**Sea Lamprey Sampler: A jigsaw of a Great Lakes invader**

**Topic:** Understand sea lampreys in the context of both their native range and their impact as a Great Lakes invasive species.

**Target Grade Range:** Middle and High School

**Time:** ~4 hours (estimation of five ~50-min class periods)

**Category:** Research

**Summary:** Students are introduced to sea lamprey topics: anatomy and physiology; native range (including ecosystem niche/role, e.g., predator-prey relationships); history in the Great Lakes; life cycle; impact on Great Lakes ecosystems; impact on Great Lakes economies; methods of control; and career pathways associated with their study and control. Students work in eight groups, each group with a topic to study about sea lampreys. Groups will present their research findings to the class.

**Goal:**

* Students learn about sea lampreys and their impact on the Great Lakes environment and economies.

**Objectives:**

* Students research and become experts on a sea lamprey characteristic and teach the rest of the class what they learned.
* Students gain an understanding of what sea lampreys are, background information, how they grow, and how they are being managed.

**Background knowledge:** Students know what invasive species are and why they are a threat to native species in the Great Lakes region.

Resource: Introduction to invasive species video, Michigan Department of Environment, Great Lakes, and Energy (MI EGLE), *Invasive Species: The Basics* (<https://www.youtube.com/watch?v=yIgysZ5Hho8>)

Resource:National Geographic Resource Library, *Introduction to Invasive Species* (<https://www.nationalgeographic.com/environment/article/invasive-species>)

**Procedure:**

*Materials and Resources:*

* Video: Great Lakes Fishery Commission, *Great Lakes Sea Lamprey: From Crisis to Control* (<https://www.youtube.com/watch?v=JVlHApc3h1c>)
* Technology (tablets, laptops, computers, or mobile devices)
* Student Project Overview Powerpoint slide
* Sea Lamprey Sampler Presentation Rubric
* Great Lakes Fishery Commission website (<https://www.glfc.org/sea-lamprey.php>)
* Sea Lamprey Sampler Presentations Note Sheet
* Sea Lamprey Sampler Presentations Note Sheet Teacher Key
* Sea Lamprey Sampler Teacher Resource Document

*Set-Up:*

* Day 1: Set up projector and device for video. Students divide into eight groups, each with a topic from those listed in the summary or other topics of student interest.
* Days 2 and 3: Provide technology for student research.
* Days 4 and 5: Provide projector, devices, and note sheets for student presentations.

*Activity Description:*

Day 1: Activity Introduction

1. Watch video *Great Lakes Sea Lamprey: From Crisis to Control*, Great Lakes Fisheries Commission (<https://www.youtube.com/watch?v=JVlHApc3h1c>)
2. Introduce the research project (see Student Project Overview Powerpoint slide) and assign student groups and topics.
   1. Students work in small groups. Each group researches one of the following topics (or other topics of student/teacher interest):
      * anatomy and physiology;
      * native range (including ecosystem niche/role, evolutionary relationships, etc.);
      * history in the Great Lakes;
      * life cycle;
      * impact on Great Lakes ecosystems;
      * impact on Great Lakes economies;
      * methods of control; and
      * career pathways associated with their study and control.
   2. Presentation Examples
      * Google slides or PowerPoint
      * Posters
      * Video recording
      * Audio recording
      * Using props and models

*Days 2 and 3: Research and develop a presentation outline*

1. Students continue sea lamprey topic research and presentation outline.
2. Students research presentation information using resources such as: *Great Lakes Sea Lamprey: From Crisis to Control*, Great Lakes Fisheries Commission (<https://www.youtube.com/watch?v=JVlHApc3h1c>) and Great Lakes Fishery Commission website (<https://www.glfc.org/sea-lamprey.php>); primary-source scientific studies; information from guest speakers; and other prior knowledge.

*Days 4 and 5: Present and consolidate information as a class*

1. Students present their research
2. Students capture information from other presentations using the Sea Lamprey Sampler Presentations Note Sheet.
3. Students engage in guided discussion after presentations to review and collaborate on information sharing. (See “Sample inquiry questions” below for suggested discussion starters.)

**Discussion:**

Group review and collaboration discussion\* **\*Additional support for discussion can be found in the Sea Lamprey Sampler Teacher Resource Document**

*Sample inquiry questions based on research and presentations* (allow for open discussion):

Informational resource: Great Lakes Fishery Commission (<https://www.glfc.org/>)

Example student answers are in red.

* Anatomy (structure) and Physiology (function)
  + How does sea lamprey anatomy and physiology support their survival in the environments where they live?

Sea lamprey’s sharp teeth along with papillae on their disc-shaped suction mouth allow them to hold onto their prey.

* Native Range
  + How are sea lamprey populations controlled in their native environment? Sea lamprey have coevolved with other species in their habitat allowing populations to be kept under control. They are endangered in some of their native areas due to dams in spawning rivers/streams, overfishing, pollution, and habitat loss.
  + What kind of habitats do lampreys prefer? Sea lampreys can live in both salt and freshwater; oceans, rivers, and large land-locked lakes. They spawn in flowing rivers and streams but will spend their adult life in deeper water attached to larger fish.
* History in the Great Lakes
  + How did sea lampreys get into the Great Lakes Basin and how did their populations spread throughout the Great Lakes (i.e., what was the vector or method of spread)? The first sighting of sea lamprey in the Great Lakes was in the 1800s due to the building of the locks and canals linking the Atlantic coast to Lake Ontario.
  + What is the timeline of their spread throughout the Great Lakes basin (i.e., where and when were they first identified; where and when were they found next; etc.)? Lake Ontario in 1830 discovered the first sea lamprey, after the Welland canal in 1919 the sea lampreys spread to Lake Erie and beyond (1921).
  + Where are they currently located in the Great Lakes? Since the 1940s, sea lampreys are found within the entire Great Lakes Basin.
* Life Cycle
  + Describe the stages of a sea lamprey life cycle (e.g., what is happening during each stage, where are they living, how much time do they spend in each stage, etc.)? There are two stages in the life cycle of sea lamprey: the sedentary stage and the free swimming stage. In the sedentary stage sea lamprey are found as ammocoetes where they are blind and worm-like. During this stage they are found within streambeds and banks. After this stage a sea lamprey transforms and starts to form their parasitic structures. Once the lamprey fully transforms they enter their free swimming stage and parasitic phase as juveniles in open water until they become full adults and return to the streams to breed and die.
  + At what stage in the life cycle are sea lampreys most dangerous to Great Lakes ecosystems? When the sea lamprey are in the sedentary stage as ammocoetes they are relatively harmless, when they transform and become juveniles in the parasitic phase is when an impact can be observed on the Great Lakes.
* Impact on Great Lakes Ecosystems (resource: <https://www.glfc.org/what-is-at-risk.php>)
  + How do sea lampreys affect Great Lakes ecosystems? During its lifetime a sea lamprey can kill up to 40lbs of fish during the parasitic (juvenile) phase. Most fish that the sea lamprey attach to will not survive or will develop an infection after the sea lamprey drops off the fish.
  + Which part(s) of the food chain is(are) their primary target? As an ammocoete, sea lamprey target the producers of the food chain, phytoplankton. However, in the parasitic phase, large fishes are a primary target.
  + How does this action in the food chain impact other organisms and habitat? If sea lampreys kill too many top predators in the system, the prey that would naturally be controlled from that top predator can increase significantly and cause a disruption in the ecosystem. That, in turn, harms prey populations by depleting their food source. If sea lampreys target many large prey fish this may drop populations and the necessary food resources for the large piscivorous fish (Piscivors are fish that primarily eat fish).
* Impact on Great Lakes Economies

Resources: 2018 article from MSU extension/Michigan Sea Grant, <https://www.canr.msu.edu/news/great_lakes_sea_lamprey_control_is_critical_msg18_kinnunen18> and Great Lakes Fishery Commision, <https://www.glfc.org/control.php>)

* + How has the presence of sea lampreys in the Great Lakes impacted industries? The invasion of sea lamprey has had a huge negative impact on the commercial fishing industry since one of the main victims is lake trout, a popular sport fish.

Sport fishing and tourism were also impacted until larger non-native fish species were introduced as replacement top predators. Examples of non-native introductions are the Pacific chinook (king) salmon and Atlantic salmon.

* Methods of Control (resource: <https://www.glfc.org/control.php>)
  + What are some chemical and physical methods to control sea lamprey populations? Two chemical lampricides are 3-trifluoromethyl-4-nitrophenol (TFM) and bayluscide, both of which target larval sea lamprey. Natural chemicals produced by sea lampreys can be synthesized and used to lure sea lamprey into a non-spawning stream or provide an “alarm cue” to communicate danger and keep them away from a spawning stream.

Physically, to control sea lamprey population, barriers and traps are used. Barriers impede the migratory movement of sea lamprey in and out of streams, however they need to be monitored to ensure they do not hinder native species movements. Traps specifically target sea lamprey especially at their adult spawning age when they are most vulnerable to pheromones and alarm cues.

* Career Pathways
  + What organizations work on sea lamprey issues?

Great Lakes Fishery Commission, US Fish and Wildlife Service, Department of Natural Resources.

* + What are the specific jobs for people to work on sea lampreys (or other invasive species) issues?
    - Fish biologist and environmental chemist who research and develop control methods and their response rate.
    - Fisheries field technicians who deploy control methods, deploy and empty traps, and monitor barriers.
    - Naturalists and educators who inform the public about sea lampreys and other invasive species including how to prevent the spread of invasive species.
  + What level of schooling is needed to do some of these jobs? What specific degrees or technical training?
    - A biologist and chemist would hold a bachelor's degree or master's degree
    - Field technicians either have an associate degree or certification or a bachelor’s degree
    - Naturalists and educators would likely hold a bachelor’s degree but might have an associate degree.

**Variations and Extensions:**

* This format can be used in small groups of students, each with a different invasive species.
* Research *native* lampreys of the Great Lakes and compare with sea lampreys. Potential focus areas: anatomy; ecosystem niche, and life cycle.
  + Resource: Michigan State University, *Five Different Species of Lamprey Live in the Great Lakes* (<https://www.canr.msu.edu/news/five_different_species_of_lamprey_live_in_the_great_lakes_msg16_kinnunen16#:~:text=The%20native%20lamprey%20that%20exist,fluids%20and%20blood%20of%20fish>)

**Additional Resources:**

* **Economics**: Consider that tourism is one of the largest industries in Michigan. What economic impact might sea lampreys have on the state economy and why?

**Research Connections:**

**United States Fish and Wildlife Service (USFWS) sea lamprey (*Petromyzon marinus*) removal**

USFWS biologists use traps to capture and remove invasive sea lamprey from the Great Lakes. Alongside removal, the project also contributes to other aspects of sea lamprey control such as dam and barrier design.

**Michigan Department of Education Standards**:

Next Generation Science Standards Performance Expectations

**MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

**HS-LS2-6** Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

**HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

English Language Arts Standards

Research to Build and Present Knowledge: Conduct research projects that use several sources to build knowledge (and answer questions) through investigation of different aspects of a topic.

Present knowledge and ideas.

Social Studies Standards:

**6 - G5.1.1** Describe examples of how humans have impacted and are continuing to impact the environment

**7 – G5.1.1** Describe examples of how humans modified the environment in the era being studied.

**8 - P4.2.3** Participate in projects to help or inform others.

**P2.3** Know how to find, organize, evaluate, and interpret information from a variety of credible sources.