snake Creek
- Grindstone Creek
- Salmon River
- Deer Creek
- Little Sandy Creek
- Blind Creek
- Lindsey Creek
- Skinner Creek
- South Sandy Creek
- Sandy Creek
- Stony Creek
- Black River

Lake Erie (US)

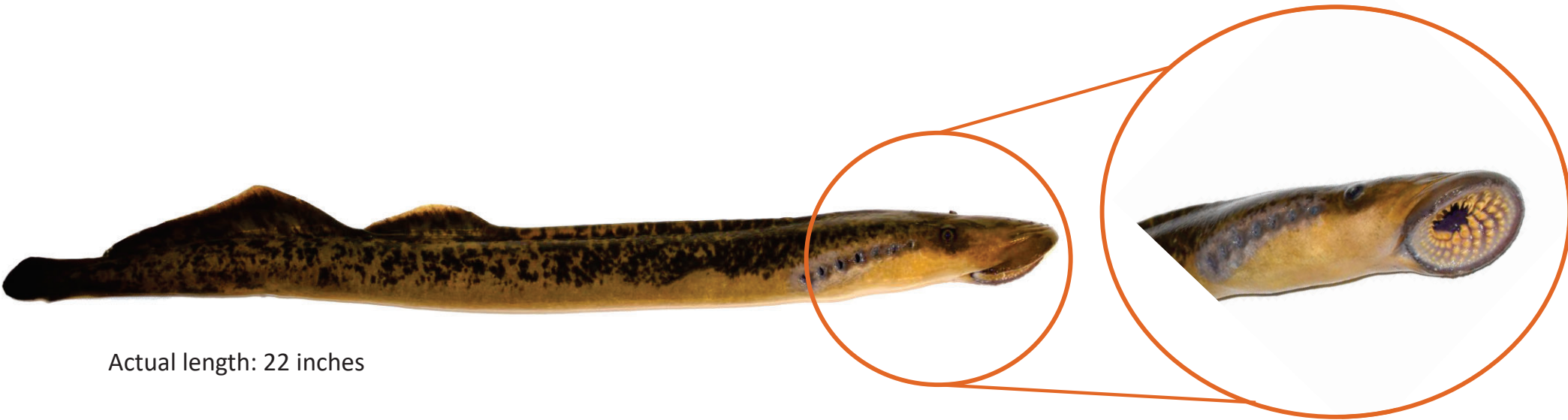
- Black River
- Pine River
- Belle River
- Clinton River
- Chagrin River
- Grand River
- Wheeler Creek
- Ashtabula River
- Conneaut Creek
- Raccoon Creek
- Crooked Creek
- Canadaway Creek
- Halfway Brook
- Cattaraugus Creek
- Delaware Creek
- Buffalo River

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

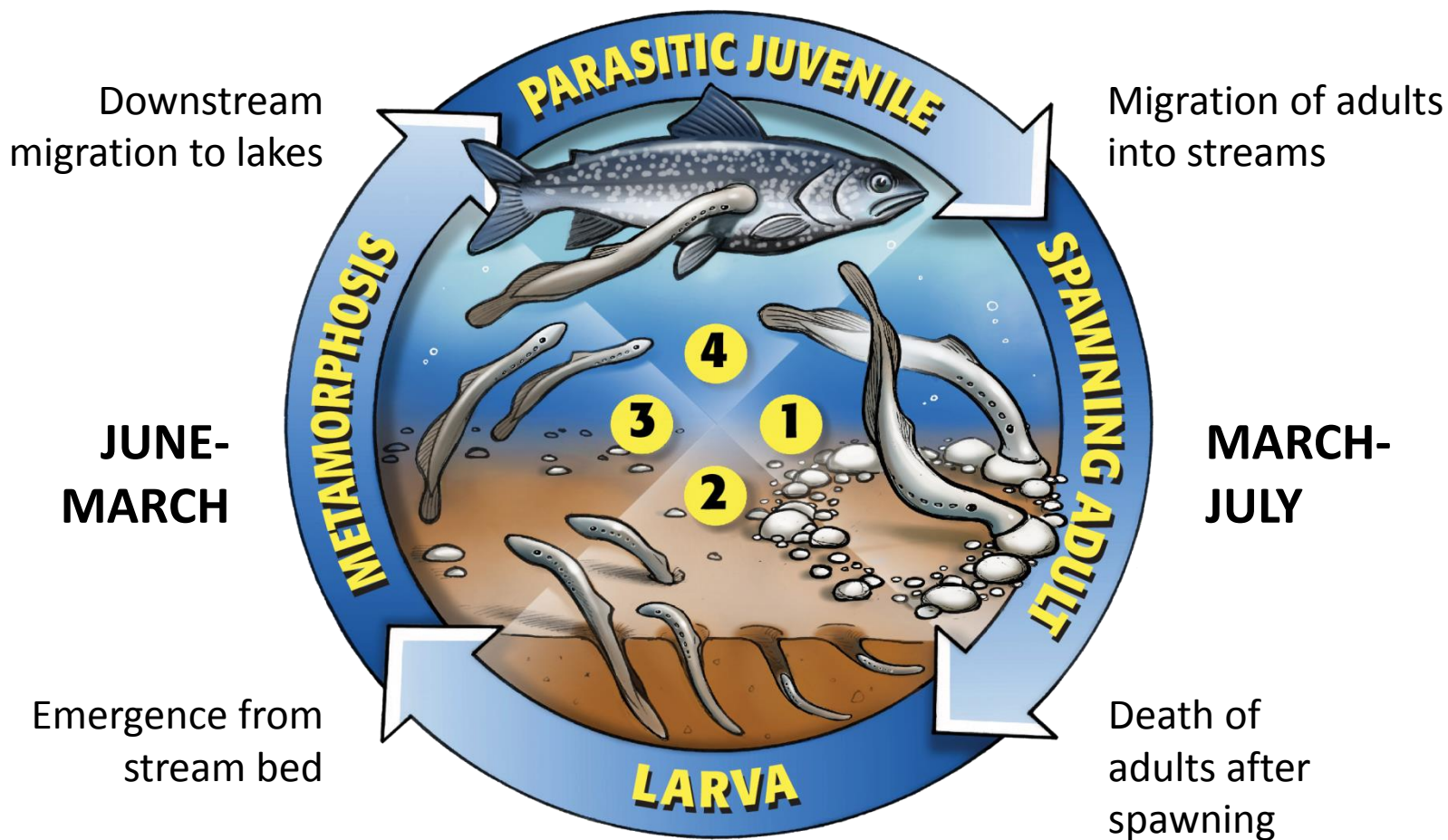
Larvae



SEA LAMPREY LIFE CYCLE

12-18 MONTHS

One summer, fall, and winter feeding on blood of host fish



Downstream migration to lakes

Migration of adults into streams

JUNE-MARCH

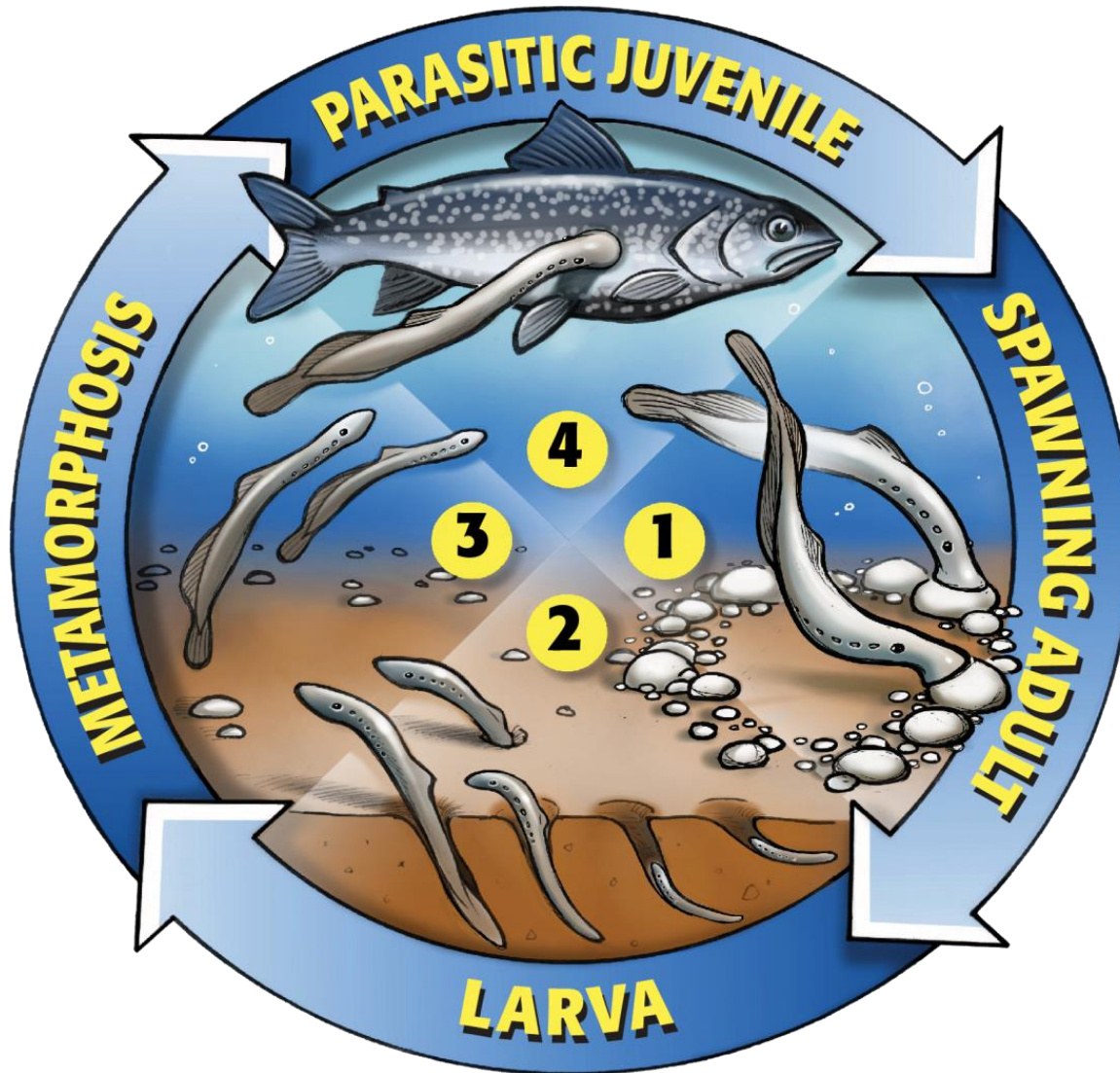
MARCH-JULY

Emergence from stream bed

Death of adults after spawning

3-10+ YEARS

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)**





Name: _____

Group #: _____

Stream name: _____

Nest #: _____



Name: _____

Group #: _____

Stream name: _____

Nest #: _____



Name: _____

Group #: _____

Stream name: _____

Nest #: _____



Name: _____

Group #: _____

Stream name: _____

Nest #: _____

True Science Leaders Action Plan

Remember **STAR**—Specific, Time-framed, Achievable, Reviewable

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)