Invasive Crayfish Collaborative
Great Lakes

Lesson 8

From Mental Maps to GIS: Modeling Data with Visualization and Mapping

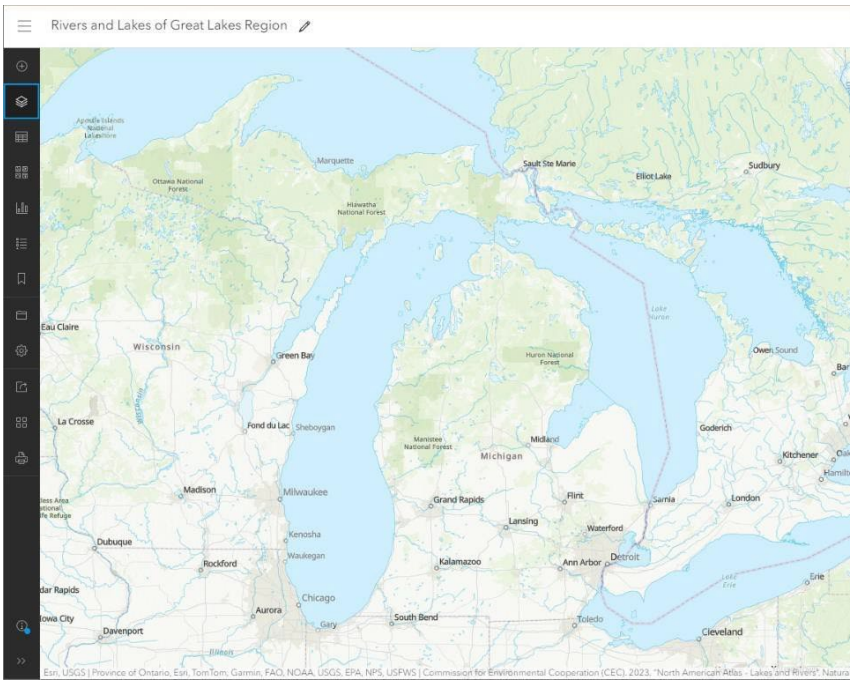
Subjects Science, Language Arts, Social Studies, Art

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

Time 45 minutes or more

Lesson Overview

Students are engaged by creating mental maps of their local watershed or the larger watershed they live in, such as the Ohio River basin. They briefly share their maps with each other, then the teacher shows a GIS-created map of the area, explaining that the students will next be able to help to create a map using GIS technology. Students submit their crayfish data if they have not yet done so, then analyze it and compare to other groups visually.



A map showing rivers and lakes created with ArcGIS Online

Goals

- Provide students with the opportunity to model the crayfish data they collected and share it with researchers, wildlife managers, other school groups, and the community at large.
- Provide students with the experience of creating mental maps about their region.
- Give students the experience of using powerful GIS software to better understand the scientific study they have been participating in and its findings.
- Increase students' understanding of the native and invasive crayfish found in their watershed and encourage them to be more environmentally aware.

Objectives

- Students will submit the data they collected (see previous lessons), analyze it with ArcGIS Online, and compare it to the data collected by other groups.
- Students will create mental maps related to their watershed and compare it to a map created with GIS software.
- Students will express orally and/or in writing what they have learned about native and invasive crayfish through the activities in the lesson and the others in this unit about crayfish and freshwater ecosystems.

Next Generation Science Standards

Performance Expectations

Building Toward

- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- HS-ESS3-6: Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.
- HS-LS2-2: Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.
- HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Crosscutting Concepts

- Stability and Change

Science & Engineering Practices

- Asking Questions and Defining Problems
- Obtaining, Evaluating, and Communicating Information

Core and Component Ideas in the Life Sciences

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 2-5; 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

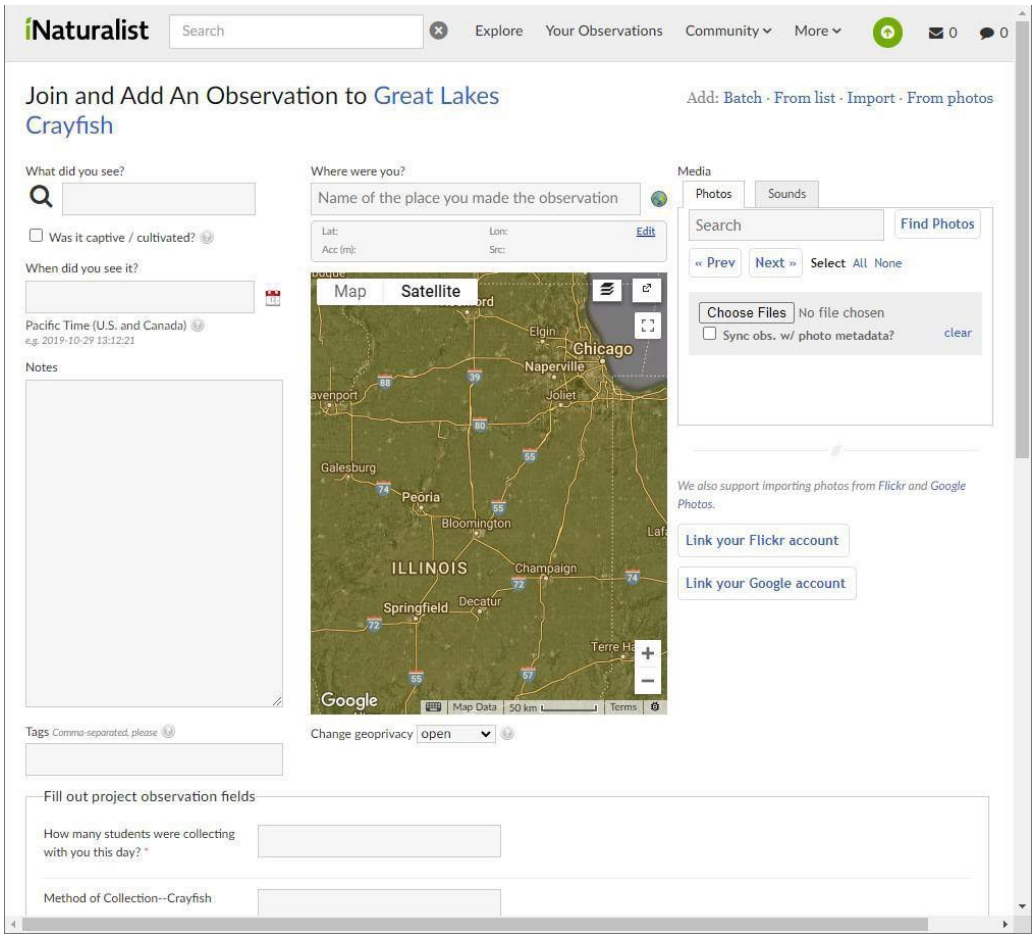
Center for Great Lakes Literacy Principles

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

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

Teacher Background

The Invasive Crayfish Collaborative (ICC) and partners have been using GIS tools from iNaturalist and Esri to collect and analyze crayfish population data and water quality to measure the health of our watersheds. As explained in previous lessons, scientific protocols are followed to reliably collect data from such a large area. It can then be submitted with the online tools. See the "American Crayfish Atlas" to identify species near you and where you might find them: findmycrayfish.web.illinois.edu. The ICC can help provide your class with equipment. Email invasivecrayfishcollaborative@gmail.com to ask about available resources.



Part of the crayfish observation form

ArcGIS and ArcGIS Online

ArcGIS is the leading Geographic Information System (GIS) software, used by professionals, such as urban planners and scientists, to create maps, which model data visually in countless ways. ArcGIS Online is a simplified version of the software that works in any modern web browser and integrates with the desktop version, if desired. It retains the software's core functionality and a subscription is free for schools, by request. It is surprisingly easy to use for such powerful software with so many data visualization tools. The website "Get Started with ArcGIS Online" is a good place to begin if you are unfamiliar with the software: learn.arcgis.com/en/projects/get-started-with-arcgis-online. Additional resources are listed in the Expand Knowledge + Skills section at the end of the lesson.

Materials

- ArcGIS Online access: arcgis.com

  Free "ArcGIS for Schools Bundle" at: esri.com/en-us/industries/education/schools/schools-mapping-software-bundle
- Pencils
- Paper (or student journals or field guides)
- Colored pencils, markers, and/or crayons for students to share
- Data projector, computer, and screen
- *Optional:* Print copies of the "Career Connections: Alex Towne, GIS Specialist" article and the "Could you work in GIS?" activity for students found at the end of the lesson
- *Optional:* Document camera

Preparation

1. Ensure the software and other materials listed above are ready for student use.
2. *Optional:* You can get support from partners by contacting invasivecrayfishcollaborative@gmail.com.

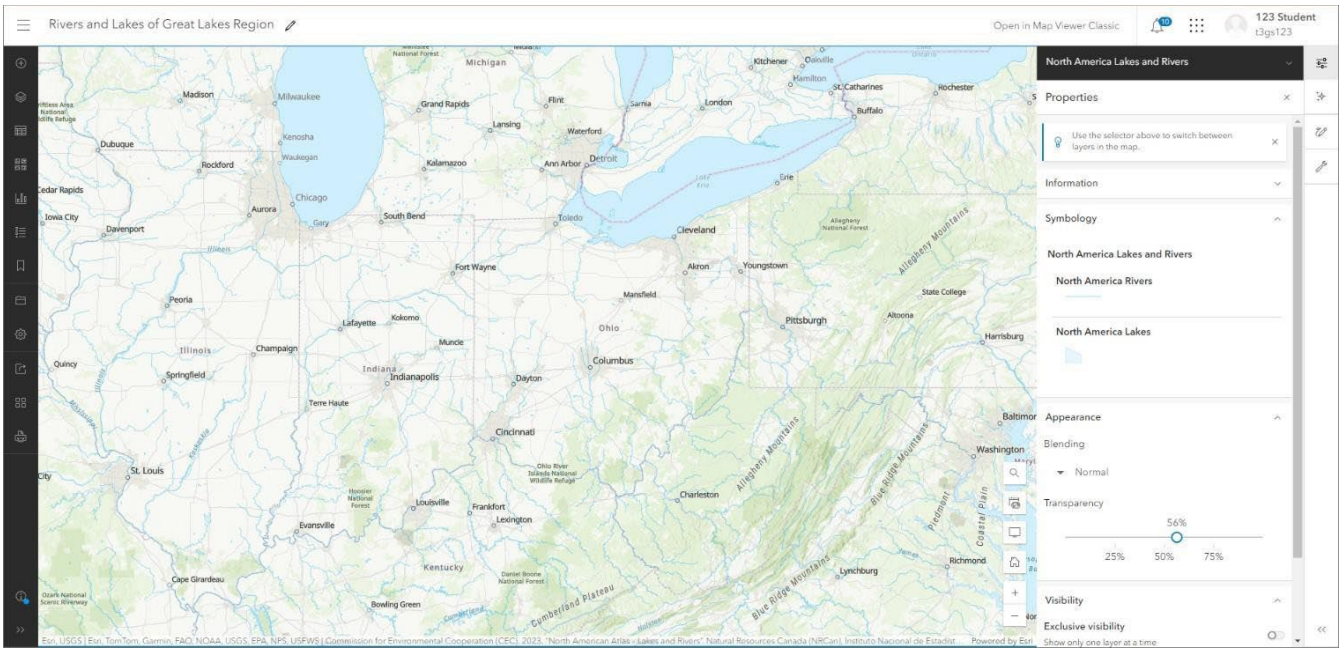
Teaching Suggestions in the 5E Model

Engage

1. Engage students by asking them to draw a map of the Great Lakes region or a river in your area, from memory. They should use a full sheet of paper and make their maps as accurate as they can without looking at any references. Ask them to try to include the details such as those below:
   - State and/or country boundaries
   - Rivers and streams
   - Boundary line of an entire river basin: the area of land that drains into it
   - Labels and/or a map legend
2. Pass out materials, if necessary, and circulate through the room to answer (and ask) questions. After about five minutes, or whenever students start to run out of ideas to add to their maps, ask the students to show their maps to a neighbor and discuss them briefly. After a minute, ask for a volunteer to share their mental map with the class using a document camera if one is available, or a digital image of it displayed via a computer/device and a data projector.

Explore

3. Show students an ArcGIS Online-created map of the Great Lakes region, or you could choose a map of a local watershed. Lead an interactive discussion about the states and/or provinces shown, rivers shown, etc. Then explain that the students will be able to add their own data points on a similar interactive map to help professional researchers, wildlife managers, and the community at large.



A map created with ArcGIS Online showing the "North American Lakes and Rivers" layer with transparency.

4. Demonstrate for students how they submit their data through the iNaturalist form for the Crayfish Study if they have not yet done so: inaturalist.org/observations/new?project_id=36381. Explain that once all of the groups submit their data, they will be able to use the online map to help compare their data with that of other groups.

Explain

5. Show students how to access the data using your ArcGIS Online account, as shown in the "Exploring Data with ArcGIS Online" handout at the end of the lesson.

   You can download the data from iNaturalist and add it to your ArcGIS Online maps:

   - Go to the iNaturalist Great Lakes Crayfish community homepage: inaturalist.org/projects/great-lakes-crayfish
   - Scroll down just a bit and click **Export Observations > CSV** on the right side of the screen. "CSV" is in smaller type, as outlined in red here:

- When the data has been exported, extract the data from the zip file in your file explorer.
- Go back to ArcGIS Online, click the "**+**" symbol, then "Add layer from file." Click on the downloaded iNaturalist CSV file. Click "Next" for the next few screens and then "Create and add to map."

6. Demonstrate how students can work with their group to analyze the data and present it visually. If they have never used the software, you should either provide them with a brief tutorial, or you might suggest they work through one or more tutorials online, such as those presented here: learn.arcgis.com/en/projects/get-started-with-arcgis-online.
    - Students can change basemap layers, customize symbol styles, or use the Find Hot Spots tool to identify areas with higher crayfish sampling activity. See more ideas at: esri.com/en-us/industries/k-12-education/your-role/teachers
7. Tell students they should be able to share at least two interesting visualizations of the crayfish data and be ready to discuss them with the class. For example:
    - How did their observations differ in different parts of the waterbody where they sampled?
    - How far away they are from a larger waterbody.
    - They could also calculate distance from the school or see how it compares with the other crayfish found in the area (according to the iNaturalist page or the American Crayfish Atlas).
8. Circulate through groups, answering (and asking) questions to help students better use the software and 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. 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.
9. Allow groups to share and close with a discussion about how the crayfish your class found compares with those found by other groups, such as other classes, U.S. Geological Survey (USGS), and/or the U.S. Fish & Wildlife Service. Include what students have learned about native and invasive crayfish, as well as freshwater ecosystems, in the complete unit. You could also discuss additional research that might add to your understanding of the health of the watershed.

Expand/Enrich

- After doing the mental maps activity, allow students to use sources to create more realistic maps of your local watershed or regional watershed. They can add your city/town, research site(s), etc. Satellite photographs available via ArcGIS Online or sites like Google Maps can also be used for reference.
- Ask students in grades 6–12 to read the "Career Connections: Alex Towne, GIS Specialist" article at the end of the lesson and then complete the "Could you work in GIS?" activity that follows it in discussion with a partner.

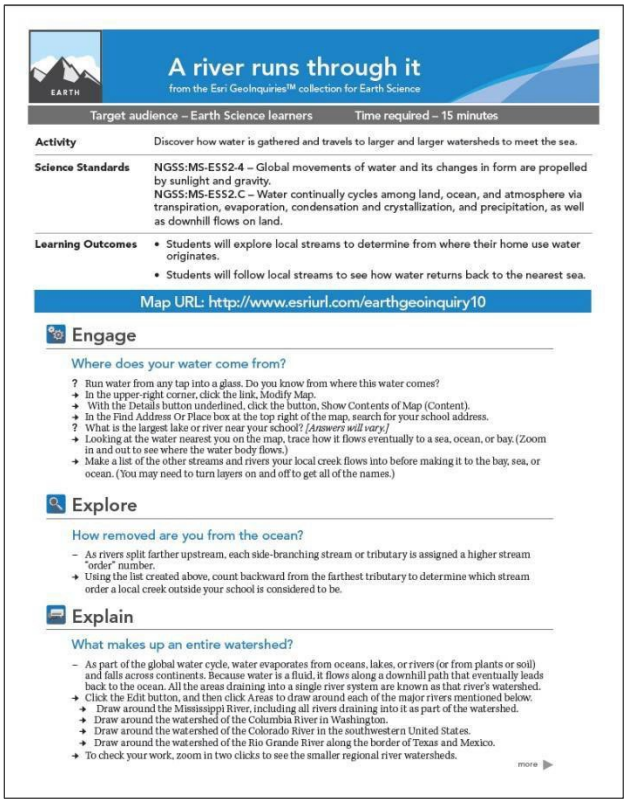
- Show one or more short videos about ArcGIS Online, such as:
    - "A Basic Introduction to ArcGIS Online:" youtube.com/watch?v=1ks6bk5AC9Y
    - "Introduction to ArcGIS Online:" youtube.com/watch?v=N-5FCICaMyM
- Ask students to write in journals or notebooks about what they learned about your area, ArcGIS Online, native and invasive crayfish, etc. throughout the lesson and unit.
- Have a more robust discussion about the concept of a watershed (basin). For instance, discuss how each term describes an area of land that drains precipitation to a river, lake, ocean, etc. Ask questions to get students thinking more about their role in the watershed, such as:
    - Where do oil and trash go after it rains?
    - How are organisms impacted by humans?
    - What can we do for a future with more life?
- Obtain maps of a smaller watershed around your school and ask students to color in the watershed. Good sources of this information include your local soil and water conservation districts and USGS.
- Do one or more of the ArcGIS lessons listed in the "Expand Knowledge + Skills" section below.

Evaluate

- Review student mental maps related to their watershed and those they created with the software, their analyses of the crayfish data, etc.
- Review completed "Could you work in GIS?" activities and provide feedback.
- Assess levels of oral participation and student understanding of the concept of a watershed, how ArcGIS Online can be used to visualize and interpret data about it, etc.

Expand Knowledge + Skills

- Esri GIS Education Instructional Materials: education.maps.arcgis.com. Search and/or browse the many lessons, maps, and other resources, including these lesson plans:
    - "Where does the water go? (watersheds):" education.maps.arcgis.com/home/item.html?id=b536a8723fd5410d8a246f884e0af1c4
    - "A river runs through it:" education.maps.arcgis.com/home/item.html?id=483ee42fb7d2437aa30b60c4e68466d0
    - "Investigating biodiversity:" education.maps.arcgis.com/home/item.html?id=4ff12184f747412093cf4aecf9628fe8
    - "Down to the last drop:" education.maps.arcgis.com/home/item.html?id=2c4e31fd3157489d807290d341723771
- "Get Started with ArcGIS Online:" learn.arcgis.com/en/projects/get-started-with-arcgis-online
- ArcGIS Skillbuilder Activities for Education: community.esri.com/ccqpr47374/attachments/ccqpr47374/k12-instruction-docs/3/3/AGOskillbuilder.pdf
- DiBiase, D. "The Nature of Geographic Information: An Open Geospatial Textbook." Penn State University: e-education.psu.edu/natureofgeoinfo



A river runs through it

from the Esri GeoInquiries™ collection for Earth Science

Target audience – Earth Science learners | Time required – 15 minutes

Activity Discover how water is gathered and travels to larger and larger watersheds to meet the sea.

Science Standards NGSS:MS-ESS2-4 – Global movements of water and its changes in form are propelled by sunlight and gravity.
NGSS:MS-ESS2.C – Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.

Learning Outcomes
- Students will explore local streams to determine from where their home use water originates.
- Students will follow local streams to see how water returns back to the nearest sea.

Map URL: http://www.esriurl.com/earthgeoinquiry10

Engage

Where does your water come from?

? Run water from any tap into a glass. Do you know from where this water comes?
→ In the upper-right corner, click the link, Modify Map.
→ With the Details button underlined, click the button, Show Contents of Map (Content).
→ In the Find Address Or Place box at the top right of the map, search for your school address.
? What is the largest lake or river near your school? *[Answers will vary.]*
→ Looking at the water nearest you on the map, trace how it flows eventually to a sea, ocean, or bay. (Zoom in and out to see where the water body flows.)
→ Make a list of the other streams and rivers your local creek flows into before making it to the bay, sea, or ocean. (You may need to turn layers on and off to get all of the names.)

Explore

How removed are you from the ocean?

– As rivers split farther upstream, each side-branching stream or tributary is assigned a higher stream "order" number.
→ Using the list created above, count backward from the farthest tributary to determine which stream order a local creek outside your school is considered to be.

Explain

What makes up an entire watershed?

– As part of the global water cycle, water evaporates from oceans, lakes, or rivers (or from plants or soil) and falls across continents. Because water is a fluid, it flows along a downhill path that eventually leads back to the ocean. All the areas draining into a single river system are known as that river's watershed.
→ Click the Edit button, and then click Areas to draw around each of the major rivers mentioned below.
→ Draw around the Mississippi River, including all rivers draining into it as part of the watershed.
→ Draw around the watershed of the Columbia River in Washington.
→ Draw around the watershed of the Colorado River in the southwestern United States.
→ Draw around the watershed of the Rio Grande River along the border of Texas and Mexico.
→ To check your work, zoom in two clicks to see the smaller regional river watersheds.

more ▶

One of the many free lesson plans available from Esri GIS Education

Education Standards

- More information about the Next Generation Science Standards, to which this lesson was aligned: nextgenscience.org
- More information about the Common Core State Standards and links to the complete documents: thecorestandards.org

Exploring Data with ArcGIS Online

1. **Login to Esri's ArcGIS Online**: arcgis.com

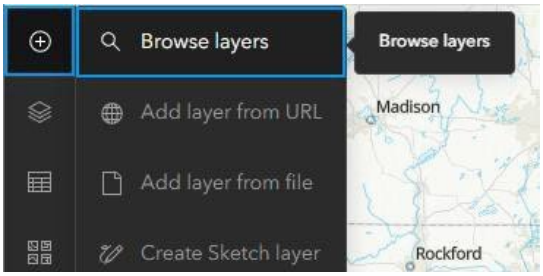
   Get it free for schools: esri.com/en-us/industries/k-12-education/schools-software

   Your school's IT team may need to apply for the School Bundle if you don't have it already.

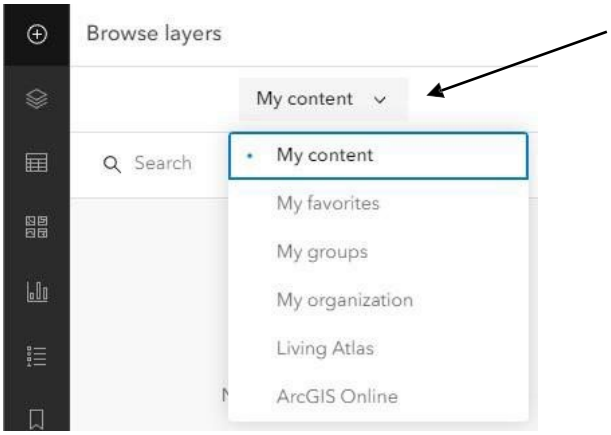
2. Click **Map** at the top of the ArcGIS Online site.

3. Add data to your map:

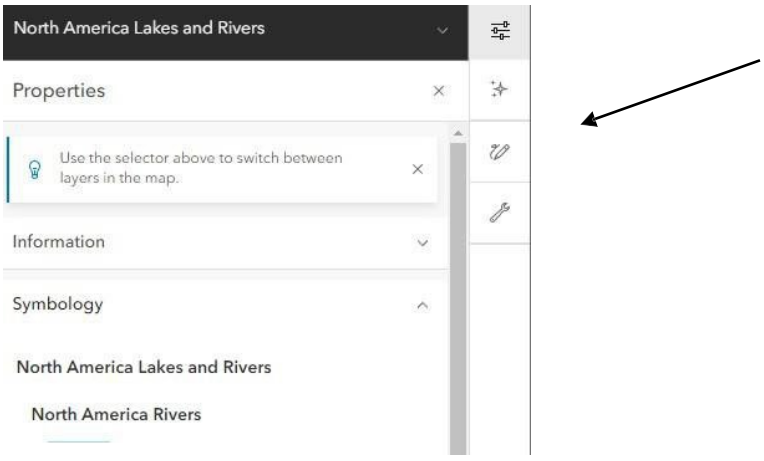
   i. Click the "**+**" button in the upper left to **Add/Browse layers**:



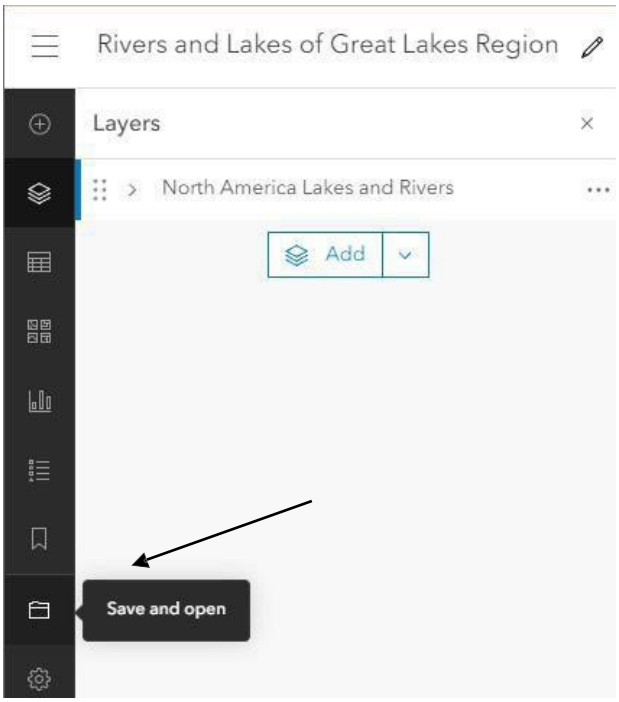
   ii. Click the down arrow to search sources such as **Living Atlas** and **ArcGIS Online**:



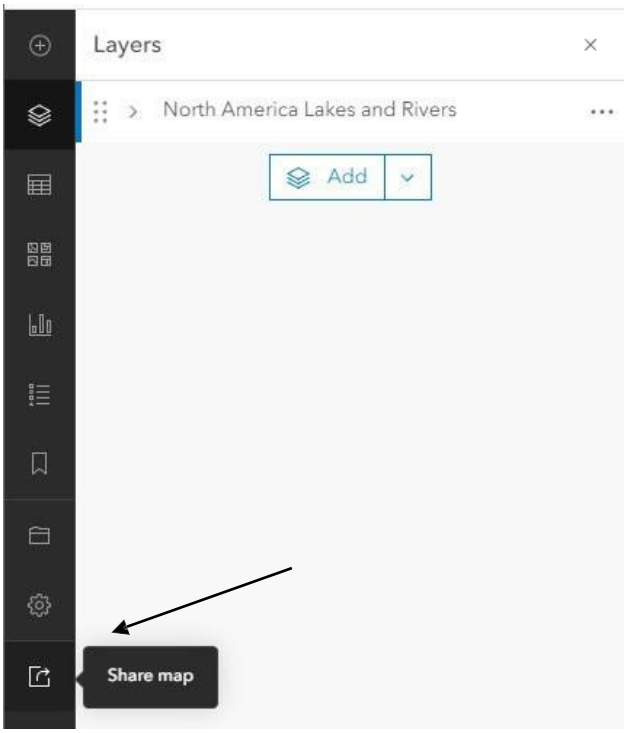
   iii. Use the **tools on the right** to add labels, icons, descriptions, etc. to maps:



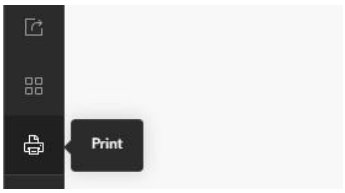
4. Click the folder icon on the left to **Save** your map:



5. Click the **Share** button on the right to get a link to a map:



6. Click **Print** to prepare a map for printing:



Career Connections

Alex Towne, GIS Specialist

Alex Towne is passionate about her career in **geographic information systems (GIS)**. As a GIS specialist, she creates maps, analyzes data, and develops models to help make land use decisions. She even gets to pilot drones!

Alex has loved maps and geography since great teachers got her excited about them as she grew up in rural northeast Oregon. She loved exploring the wide-open landscapes, riding horses, and shooting cans in a beautiful, remote canyon. There were more rattlesnakes in this area than people, with a population of just 175 humans! Alex was deeply influenced by her time spent outdoors. She remembers nights as a child checking on the cows with her dad (she liked to point the spotlight), hiking in the Eagle Cap Mountains with her mom, and spending countless summer days swimming in Wallowa Lake.

Alex earned a Bachelor of Arts degree in geography from Portland State University. She chose her major in part because of intriguing GIS courses. This interest motivated her to further her education with a graduate certificate in GIS from Oregon State University (OSU), where she became proficient with tools like ArcGIS Pro.

Alex's favorite book as a child was a large atlas (book of maps). "I really like the power maps have to display data in such a user-friendly way, and that geographic reasoning applies to every subject," she said. Alex's love of maps serves her well in her position with the Grand Ronde Model Watershed (GRMW), where she provides map making and data analysis services for the organization and its many partners. These include the U.S. Forest Service, Oregon Department of Fish and Wildlife, The Confederated Tribes of the Umatilla Indian Reservation, The Nez Perce Tribe, Trout Unlimited, the Bonneville Power Administration, and others.

Alex Towne pilots a drone for use in GIS.
Photo: Grand Ronde Model Watershed

Alex enjoys working in a STEM career in rural Eastern Oregon, where she grew up.
Photo: Grand Ronde Model Watershed

Alex enjoys working with GRMW because, “I believe in the work that is being accomplished, and what better place to do that than a place I love so much.” As a Wallowa County native, Alex brings insight and a unique perspective to her projects, such as the Wallowa County Atlas Project.

Alex’s favorite part of her job is assisting with field data collection, including piloting a drone to collect aerial imagery. She assists with habitat monitoring projects and pre- and post-project assessments. For instance, she does imagery classification to make models that describe what colors in an image represent different types of land cover. That helps her determine the acres of vegetation, how much area is in a floodplain, and how habitat for endangered fish species (Chinook salmon and steelhead) changes over time. An important goal is keeping water high up in streams longer, so the watershed doesn’t dry out as quickly. Increasing riparian areas (buffer zones with native plants along rivers), helps slow water and erosion and provides shade to benefit fish and other wildlife. This is a critical goal of her work.

Alex sees many opportunities for others to pursue careers in GIS no matter where they live. “It’s used in every field now, including healthcare and social services, not just natural resources,” she added. She also loves to write, which helps her produce a newsletter, *Ripples in the Grande Ronde*. You can read it and learn more about GRMW’s work at grmw.org.

When she’s not working, Alex is outside with her husband Keith, hunting, fishing, hiking, rafting, swimming, and playing with their dogs, Bailey and Bobby, and their cat, Bo. She enjoys a healthy lifestyle and working to protect the environment. Instead of sitting at her desk, she stands, with a reusable water bottle at the ready. She holds tightly to her roots.

She observes the world around her with a curious mind and uses GIS to discover patterns that can benefit people and natural ecosystems.

RIPPLES IN THE GRANDE RONDE

FALL EDITION 2021

RIVERS UNITING NEIGHBORS·QUARTERLY NEWS FROM THE GRANDE RONDE MODEL WATERSHED

The Wallowa River – McDaniel Project

A Passion for Rivers and a Continuing Legacy

by Winston Morton, *Oregon Department of Fish & Wildlife*

A Passion for Rivers

When Doug McDaniel was a boy growing up in Wallow County, he spent a lot of his free time in the river bottoms of the Lostine and Wallowa Rivers. Whether it was with his fishing pole or with a shotgun, these rivers were places of wonder and beauty for him.

A lifetime later, Doug reminisced about those times along the river as he told me about climbing along a wood jam and over the pool created by the wood to get to a better fishing spot and finding a large Chinook salmon resting in the pool. With an ear-to-ear grin, he talked about that fish and mentioned that he would often find them in these types of locations resting after their arduous journeys returning from the ocean to the stream of their birth. After being born in these rivers, these iconic fish travel hundreds of miles to the ocean, spend two or three years in the waters feeding and becoming mature, and return by the very same path to their natal waters. This journey fascinated him.

By the time I met Doug in 2004, he had led a full life and had "retired" to cattle ranching. He also had turned his interests to the section of the Wallowa River on which he lived. The Wallowa River running through his and Gail Hammack's place just outside of Lostine had a decent riparian area with some tall black cottonwoods. Although the area was narrow, these trees and other riparian vegetation provided shade that keeps water temperatures cooler, maintaining preferred conditions for the river's salmonid inhabitants. The stream channel itself particularly caught Doug's attention. It had been relocated from its historical location and channelized, held in place with a levee. It was clear to him that the river was missing the type of habitat he remembered the adult Chinook utilizing. The mile of river running through their property was just one giant riffle. There were neither

Continued on page 2, PASSION

The late Doug McDaniel fishing a restored section of the Wallowa River on his and Gail Hammack's ranch outside of Lostine, OR. (Photo: Gail Hammack)

Alex Towne creates this newsletter as another fun part of her work with the Grande Ronde Model Watershed.

Alex Towne hiking on top of Ruby Peak in the Wallowa Mountains where she works.

Name(s): _____ Period: _____ Date: _____

Could You Work in GIS?

Read about Alex Towne's career to help you decide if GIS could be part of your own future!

1. What does the acronym GIS stand for? _____

2. What are some career fields that use GIS? _____

   _____

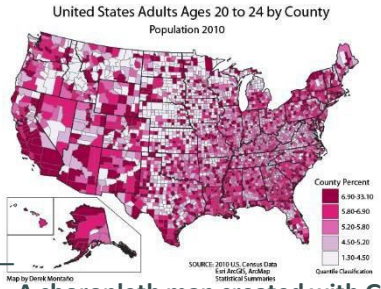
3. Imagine that you were hired as a GIS specialist. What kinds of projects might you work on? What kinds of maps might you make? Some different types are explained here: youtu.be/VgeMUpK-qXM

   _____

   _____

   _____

   _____



A choropleth map created with GIS
Photo: Wikimedia Commons

4. Do you think you would enjoy a career as a GIS specialist? Why or why not?

   _____

   _____

   _____

5. What other career paths might you enjoy? Are any in STEM (science, technology, engineering, and mathematics)? Describe what appeals to you about these career options.

   _____

   _____

   _____

   _____