Invasive Crayfish Collaborative
Great Lakes

Lesson 5

Collecting Reliable Crayfish Data

Subjects Science, Math, Language Arts

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

Time 45 minutes or more + travel time; overnight preparation suggested

A student safely holds a crayfish by the carapace.
Photo: Illinois-Indiana Sea Grant

Lesson Overview

Students participate in a scientific field study* and apply what they have been learning about native and invasive crayfish. They first learn to safely collect reliable data from a nearby freshwater ecosystem. Then they analyze the data and present it visually. By participating in the project, students develop an understanding of the power of community science to help monitor invasive and native species and improve watershed health. Students are strongly encouraged to complete prior lessons before beginning this study.

**A scientific collection permit is required for the crayfish study, and approval may take up to 4 months. Plan early to avoid delays.*

Goals

- Students will demonstrate techniques for safely collecting and then submitting accurate data about the distribution of crayfish species.
- Students will experience the power of monitoring invasive and native species to assist researchers and wildlife managers and improve the health of their local watershed.
- Students will be encouraged to be better stewards of their local watersheds.

Objectives

- Students will follow a scientific protocol to measure and record data about crayfish specimens in a natural freshwater ecosystem.
- Students will analyze data collected as a class and create visualizations with it.
- 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

Building Toward

- MS-LS1-4: Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
- 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.
- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- 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.

Crosscutting Concepts

- Stability and Change
- Structure and Function

Science & Engineering Practices

- Asking Questions and Defining Problems
- Constructing Explanations (for science) and Designing Solutions (for engineering)
- Obtaining, Evaluating, and Communicating Information

Core and Component Ideas in the Life Sciences

LS1: From Molecules to Organisms: Structures and processes

- LS1.A: Structure and Function
- LS1.B: Growth and Development of Organisms
- LS2: Ecosystems: Interactions, Energy, and Dynamics

Core and Component Ideas in Earth and Space Sciences

ESS2: Earth's Systems

- ESS2.C: The Roles of Water in Earth's Surface Processes

Common Core State Standards

Speaking and Listening Standards for Grade 6

(similar standards for grades 3–5; 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.

Math Standards: Measurement & Data

- Represent and interpret data

Math Standards: Statistics & Probability

- Develop understanding of statistical variability
- Summarize and describe distributions

Center for Great Lakes Literacy Principles

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

Teacher Background

This project provides you and your students with the opportunity to support ongoing scientific research. As we have explored in other lessons in this curriculum, a few species of crayfish are negatively impacting other freshwater species at an alarming rate, and your class can play an important role in better understanding and addressing the problem. They should also gain a closer connection to—and appreciation of—your local watershed and its health, for the benefit of people and wildlife. This lesson focuses on collecting data safely in the field and allowing students to begin to explore data through analysis and visualization.

Invasive crayfish pose a substantial threat to aquatic habitats in the Great Lakes region because of their ability to reduce habitat quality, to dramatically alter aquatic food webs, and to outcompete native species. Current efforts to prevent the introduction and spread of invasive crayfish consist largely of reducing the size of existing populations and encouraging people to refrain from releasing crayfish into new bodies of water. The Invasive Crayfish Collaborative (ICC) focuses on improving collective management and outreach capabilities by disseminating novel crayfish research, encouraging collaboration between members, and conducting research and outreach projects with collaborators.

A group of students prepares to collect crayfish data with waders and nets from the ICC.
Photo: Kelsey Berke

Materials

Materials needed will vary based on the methods you will be using to collect crayfish. The ICC can help provide your class with equipment. Email invasivecrayfishcollaborative@gmail.com to ask about available resources, such as:

- Overnight crayfish traps (Frabill Torpedo Crayfish Trap or similar) with ropes and/or nets to catch crayfish
- Bait, such as:
  - Dry dog food: 1/2 cup (113 grams) per trap
  - Traps can also be baited with canned cat food (1 can/trap); bring screwdriver or hammer and nail to site to put holes in can(s)
  - Fish or meat scraps will also work for bait
- Seine nets with poles
- Kick nets or D-frame nets
- Crayfish identification books (i.e., *The Field Guide to Crayfishes of the Midwest:* shop.inrs.illinois.edu/inhs-man.html)
- Boots or waders for stream wading

Other materials you might use include:

- GPS device(s) and/or smartphone(s) to collect latitude and longitude data
- Digital camera(s) and/or smartphone(s) to photograph specimens
- Thermometer(s) or probes for testing water and air temperature
- Field map(s) and/or smartphones with Google Maps app (or similar, if you expect to have coverage)
- Copies of these for student groups to share:
  - Crayfish sampling sheets (found after this lesson)
  - "Native and Invasive Crayfish of the Great Lakes Region" reading (found at the end of Lesson 4)
- Pencils
- Rulers or calipers to measure crayfish
- Cooler/ice (to humanely euthanize invasive crayfish, if found)
- Bucket and gallon-size plastic bag(s)
- Sampling permit(s), if required in your area
- Clothing items listed in the Preparation section, below.
- *Optional:* Digital scale and mesh bag
- *Optional (if trapping crayfish in deeper water):* Buoys
- *Optional:* Tablets or smartphones to submit data directly into the "Great Lakes Crayfish" iNaturalist project page: inaturalist.org/projects/great-lakes-crayfish

- *Optional:* Student field journals
- *Optional:* Magnifying devices such as hand lens(es), and/or macro lenses to attach to smart phones/tablets
- *Optional:* Colored pencils, markers and/or crayons for students to share
- *Optional:* Support from a partner to work with your class. Email invasivecrayfishcollaborative@gmail.com for recommendations.

Preparation

1. **Obtain a scientific collection permit** if required in your area to collect crayfish.
    - The Illinois Department of Natural Resources requires each classroom participating in this program in Illinois to complete a free "Scientific Collecting Permit" here: dnr2.illinois.gov/ScientificPermit/SciPermit

      If you will be collecting on State of Illinois land you will also need to fill out the "Illinois Site Permit:" naturalheritage.illinois.gov/permits/permit-for-state- sites.html
    - Other Great Lakes state and provincial permits: Scientific collector permits for Indiana, Michigan, Minnesota, Ohio, New York, Pennsylvania, Wisconsin, Ontario, and Quebec can also be found at the end of the Expand Knowledge + Skills section at the end of this lesson.
    - All states: You can likely find the scientific collector permit for your respective state at its respective Department of Natural Resources website. Public sites will likely require completed permits or official approval processes through the landowner (e.g., McHenry County Conservation District, Lake County Forest Preserve). Note that it may take a few weeks to a few months to obtain a state permit for scientific research. Approval for sampling on private property should also be gained from the landowner. If you have questions or need assistance with this process, contact your state fish and wildlife department. You or they can also contact us with questions at invasivecrayfish.org/contact-us.
2. **Visit the "Great Lakes Crayfish" iNaturalist project page** to prepare to submit data: inaturalist.org/projects/great-lakes-crayfish.
3. **Prepare to safely sample crayfish** in aquatic habitats (e.g., streams, rivers, ponds) and share the safety rules below with students:
    - Tell students that they should be prepared to work at a waterbody where they may step on rocks, mud, and other slippery things. To maximize safety, they should wear:
        - Close-toed shoes
        - Layers of clothing
        - These can also be worn or brought to the site, some of which may be provided by contacting invasivecrayfishcollaborative@gmail.com:
            - Waders/tall rubber boots
            - Protective gloves
            - Waterproof pants

- Wading may be difficult for younger students. Grade 3-5 educators should either collect crayfish for their students or have students help set and retrieve overnight traps.
- We highly recommend that all participants apply bug spray prior to entering the site to prevent any mosquito or tick bites that may pose a health risk. Sunscreen should also be applied.
- Inform students of important rules/safety tips, which include:
    - Always work in groups of at least two people.
    - Do not enter a waterbody unless the depth is lower than the knee of the shortest participant. A meter stick or other tool can be used to check depths before moving further into the water. Tell students to be prepared for sudden drop offs in rivers. This is especially important if they will be wearing waders, which can quickly fill with water and become dangerous weights.
    - Look where you are stepping and move slowly. There may be tripping hazards (e.g., boulders, dead trees, roots, etc.) or crayfish at the bottom of the waterbody.
    - In slow-moving streams and stagnant ponds with fine substrate (e.g., mud/muck), there is a risk of stepping in and having your foot sink deeper than you expect.
- You may want to ask students to bring water bottles and snacks for the trip.

4. **Choose an ideal location to collect crayfish**:
    - Ask around in your community and/or use the "American Crayfish Atlas" to identify species near you and where you might find them: findmycrayfish.web.illinois.edu. Click "Map" then select "All Species" to see the data points appear. Zoom in with the "**+**" button in the lower-right.
    - Visit the location(s) prior to field studies to determine if the area(s) is/are safe and accessible for your students.
    - Determine if the location is a suitable environment for crayfish sampling. (Coarse and rocky substrates are most ideal for crayfish sampling.)
    - Begin testing different sampling methods to determine what methodology will work best with your supplies, time available, and level of comfort.
5. **Ensure students return signed permission forms.** There is one listed at the end of this educator's guide.
6. Unless you are taking students to set overnight traps on one field trip, then collecting the traps on a field trip the next day, **we highly recommend that you set traps the afternoon or evening before you want the students to collect them.** If possible, travel to the research site with a small group of students to throw out the traps in a river or stream far enough apart from each other that the lines will not get tangled. You could also wait another day to collect the traps, if necessary.
7. *Optional:* Review the information about native and invasive crayfish at the end of lesson
    - Additional sources are listed in the Expand Knowledge + Skills section at end of the lesson, which could also help you prepare to answer student questions.

Teaching Suggestions in the 5E Model

Engage

1. Tell students they will be able to collect important data about the native and invasive crayfish species found nearby. The data will be shared with university researchers and wildlife managers in states around the Great Lakes region.
2. Ask students to form groups of 2–4. Show them the available equipment, such as traps, nets, and waders, and ask them to think about what specific techniques they could use to catch crayfish safely based on what they have learned about crayfish and freshwater ecosystems.
    - Ask them to quickly brainstorm their ideas, recording them in science notebooks or with an electronic device.
    - Circulate through the room to answer (and ask) questions. Tell students when they have one more minute to brainstorm and be ready to share their best ideas.
    - Ask the groups to share their ideas and demonstrate possible techniques to the class.
3. *Optional if time allows:* Ask the groups to think of questions about crayfish that may live nearby and where they might be easy to find.
    - Ask them to brainstorm and record their ideas.
    - Circulate through the room to answer (and ask) questions.
    - Ask the groups to share their ideas and discuss how they will now be able to apply everything they've been learning about crayfish to do actual field research in a nearby freshwater ecosystem.
4. You and/or experienced students can demonstrate recommended techniques for how to use the equipment such as crayfish traps and nets. This can be done in the classroom and/or in the field.
    - If traps will be used, explain how to tie a rope to the trap clip. If you are using cat food for bait, explain that before they toss in traps, they will punch holes in the top of a can with a nail or screwdriver and attach it to the inside bottom of the trap. Or they will add a half cup (113 grams) of dog food per trap. It is recommended that leaves, sticks or other vegetation also be added to traps to provide cover for any trapped fish and crayfish and help them avoid predation.
    - Tell students that the most important step in throwing traps into a waterbody is to always remember to hold the end of the rope! They need to completely submerge the traps under water. Then they should tie the rope to something secure on shore, such as a tree.
    - If buoys (or empty plastic bottles) will be used with traps, show how to add your name, contact information, and permit number (if applicable) to them. That information can also be displayed on a card attached to the other end of the rope.

5. **Safely handling crayfish and reducing risk of harm to them and their ecosystems:**

   Ask students how they think they should hold live crayfish.

   - Discuss how they should hold them from the back of the carapace to avoid being pinched and/or avoid hurting the crayfish.
   - Tell students they should return native specimens to the waterbody where you caught them after photographing and identifying them. **Explain that they should never release any organisms into areas from which they did not originate.** If you or your students find an invasive crayfish, please **do not** return it to the waterbody. Instead, place it in a plastic bag and euthanize it by placing it in a freezer overnight. Tell students that by doing so, they are helping the rest of the organisms in the ecosystem.
   - Tell students that if they need to handle crayfish for more than a few minutes, they can dunk the crayfish in water to allow them to rewet their gills.
   - Explain that crayfish may shed their chelae (claws) as a defense mechanism if they are held by their tips, so students should be very careful not to do that.

6. **Photographing crayfish:**

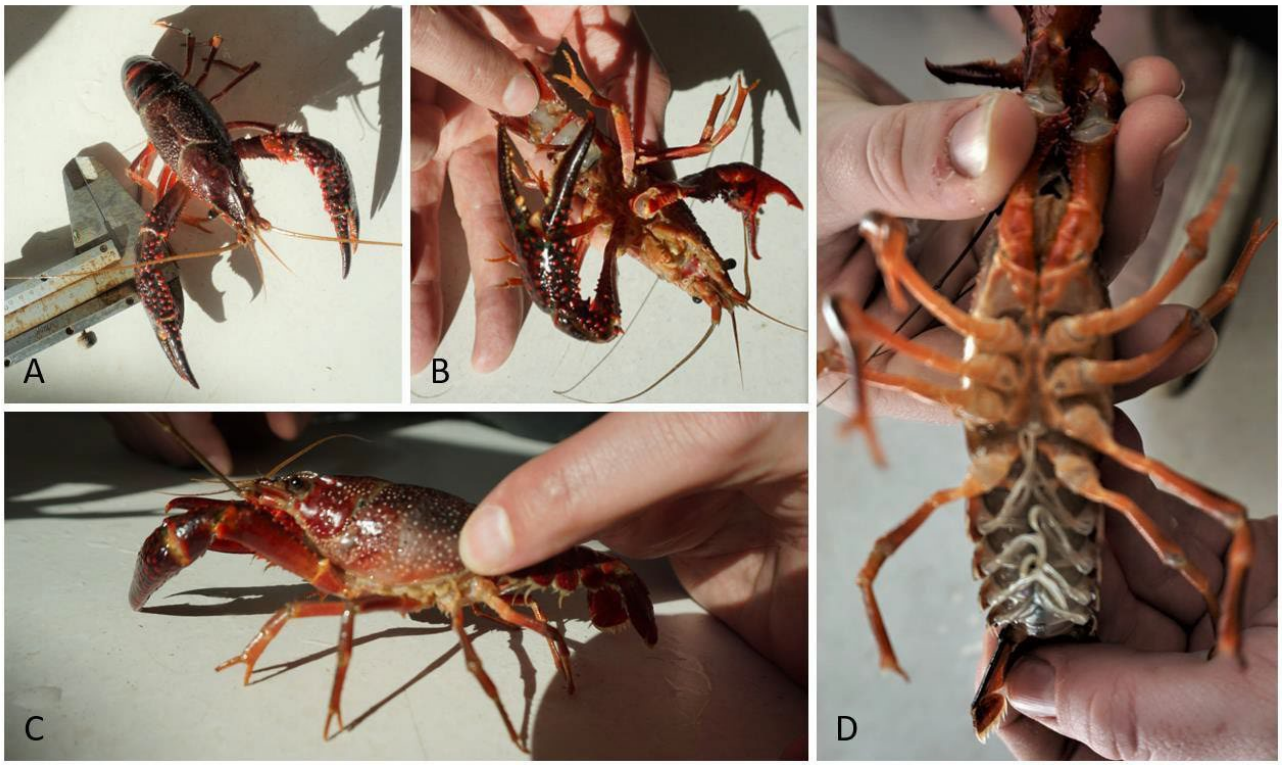
   Guide students through the process of correctly photographing crayfish as shown in the photos below and described here:

   A. From above with a ruler or coin for scale

   B. Close up on chelae (claws)

   C. From the side

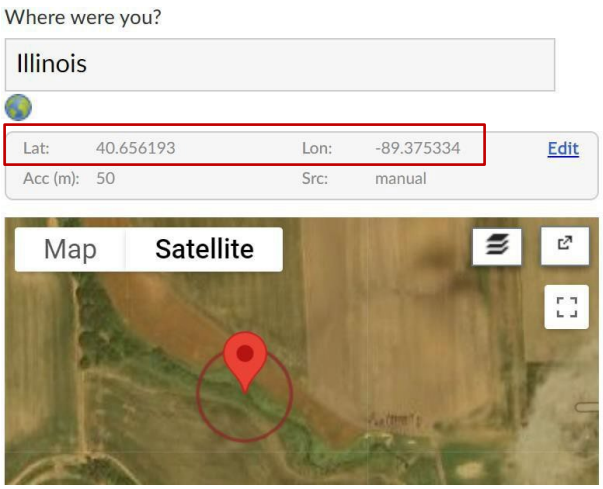
   D. From the underside (ventral view) to clearly see the reproductive structures, also known as gonopods in males



Exemplar crayfish photos, described above. *Photos: Illinois-Indiana Sea Grant*

When photographing more than one crayfish, include a numbered note card and/or numbers or letters added with a computer in one or more of the photos. This will help to keep track of the crayfish when reporting on iNaturalist. Additional tips for taking pictures of crayfish can be found on the "How to Photograph Crayfish for iNaturalist" here: inaturalist.org/journal/dan_johnson/16497-how-to-photograph-crayfish-for-inaturalist.

7. Discuss with students how to record location information:
    - You might first ask students what they know about latitude and longitude and why these coordinates are useful. Then ask how they might find that information. Discuss their ideas and clarify any misunderstandings. Details and clear visuals about latitude that you might add are at oceanservice.noaa.gov/facts/latitude.html. Note the "What is longitude?" button on the right. Depending on the level of your students, you could share more technical details during the Explain part of the lesson (after your field study), when discussing the student's location data.
    - Tell students that latitude and longitude coordinates are reported for this scientific study through the iNaturalist platform, which uses the decimal degree format. When submitting observations, click on the map to see the latitude and longitude coordinate information at the top:



    - Other options to find the data include using Google Maps, a smart phone, or a GPS device. Different formats for latitude and longitude are included below. Decimal Degree is the format used by iNaturalist (D= degrees, M= minutes, S=seconds, H=hemisphere)
        - Decimal Degree–DDD.DDDDDD°
        - Degree Minute Second–DDD° MM' SS.SS'' H
        - Minute Decimal–DDD° MM.MMM'
    - If you need to convert location information, you can use online conversion resources such as fcc.gov/media/radio/dms-decimal.
    - Feel free to contact invasivecrayfishcollaborative@gmail.com with questions.
8. Discuss behavior expectations for the trip, and how this field investigation is a special privilege that they should enjoy and not want to lose. If desired, ask the class to form research teams of 2–4 students with whom they will work to collect data (or you can choose the groups).

Explore

9. Ask students to help you carry the equipment to the research site. Pass out data sampling sheets to student groups (found at the end of the lesson). If traps were set the night before, students can pull them in and collect and record the data on the sheet.
10. Demonstrate the use of other available equipment, such as:

    - **Seine nets, which are** used to catch crayfish stirred up from the stream bottom. Attach seine net ropes to poles. The seine net should be oriented as pictured below.

A group collects crayfish with a seine net.
Photo: Illinois-Indiana Sea Grant

This method requires two people in the stream to hold a seine net downstream while one or more people upstream disturb the stream bottom by shuffling their feet or flipping rocks.

- Have two people, one person holding each pole, spread the net out across the stream with the weighted side on the bottom of the stream and the floats above the water.
- Seine net holders should stand 1–2 feet downstream from one or more feet-shufflers.
- Feet-shufflers should walk upstream of the net, dragging their feet to stir up the stream bottom as the net-holders walk slowly upstream behind them.
- Use your best judgment on the amount of time and distance for seine netting. We recommend about five minutes or 15 feet. Record the number of shufflers, time spent shuffling, and distanced shuffled.
- Once finished, remove nets and their contents from the stream by scooping the weighted bottom of the nets up towards upstream.
- Place the net with the contents right-side-up on the stream bank. Collect crayfish by hand and place them in buckets. If many crayfish are caught, placing some pieces of PVC pipes in the buckets will give them a place to

hide and reduce their stress. Note: You might catch fish and other invertebrates with this method. Place other species you wish to view in a bucket separate from any crayfish or return them to the stream. (Placing other species in a separate bucket is important to eliminate the risk crayfish will predate upon them.)

- Identify crayfish and collect data using the "Seining for Crayfish" data sheet at the end of the lesson.

Kick nets: Similar to seine nets, crayfish are stirred up from the bottom of a stream into a net downstream that is usually held by two people. The net is then carefully lifted out of the stream. Contents are observed and sifted through by hand as described above.

A very low-cost kick net can be created by stapling synthetic window screen to two dowels or other light pieces of wood:

A simple kick net made by stapling window screen to scrap wood.
Photo: Deb Berg

- **D-nets:**

Participants can hold D-nets on poles to catch crayfish or work with a partner to catch them:

- As with the other methods using a net, it should touch the bottom of the stream. If one person is collecting, they can stand upstream and shuffle their feet, kicking up rocks and substrate.
- If two or more people are collecting, they can hold the net so it is facing upstream while the other participant(s) shuffle(s) their feet, kicking up rocks and substrate.

A student catches crayfish with a D-net.
Photo: Illinois-Indiana Sea Grant

- Sift through the contents by hand and pick crayfish out and place them in a bucket or tray. If many crayfish are caught, placing some pieces of PVC pipes and/or leaves and sticks in the buckets will give them places to hide and reduce their stress.
- Identify crayfish and collect data. See the "Kicknet Sampling for Crayfish" data form at the end of the lesson.
- We recommend using this method in addition to baited traps or seine/kick netting so that more students can have a hands-on experience. You should also collect more crayfish data!

- **Hand catching:** Crayfish can also be caught by hand. Tell students that crayfish will attempt to escape by jetting backwards with a fast swish of their tail, so they should be approached from the back, which should also keep students from being pinched!
- **Safety reminder:** Whenever participants enter the water, the stream water should be no higher than knee height of your shortest participant.

11. Tell students that they should fill a bucket with enough water from the stream to submerge crayfish.
12. *Optional:* If you have access to tablets and/or smartphones with internet, students can use them to submit data directly to the iNaturalist form: inaturalist.org/observations/new?project_id=36381.
13. Rotate through the groups, answering questions and helping students to correctly measure and record the data about the crayfish specimens.
14. After all the data is recorded and specimens have been photographed, students can also record any additional observations and/or illustrations in field journals.
15. Baited traps can be tossed back in if another sample is desired. Since crayfish are generally nocturnal, it may be necessary to leave the traps overnight before another sample can be collected. More samples will result in more reliable data, but whatever data you are able to collect is helpful.
16. Tell students that counting zero crayfish in a trap is also important data that can be recorded. A trap could be pulled out empty many times, so students should be prepared

with this expectation and know that they did not do anything wrong. However, they may wish to try a slightly different location for their next trap toss—near more rocks that crayfish can use for cover, in a shady area protected from the sun, in deeper water farther out in the stream, etc.

17. Work with students to ensure all the materials are collected. Travel back to the classroom.

Explain

18. Ask the groups to share their data and observations. Crayfish data can be recorded in a table such as the one below, either on the board, in a shared spreadsheet, etc. If students were not sure of species or gender, photographs can be shared with you and other groups to reach consensus about the two important data points.

Crayfish Data	**Crayfish 1**	**2**	**3**	**4**	**5**	**6**	**7**
Species							
Gender							
Length of carapace (cm), from tip of rostrum to end of cephalothorax							
Body length (cm), from tip of rostrum to end of telson *(optional)*							
Weight *(optional)*							

19. Ask students to work with their group to analyze the data and present it visually. See the "Native + Invasive Crayfish" lesson in this curriculum for strategies to facilitate the process, but we recommend that this activity be an opportunity for students to first work together without your help to explore the data and improve their data analysis and visualization techniques. Tell students they should be able to share at least two interesting visualizations of their crayfish data and be ready to discuss them with the class. *Visualization ideas: Younger students could draw a crayfish and add body length data. Older students could graph the relationship between carapace length and weight.*

20. Circulate through the groups, answering (and asking) questions to help students arrive at their own conclusions. After about 15 minutes, or whenever groups start to finish, tell students they will have two more minutes to work and ask them to be prepared to show and explain their best data visualization(s). If time allows, you can also ask students to explain their visualizations in writing.

21. Allow the groups to share their graphs and ideas. Discuss their findings, then ask them to use the "American Crayfish Atlas" to match their findings with those of crayfish scientists and other data collectors: findmycrayfish.web.illinois.edu.

    - Show them how they can click "Map" then select "All Species" to see the data points. Point out how they can zoom in with the "**+**" button in the lower-right to locate the sampling location(s) they visited.

- Have them compare their observations with those documented on the map. Ask them to develop a list of species that they believe their collected crayfish may be (if they have not yet been identified).

22. Close with a discussion about what was learned about the native and/or invasive crayfish at the site and what your research findings might indicate about the health of the freshwater body. If time allows, discuss strategies that can be used to help make the ecosystem healthier.

Enrich/Extend

- If they have not yet done so, ask students to work with a partner to submit their data to the "Great Lakes Crayfish" iNaturalist project: inaturalist.org/projects/great-lakes-crayfish. First demonstrate the process, then circulate through the groups to answer questions and ensure the data and photos are submitted correctly. This process can also be managed by select trained students.
- Invite students to dissect crayfish specimens, which is an especially good option if you euthanized invasive crayfish. Note that it might get messy when dissecting frozen crayfish. You might want to wear gloves and use hand sanitizer before, during, and after dissection. Preserved crayfish can also be purchased from companies such as Carolina Biological. You can show one of the videos below to guide students through the process, or use one or more resources, such as:
  - "Crayfish Dissection" page from Biology Junction: biologyjunction.com/crayfish_dissection.htm
  - "Crayfish Dissection" video: youtube.com/watch?v=W7F0jZgdc8A
- Students can view the crayfish specimens and/or their body structures under magnification with a microscope, hand lens, and/or macro lens. You can also use a microscope or macro lens connected to an electronic device and/or data projector to show them to the whole class.
- Ask students to record their specimen observations in writing in field journals, labeling illustrations in detail, etc. You can also ask them to write a summary of what they have learned about native and invasive crayfish, using illustrations to better illuminate their points.
- Students can create detailed, labeled scientific illustrations of the crayfish species they observe. Photographs they took can be used for reference.
- Show one or more short video clip(s) about crayfish and/or data collection techniques, such as:
  - "Crayfish Anatomy," which has an explanation with visuals of how to determine crayfish sex: youtube.com/watch?v=qPc8XFaIbTM
  - "Seining at the River." Kick net/seine net demonstration: youtu.be/Rh6nF-kFKf4
- Invite students to create public service announcement videos about invasive crayfish and ways to keep them from spreading.

Evaluate

- Ask students to summarize in writing the process of collecting reliable data for the crayfish study. This could be done in bullet points and/or paragraph form.
- Review tables of crayfish measurements, data visualizations, and analyses.
- Assess levels of oral participation and student understanding of native and invasive crayfish, how to record scientific data about them and their impacts on freshwater ecosystems.
- Students can be asked 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

- Bowling, Terra (2023). "Great Lakes Crayfish Regulation." See the link at: invasivecrayfish.org/publications
- "Crayfish Biology." Biological Surveys and Assessment Program. University of Illinois: publish.illinois.edu/biologicalsurveys/research/crayfish-biology
- "Identifying Crayfish." Illinois Natural History Survey: hmdc.mo.gov/sites/default/files/2020-07/crayfish_ID_brochure_6-08_0.pdf
- "Rusty Crayfish: A Nasty Invader." Univ. of Minnesota Ext.: bonelakewi.com/docs/LakeStewardship/RustyCrayfishNasty.pdf
- "How one scientist enlisted a lakeside community to study (and eat) invasive crayfish" Cascade PBS: cascadepbs.org/2019/09/how-one-scientist-enlisted-lakeside-community-study-and-eat-invasive-crayfish

Data Collection Guidance/Lesson Plans

- Larson, E.R. and Olden, A.D. (2016). "Field Sampling Techniques for Crayfish." In book: *Biology and Ecology of Crayfish*, pp.287-324: depts.washington.edu/oldenlab/wordpress/wp-content/uploads/2013/01/Crayfish_Chapter2016.pdf
- "Introducing Biodiversity and BioBlitz." National Geographic: media.nationalgeographic.org/assets/activity/assets/introducing-biodiversity-and-bioblitz-1.pdf
- "Analyzing BioBlitz Data." National Geographic: media.nationalgeographic.org/assets/activity/assets/analyzing-bioblitz-data-1.pdf
- "Connecting Students to Citizen Science and Curated Collections." North American Network of Small Herbaria: collectionseducation.org
- *Crawfish Educational Materials for Grades K-8 & High School Biology*. Louisiana Crawfish Promotion and Research Board: lsuagcenter.com/NR/rdonlyres/4884B6D1-62E6-4ED1-9964-77F2A3CB834A/46487/CrawfishLessonPlanK8HSLab1.pdf
- "COSIA Outreach Activities- Crayfish Investigations." Lawrence Hall of Science: marestage.lawrencehallofscience.org/college-courses/COSIA/outreach-activities
- "Seining at the River." Kick net/seine net demonstration: youtu.be/Rh6nF-kFKf4

Invasive Species

- "GLANIS: Great Lakes Nonindigenous Species Information System." NOAA–Great Lakes Environmental Research Laboratory: glerl.noaa.gov/glansis
- "Invasive Species." U.S. Fish & Wildlife Service: fws.gov/invasives
- "Transport Zero." Be A Hero campaign: transportzero.org

Scientific Permit Applications and Resources for Great Lakes States and Provinces

- **Illinois**: dnr2.illinois.gov/ScientificPermit/SciPermit

  Illinois state sites: naturalheritage.illinois.gov/permits/permit-for-state-sites.html
- **Indiana**: in.gov/dnr/nature-preserves/research-and-collecting-permits

  Indiana state sites: in.gov/dnr/state-parks/science-and-natural-resources/research-and-collecting
- **Michigan**: survey123.arcgis.com/share/f57a024af3a84432b045c218fb3f140e

  More info: michigan.gov/dnr/managing-resources/wildlife/wildlife-permits/scientific-collectors-permits-wildlife
- **Minnesota**: dnr.state.mn.us/permits/scientific-research.html
- **New York**: extapps.dec.ny.gov/docs/wildlife_pdf/lcpsci2013.pdf
- **Ohio**: ohiodnr.gov/buy-and-apply/special-use-permits/collecting-research/scientific-collecting-wild-animals

  How to apply in Ohio: ohiodnr.gov/static/documents/wildlife/permits/Scientific%20Collection%20and%20Education%20Permits%20-%20Applying%20in%20OWLS.pdf
- **Pennsylvania**: fishandboat.com/Forms-Permits/Documents/SciColl_InterimSolution_Application_Form.pdf

  PA parks and forests: research.dcnr.pa.gov/ResearchApplication/Application
- **Wisconsin**: dnr.wisconsin.gov/topic/endangeredresources/permits

  Contact DNRTEAMWMWildlifeSwitchboard@wisconsin.gov for State Natural Areas.
- **Ontario and Quebec:** pac.dfo-mpo.gc.ca/fm-gp/licence-permis/scientific-scientifique-eng.html

  Contact your local ministry at ontario.ca/page/ministry-natural-resources-and-forestry-work-centres and find more information about Quebec permitting at mrnf.gouv.qc.ca.

KICKNET SAMPLING FOR CRAYFISH

<table>
<tr><td colspan="4">Use this data sheet for kicknet sampling. To calculate "catch per unit effort," use a new datasheet for each group of students working together with one piece of equipment. Fill out as many lines under "crayfish" as crayfish you have caught with that net. * Starred fields are required.</td></tr>
<tr><td>* Date:</td><td colspan="2">* Coordinates:</td><td>* Number of students sampling today:</td></tr>
<tr><td colspan="4">Notes on location:</td></tr>
<tr><td>Net #:</td><td>Time spent kick netting on this sampling effort:</td><td># crayfish caught:</td><td># people kick netting on your net:</td></tr>
<tr><td colspan="4">General notes:</td></tr>
</table>

CRAYFISH

Crayfish Photo #s (or name)	*** Photos** (check after photos taken)	**Species**	**Sex**	**# Chelae (claws) Missing**	**# Other Legs Missing**	**Carapace Length (cm)**	**Notes about Crayfish**
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				

SEINING FOR CRAYFISH

Use this data sheet when you are sampling for crayfish with your seine nets. Use a new datasheet for each round of seining that you complete to get an accurate “catch per unit effort.” *** Starred fields are required.**			
*** Date:**	*** Coordinates:**	*** Number of students sampling today:**	# crayfish caught in this net:
Notes on location:			
Seine #:	Time spent seining with this sampling effort:		# people shuffling feet:
General notes:			

CRAYFISH

Crayfish Photo #s (or name)	*** Photos** (check after photos taken	**Species**	**Sex**	**# Chelae (claws) Missing**	**# Other Legs Missing**	**Carapace Length (cm)**	**Notes about Crayfish**
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
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	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
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	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				
	☐ top ☐ side ☐ under ☐ claw		☐ male ☐ female ☐ unknown				

TRAPPING FOR CRAYFISH

Use this data sheet for trapping crayfish. Traps must be set out overnight. It is best to collect traps within 24 hours, so that the crayfish in that trap do not run out of food and are not predated upon. Use one datasheet for all traps. Starred fields are required.			
***Coordinates:**		***Number of students sampling today:**	
Notes on location:			
# Traps set:	# Crayfish caught in traps:	***Time/date traps were set:**	***Time/date traps were received:**
General notes:			

CRAYFISH

Crayfish Photo #s (or name)	*** Photos** (check after photos taken	**Species**	**Sex**	**# Chelae (claws) Missing**	**# Other Legs Missing**	**Carapace Length (cm)**	**Notes about Crayfish**
	□ top □ side □ under □ claw		□ male □ female □ unknown				
	□ top □ side □ under □ claw		□ male □ female □ unknown				
	□ top □ side □ under □ claw		□ male □ female □ unknown				
	□ top □ side □ under □ claw		□ male □ female □ unknown				
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	□ top □ side □ under □ claw		□ male □ female □ unknown				
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	□ top □ side □ under □ claw		□ male □ female □ unknown				
	□ top □ side □ under □ claw		□ male □ female □ unknown				