



**Subjects** Science, Language Arts, Art

**Grade Levels** Ideal for grades 6–12, adaptable for 3–5

**Time** 45 minutes or more

### Lesson Overview

Students first read about mysterious population changes in a freshwater ecosystem, then create line graphs to show the changes over time. They think about what might be causing the changes and brainstorm with a partner about how the changes might be causing problems in the freshwater ecosystem. Lesson options are listed in the “Enrich/Extend” section.



**Kind of cute, but big trouble: an invasive species**  
*Photo: Flowermaze via Pixa*

### Goals

- Students explore issues around native and invasive species by analyzing hypothetical data about changing populations over time.
- Students become aware of how certain species can have negative impacts on ecosystems, including through reductions in biodiversity.
- Students increase their understanding of native and invasive crayfish and the roles that they and other macroinvertebrates play in freshwater ecosystems
- Students think critically about how invasive crayfish can be a threat to different native species and biodiversity

### Objectives

- Students will read about a hypothetical situation and use the information to graph data and help them analyze it.
- Students will research species from the Great Lakes region to determine their roles in freshwater ecosystems.
- Students will express orally and/or in writing what they have learned about native and invasive crayfish and their impacts on freshwater ecosystems.

## Next Generation Science Standards

### Performance Expectations

- MS-LS2-1: Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-4: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
- HS-LS2-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- 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.

### Building toward

- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

### Crosscutting Concepts

- Cause and Effect: Mechanism and Explanation
- Stability and Change
- Systems and System Models

### Science & Engineering Practices

- Developing and Using Models
- Asking Questions and Defining Problems
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

### Core and Component Ideas in the Life Sciences

#### LS2: Ecosystems: Interactions, Energy, and Dynamics

- LS2.A: Interdependent Relationships in Ecosystems
- LS2.C: Ecosystem Dynamics, Functioning, and Resilience



## Common Core State Standards

### Speaking and Listening Standards for Grade 6

(similar standards for grades 4–5; 7–12)

- Standard 1.** Engage effectively in a range of collaborative discussions (one- on-one, in groups, and teacher- led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.
- Standard 4.** Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.
- Standard 6.** Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

### College and Career Readiness Anchor Standards for Writing

- Standard 6.** Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.
- Standard 7.** Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.



## Center for Great Lakes Literacy Principles

**Principle 5.** The Great Lakes support a broad diversity of life and ecosystems.

**Principle 6.** The Great Lakes and humans in their watersheds are inextricably interconnected.



## Teacher Background

An **invasive species** is defined as any non-native organism that causes harm to the environment, economy, or human health (EPA: [epa.gov/greatlakes/invasive-species-great-lakes-0](https://www.epa.gov/greatlakes/invasive-species-great-lakes-0)). It can take over the habitat of native species, forcing the native species to decline in population or to disappear from their natural environment. Invasive species tend to be highly competitive, highly adaptive, and successful at reproducing (Washington Invasive Species Education: [wise.wa.gov](https://www.wise.wa.gov)).

A few species of crayfish are spreading rapidly in freshwater ecosystems worldwide, disrupting local habitats and negatively affecting countless species. Native crayfish species are now among the most threatened groups of organisms. In fact, an estimated “48 percent of North American crayfish species are at risk of extinction” (Larson & Olden 2010: [jstor.org/stable/40864210](https://doi.org/10.1007/s10841-010-9410-1)). Invasive crayfish are believed to be the leading cause of this decline, and humans have played a significant role in their spread, through the release of classroom science organisms, live fishing bait, pets, etc.

Additional information and visuals are found in the introduction to this curriculum and in the “Expand Knowledge + Skills” section at the end of the lesson.

## Materials

- Copies of the following for each student (found after lesson):
  - “The Mystery of the Changing Crayfish Populations”
  - *Optional*: “Invasive Species Project”
- Graph paper or graphing software
  - Graph paper can be generated in different formats and printed free at [incompetech.com/graphpaper](https://www.incompetech.com/graphpaper).
  - Alternatively, Microsoft Excel and Google Sheets are two programs that can be used to create graphs. “How to Make a Line Graph in Excel” is one of many videos and web pages online that explains the process: [youtu.be/3o11OlgYDo](https://youtu.be/3o11OlgYDo)
- Markers, crayons, or colored pencils for students to share
- *Optional*: Posterboard

## Preparation

1. Ensure all materials above are ready for student use.
2. *Optional*: Learn more about topics in the lesson in the More Resources/References section at end of the lesson to prepare to answer student questions.
3. *Optional*: Arrange for a guest speaker with expertise on freshwater habitat restoration projects to visit your class. Contact us here for possible recommendations: [invasivecrayfish.org/contact-us](https://www.invasivecrayfish.org/contact-us)

## Teaching Suggestions in the 5E Model

### Engage

1. Engage students and encourage them to apply prior knowledge by asking what they would do if they discovered that native crayfish and other macroinvertebrates (small animals without backbones) seem to be less common in a nearby stream, while some new crayfish species are appearing there.
2. Ask students to think about what research project(s)/tests they might conduct to get more information, who they might talk to about it, and what other problems might be related to the issue. Tell them they will have a few minutes to brainstorm their ideas with a neighbor, recording them on paper or with an electronic device in words and pictures.
3. Circulate through the groups, answering (and asking) questions to help students arrive at their own conclusions. After a few minutes, tell students they will have one more minute to brainstorm and to be prepared to share their best ideas with the class.
4. Allow the groups to share their ideas and tell them that they will be working with a partner to graph some data to learn about the issue.



**Bluegill sunfish are native to the Great Lakes basin and get their name from a darkened blue spot on their gills.**

*Photo: U.S. Fish and Wildlife Service*

### Explore

4. Ask students to form groups of 2–3 while you pass out the “The Mystery of the Changing Crayfish Populations” activity sheet. Ask them to first read through the scenario. Explain that after they finish reading, they should work together to graph the data and answer the questions in the “Your Challenge” section.
5. Tell students they should conduct additional research, as necessary, to determine what roles each of the species listed in the table play in the Great Lakes ecosystem. They may use the Internet and other available reference sources; they should cite the sources they use for additional information.

### Explain

6. Circulate through the room answering (and asking) questions, helping the groups get started. Encourage students to use reliable sources to research the organisms listed in the table on the student activity sheet. Suggest sites listed in the Expand Knowledge + Skills and Resources sections, if needed.
7. Allow students time to complete their investigation outside of class, if necessary.
8. Once students have completed their research, ask a group to share their graph of organism abundance during a full class discussion. Ask other groups if their graphs are similar and discuss different ways of displaying data.
9. Ask students to share their observations about what is happening to organisms in Large Lake. Consider asking different groups to share what they discovered about each organism listed in the table.
10. Write the terms “native species” and “invasive species” on the board. Ask students if they know what these terms mean and how the terms were used in sources they found through their research. Ask students if they have heard about any other invasive species found in the U.S.

11. If students haven't already mentioned that Rusty and Red Swamp Crayfish are invasive species found in Large Lake (and the Great Lakes), share that information. Ask students what impacts these two crayfish species might be having on the other species in Large Lake, based on the data.
12. Ask students to think about the different ways an invasive species could negatively impact a native species. Help them understand that invasives can outcompete natives for space and food, introduce new diseases, and disrupt an entire ecosystem.

## Enrich/Extend

- Students can complete the “Invasive Species Project,” explained on the handout following the lesson plan.
- Ask students to read “Native & Invasive Crayfish of the Great Lakes Region” found in the introduction to this curriculum. They can use it as a reference to help them compare two crayfish species. This can be done using a graphic organizer such as a Venn diagram and/or a written analysis.
- Have students read cartoons about invasive crayfish and/or create their own cartoons. Excellent examples and ideas are listed in the “Stone Soup: Invasive Species and Cartooning” lesson plan found on the TakeAIM website: [takeaim.org/wp-content/uploads/2016/11/StoneSoupTeachersLP.pdf](http://takeaim.org/wp-content/uploads/2016/11/StoneSoupTeachersLP.pdf)
- Show some or all of the TED-Ed Animation “The Threat of Invasive Species—Jennifer Klos” at [ed.ted.com/lessons/the-threat-of-invasive-species-jennifer-klos](http://ed.ted.com/lessons/the-threat-of-invasive-species-jennifer-klos). Ask the students to work through the “Think” questions with a partner, recording their ideas in science notebooks or via the online system. Discuss their ideas as a class and/or through the discussion board accessed via the “Discuss” link.
- For younger and/or less experienced students, consider reading through “The Mystery...” scenario as a class and answering questions before forming groups to work on the project.
- Investigate the biodiversity of macroinvertebrates in a nearby stream to evaluate water quality based on the prevalence of different species. You can also help to improve water quality by doing a service project such as planting native plants or removing trash. Good activities to support this field work are found in:
  - “Stream Side Science” lesson plans from Utah State Univ. Extension Service: [extension.usu.edu/waterquality/files/Stream-Side-Science.pdf](http://extension.usu.edu/waterquality/files/Stream-Side-Science.pdf)
  - SOLVE's *Environmental Service-Learning* curriculum: [engagingeverystudent.com/project/solve-environmental-service-learning-curriculum](http://engagingeverystudent.com/project/solve-environmental-service-learning-curriculum)
- Invite students to create public service announcement videos about ways to help keep invasive species of animals and plants out of our ecosystems.

## Evaluate

- Review student research projects and answers to the questions.
- Use student participation in class discussion and activities to determine student understanding.
- Ask students to reflect on the lesson in writing and/or orally, including about what they learned and what you, as the teacher, might do to improve the lesson next time.

## Expand Knowledge + Skills

### Science/References

- Data in “The Mystery of the Changing Crayfish” activity adapted from: Wilson, K. A., Magnuson, J. J., Lodge, D. M., Hill, A. M., Kratz, T. K., Perry, W. L., & Willis, T. V. (2004). A long-term rusty crayfish (*Orconectes rusticus*) invasion: dispersal patterns and community change in a north temperate lake. *Canadian Journal of Fisheries and Aquatic Sciences*, 61(11), 2255-2266. [jvzlab.limnology.wisc.edu/wp-content/uploads/sites/1902/2022/11/Wilson\\_2004\\_long-term\\_CJFAS.pdf](http://jvzlab.limnology.wisc.edu/wp-content/uploads/sites/1902/2022/11/Wilson_2004_long-term_CJFAS.pdf)
- Helfrich, L.A. and DiStefano, R.J. “Sustaining America’s Aquatic Biodiversity—Crayfish Biodiversity and Conservation.” Dept. of Fisheries and Wildlife Sciences, Virginia Tech: [pubs.ext.vt.edu/420/420-524/420-524.html](http://pubs.ext.vt.edu/420/420-524/420-524.html)
- Invasive Species in the Great Lakes, EPA: [epa.gov/greatlakes/invasive-species-great-lakes-0](http://epa.gov/greatlakes/invasive-species-great-lakes-0)
- “Field Guide to Michigan Crayfish.” Department of Fisheries and Wildlife Michigan State University: [docslib.org/doc/2887390/field-guide-to-michigan-crayfish](http://docslib.org/doc/2887390/field-guide-to-michigan-crayfish)
- “Invasive Crayfish 101.” Invasive Crayfish Collaboration: <https://invasivecrayfish.org/invasive-crayfish-101/>
- “Research Reveals Hope for Managing Invasive Red Swamp Crayfish.” U.S. Fish & Wildlife Service: [fws.gov/story/2024-02/research-reveals-hope-managing-invasive-red-swamp-crayfish](http://fws.gov/story/2024-02/research-reveals-hope-managing-invasive-red-swamp-crayfish)
- “Marbled Crayfish Raises Eyebrows, and Concerns.” Great Lakes Now: [greatlakesnow.org/2024/04/marbled-crayfish-raises-eyebrows-and-concerns](http://greatlakesnow.org/2024/04/marbled-crayfish-raises-eyebrows-and-concerns)

### Videos

- “The Threat of Invasive Species—Jennifer Klos.” TED-Ed: [ed.ted.com/lessons/the-threat-of-invasive-species-jennifer-klos](http://ed.ted.com/lessons/the-threat-of-invasive-species-jennifer-klos)
- “What Are Invasive Species?” Explore Nature/National Park Service via YouTube: [youtube.com/watch?v=ZzPM7Dw9Gg](http://youtube.com/watch?v=ZzPM7Dw9Gg)

### Lessons/Activities

- “Bugs Don’t Bug Me” and many more aquatic macroinvertebrate lessons, in the “Stream Side Science” program from Utah State Univ. Extension Service: [extension.usu.edu/waterquality/educator-resources/lessonplans](http://extension.usu.edu/waterquality/educator-resources/lessonplans)
- IDAH<sub>2</sub>O water education resources, including curriculum and videos, Univ. of Idaho Ext.: [uidaho.edu/extension/idah2o/resources](http://uidaho.edu/extension/idah2o/resources)
- “Watershed Detectives” lesson from Utah State University Ext.: [extension.usu.edu/waterquality/files/watershed-detectives.pdf](http://extension.usu.edu/waterquality/files/watershed-detectives.pdf)

### Education Standards

- More information about the Next Generation Science Standards, including a link to the *Framework for K-12 Science Education* to which this lesson was aligned: [www.nextgenscience.org/framework-k%E2%80%9312-science-education](http://www.nextgenscience.org/framework-k%E2%80%9312-science-education)
- More information about the Common Core State Standards and links to the complete documents: [www.corestandards.org](http://www.corestandards.org)

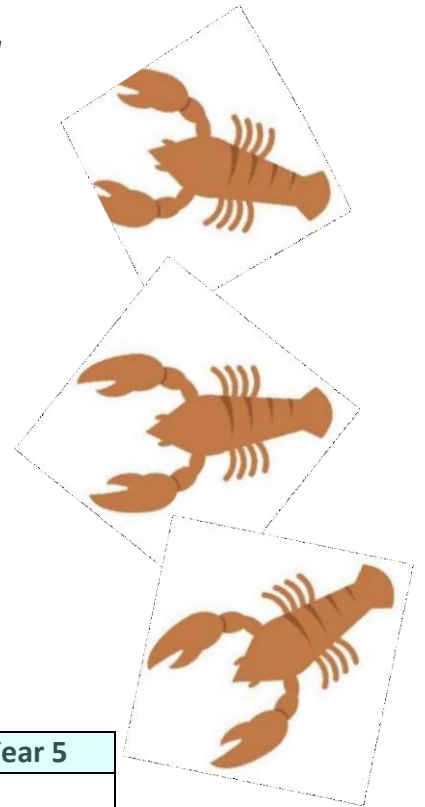
# The Mystery of the Changing Crayfish Populations



**Scenario:** Scientists monitoring wildlife at Large Lake were alarmed when they observed different species of crayfish in the area. A historically popular fishing lake, the scientists and wildlife managers were concerned that the introduced species might be negatively impacting fish populations and biodiversity.

To discover how many of these new species were present, they trapped crayfish at different locations around the lake over several years. They also sampled for snails, fish, and amphibians to determine if there were changes in the numbers of organisms. At one monitoring location, they recorded the following numbers of organisms captured in one day.

Species	Year 1	Year 2	Year 3	Year 4	Year 5
Virile crayfish	10	9	6	3	1
Rusty crayfish	0	1	4	7	10
Red swamp crayfish	0	2	3	6	9
Snails per square meter	8,500	7,000	4,000	1,500	500
Bluegill sunfish	20	17	12	10	7
Eastern newts	16	14	10	6	2



## Your Challenge:

1. Create a graph that shows the numbers of species collected over time.
2. Explain the data changes over time in writing. What might be causing them?

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3. Brainstorm with a partner about how the changes might be causing problems in the freshwater ecosystem. Record your ideas in words and pictures on the back of this sheet or in science notebooks.
4. Research the roles that each of the organisms listed in the table play in the Great Lakes ecosystem. Going back to question 3, how do you think rusty crayfish and red swamp crayfish are impacting the other species? What evidence do you have? What other studies would you want to conduct to be more certain of your ideas?

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

# ***Invasive Species Project***

*Adapted with permission from a similar project by Erin Cole*

## **Your Assignment**

Research an invasive species that is impacting an ecosystem near you. Create a “management sales pitch” to share your information and warn others about the dangers of these invasive organisms.

## **Overall Guidelines**

You will be trying to convince your classmates that your animal or plant is the most damaging to the ecosystem it has invaded. Our money and other resources should go to managing it NOW! Some things to think about in your sales pitch:

1. What kind of damage is your organism causing? Economic? Environmental? Aesthetic (natural beauty)?
2. If it is not a big problem in our area yet, could it become really damaging? How?
3. What are cost-effective ways to get rid of it?
4. Is there an organization that is already trying to get rid of it? If so, could they use help?

## **Information Requirements**

1. Common and scientific name of your plant or animal
2. Detailed description of what it looks like; how to not confuse it with similar organisms
3. Its original ecosystem (where it is native and originally from)
4. Where it can be found now (region, specific place in ecosystem)
5. How scientists think the organism arrived in its new location
6. How it harms humans and ecosystems (Be specific: for example, if it takes over land from other plants, How does it do it? If it causes economic damage, to what industries or structures?)
7. What humans are trying to do to stop the invasion (Again, be as specific as possible: is there a specific organization that is already trying to stop it? What tools/chemicals/methods are they using, and are there pros and cons to the various methods?)
8. All sources of information, including photos, are cited in MLA format

## **Formatting Requirements**

1. 4–10 slides created with PowerPoint, Google Slides, Prezi, or another program, including a sources page at the end
2. A title slide with a photo or drawing of the plant or animal (created with graphics software or drawn by hand and scanned or photographed)
3. The presentation should last **no longer** than 3 or 4 minutes and should seem like a “sales pitch,” not just an informational speech—be persuasive!



## Evaluation

Your presentation will be scored as follows:

Requirement	Score
<b>Information:</b> All information accurate and requirements met; sources listed	/ 20
<b>Organization:</b> Presentation is neat and organized	/ 5
<b>Visual Engagement:</b> Photo or drawing on first slide and other visuals engage the audience and help to communicate information	/ 5
<b>Persuasiveness:</b> Presentation is persuasive about the need to control the species	/ 5
<b>Conventions:</b> Correct grammar and spelling used	/ 5
<b>Total</b>	<b>/ 40</b>

### Choices Include:

#### Invasive Animals

1. Zebra mussels or quagga mussels
2. Chinese mitten crab
3. Nutria
4. European starling
5. English house sparrow
6. Sea lamprey
7. American bullfrog
8. Rusty crayfish
9. Feral pig/feral swine
10. Red-eared slider
11. Pond Loach
12. Northern snakehead
13. New Zealand mud snail
14. Round goby
15. Asian clam
16. Silver, bighead, black, or grass carp
17. Red swamp crayfish
18. Spotted lanternfly
19. Emerald ash borer
20. Marbled crayfish

#### Invasive Plants

1. Cheatgrass (downy brome)
2. Honeysuckle
3. Curly-leaf pondweed
4. Bull, Canada, or musk thistle
5. Common or cutleaf teasel
6. Brazilian waterweed
7. Common reed
8. European frogbit
9. Purple loosestrife
10. Spotted or Japanese Knapweeds
11. Hydrilla
12. Brittle waternymph
13. Starry stonewort
14. Garlic mustard
15. Narrow-leaved cattail
16. Eurasian watermilfoil
17. Tree of heaven
18. Butterfly bush
19. Kudzu
20. Reed canary grass

#### Resources

- “Invasive Species” Illinois Dept. of Natural Resources: [dnr.illinois.gov/conservation/iwap/invasivespecies.html](http://dnr.illinois.gov/conservation/iwap/invasivespecies.html)
- MLA citation guide, Purdue Online Writing Lab (OWL): [owl.english.purdue.edu/owl/resource/747/02](http://owl.english.purdue.edu/owl/resource/747/02)
- USDA Invasive Species resources: [invasivespeciesinfo.gov/us](http://invasivespeciesinfo.gov/us)
- USDA Plants database: [plants.usda.gov](http://plants.usda.gov)
- USGS Nonindigenous Aquatic Species database: [nas.er.usgs.gov](http://nas.er.usgs.gov)