Camp Curriculum

Montana State University Geospatial Skills Camp

Maida Knapton
Delaney Holman
Jeannie Chipps
Beth Nelson
Nick Lux
Suzi Taylor
Julia Wente





Air Force Office of
Scientific Research

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GIS Mental Maps & Spatial Thinking

Montana State University Geospatial Skills Camp
Lab 01

Introduction:

Mental maps are patterns and pathways stored in our mind that help us navigate our day-to-day experiences, and visually understand our world. What is special about this is that everyone's mental maps are unique to their own mind, and even animals share these maps as well!

What is the shortest route to the stock tank? Which street should I go down to get to the ice cream shop? Which meadow is the best grazing for an elk the winter, and how do I get there?

Objectives:

The objective of this exercise is to illustrate how we use our own creativity and maps to think geographically and introduce geospatial terms. The following bullets are what we will cover in lab today.
Discuss how geographic knowledge and spatial awareness is unique to our location in Montana.
What features do we use to make readable maps?
Moving our mental maps to paper.
Practicing concepts of location, direction, distance, scale and navigation. These will be our geospatial terms for the day.
Introduce software (computer tools) that we will be using through the week.

Part 1. Spatial Thinking.

Class Exercise

Let's view a couple different maps. Have the students observe paper maps & digital maps.

Class question 1

When we are looking at maps on our phone, walls, or in our hands in the outdoors, what components do we use to orient ourselves to the map?
North arrows
Scale bars
Legends
Features
Colors & patterns
Names

Class question 2

In Montana, 33% of its 147,040 square miles is public land. What is public land? Public lands are areas of land and water owned collectively by the American People and managed by governmental agencies. What are activities you all enjoy doing on public lands, and does anyone know the agencies that manage them in Montana?

Let's take a look at a land cover map of public lands in Montana.

See Montana Public Lands Map A.
*Is this realistic, or a good way to represent our data Hint, what type of context is missing? Maybe spatial relationships/ context**?***

See Montana Public Lands Map B.
Is this realistic? Why is this a better spatial representation of our Public Land? Is it easy to tell that 33% of Montana Land it public now?
Great! By deciding what is the best way to represent our data, we can say that we have analyzed spatial data.

Part 2. Mental Maps

Supplies: paper & colored writing utensils.

Mental Map 1

Let's start with our home state of Montana.
Montana is approximately 147,040 square miles big, within this distance think about where your home lies. Draw the outline of Montana.
What **geographic features** (mountains, rivers, plains, cities, towns, highways, coulees, forests etc..) will you use to orient yourself? Make sure to add these **geographic features** to your map, and to the best of your mental map knowledge fit the features to **scale** (in this context, scale describes visually how naturally big a feature is compared to our state, or how much space does it take up).
On your mental map of Montana and the **geographic features** that you used to orient yourself, add a point to your map of where you consider home.
Once finished with your map, share your thoughts with your group or class.

Mental Map 2

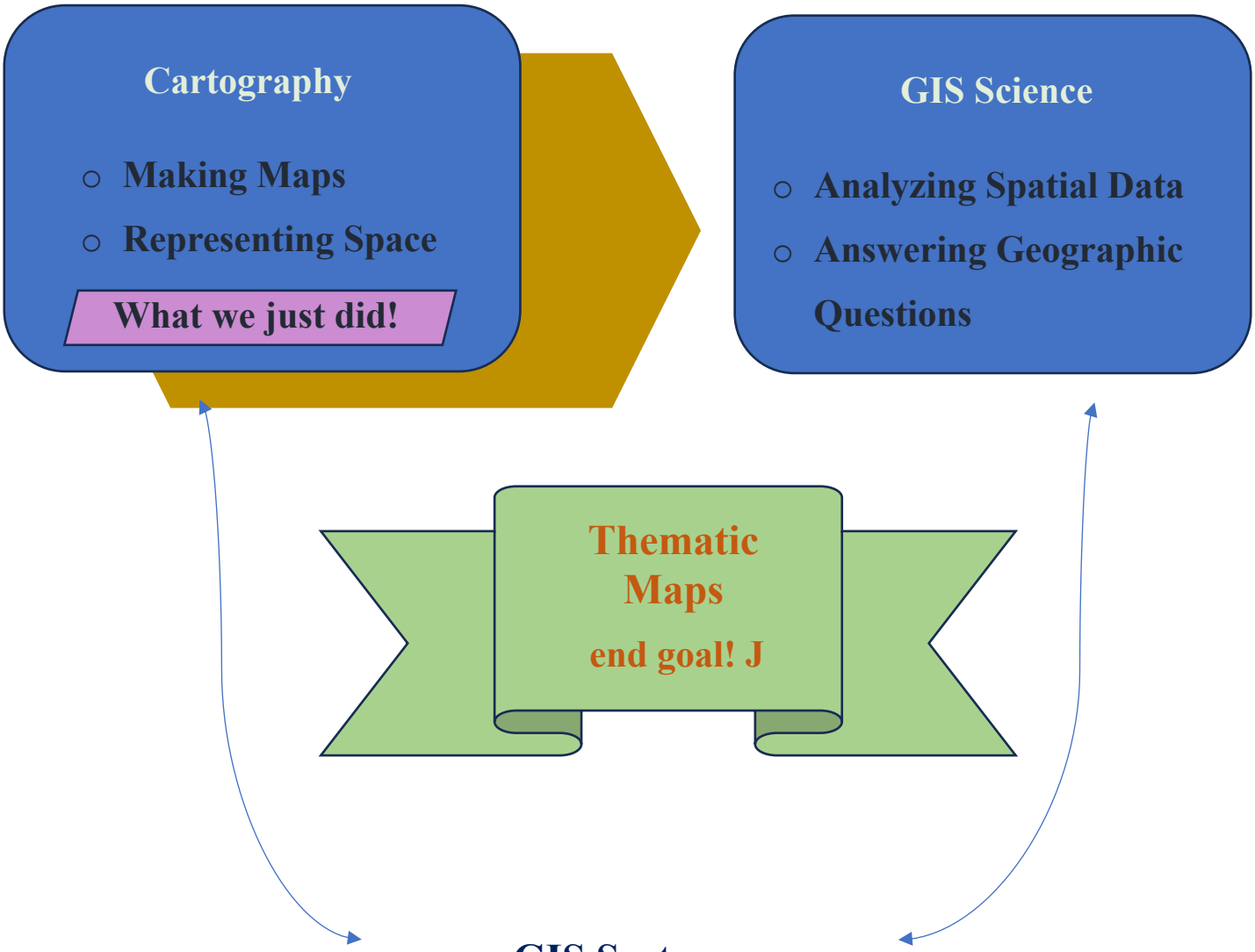
Next, use your imagination and pick a new geographical area to mentally map out that has a different **scale** than what our Map 1 was.
What **scale** is your map? Is it smaller than your first mental map of Montana or bigger? Make an estimate of how large the area is using a numeric scale, AKA how many miles, acres, feet, inches.
What **direction** will your map be oriented? Draw a compass on your map that shows the viewer which direction is North, East, South and West.

What **geographic features** (mountains, rivers, plains, cities, towns, highways, coulees, forests etc..) did you use to orienteer yourself?
Add a **scale** bar to your map that represents the distance of your map.
Once finished with your map, share why you chose the **geographical location** you did, what **scale** you used, and what **geographical features** you used to orient yourself.

Great! You have used geospatial terms, cartographic elements and your own creativity to produce a map, that's what it is all about!

Part 3. Geospatial Software

What tools will we be using and learning about to create our maps and activities this week?



GIS Systems

- AKA Computer Software!
- Google Earth, & ArcGIS

We will chat more about this in lab 02

Map Projections & Coordinate Systems

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Lab 02.1

Introduction:
This lab is all about how we put the Earth onto a piece of paper. The process involves 2 Geospatial concepts: Map Projections and Coordinate systems!

We will be going over the two concepts briefly with visual videos, written text, and an exercise to understand how we can use Projections and Coordinates to create accurate maps and represent our spatial data.

Objectives:

- Understand the differences between coordinate systems and projections.
- Learn how to select an appropriate coordinate system and projection for a map.

Part 1: Map Projections

Every 2-Dimensional map we create deforms the true 3-Dimensional shape of the earth. This is because it is impossible to represent a curved surface (the earth) on a flat one (a map) without stretching, skewing, breaking, and tearing its true dimensions and shape.

It may be difficult to conceptualize, but let's take an empty eggshell that is perfectly round as an example. The only way we can take the empty eggshell and flatten it onto a 2-D surface (say a table) is by crushing the egg into small pieces and then reassembling the pieces in the correct order. Still, the surface of the crushed egg will not be completely level with the table, and there will likely be gaps between the broken shells, but it will be more accurate.

One way we project the 3-D Earth onto a 2-D map is similar to splitting/breaking the egg into smaller pieces. We will learn about different types of Map Projections and how we apply these distortions in a systematic way that allows you to control where and how it happens.

Look through the following links and discuss the questions that follow!

Making Observations about Projections

Make observations about the projections while considering these guiding questions:

- How might different projections affect our perception of geographical features?
- When would some of these projections be more useful than others?

Part 2: Coordinate Reference Systems

How do we understand the precise location of where we are on the Earth? Through a Coordinate Reference Systems (CRS)!

Coordinate reference systems (CRS) enable any precise location on Earth to be specified through a set of numerical values known as coordinates.

You can explore coordinate reference systems at the following links:

This type of Coordinate Reference System uses angles to break the Earth up into a grid system by using lines that run east to west. Lines that run east to west around the earth are called Latitude. Lines that run North to South are called Longitude.

- What is your current latitude and longitude?

Part 3: Eggshell Activity

Now that students have been exposed to a few different projections and understand what Coordinate Reference Systems are, we will attempt to make our own Projection and Coordinate Systems using eggshells.

- How are eggs similar to our Earth? Think about the Earth's crust, mantle, and core; and then think about an egg's shell, egg white, and yolk.

Students may try to mimic a projection style that they observed or attempt to create their own!

Activity Steps:

1. Each student will need a hard-boiled egg, markers, scissors, a spoon, and a ruler.
2. Using the markers, students will be given the opportunity to draw Earths Continents, and a Coordinate Reference System.
3. If possible, students may use their phones to record a video which represents the 3D design on their egg to compare with their 2D projection.
4. Students will then crack their 3D egg and attempt to line up the pieces so that their image is conserved on a 2D plane.

Egg Guiding Questions:

- Do the eggshells ever lay perfectly flat?
- Were you able to complete your image without any gaps between the shells?
- Compare with a friend. Did you center your projections around the same point on the egg?
- How might this compare to projections of the Earth?

Additional Resources:

QGIS Map Projections and CRS detailed explanation
https://docs.qgis.org/3.34/en/docs/gentle_gis_introduction/coordinate_reference_systems.html

Esri Map Projections
https://learn.arcgis.com/en/paths/map-projections/

Different Types of Data: Vector & Raster

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Lab 02.2

Introduction:

Just as there are different forms of art (sculpting, painting, & weaving), there are different forms of data. The two forms of data we will explore in this lab are Vector and Raster Data. These types of data have different properties that are used to represent different things. The best way to understand Vector and Raster data is to look at maps comparing the two! In this lab, you will follow the links attached in the document to explore Vector and Raster Data.

Objectives:

- Understand how Vector data looks and is used and create your first map.
- Understand how Raster data looks and is used.

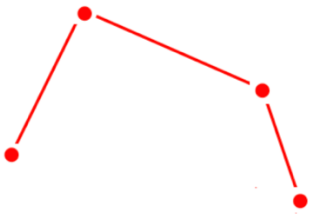
Part 1: Vector Data

What is Vector data?

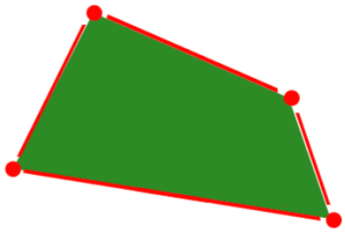
Long story short, Vector data consists of coordinates and are represented by **points**, **lines** and **polygons**.



1. Points are simply XY coordinates (recall what Coordinate Reference Systems are).



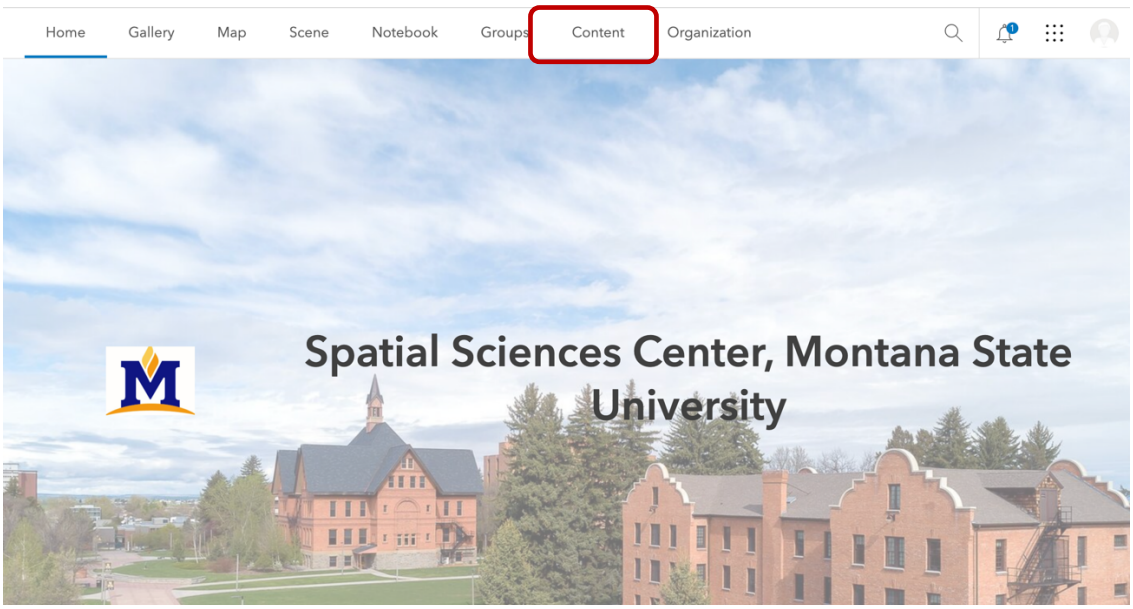
2. Lines are points that have been connected. In mapping, lines usually represent linear features. Can you think of any linear features?



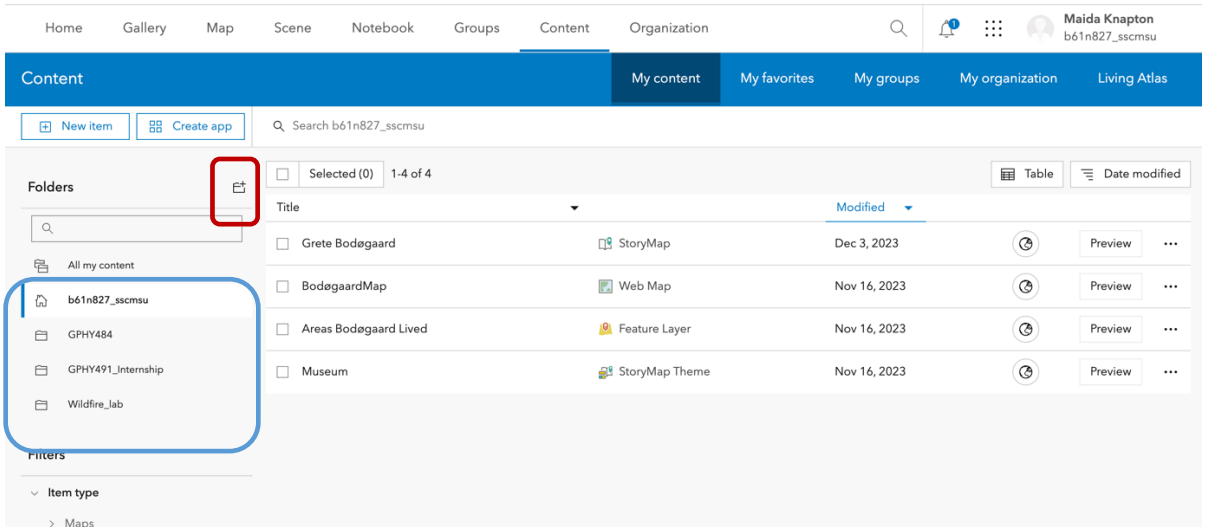
3. Polygons are closed lines that represent an area.

ArcGIS online is a cloud-based mapping and analysis program that we will be using this week. Lets navigate to ArcGIS online, and sign in with your account that has been created by Montana

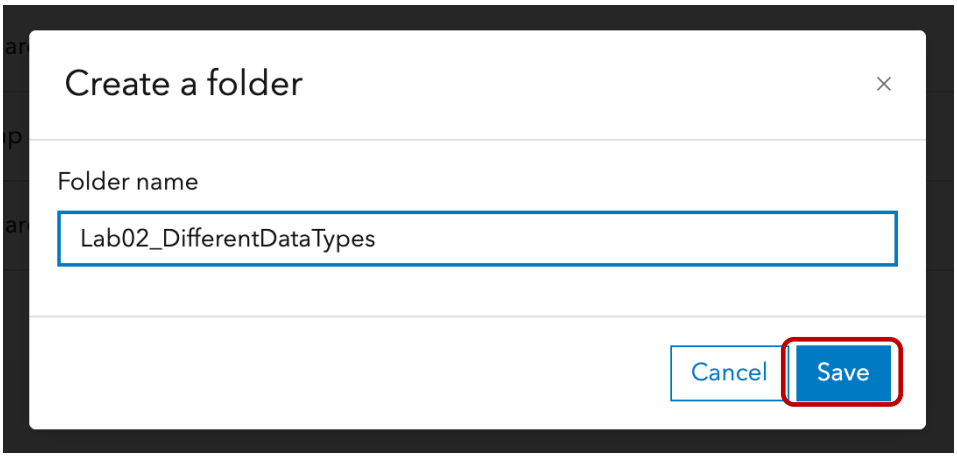
State University. In your browser, search for '**ArcGIS online Login'.** Before you sign in with your username and password, make sure to sign into the MSU's URL which is: sscmsu.



Once you have logged in, you will see your ArcGIS online Home Page. The navigation bar at the top of your page is where we will access our **Content** page. This is where we will create and store our individual maps and data**.** Click on **Content.**

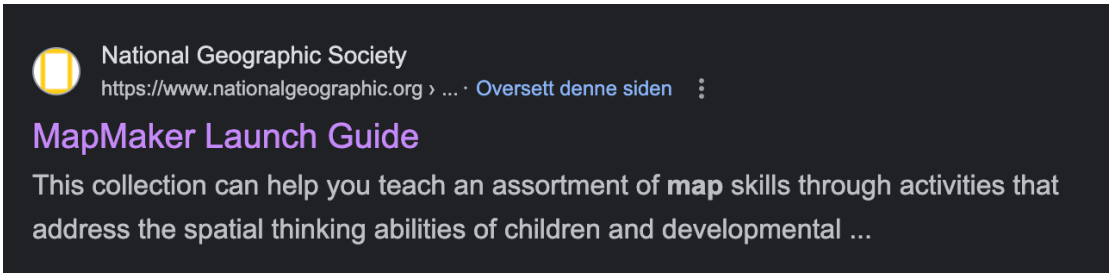


In the content page, we can create folders to organize our different projects. Click **Create Folder**. Note that your new folder will show up in the purple box outlined in the image above.



Name your folder Lab02_DifferentDataTypes. Make sure there are no spaces! Click **Save.** The reason why we have created this folder is because we will create and save our first map here.

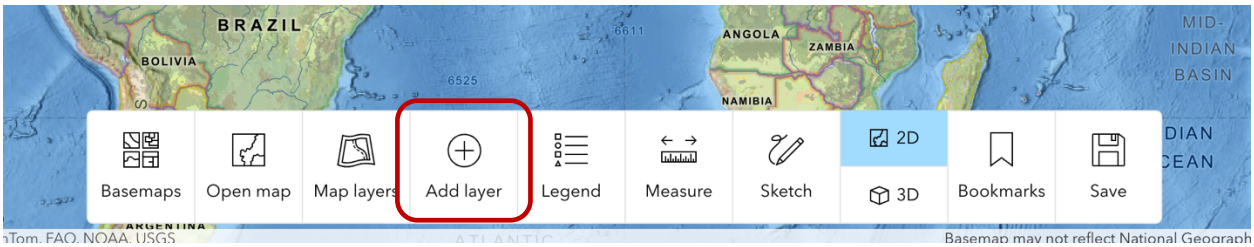
Now, lets explore a Vector Layer through National Geographic Map Maker. Type into your browser 'National Geographic Map Maker Launch Guide'.



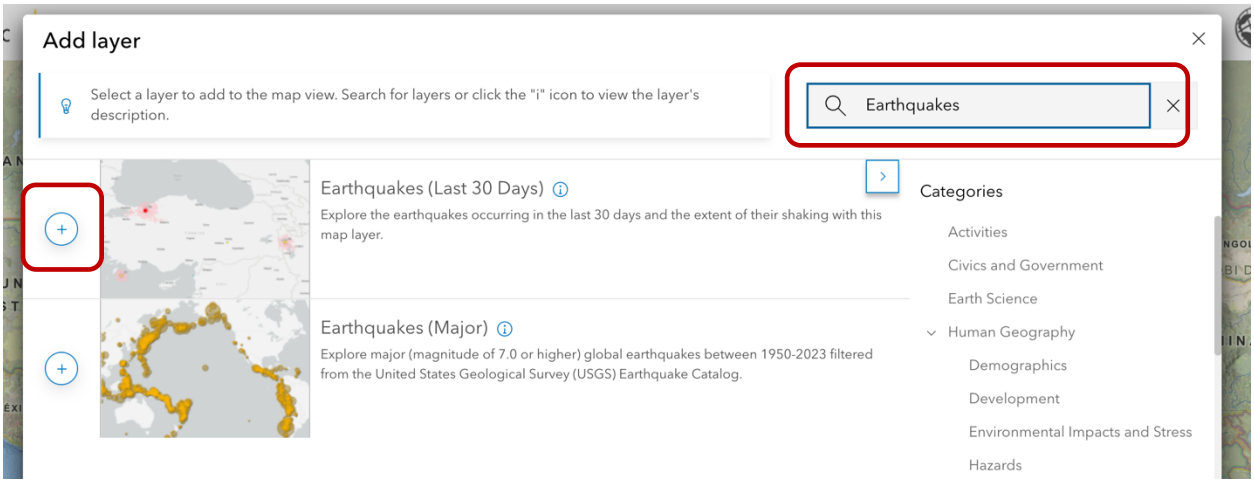
Click **MapMaker Launch Guide**.



Click **Explore MapMaker 4.0**.



At the bottom of the National Geographic Map Maker, you will see the make making bar. Lets explore a Vector data layer by looking at recent earthquakes. To add this layer, Click **Add layer**.



In the search bar, type in Earthquakes. Click **the Earthquakes (last 30 days)** Layer.



Your new layer will show up in the map layers icon in the map making bar, and on your map. If you want to organize how your data lays on top of each other, open the **Map Layers** and reorder your layers by dragging one on top of another.

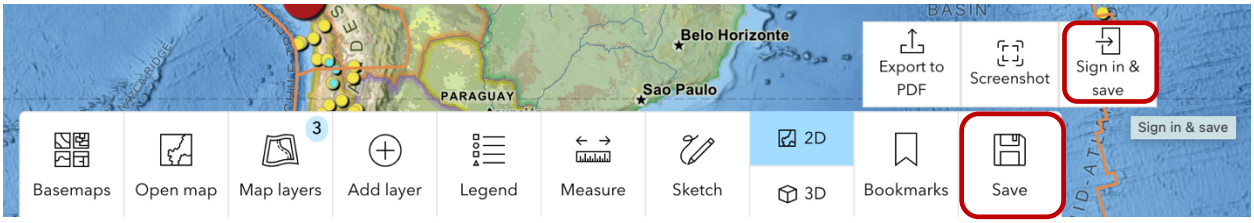
Now, navigate to an earthquake that occurred on land, and one that occurred in the ocean. Identify a point and polygon by clicking on them. Note what the two types of vector data represent by reading the Metadata window (description explaining the data).

In a group or with your class, discuss the following questions.

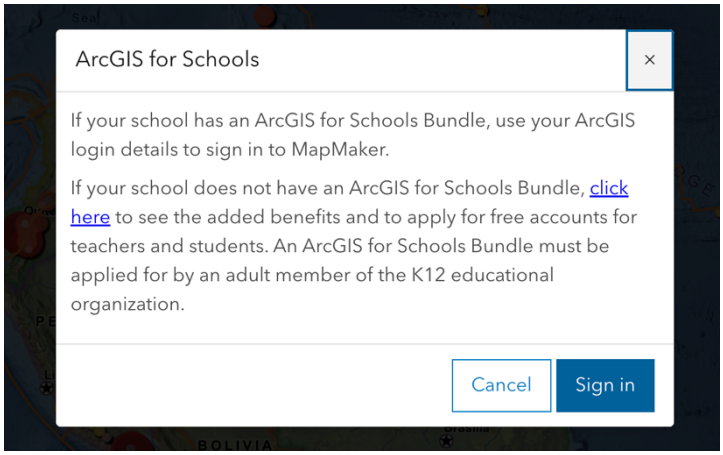
- Discuss with a neighbor or group what you thought each form of vector data does well representing.
- From looking at the polygons, what spatial inferences can you make about how a earthquake travels on land vs in water?
- Earthquakes can be predictable. How can we use this map to make spatial inferences on communities that might be high risk?

By using the same processes as above, add a new layer that outlines the Earths Tectonic Plate Boundaries and areas of Volcanic activity.

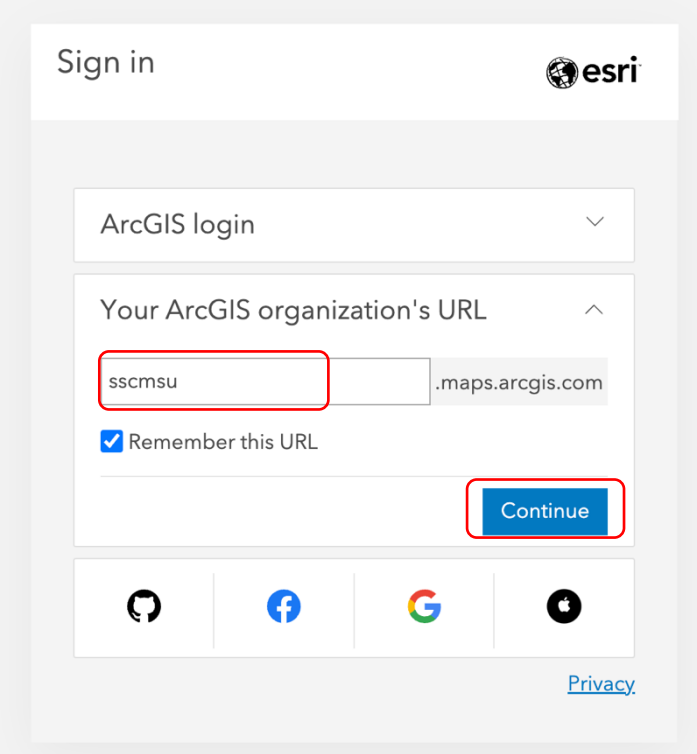
- What spatial inferences can you make between Volcanoes, Tectonic plates, and recent Earthquakes?
- From your inferences, can you determine human communities that might be at high risk of a natural disaster caused by an earthquake?



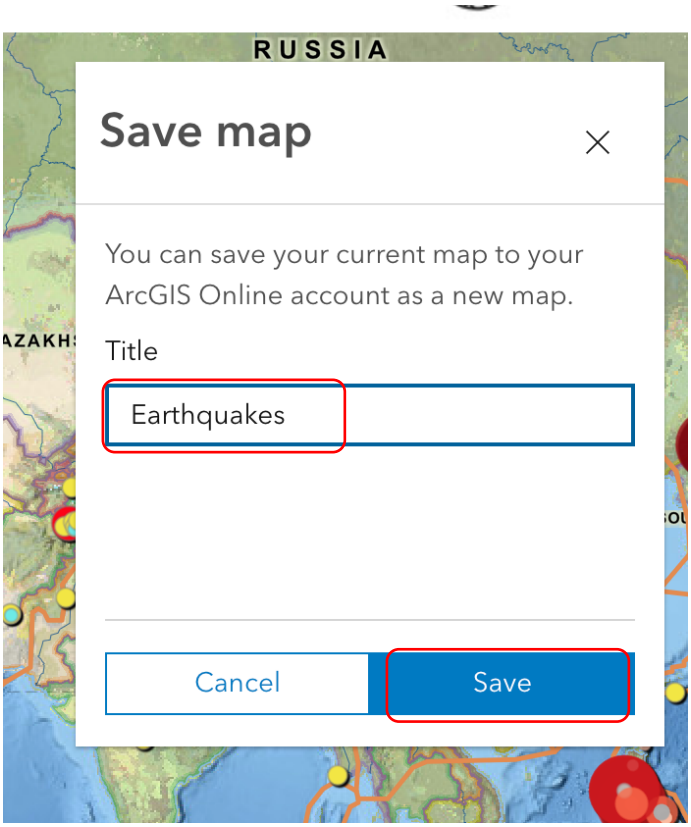
Now we will save our map and its layers to our personal ArcGIS online account. Click **Save**. Click **Sign in & Save**.



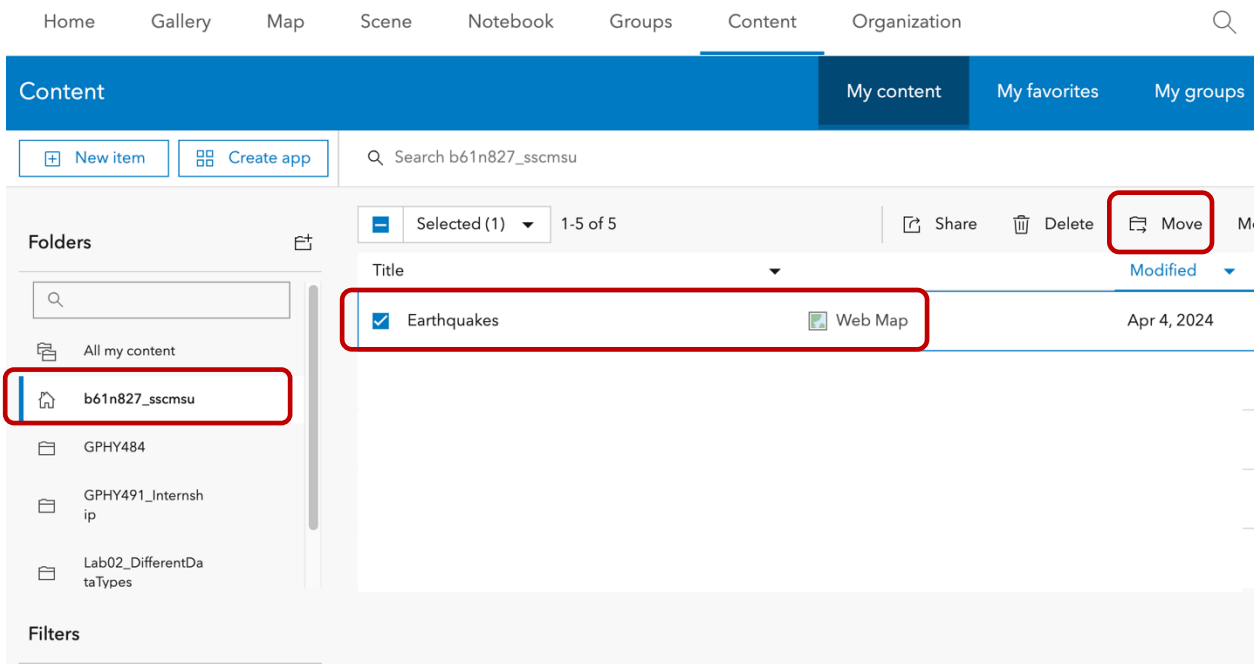
Click **Sign in**.



A new tab in your browser will open where you can sign into your ArcGIS account.



After you have signed into your online ArcGIS account, we will go back into National Geographic Map Maker, and name our map something relevant to the data. Click **Save.**



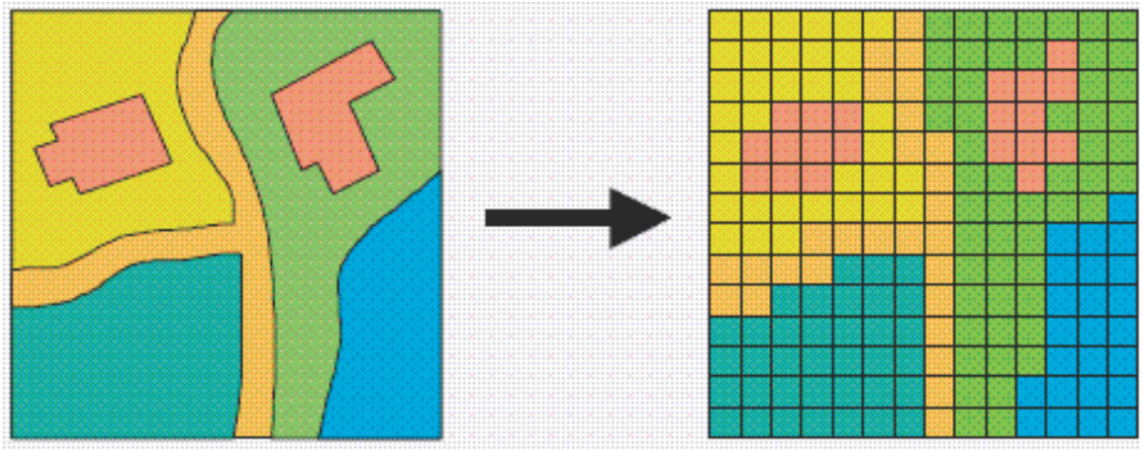
After you have saved your map, it will show up in you content page under your home folder. Lets move your new map into the Lab02_DifferentDataTypes folder you made. Click the Square next to the title of your map, and then Click **Move.** A window will pop up with your folders. Place your map into your Lab02_DifferentDataTypes folder and click **Save**.

Great Job! You have successfully made your first ArcGIS map! ☺

Part 1: Raster Data

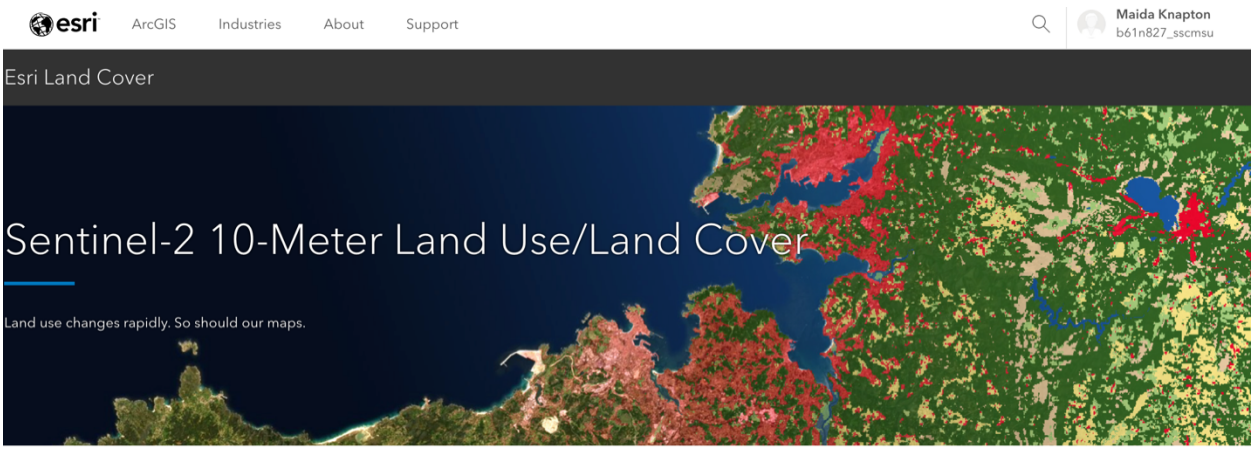
What is Raster data?

Raster data is made up of pixels, or grid cells. Each pixel is represented as a square, and can vary in size from one meter by one meter, to one kilometer by one kilometer. Each pixel has its own value or class representing the land it is covering.

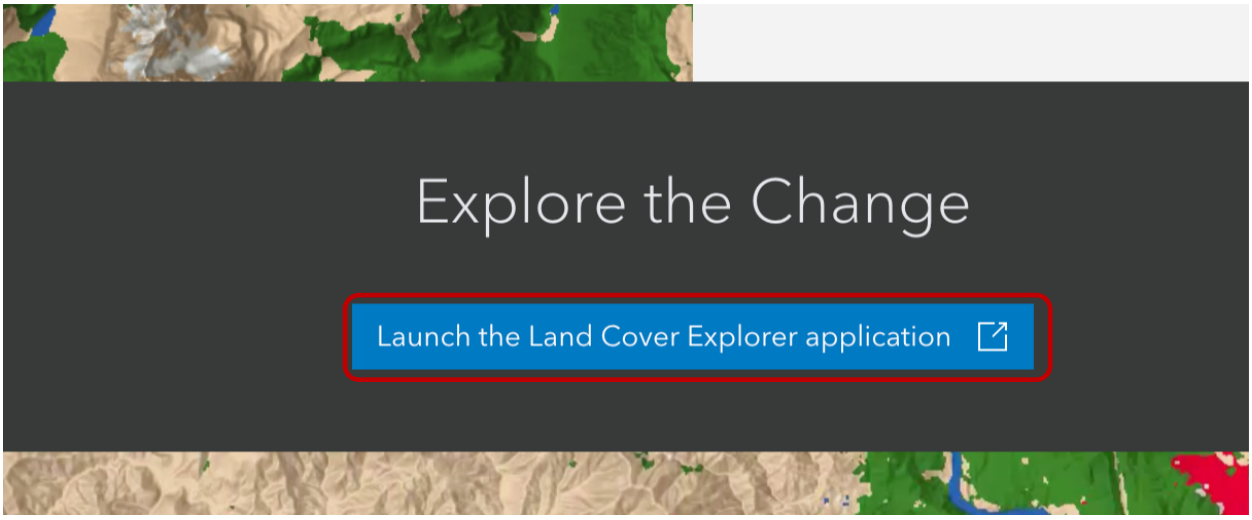


Lets explore a Raster Land Cover Dataset. By searching in your browser (or clicking the link down below), look up ‘Sentential-2 10-Meter Land Use/ Land Cover’

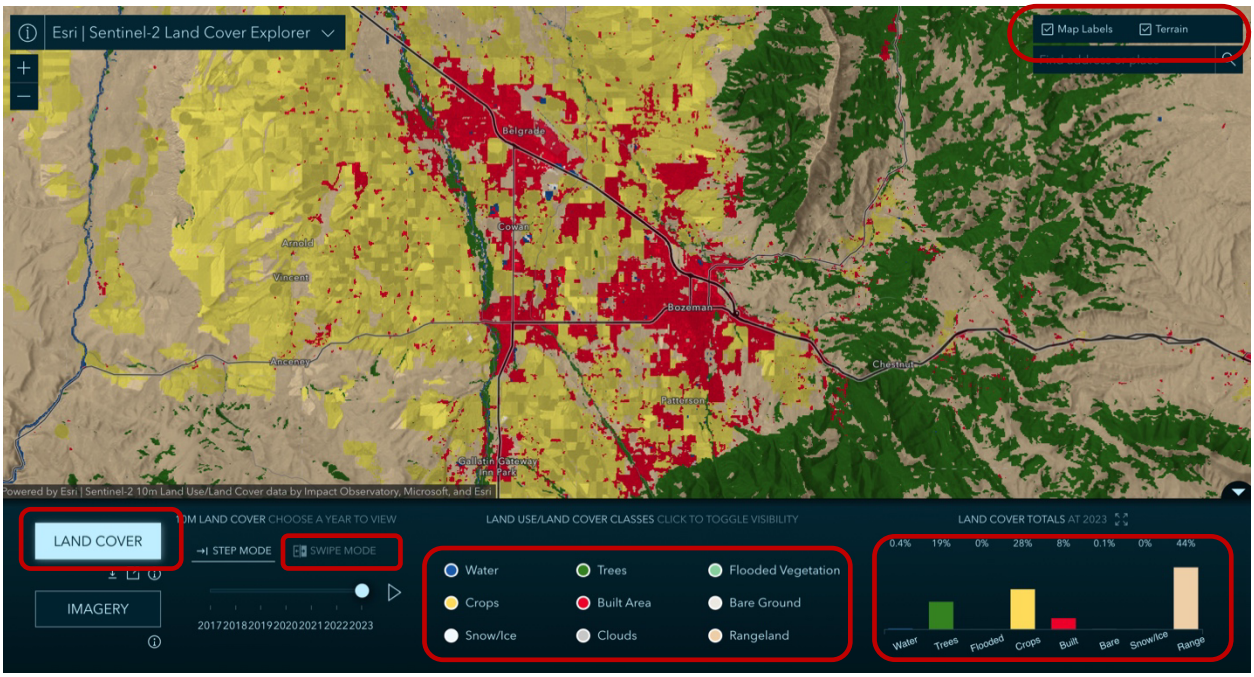
- https://livingatlas.arcgis.com/landcover/



Read through the descriptions on this page. This will help you understand the dataset and why its important! Land use is changing every day. This world map uses Raster data in order to classify land and quantify its change.



Once you have read through the site, at the bottom of the page you will see this button. Click **Launch the Land Cover Explorer Application**. Please note that Raster datasets are very large storage wise, so you might have to wait a minute for the map to load.



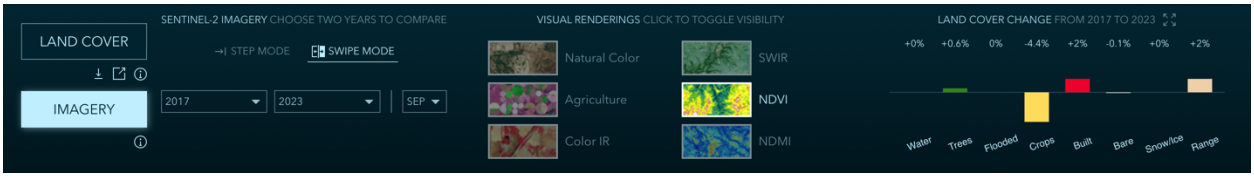
Navigate to anywhere in the world you are interested in. Make sure **Map labels** and **Terrain** are turned on, and you are in the **Land Cover** dataset.

- What does each pixel color represent? Hint: find the Raster legend.
- Zoom into where two different pixels are. What shape are the pixels?
- What year are you looking at and what is the highest percentage of land use?

Find the year the raster is representing and look at the bar graph showing the breakdown of land use.

- How has this area changed since 2017?

To visually view land use change, click the **Swipe Mode** and set the years to 2017 and 2023. Then swipe back and forth between the two on your map. To numerically view land use change, look at your bar graph.



Next, lets look at **Imagery**. Are you seeing the same land use changes as when **Land Cover** was turned on? Click through the different **Visual Renderings**.

Great Job!! This was a big Raster dataset, and now you have a good idea of how powerful it can be. Share your results from the blue discussion questions above with your group!

Part 3: Data Discussion Questions

After you have explored both Raster and Vector data, you have a good idea of the pros and cons of both. Lets chat about a few things to wrap up this lab so you will be prepared for the rest of this week when working with different types of data!

It is not always strait forward which spatial data you should use for your maps and to answer your spatial question. Sometimes you just have to try both (if available)! When you are deciding what data to use, ask yourself these questions.

1. Do you want to work with pixels or coordinates?

   Raster data works only with pixels. Vector data works only with coordinates.

2. What is your map scale, and how much of your data will be covering your map?

   Vectors can scale objects up to the size of a billboard, but you don't get that type of flexibility with raster data. So, what scale will your map be? Are you looking at a continent or a town

3. Do you have restrictions on File size?

   Raster files can be very large, and therefore difficult to import/ export if you don't have time or the computer power!

Additional Resources:

- Vector vs Raster in GIS: What is the difference? types-vector-raster/
- Esri Lab: Raster is faster by vector is corrector: https://gisgeography.com/spatial-data-

Identifying Human Wildfire Risks

Montana State University Geospatial Skills Camp

Lab 03.1: Learning about data by creating your own.

Introduction:

The increasing frequency and severity of human caused wildfires pose a significant threat to communities, ecosystems, and public safety. In order to mitigate these risks effectively, it is crucial to understand the underlying factors contributing to wildfire occurrence and spread. According to climatecentral.org, wildfires in Montana have on average been increasing in heat and severity since 1970. This is due to many reasons such as increased human population, increased accumulation of dead vegetation, and human caused climate change.
In part one of this lab, we are going to use our mapping skills to try and find some examples of potential wildfire hazards in our area and create a map from our observations. We do this by collecting our own data outside to look at human caused wildfire risks in our area. We will be looking for hazards such as dead leaves/trees close to power lines, trash piles, cigarettes on the ground and blocked fire hydrants. Feel free to be creative and identify any risks you would like!

Objectives

- Learn to create our own data using ArcGIS field maps
- Create our own map using the data we collected.

Terms & Definitions

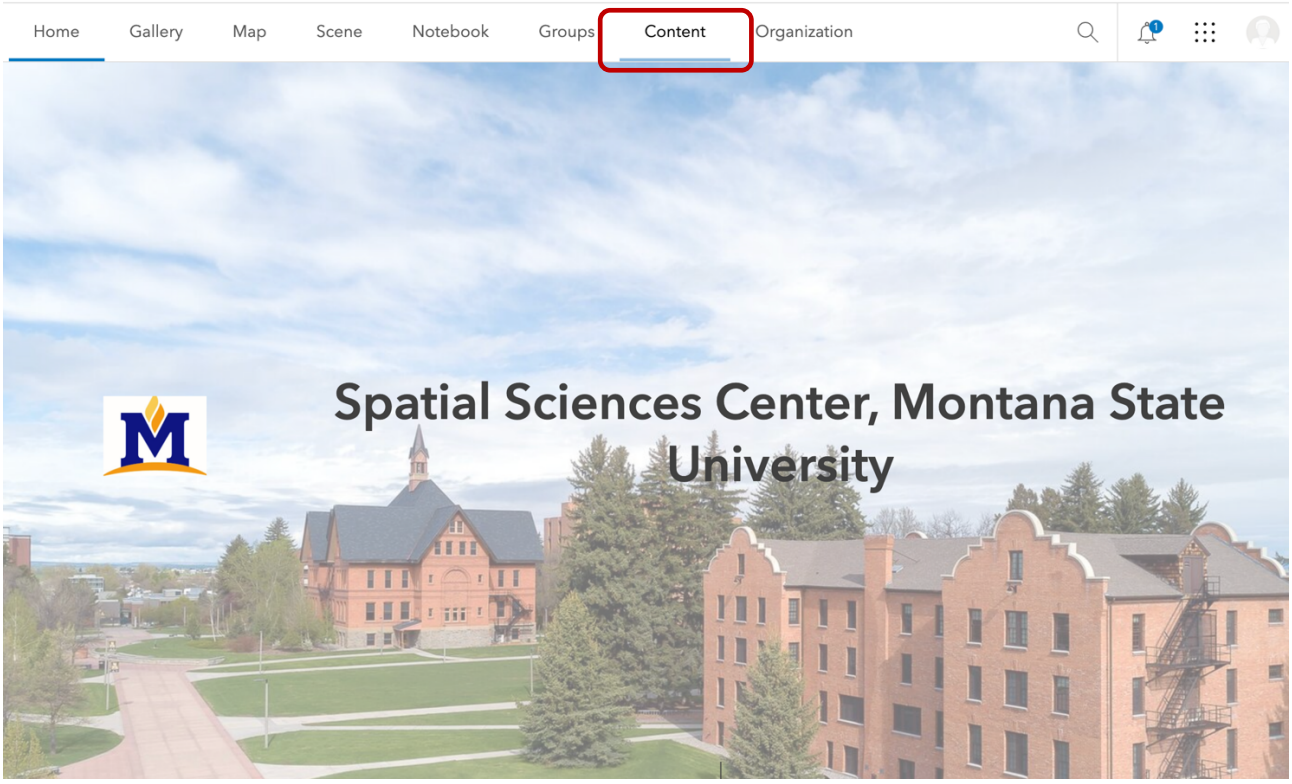
- **Primary data:** data that you produce or create to answer your own spatial question.
- **Secondary data:** data that an individual or organization has created that you downloaded are now using and/ or adapting to answer your own spatial question.
- **Vector Data:** spatial data represented by points, lines and polygons.
- **Feature layers:** is layer of data that can be either Primary or Secondary data, and it includes the item or focus that is being mapped. For example, if we create a Feature layer of fire hydrants, the layer should show all of the fire hydrants in an area and any other information relevant to the hydrants.
- **Symbology:** How we represent our data visually. If we are mapping fire hydrants and trash cans using points, we can change the color and symbol of the fire hydrants to look like a fire hydrant, and the color and symbol of a trash can to look like a trash can.

Part 1: Collecting Our Own Data (Primary) to look at Fire Risks

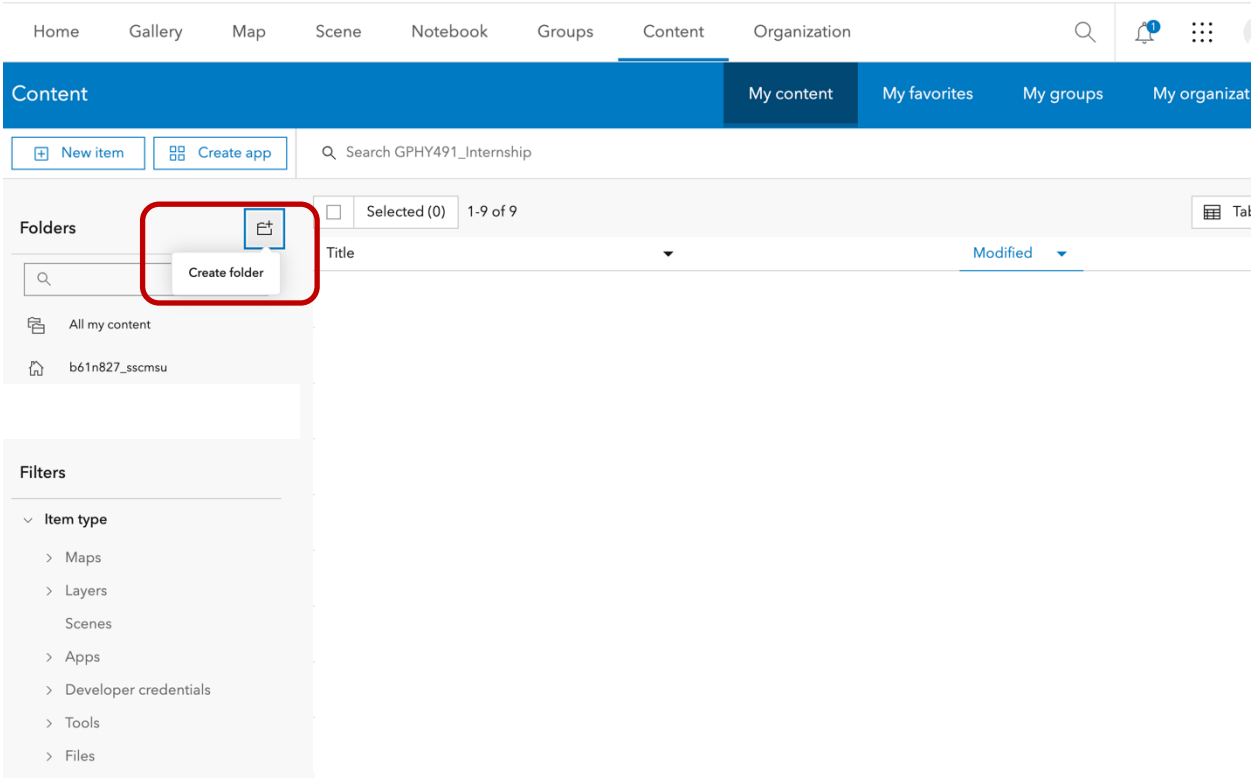
Setting up ArcGIS online & ArcGIS Field Maps

In order to begin to import both primary and secondary data files into our online ArcGIS directory, we need to first make sure we have created folders to store our projects and data in that are organized and easily recognizable. This is a big factor in making our projects go smoothly! The following steps will help you to create an organized content page.

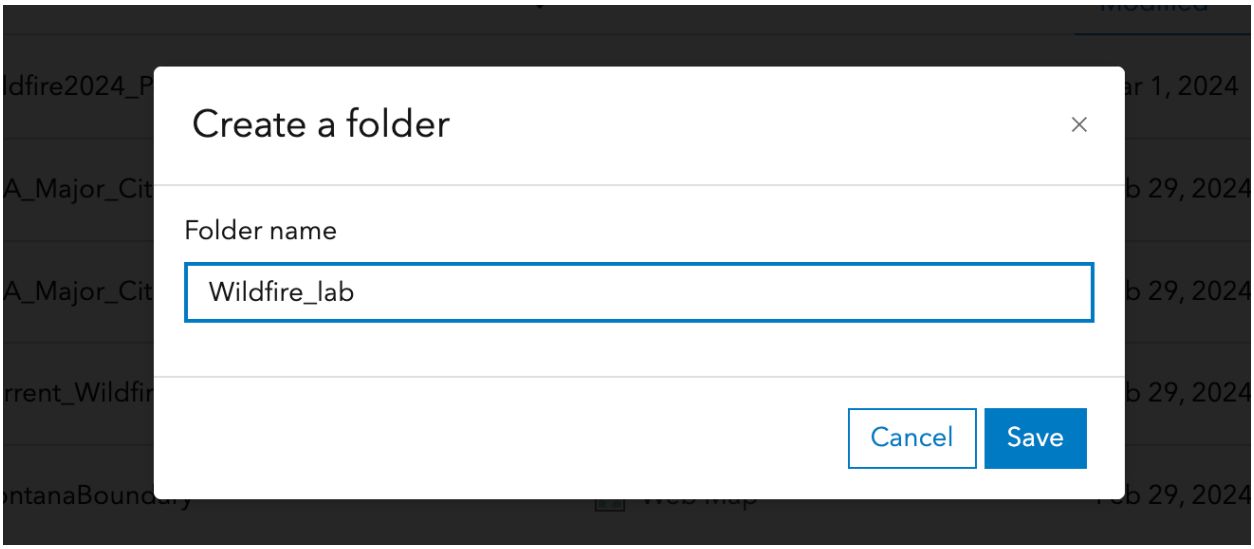
Step 1: Create a Folder for your Wildfire Lab, to store data & maps.



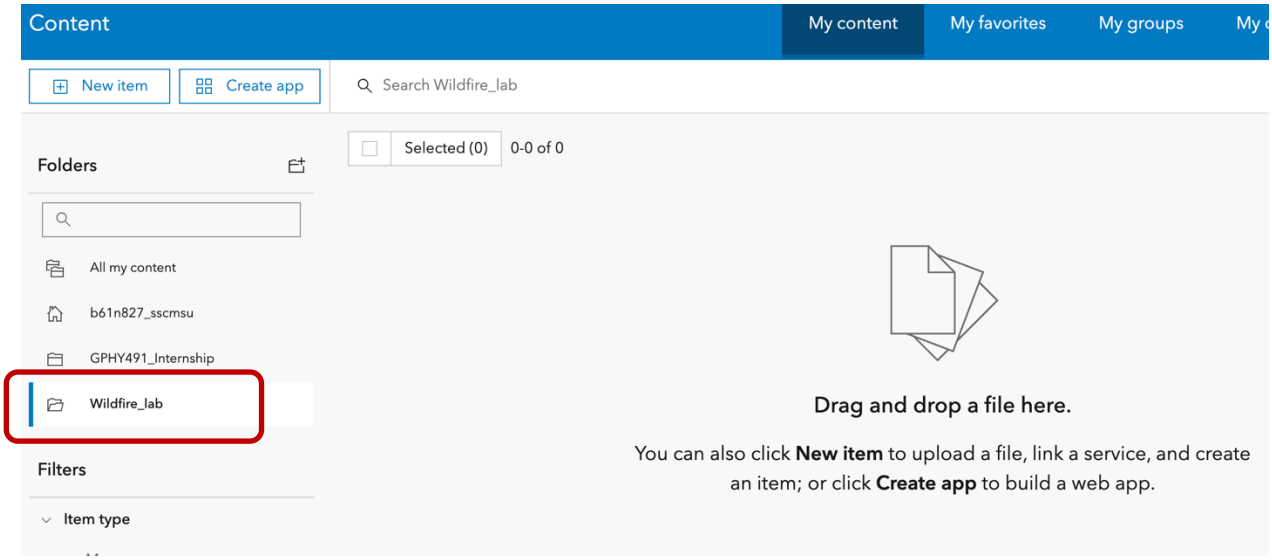
Login to ArcGIS online. Once you have arrived at the home page that you can see above, click on the **content** tab. This will take you into where we will be storing our data, and projects.



The first step in organizing our content page is create a folder that is labeled ‘Wildfire_Lab’. In the screenshot above, you can see a red box that outlines the button to create a new folder. Click on the Create folder Icon.

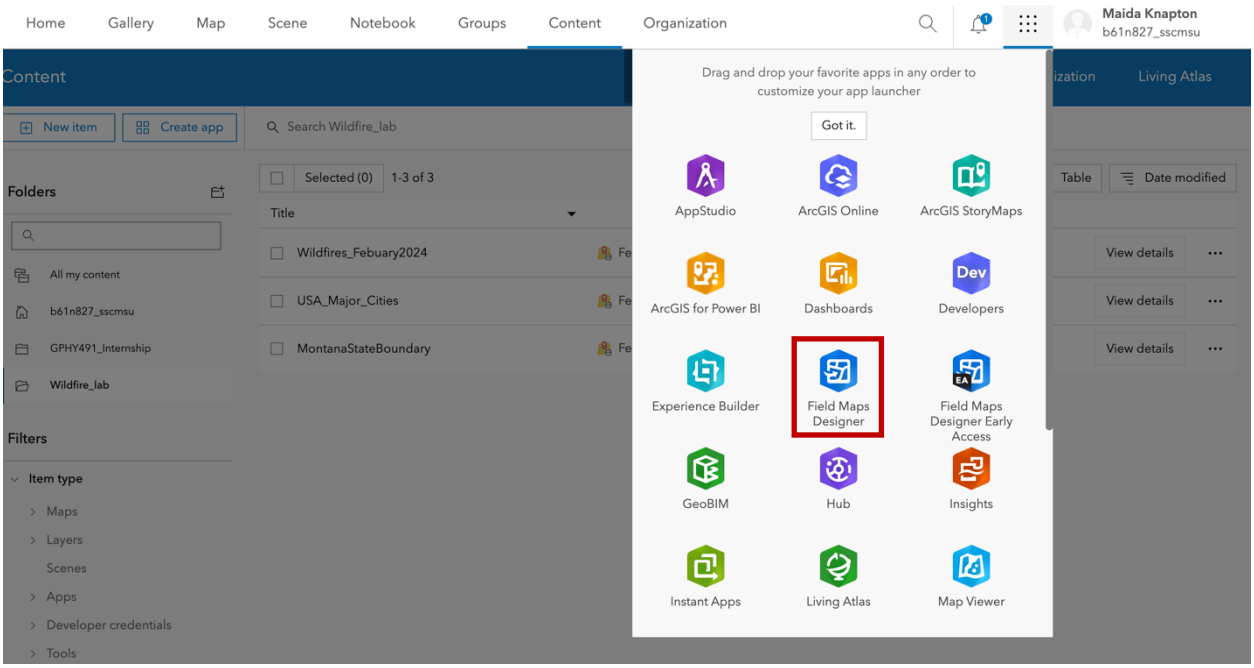


Name your folder ‘Wildfire_lab’. Hit save.

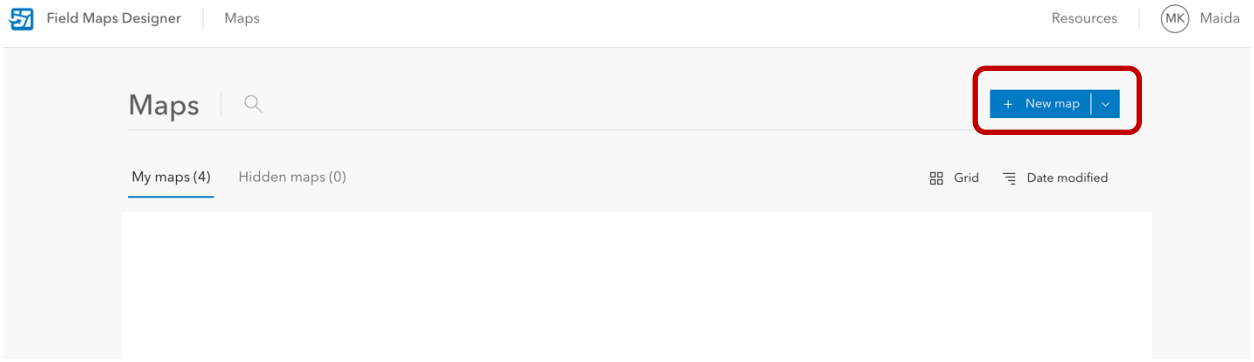


Now you will see a new folder titled Wildfire_lab on the left-hand side of your screen. Next, we will work through the steps to begin collecting our own fire risk data!

Step 2: Set up our ArcGIS Online & Field Maps to collect primary data

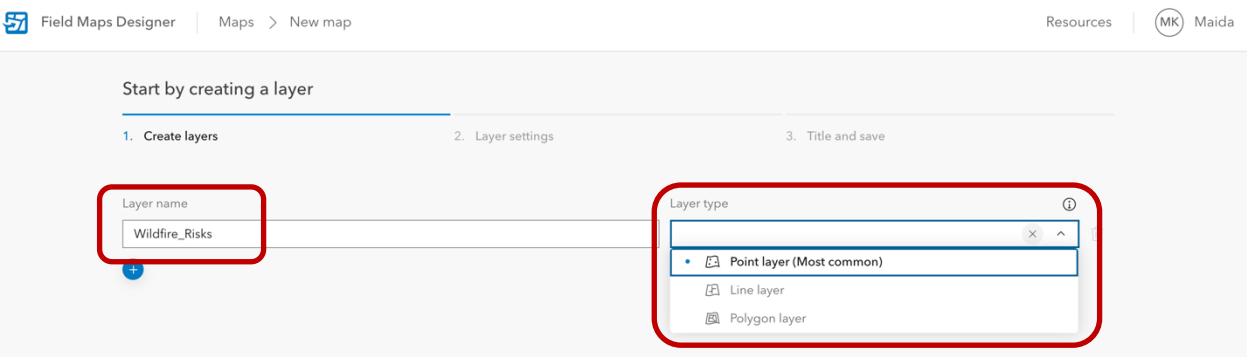


In ArcGIS online, move your mouse to the top left hand side of your screen where you will see 9 dots next to the bell icon. Click on the Dots so that the screen in the image above pops up. Then, Click the **Field Maps Designer** icon. This will take you to a new tab.



Your screen should look like this now. Click the **New Map** icon. This is where we will be creating our layer for collecting our primary data. In this case, a layer is a term that we use to describe a collection of geographic data.

If this is confusing, please ask your instructor! There are a lot of new terms and applications here, and understanding what they are will help in the rest of our activities for this week ☺ You got it!

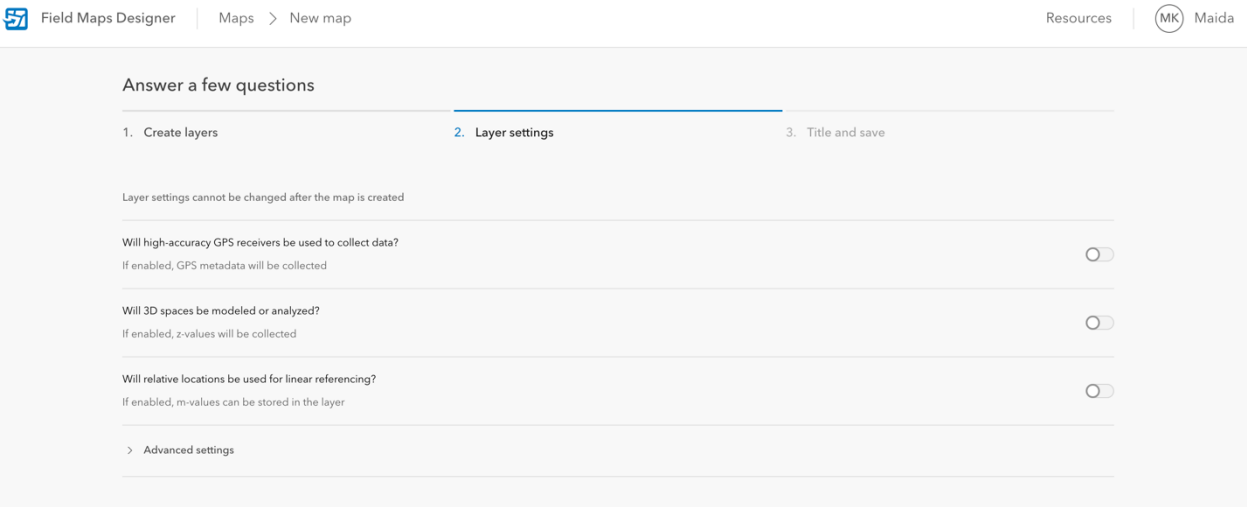


Here is where we will create our Fire Risk layer. Name the Layer name **Wildfire_Risks.** In the layer type drop down, view the different types of Vector data we can choose form. You will see a line layer, polygon layer, and a point layer.

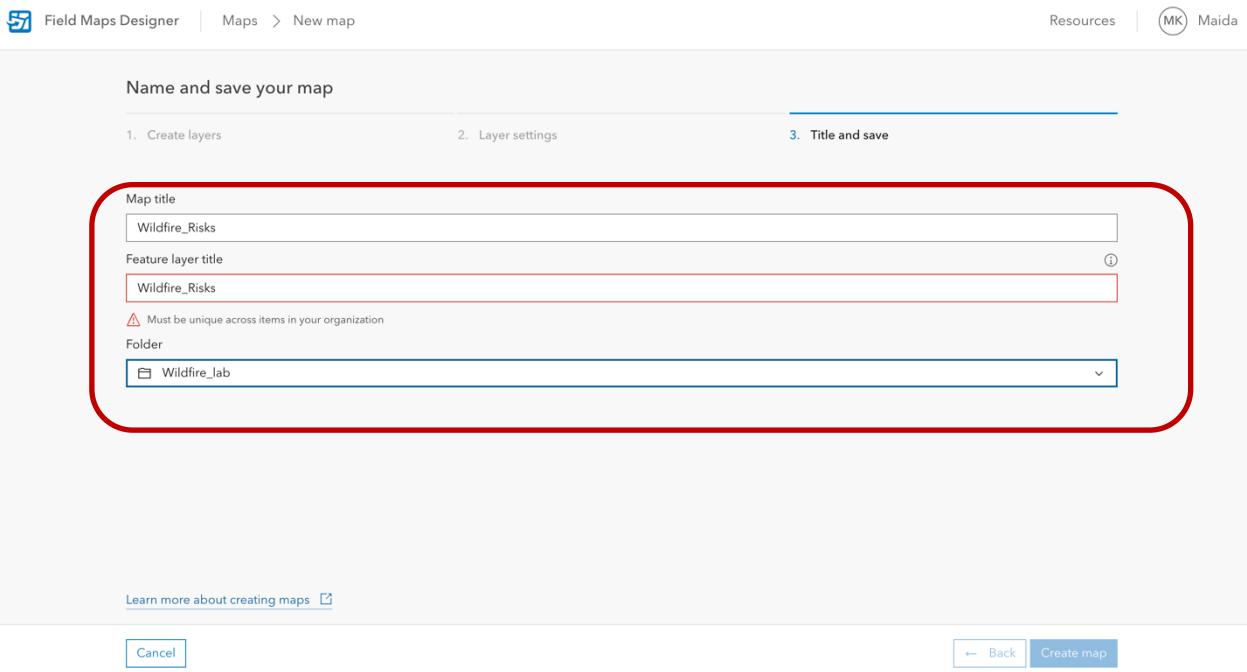
When we are identifying fire risks, it is likely that we will find risks that are at a single location, and are a small area (cigarette butts, trees next to a powerline, etc.) What type of Vector data will should we use to identify our risks?

- Let's use point data. As it works great for identifying the variables we will likely encounter.

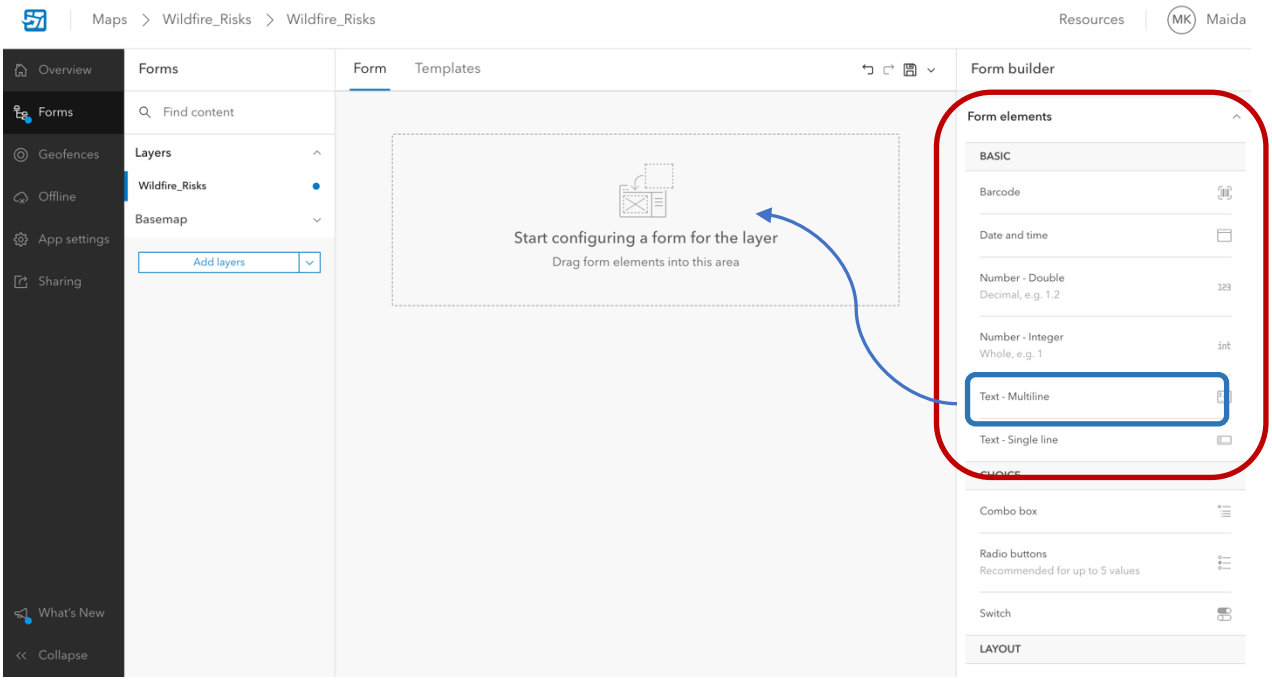
In the layer type, select the **point layer.** Click **next**.



The next step in creating our layer is selecting our layer settings. Since we will not be using a survey grade GPS, a 3D model, or linear referencing, we DON'T want any of these options selected. Click **Next**.



Now we will name our feature layer and our map, and then save it to the Wildfire_lab folder we created in step one. Title your map **Wildfire_risks**. Title your Feature Layer title **Wildfire_risks** or something similar. Save your map to your **Wildfire_lab** folder which is located in your ArcGIS online account. Hit **Create Map.**

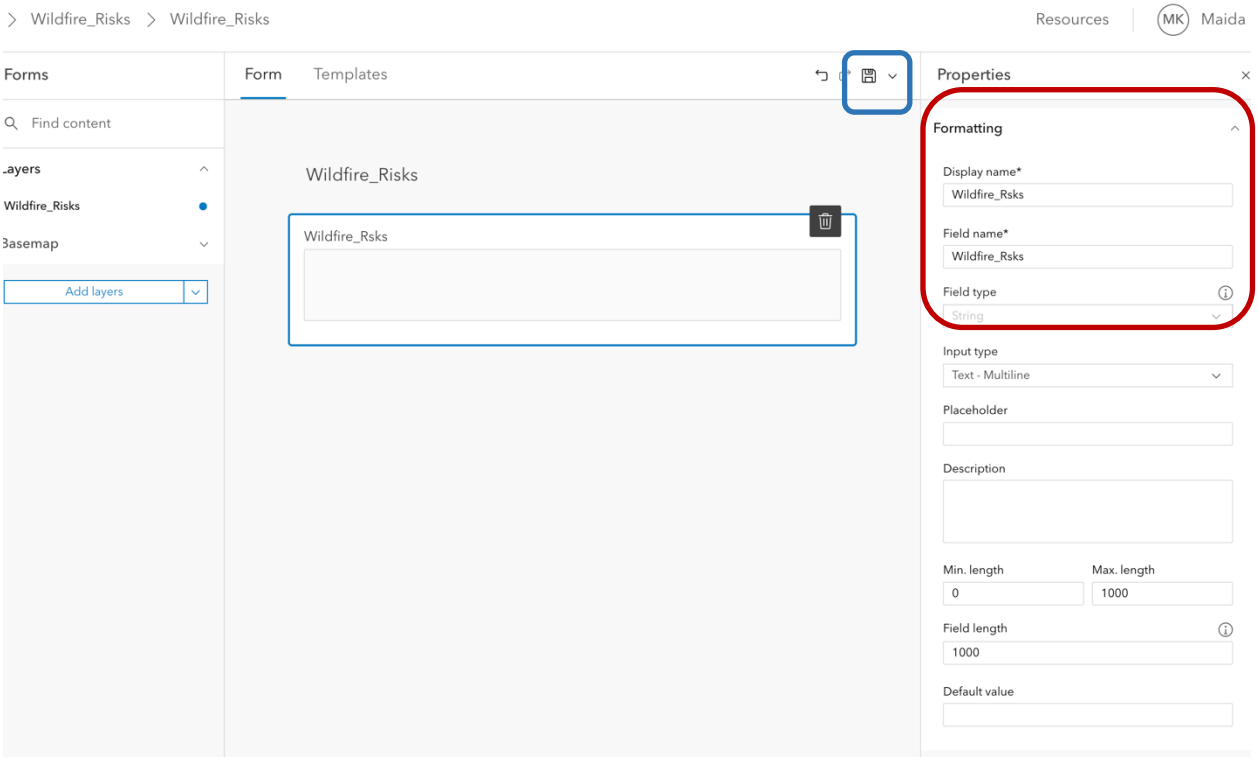


The next step we will do will be to create the format of how our points are collected. This is where we will format the details we want to collect when we mark a wildfire risk. In the right-

hand side of your screen, you will see different format options. Click and drag the **Text – Multiline** option to the Box that says, ‘Start Configuring a form for the layer”.

Now, when we go to take a point when we are outside, we can add an image, description, and see our GPS accuracy and our latitude and longitude. These details are important when we are collecting data!

Almost done!

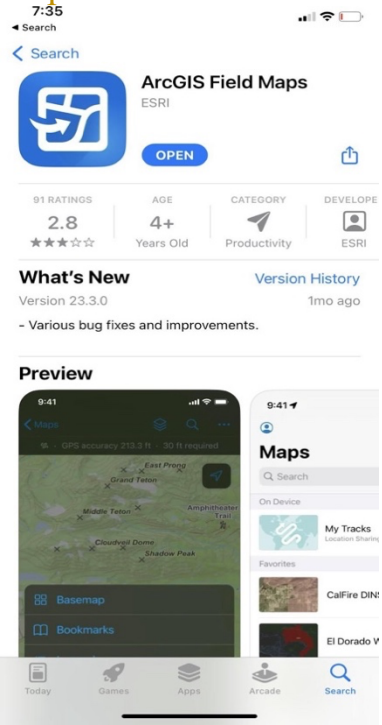


Lastly, we will name both our Display Name and Field name **Wildfire_risks**. Keep all the other selections the same. To the left of the Display Name you will see a save button, click the **save button**, and it will save your elements to a map!

If you would also like to add another feature layer besides wildfire risks such as wildfire mitigators, you sure can. Just drag and drop another **Text – Multiline** into the box that says ‘Start Configuring a form for the layer”. An example of a fire mitigator is a fire hydrant and fire extinguishers.

Next, we will use the ArcGIS field Maps app to map out places with wildfire risks.

Step 3: Use ArcGIS Field Maps to collect your Data



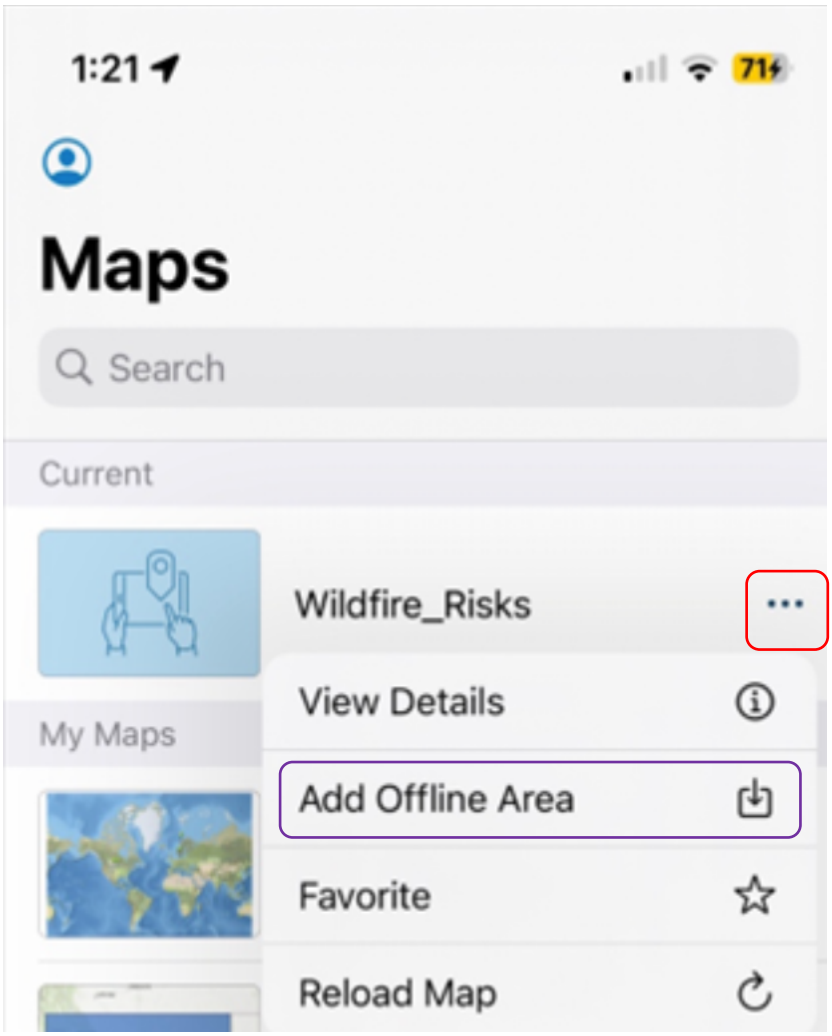
Download "ArcGIS Field Maps" on your phone/tablet if it is not already.

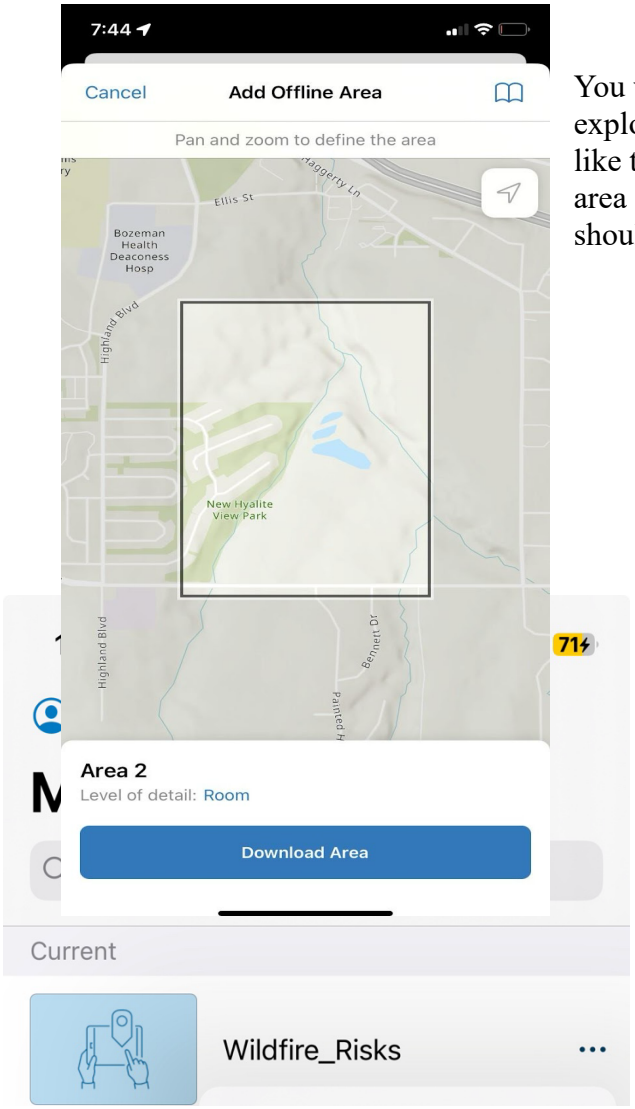
Login using your same username and password.

You will now see your feature layer that you created in Step 2.

If you are not using a phone/ tablet that can go offline, you will need to download an offline area while you are still connected to Wi-Fi.

To download an offline area, Click the three buttons on the left of your Wildfire_Risks. Click **add offline area**.


1:21
Maps
Search
Current
Wildfire_Risks
View Details
My Maps
Add Offline Area
Favorite
Reload Map



You will now be able to zoom into the area you will be exploring. Drag the offline rectangle to the place you would like to investigate for fire hazards. Once you select your area click “Download Area” and let the area download. This should only take a minute.

Now it is time to go on a walk and look for fire hazards. Click on the Wildfire_Risks Map icon. It will open up to your location.

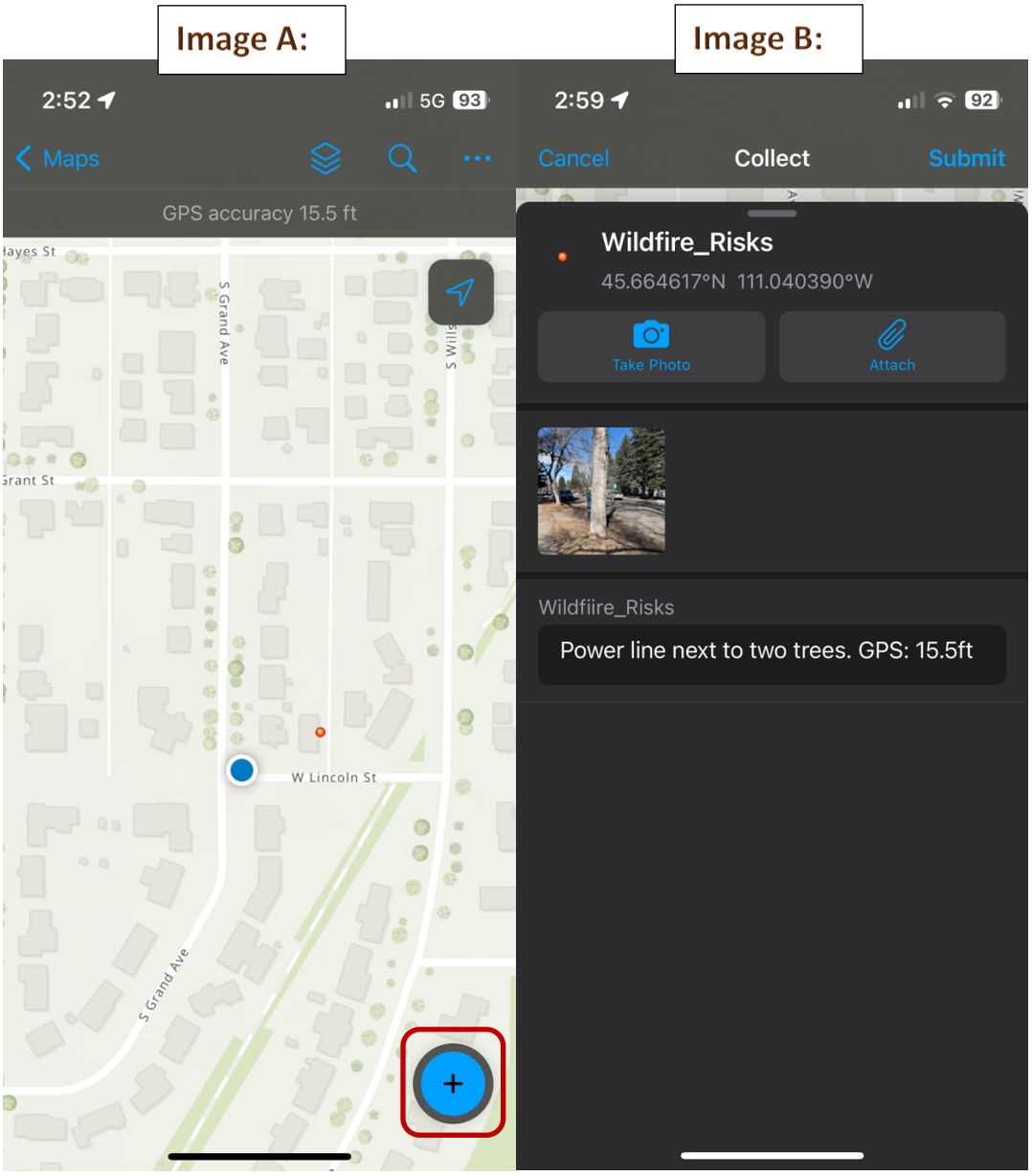
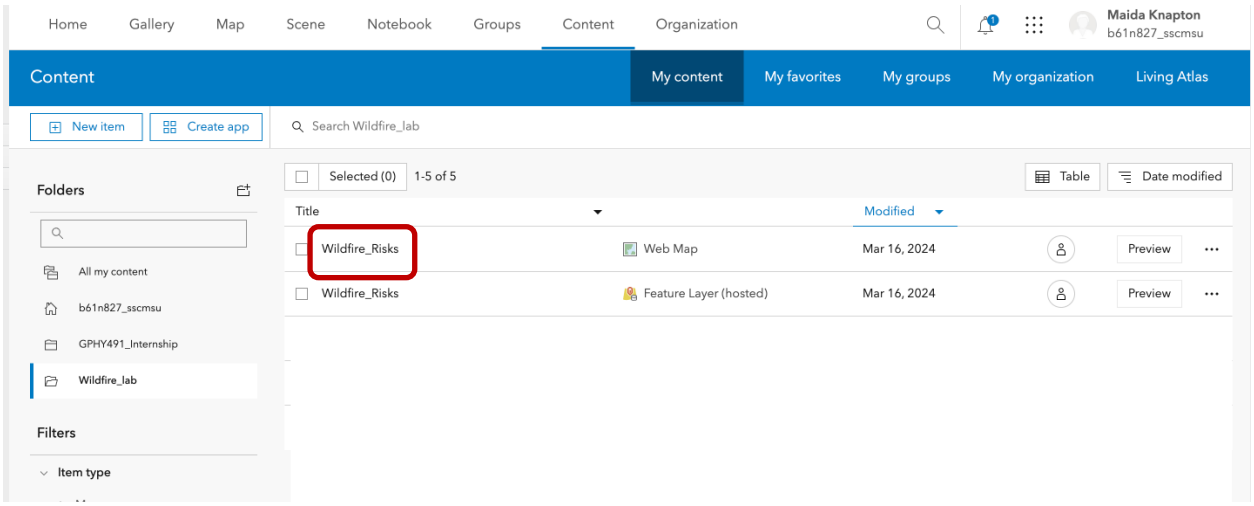
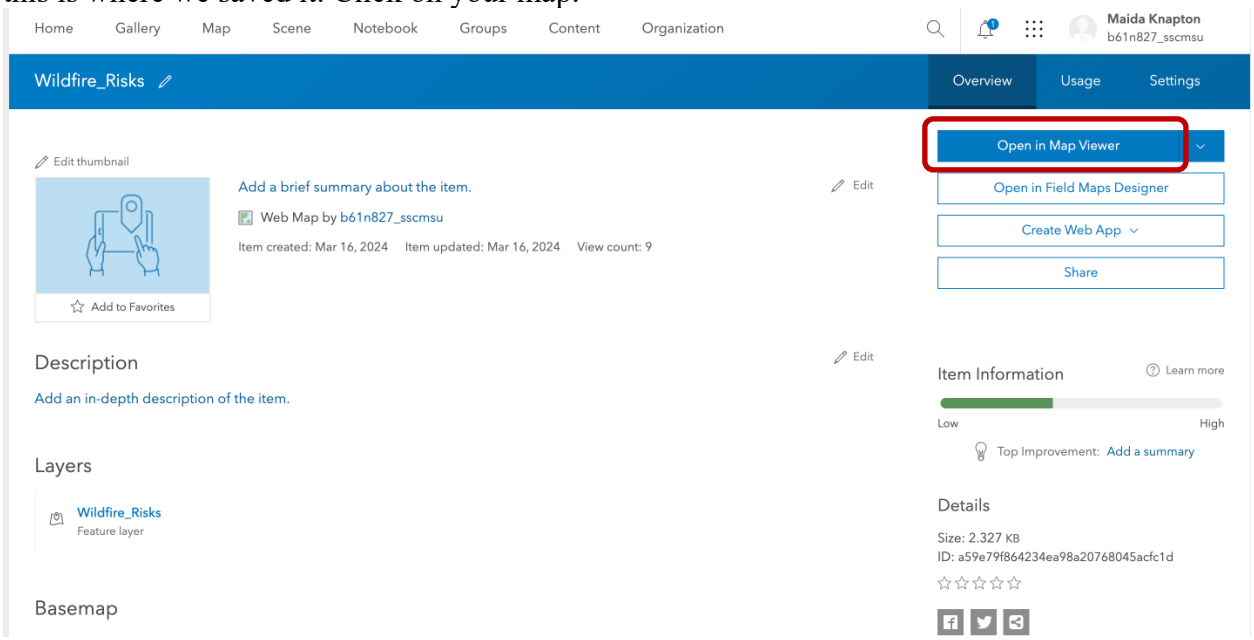


Image A: When you find a potential wildfire hazard click the blue plus button in the lower right hand corner of the screen. NOTE: you must have a GPS accuracy of 30 ft or less.
Image B: Clicking on the blue button will give a pop up menu that shows the following elements you selected when creating your feature layer. Fill out the information on what it is you are mapping and the GPS accuracy you have (look at the top of your screen) in the info box and include a picture of your observation. Notice that the Latitude and Longitude of your point was recorded. Then click the **Submit** at the top right hand of your screen.

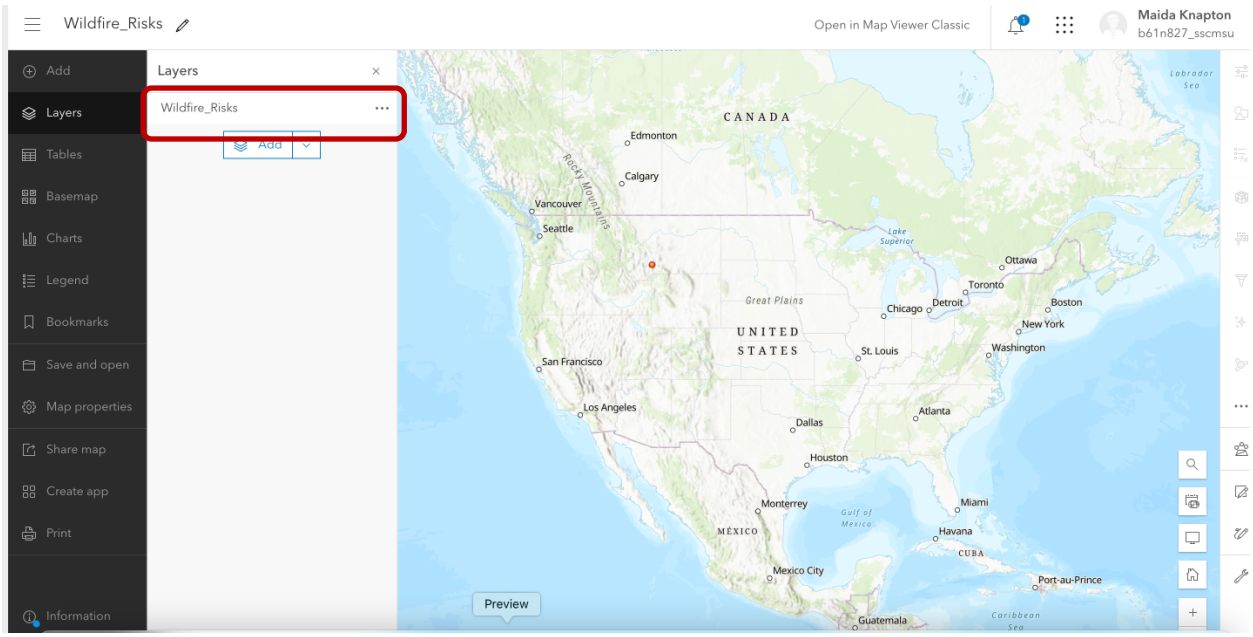
Step 4: Let's take a look at your observations on your map



Once back to the classroom go onto “arcgis online”. Once logged in click Navigate to your Wildfire lab folder. Your map will pop up in your inventory along with your feature layer, since this is where we saved it. Click on your map.



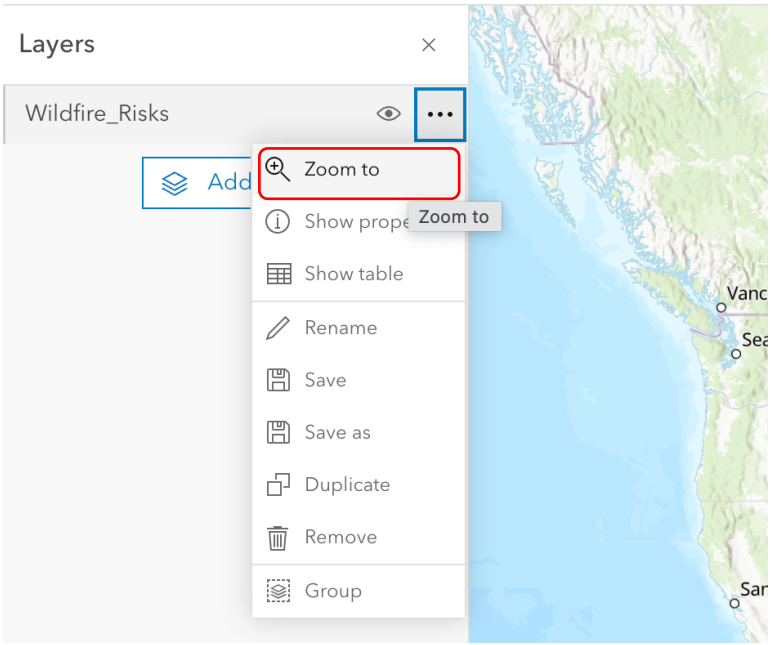
It will Bring you to the profile of your web map. Click **Open in Map Viewer**.



Great!! You have a map.

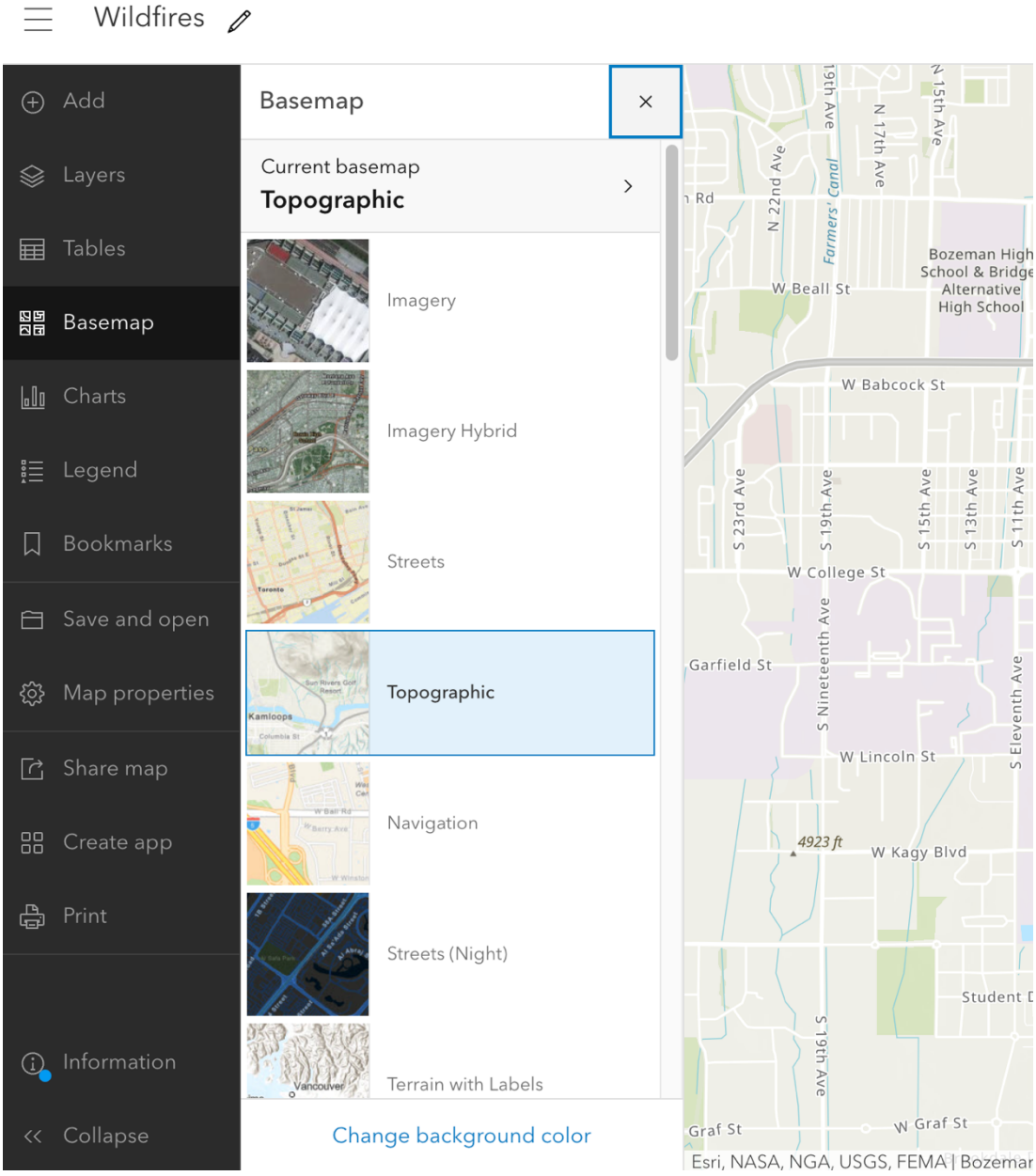
Now you have your map with your feature layer. Navigate to the upper left hand side of your screen, under layers you will be able to see the feature layer you created! This is where all feature layers will be located.

ks



Click on the three dots next to your Wildfire_Risks feature layer.
You will see a pop up with different options. Click **Zoom to** to zoom to your data points.

Step 5: Edit the Base Map.

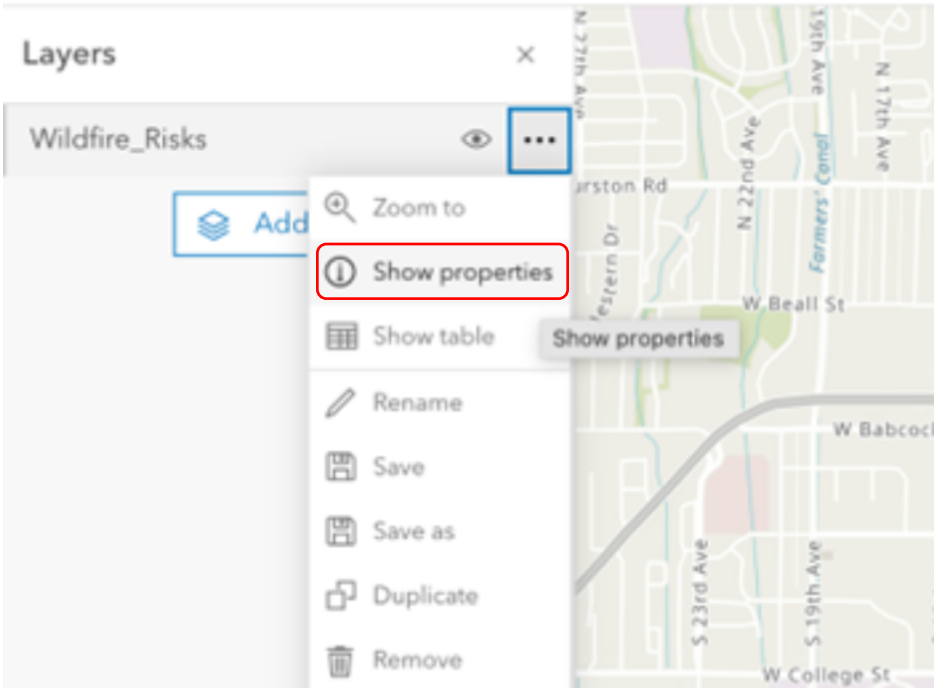


Navigate to the left-hand side of your screen. Click the **Basemap** option and change your Base map to what you think helps to represent your data best.

NOTE: In the next step we will change the symbology of our points. If you switched your symbology of your points around and are having a hard time seeing your data because of your base map, switch your base map!

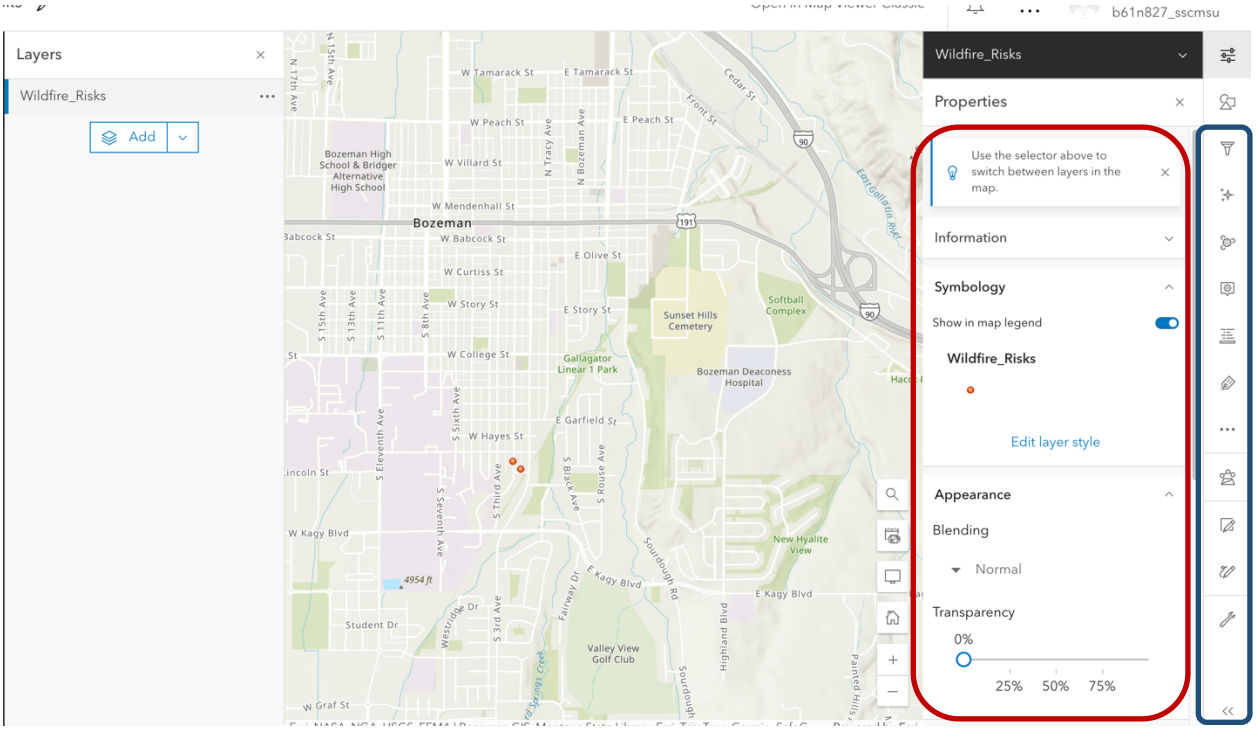
Step 6: Edit the Symbology of your data points.

What is symbology?

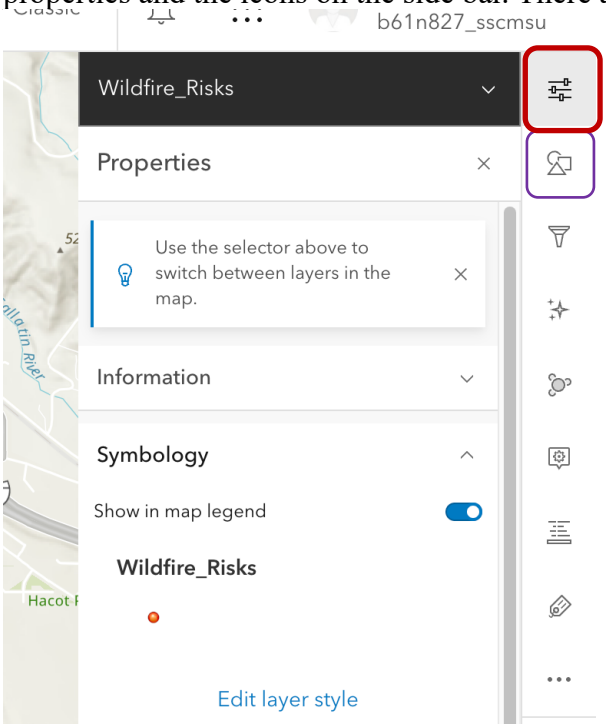


- **Symbology:** How we represent our data visually. If we are mapping fire hydrants and trash cans using points, we can change the color and symbol of the fire hydrants to look like a fire hydrant, and the color and symbol of a trash can to look like a trash can.

Cick on the three dots next to your Wildfire_Risks feature layer.
Select the **Show Properties** button.

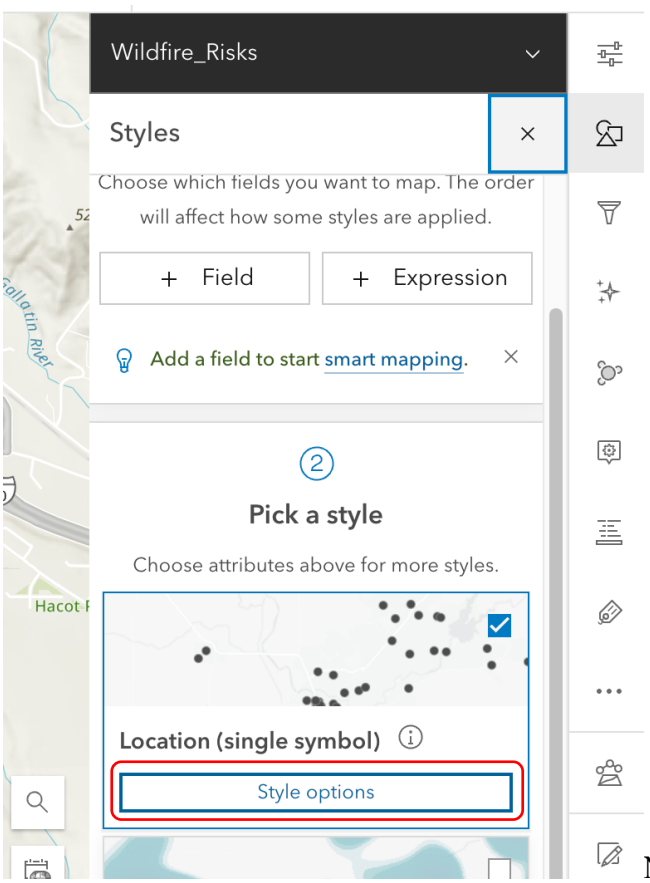


A new window will pop up in the right hand corner of your screen. This is where we can view the properties and edit the symbology (color and shape of our points). Scroll through the properties and the icons on the side bar. There are lots of Symbology options here!



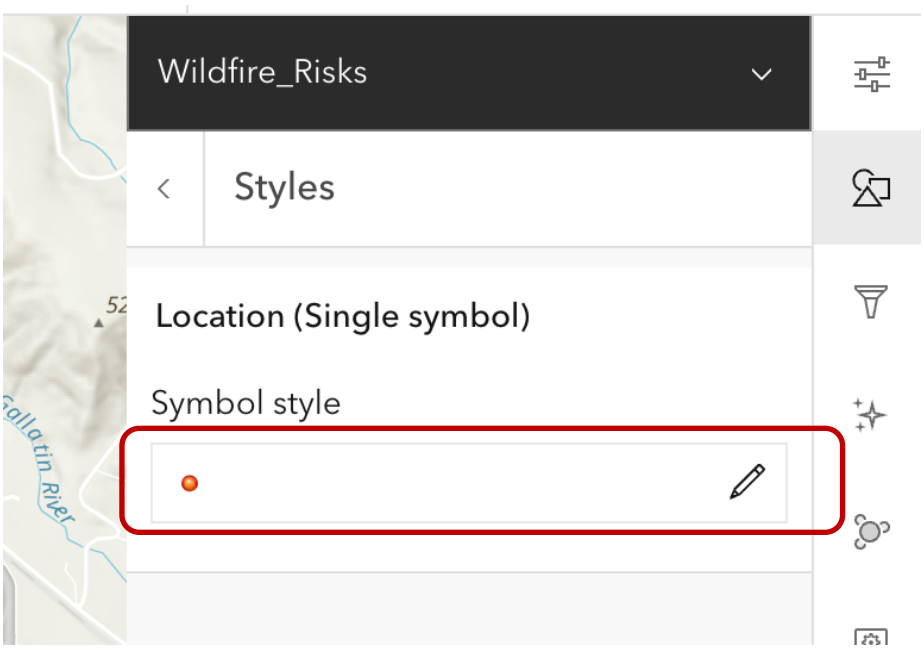
Let's change the shape of our point.

Currently, we are in the **properties** section (see the red box). To edit our symbol, we need to be in the **Styles** section (see purple box). Click on the **styles** box.

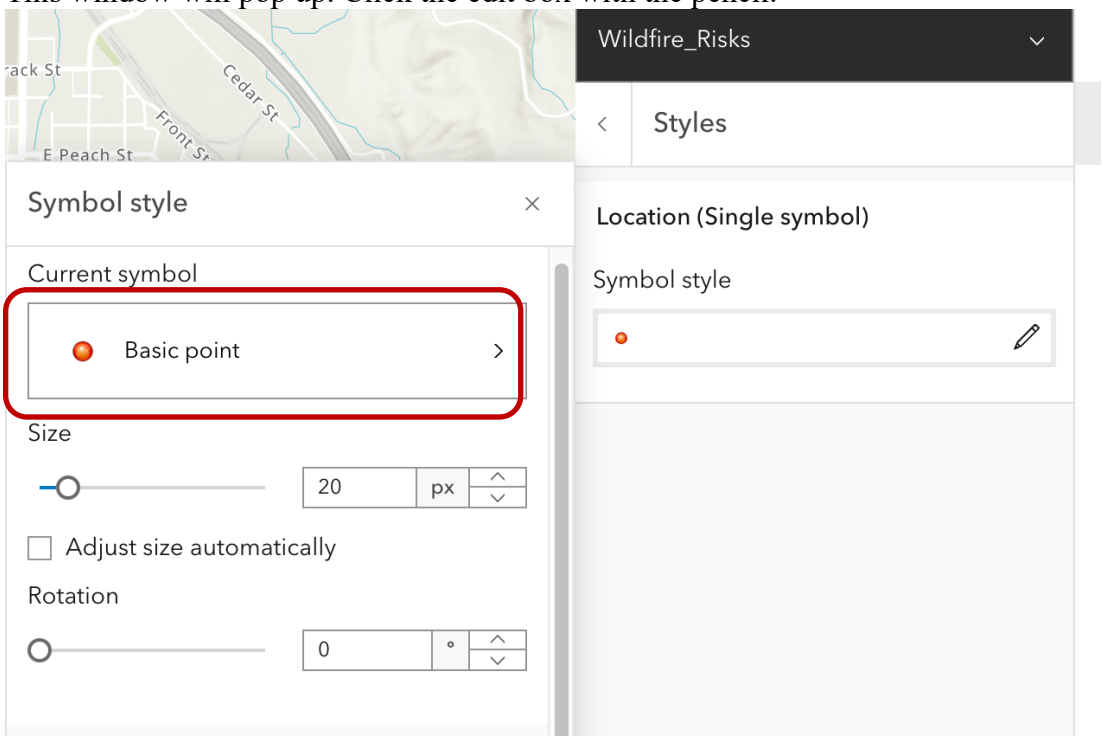


NOTE: if you hover your mouse over the icons on the right-hand side, they tell you what they are.

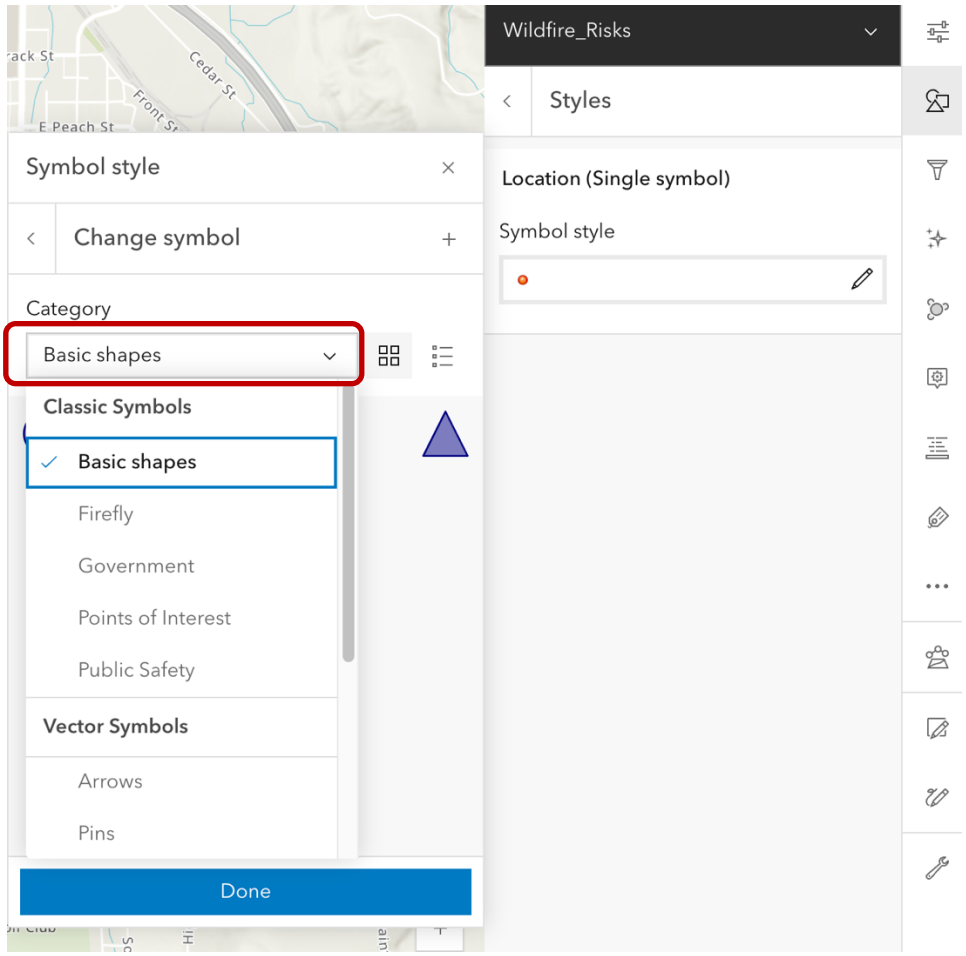
Click **Style options**.



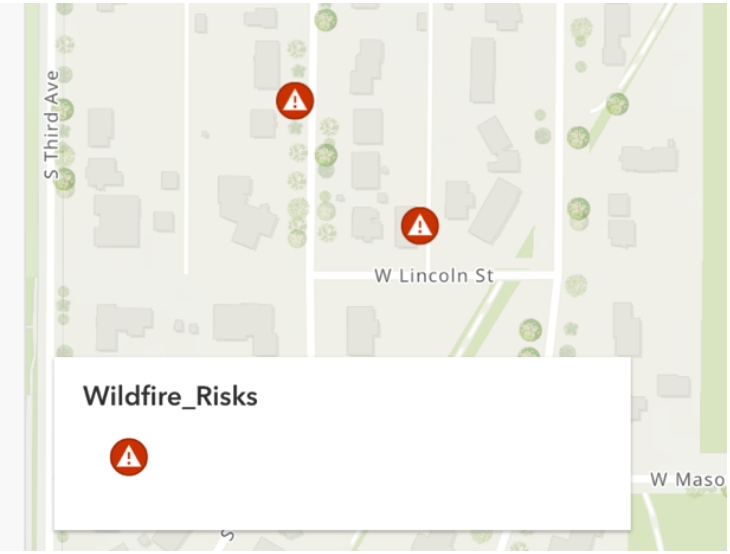
This window will pop up. Click the edit box with the pencil.



Now you can edit the size, rotation and shape of your point. To change the shape, Click **Basic Point**.



Click on the Category drop down. Scroll through the different symbol options. I recommend clicking on **Government** and/ or **Public Safety**, they have great options. Once you have picked a new symbol, click **done**.



Here are my new symbolized points! Now navigate to the left-hand side of your screen, and in the selection bar, click the **Save and Open** button. Then click the **Save button.**

Great job! Next, in part 2 of this Wildfire lab we will learn how to import Secondary Data, and then make a map.

Engineering Design Challenges

Montana State University Geospatial Skills Camp

Overview of options:

Option A: Build your own air quality sensor and case (from NASA!)
Students begin by following a set of directions to build and program an air quality sensor created by NASA. Then students will compare this DIY sensor to commercially available air quality sensors (all camps will get the commercial air quality sensors for other activities in the camp) and design a case for their air quality sensor based on where the air sensor would be housed locally.

Option B: Tracking microplastics in water sources
Students begin by exploring tap water (or nearby sources) microplastics concentrations and learn about citizen science projects to track microplastics. Students will explore two methods to sample microplastics in water and will design a system that will enable them to measure microplastics in local sources.

Option C: On the hunt for grasshoppers and bugs
Students will use multiple tools to collect grasshoppers and other insects/bugs locally and track them using citizen science. Then students will design new ways to trap and track grasshoppers in their local area.

Introduction:

Our goal in these activities is to provide you with an opportunity to engage in the engineering design process. The picture below shows one framework for considering how to engage in engineering design.

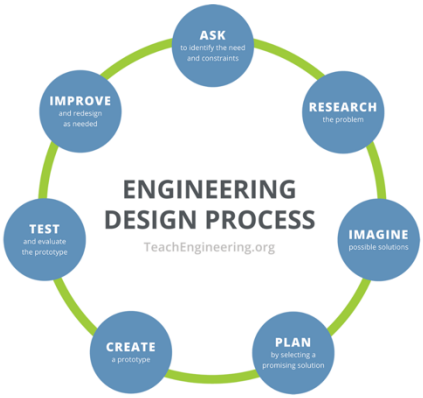


Figure 1: The engineering design process framework from TeachEngineering.org

Part 1: Defining the Problem – Ask & Research

In this section we encourage you to ask questions and research more about the problem you are trying to solve. This is a brief overview of the problems, but the key thing to remember is that you are solving the problem for your own camp location. This means you will make decisions about the project and figure out the problem collaboratively with your camp educator!

Project background:

OPTION 1: We are challenging you to build a device that will enclose your DIY air quality sensor or the ATMOtube. You should think about where you will put the device to make air quality samples.

OPTION 2: We are challenging you to create a system to capture grasshoppers and/or other bugs for identification purposes. This will build on what you learn from local experts.

OPTION 3: We are challenging you to create a system to help visualize the presence of microplastics using UV light and a camera.

Step 1: Ask questions to identify constraints

Create a list of questions to ask yourselves and your camp educator. Here is an example set of questions:

- Are we going to be enclosing a sensor?
- Will our device be hanging?
- Will our device be open to rain/water in some way?
    - Can the device be exposed to the amount of water that your location is likely to get (you may want to look at the ATMOtube information online. If it is the DIY Air Quality version, this should not be exposed to any water).
    - If you are designing a system for visualization in option 3, you might want to consider whether you will take samples in the field and bring water back to the camp, or if you will be visualizing the water near the water source. This might influence how much water your device might be exposed to.
- Will animals messing with the device be a concern?

Step 2: Research

To research as an engineer, you may need to explore online whether there are similar sensor cases (hint: you do have both the Kestrel and the ATMOtube that you could compare) or methods of visualizing and how are they used. You may also need to research the conditions of the location you want to take air quality, water, or bug samples with. This research might include making measurements directly (of both the location you will store your device, and of the device itself) or exploring maps of the location. For instance, are you going to be collecting water in a stream or lake, air quality near a road or in a forest, or bugs in a small garden or a large field.

At the end of part 1, make a list of the design requirements for your device/system. This list should be prioritized from high to low. You may need to consider what materials are available to you from your camp educator as there may be constraints on what materials can be used!

Part 2: Designing Solutions – Imagining and Planning

We hope you are now ready to begin designing solutions! Create a sketch of what you would like to build and, on that sketch, make notes about how you are addressing the design requirements you listed at the end of part 1. Ideally, each member of the team will create a design so you

Part 3: Prototyping, Testing, and Iteration – Create, Test, Improve

Step 1: Create a prototype

Based on the design requirements and your sketches, create a prototype of your case for your device.

Step 2: Design tests for your prototype

To determine whether your prototype will successfully meet the design requirements, you should engage in testing the prototype. Typically, engineers use a combination of computer tests and hands-on tests. Sometimes the computer tests will be used before the hands-on tests to make them more efficient (for instance, force-testing material strength before they purchase materials). For our camp, we will not have you engage in computer modelling of your design, but feel free to research what that might look like! Engineers also will often run multiple tests, which you may or may not have time for. One important test to consider is whether the case you have made prevents the air quality sensor from functioning. As a team, you should decide how to test that your air quality readings are the same whether your sensor is in the case or outside of the case! If you can, run this test multiple times to make sure it works!!

Step 3: Improve your prototype

Based on the results of your test, you may need to make iterations, or improvements, to your design. Maybe your design was too heavy, or too big. Or when the air sensor was in your case you got different readings. It might be helpful to create a chart that shows the changes you make based on the test results.

Test result/issue	Improvement/iteration	New outcome

Identifying Human Wildfire Risks

Montana State University Geospatial Skills Camp

Lab 03.2: Learning about Secondary Data

Introduction:

In part two of this Fire lab, we will be looking at wildfires across the USA that occurred in February and their geospatial relationship with human population.
Geospatial relationships can be identified when we draw inferences from the spatial relationships between the wildfires across the USA that occurred in February and areas with a high density of human population. To do this, we will be downloading and importing our own data into our Wildfire_lab folder in ArcGIS online, and then creating a map with the data.

Objectives

- Learn how to use secondary data to make a map in ArcGIS online.
- Create our own map using the secondary data.

Terms & Definitions

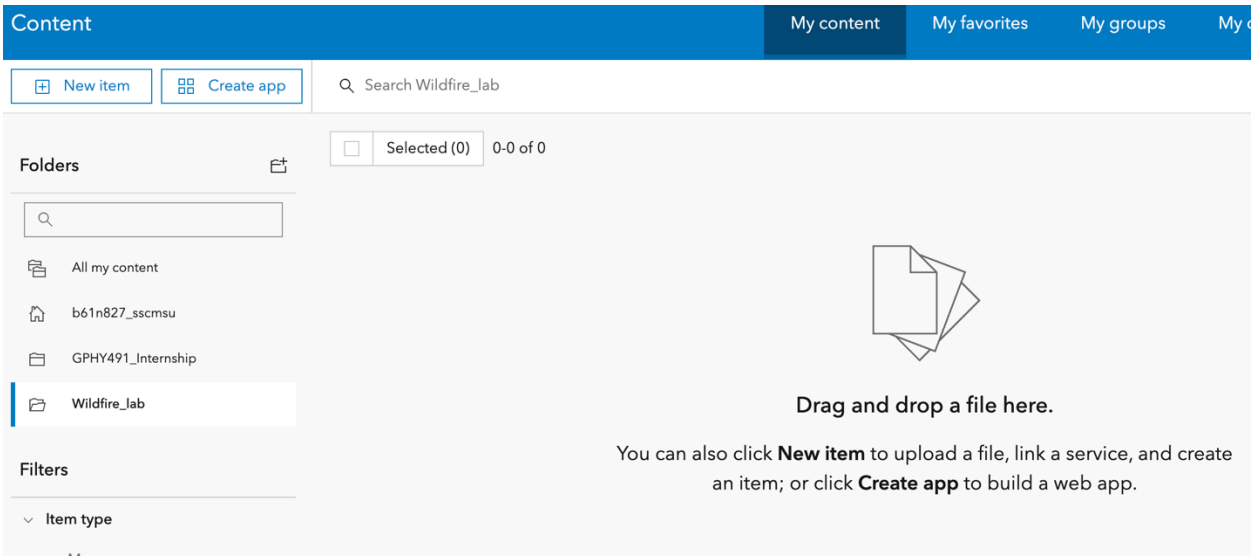
- **Primary data:** data that you produce or create to answer your own spatial question.
- **Secondary data:** data that an individual or organization has created that you downloaded are now using and/ or adapting to answer your own spatial question.
- **Vector Data:** spatial data represented by points, lines and polygons.
- **Feature layer:** is layer of data that can be either Primary or Secondary data, and it includes the item or focus that is being mapped. For example, if we create a Feature layer of fire hydrants, the layer should show all of the fire hydrants in an area and any other information relevant to the hydrants.
- **Symbology:** How we represent our data visually. If we are mapping fire hydrants and trash cans using points, we can change the color and symbol of the fire hydrants to look like a fire hydrant, and the color and symbol of a trash can to look like a trash can.

Using Secondary Data to look at Fire Risks

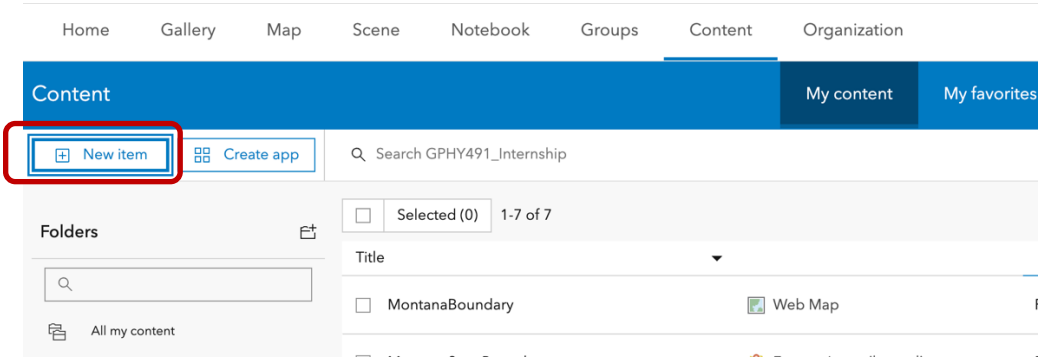
Adding Feature Layers from Secondary Data Files

In order to begin to import secondary data files into our online ArcGIS directory, we need to first make sure we have created folders to store our projects and data in that are organized and easily recognizable. This is a big factor in making our projects go smoothly! The following steps will help you to create an organized content page.

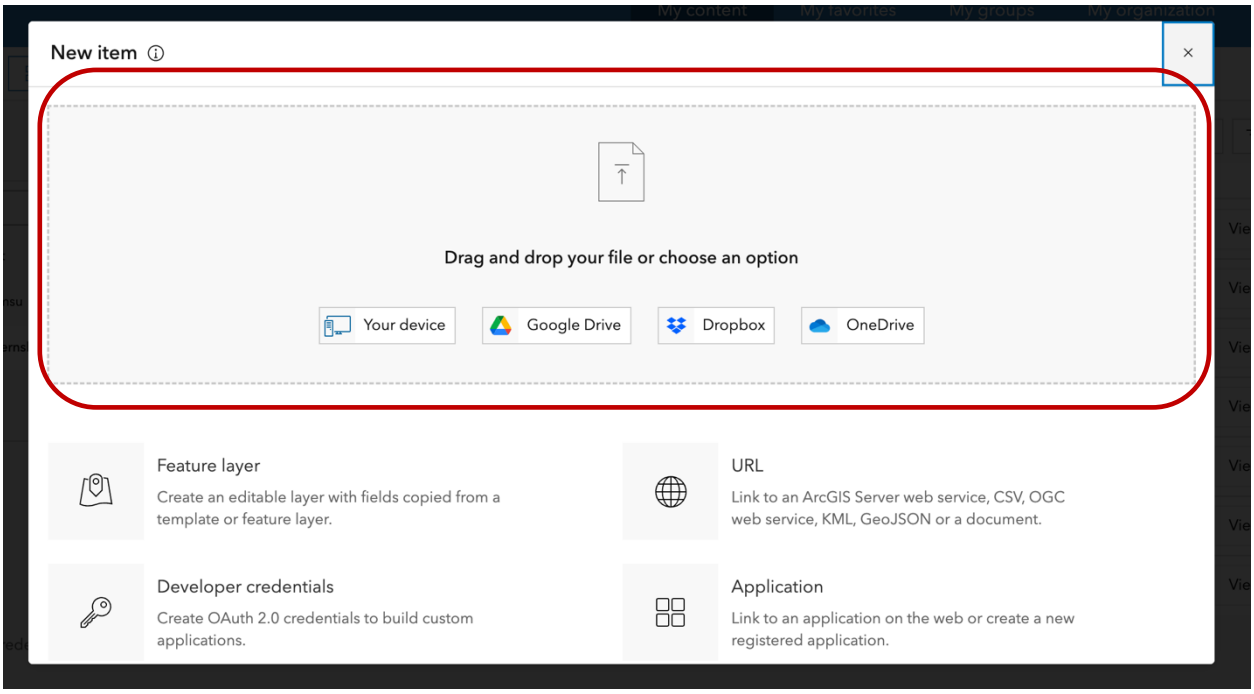
Step 1: Import our Secondary Wildfire data into our Wildfire_Lab



Navigate to ArcGIS online, and to your content. Make sure you see your Wildfire_lab folder that we made from Lab 03.1!



Click the **New Item** icon on the left hand side of your screen.



A window will open where you can add files by dragging them from your Onedrive and dropping them in the pane, or in the pane you can choose a connection to your own file directory. NOTE: If you are importing your data from the connection option, make sure pop-ups are disabled on your device otherwise this option will be blocked. It does not matter what way you decide to import your data, as they both pull from the same source.

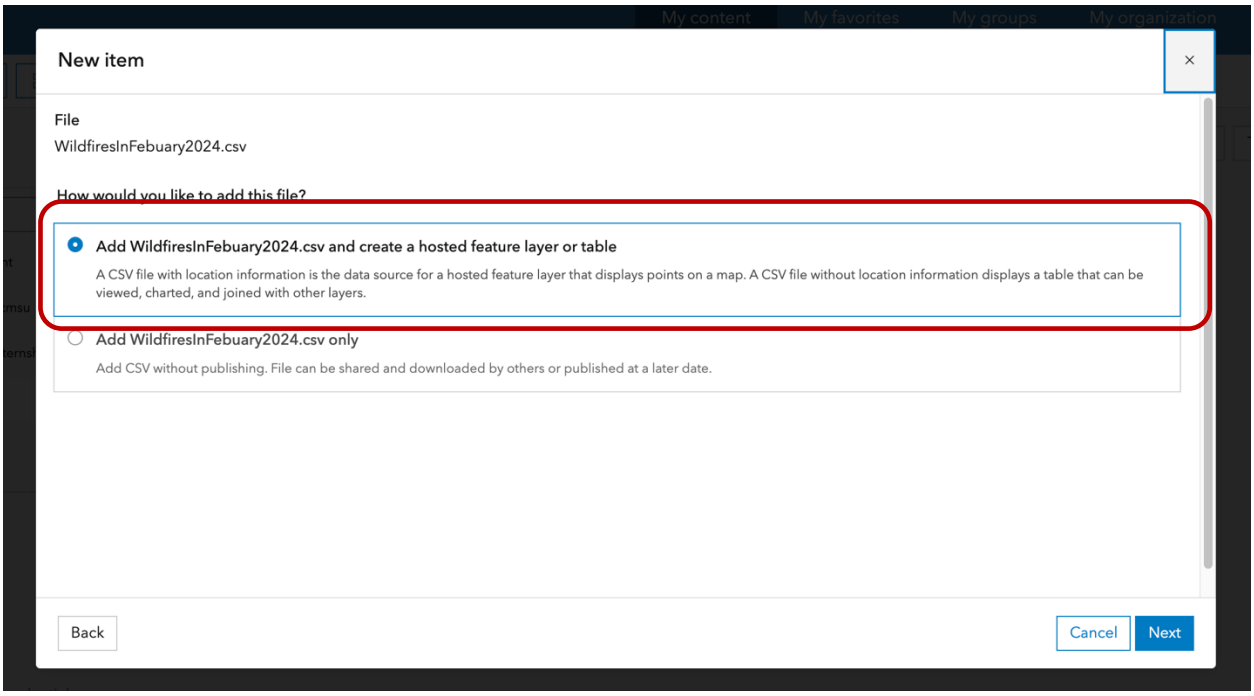
The first file that you will be uploading will be named WildfiresInFebuary2024.csv .
What is a CSV file and what does it look like? Navigate to your Wildfire_lab folder in your Onedrive and double click on the WildfiresInFebuary2024.csv.

- A CSV is a data sorage method that uses rows and columns to organize fields.

Scroll through the Columns until you find the location defining fields. What is this file structure using in order to store the location of the fires on our Earth? Think about what Coordinate systems are used for and what we discussed in the Map Projections Lab.

- See the X and Y labeled columns. Note: the InitialLongitude & InitalLatitude columns also represent location defining fields, however, ArcGIS online only will use the X and Y column as the location defining field since it is a universal way of defining locations.

Now that you understand how a CSV stores data, and the Fields that are included in the WildfiresInFebuary2024.csv lets import it into our ArcGIS online Wildfire_lab folder.

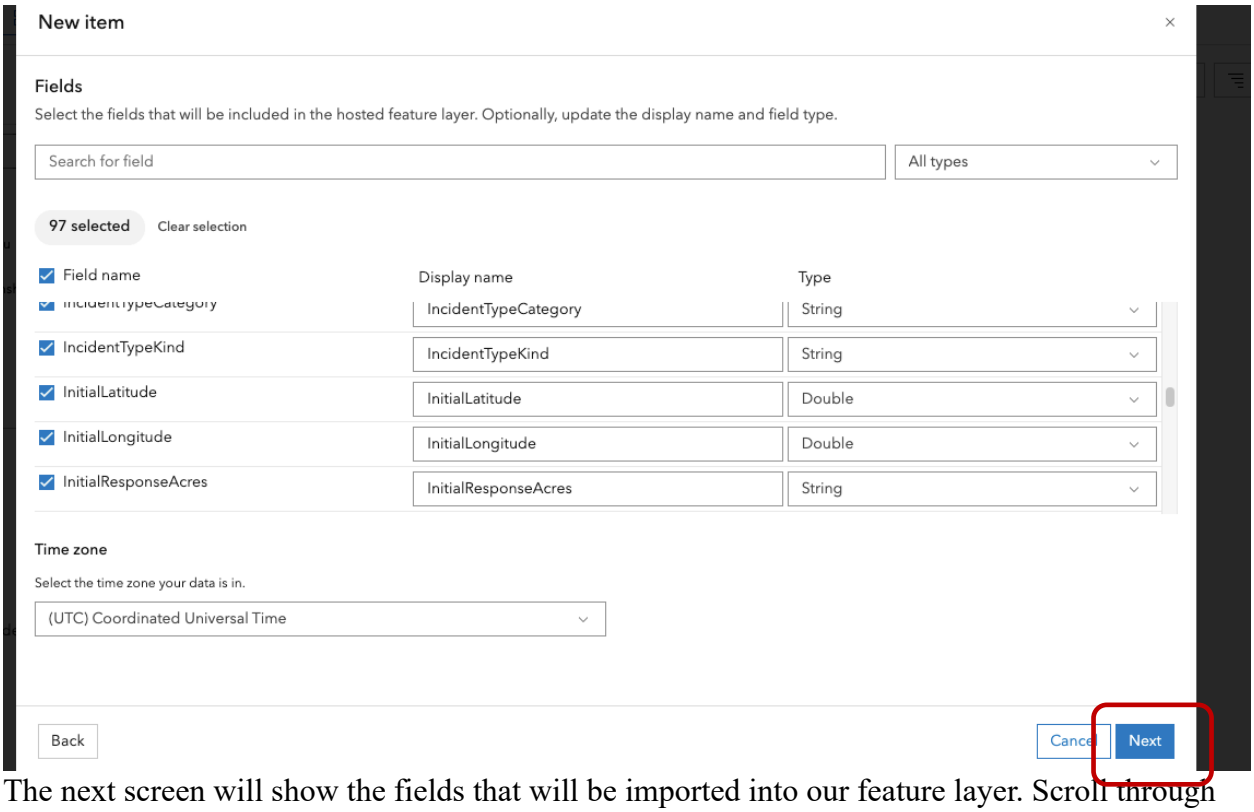


After you added the WildfiresInFebuary2024.csv file, we will need to select a few preferences on how we want to import our data. The first thing you will be asked is if you want to add your file with location data (AKA the Latitude and Longitude column, Represented as X & Y), which we do! As this will give us the location of the fires as points, and we will then be able to see them on our map. So, make sure the button **Add WildfiresInFebuary2024.csv and create a hosted feature layer or table is** selected.

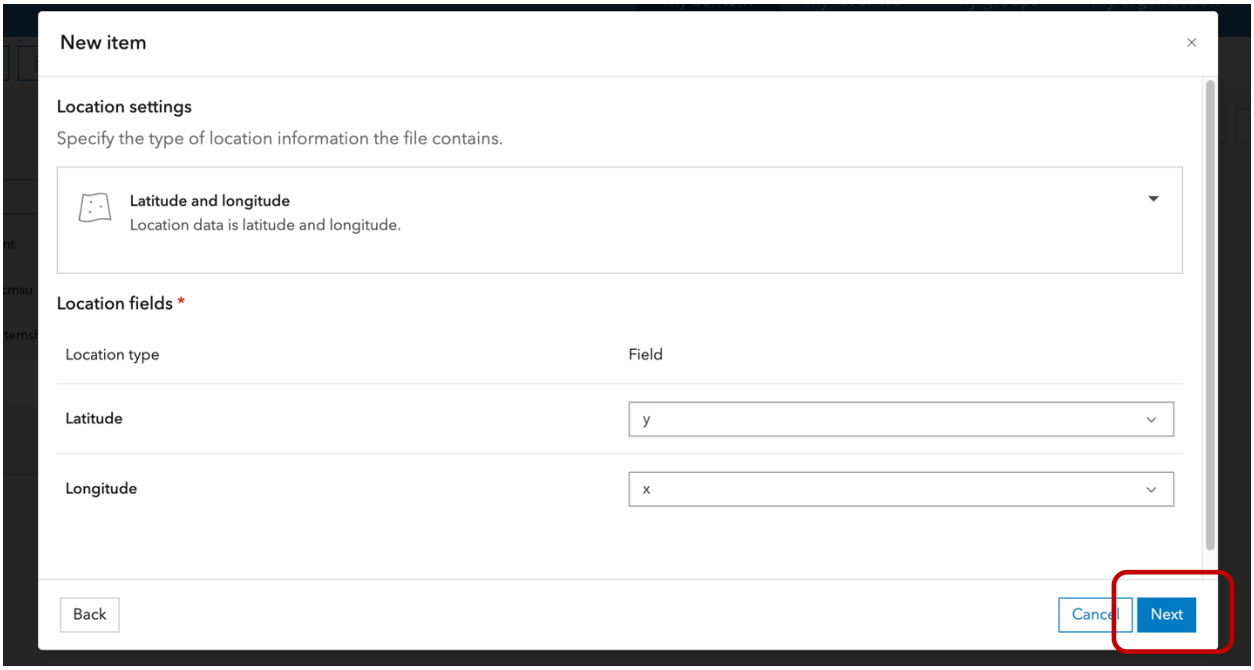
This process creates a **feature layer**.

What is a Feature Layer?

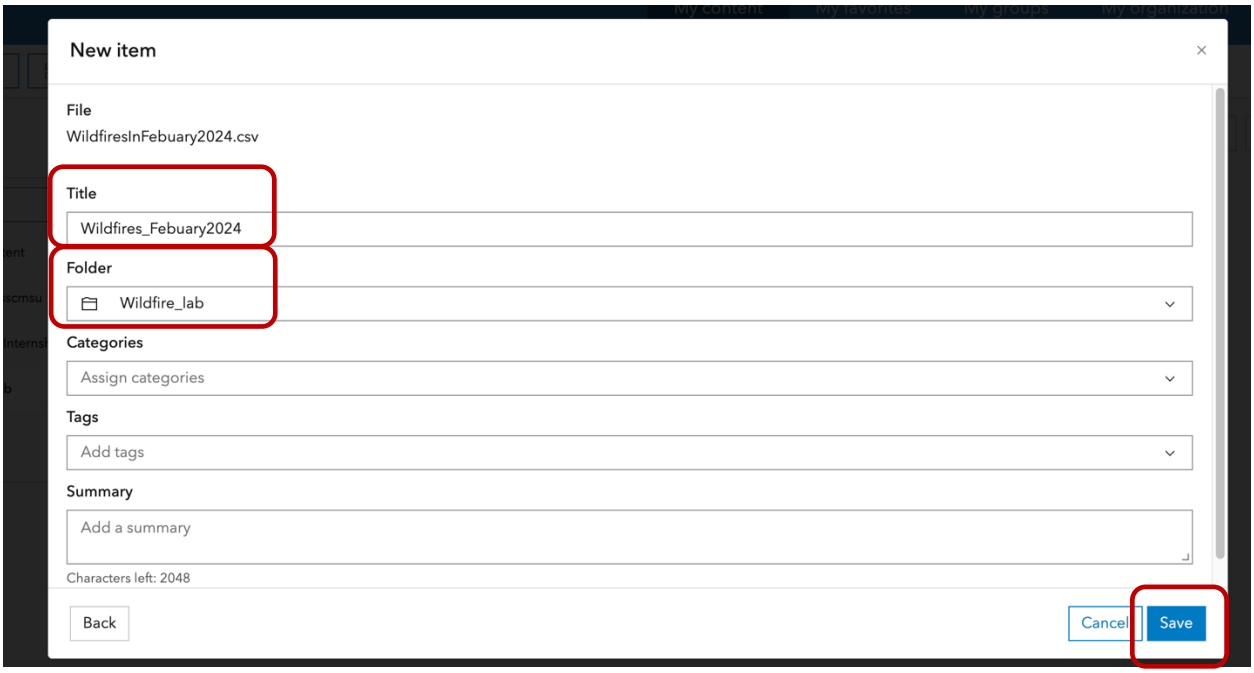
- A feature layer is a layer of data that can be either Primary or Secondary data, and it includes an item or focus that is being mapped. For example, if we create a Feature layer of fire hydrants, the layer should show all of the fire hydrants in an area and any other information relevant to the hydrants.



The next screen will show the fields that will be imported into our feature layer. Scroll through the **field name** section, these are all of the column's heads from the WildfiresInFebuary2024.csv . We will keep all current selected options as is. Click the **Next** button.



The next screen is where we will specify our Latitude and Longitude. Keep the original selection and hit next.



The next screen is where you name your file and save it into your Wildfire_Lab folder. In the title area, name your feature layer Wildfires_Febuary2024 and under the folder area save the feature layer to your Wildfire_lab. Press Save.

Great! Now you have created your first feature layer from secondary data! ☺

Step 3: Next, we will be adding the US major Cities data file.

US Major Cities

Now that you know how to import a CSV, we will be repeating the same process with data on the US major cities. This data set was downloaded from The US Census Bureau Website, which is a government organization that conducts demographic, economic, and geographic studies to provide public data about its people and economy.

Open the USA_Major_Cities.csv Data set in your OneDrive and look at the fields.

Scroll through the Columns and locate the X and Y columns, and the Population Column. Did you find them?

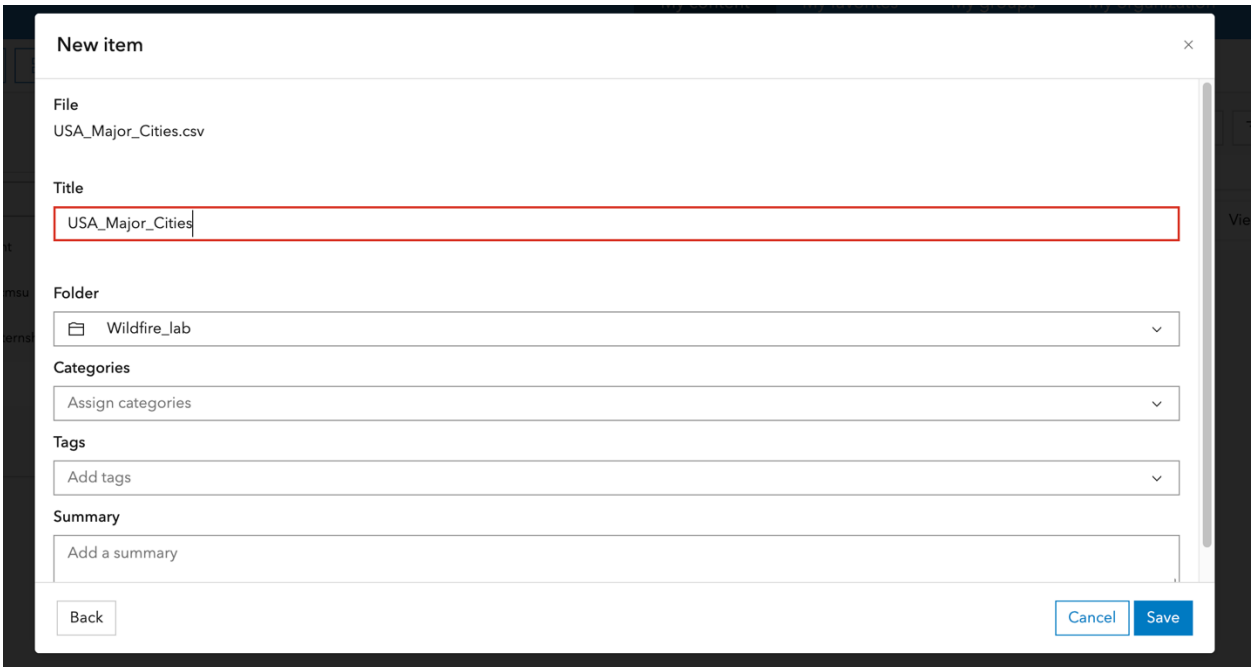
- These fields are essential, as we need the number of people in each city, and the location of the city in order to compare the location of the Cities to the location of the February Wildfires.

Create a new item, and then drag the USA_Major_Cities.csv dataset into the window.

In the next window, make sure you add your file with location data, just as we did with the WildfiresInFebuary2024.csv . Click next.

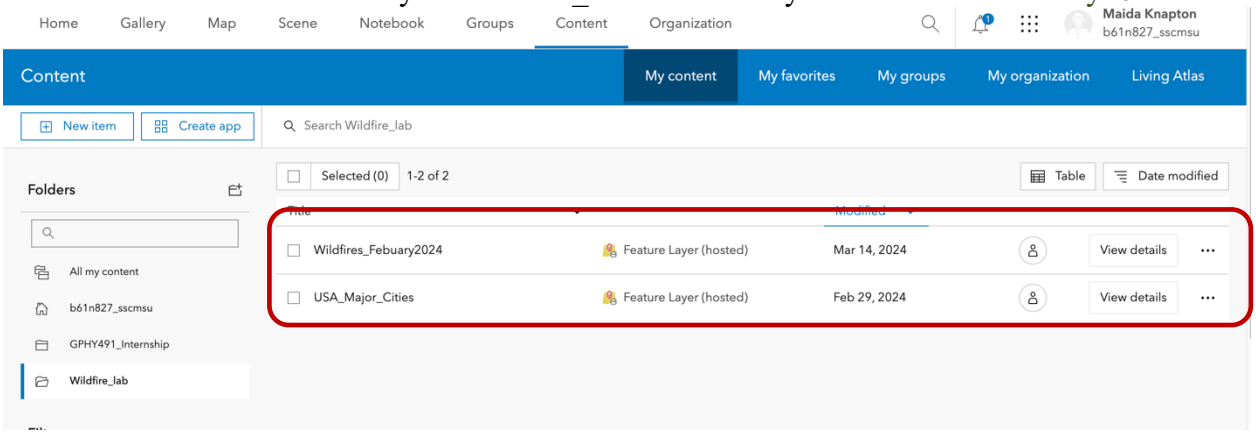
In the next window, double check the field names and make sure the **X, Y** and **Population** is selected. Make sure you keep all of the original selections! Click next.

In the next window you will see the **Location** settings. Double check the **latitude** is set to **Y** and **Longitude** is set to X. Click next.



In the last window, Title your feature layer **USA_Major_Cities**, and save it in your **Wildfire_lab** folder.

Check to see if it was saved in your Wildfire_lab folder with your WildfiresInFebuary2024.csv



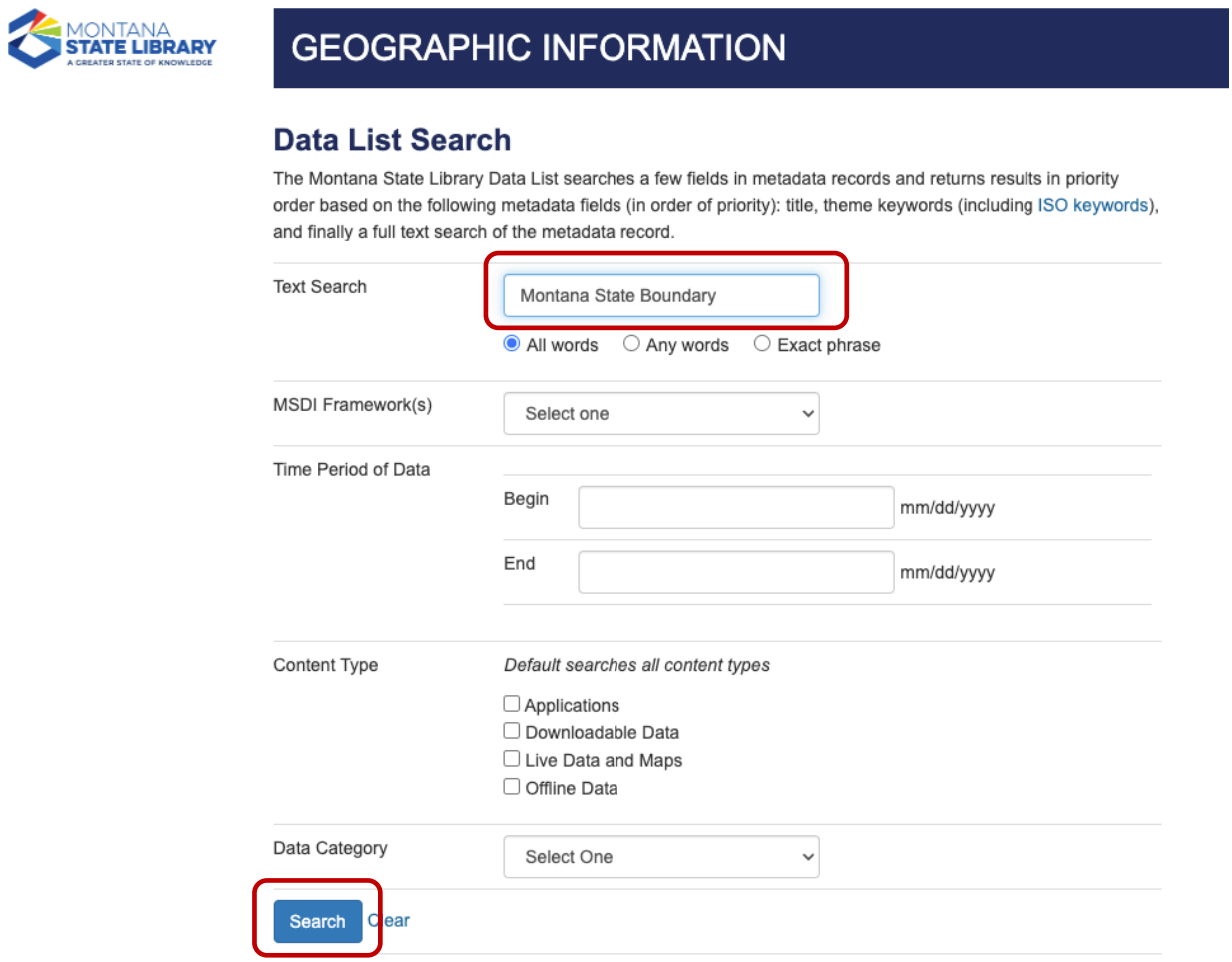
Great! You have created a feature layer for US Major Cities! ☺

Step 4: Next, we will be adding the Montana State Boundary data file.

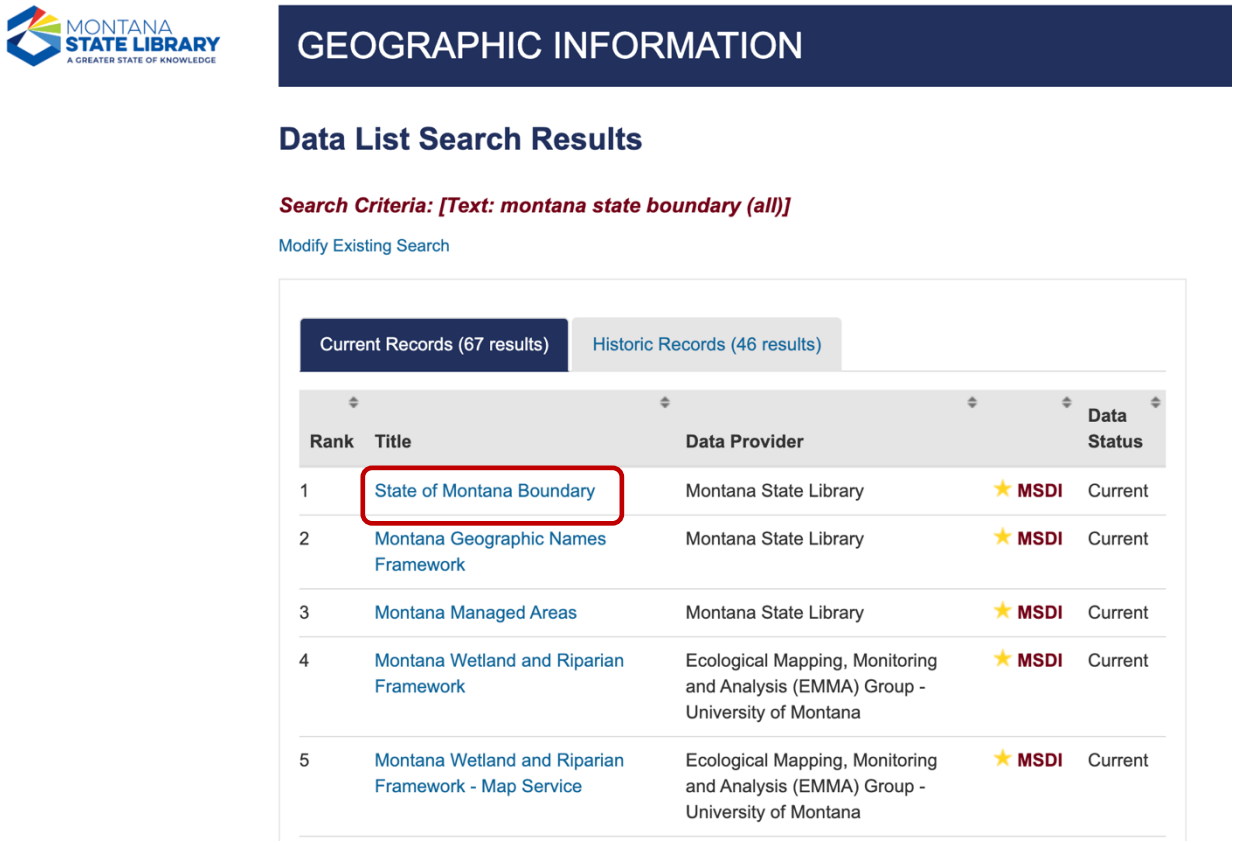
Montana State Boundary Data

For this next layer, we will learn how to download Geospatial data off the internet and import it into ArcGIS online. Many organizations such as the USGS, US Census, DNRC, and Montana clearing house have Secondary data open for public download.

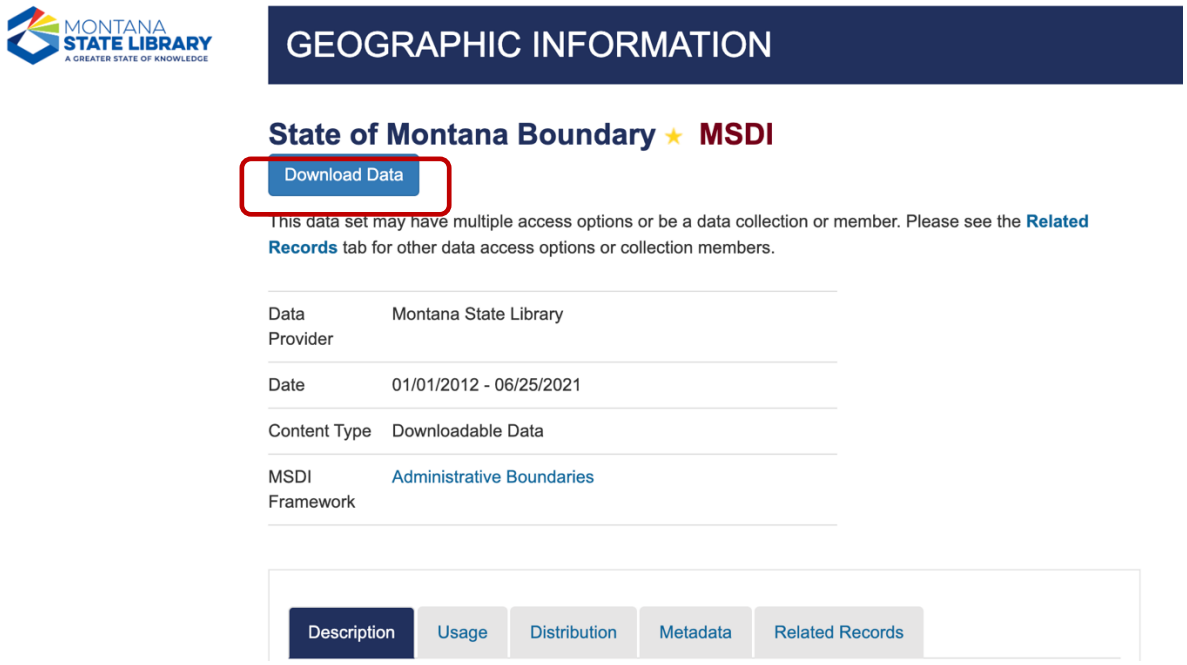
The Montana Clearing House is a is run by the Montana State Library, and we will use this to download the Montana State Boundary as it is free and has great datasets! Keep this in mind when you are working on your own projects. Navigate to the Montana Clearing House website from this link: https://mslservices.mt.gov/Geographic_Information/Data/DataList/default.aspx



The text search box is where we can use key words to find different data sets. In the Text search box, type **Montana State Boundary**. Click the **search** button at the bottom of the page.



The key words that we entered will have pulled up the following data sets. Click on the blue words for the data set titled **State of Montana Boundary**.



Click the **Download data** button.

ftpgeoinfo.msl.mt.gov - /Data/Spatial/MSDI/Admin

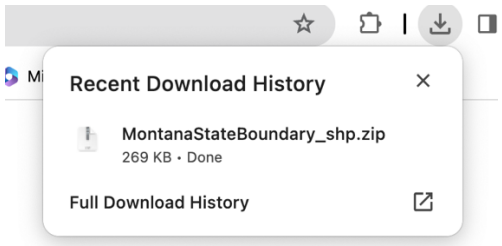
[To Parent Directory]

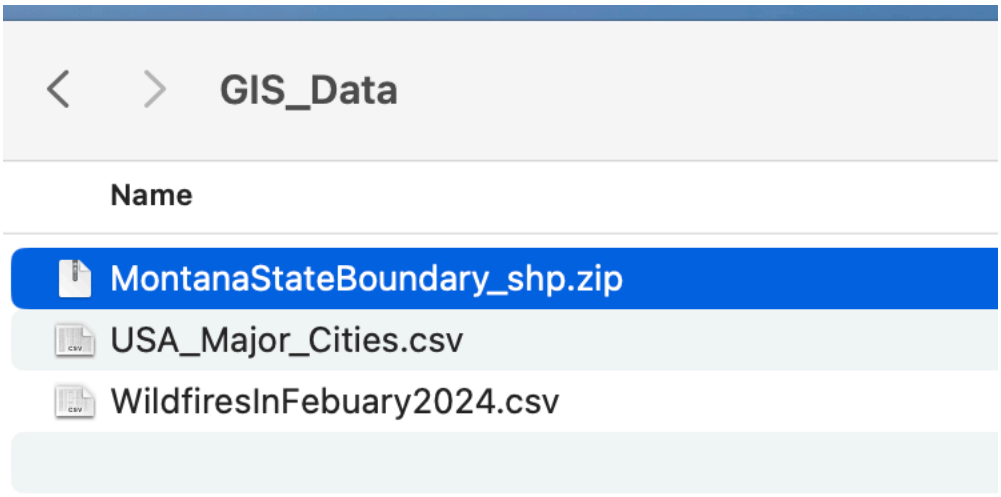
3/15/2023	2:27 PM	<dir>		CountyCommissioner_2020Census
3/9/2023	4:48 PM	<dir>		Elections
1/9/2023	9:48 AM	<dir>		Historic
11/24/2021	4:55 PM		10448	MontanaCongressionalDistricts.xml
11/24/2021	4:47 PM		356665	MontanaCongressionalDistricts.zip
11/24/2021	4:46 PM		619289	MontanaCongressionalDistricts_shp.zip
5/6/2019	2:18 PM		1170966	MontanaConservationDistricts.zip
5/7/2019	10:44 AM		1975160	MontanaConservationDistricts_shp.zip
7/1/2021	1:18 PM		14065	MontanaCounties.xml
7/1/2021	10:19 AM		74194223	MontanaCounties.zip
7/1/2021	10:19 AM		3491533	MontanaCounties_shp.zip
1/5/2024	12:01 PM		10977	MontanaCountyCommissionerDistricts.xml
1/5/2024	11:46 AM		10665129	MontanaCountyCommissionerDistricts.zip
1/5/2024	11:46 AM		4393234	MontanaCountyCommissionerDistricts_shp.zip
3/4/2024	12:20 PM		17952	MontanaIncorporatedCitiesTowns.xml
3/4/2024	12:20 PM		21700590	MontanaIncorporatedCitiesTowns.zip
3/4/2024	12:20 PM		1097463	MontanaIncorporatedCitiesTowns_shp.zip
1/30/2024	5:26 PM		5440	MontanaLegislativeDistricts.xml
1/30/2024	5:20 PM		7106155	MontanaLegislativeDistricts.zip
3/7/2023	7:56 AM	<dir>		MontanaLegislativeDistricts_2024_2032
2/28/2023	10:09 AM		4142	MontanaLegislativeDistricts_2024_2032.xml
2/27/2023	7:54 PM		3607055	MontanaLegislativeDistricts_2024_2032.zip
2/28/2023	10:45 AM		1324681	MontanaLegislativeDistricts_2024_2032_BlockList.zip
2/27/2023	10:03 AM		3175165	MontanaLegislativeDistricts_2024_2032_FINAL_REPORT.pdf
2/27/2023	7:55 PM		6491286	MontanaLegislativeDistricts_2024_2032_shp.zip
1/30/2024	5:20 PM		5996320	MontanaLegislativeDistricts_shp.zip
11/6/2023	4:37 PM		49503	MontanaManagedAreas.xml
11/6/2023	4:37 PM		5952917	MontanaManagedAreas.zip
11/6/2023	4:37 PM		11181977	MontanaManagedAreas_shp.zip
9/9/2021	2:03 PM		14962	MontanaReservations.xml
8/2/2023	1:53 PM		3601840	MontanaReservations.zip
9/9/2021	2:03 PM		15769	MontanaReservations_OffReservationTrustLand.xml
8/2/2023	1:53 PM		528233	MontanaReservations_shp.zip
1/5/2024	11:59 AM		17940	MontanaSchoolDistricts.xml
1/5/2024	11:48 AM		169551342	MontanaSchoolDistricts.zip
1/5/2024	11:48 AM		5745160	MontanaSchoolDistricts_shp.zip
7/1/2021	1:20 PM		12669	MontanaStateBoundary.xml
7/1/2021	10:18 AM		1671653	MontanaStateBoundary.zip
7/1/2021	10:18 AM		275528	MontanaStateBoundary_shp.zip
2/2/2024	12:55 PM		16076	MontanaTIFDs.xml
2/2/2024	12:54 PM		2854251	MontanaTIFDs.zip
2/2/2024	12:54 PM		250505	MontanaTIFDs_shp.zip
3/4/2024	1:31 PM		17071	MontanaVotingPrecincts.xml
3/4/2024	1:31 PM		124691654	MontanaVotingPrecincts.zip

The download button will take you to the list of data sets available. There are a lot, and it is kind of messy, but look at the blue text for the MontanaStateBoundary_shp.zip. Click the data file, and it will download to your computer.

What is a Shape File?

- A shape file is commonly used when we are storing Vector data that includes Lines and Polygons. Since the Montana state Boundary is a Polygon, we will need a shape file.

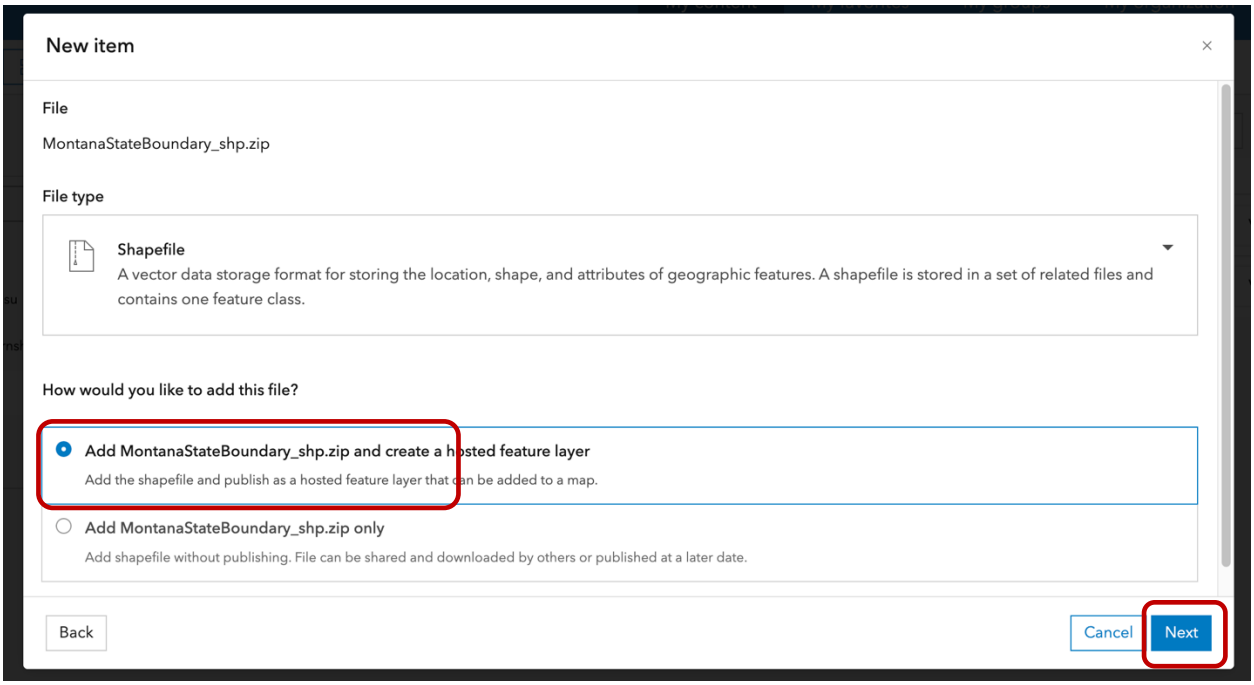




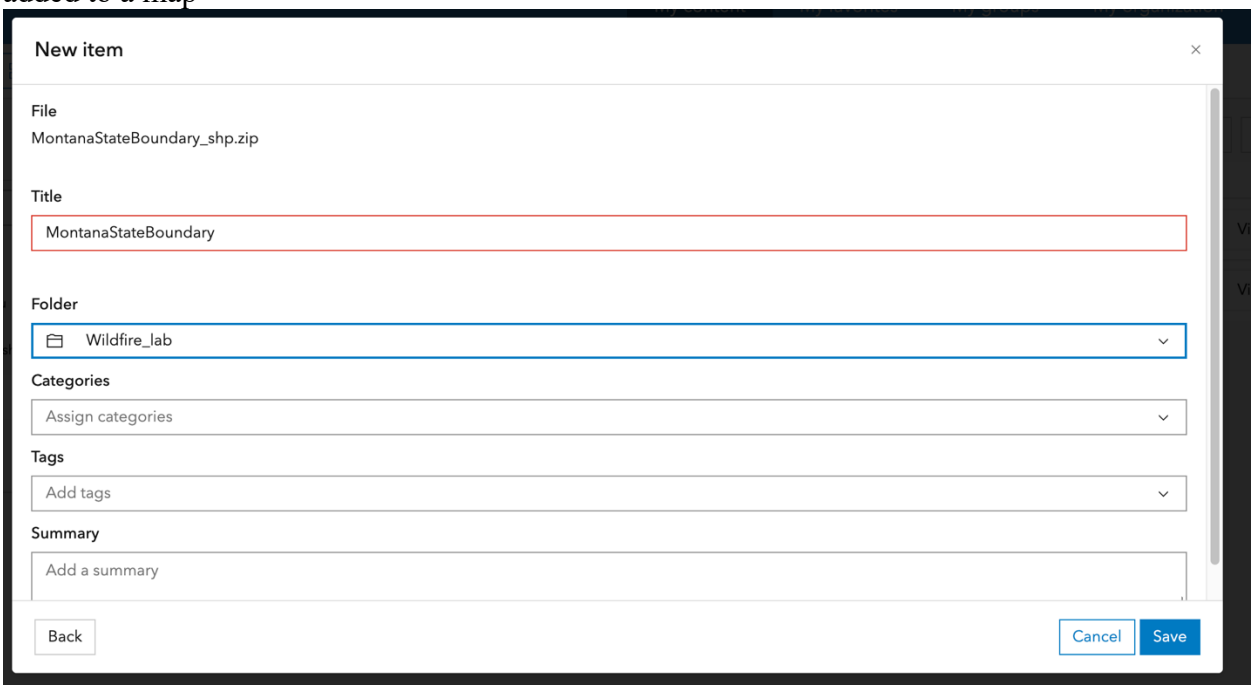
Next, we will drag our newly downloaded file into our OneDrive in our Wildfire_lab folder so that our files look like this. Currently the MontanaStateBoundary_shp.zip file is zipped closed (notice the .zip at the end of our file name). This means there are several files that are contained & compressed in a single file location.

We will need to import this zipped file into ArcGIS online as a Feature Layer. We will follow a couple of the same steps we did when we imported the Wildfire_Febuary2024 and the USA_Major_Cities. However, we have less selection to do since a shape file does not contain fields, and X & Y coordinates that need to be selected. Yay!

Navigate to your ArcGIS online. Create a new item, and then drag the MontanaStateBoundary_shp.zip zipped file into the new item window.



In the next window, make sure you add your file and publish as a hosted feature layer that can be added to a map



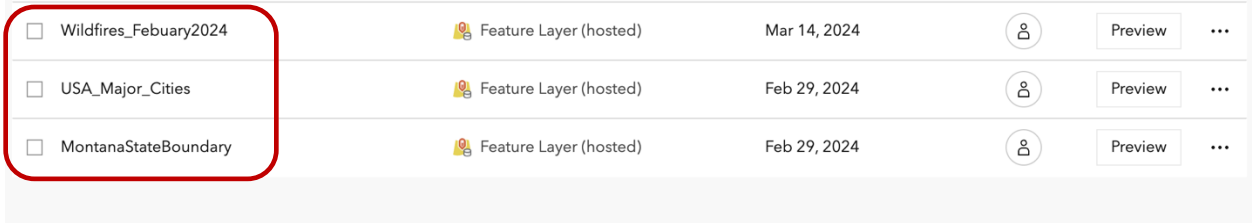
In the last window, name your file MontanaStateBoundary and save it to your Wildfire_Lab folder. Click **Save**.

Check to make sure all 3 secondary data files that you created are in your Wildfire_lab folder.

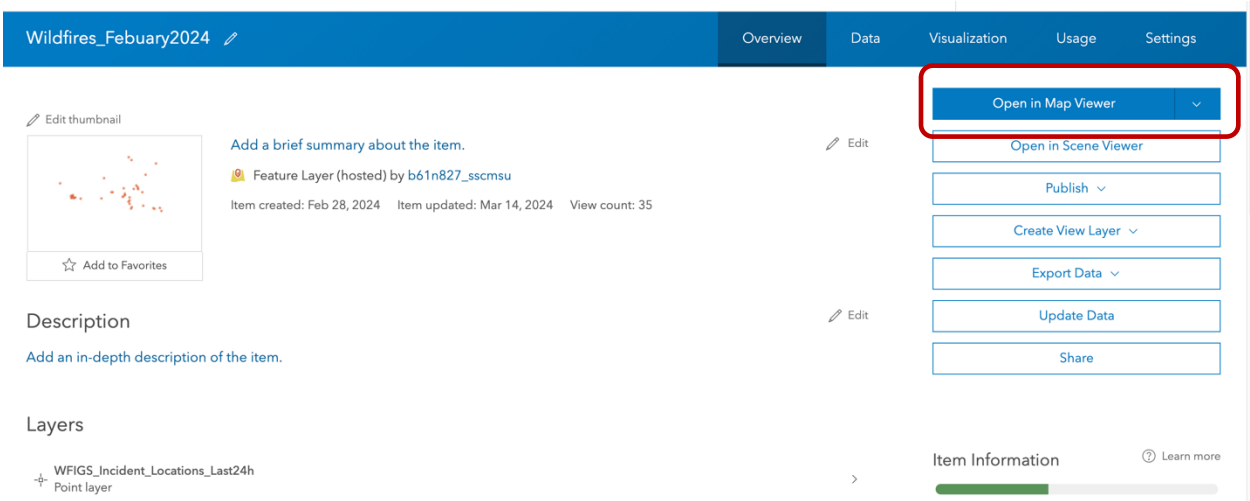
Now for the fun part! **Map making** ☺

Step 5: Creating a Map from our Feature Layers & making Spatial Inferences.

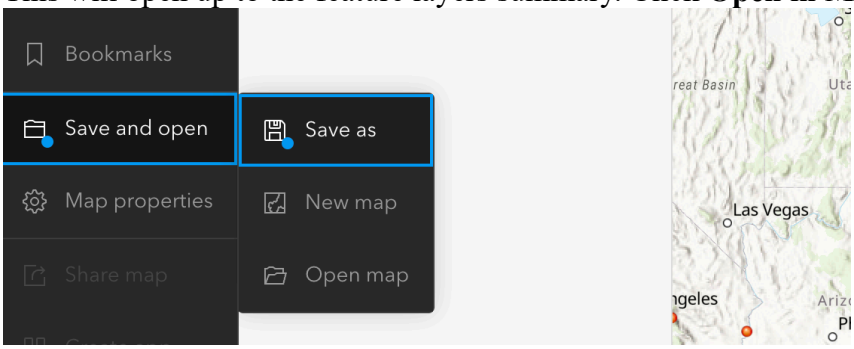
Navigate to your Wildfire_lab folder in ArcGIS online.



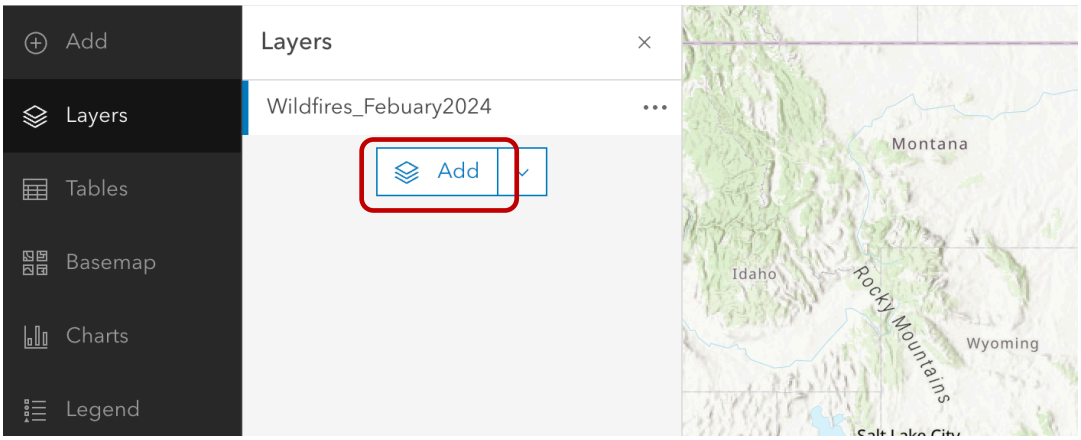
Click on any of your newly created feature layers.



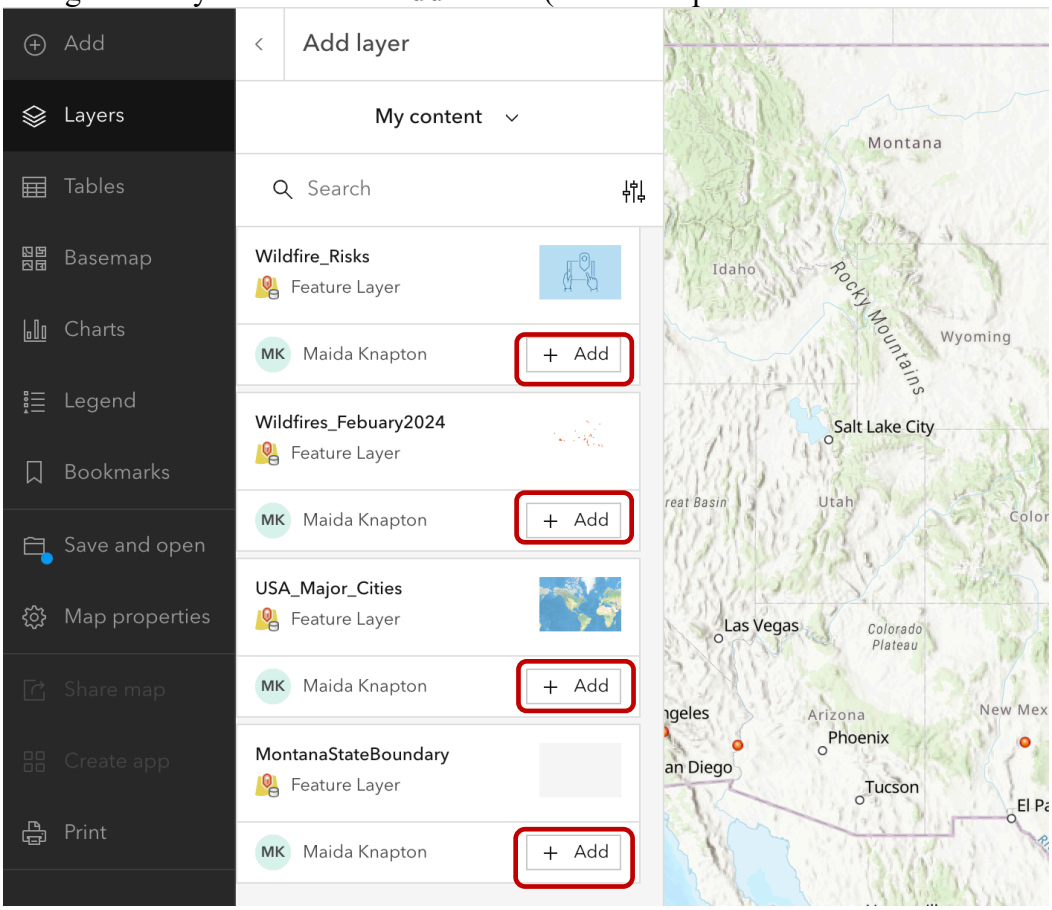
This will open up to the feature layers summary. Click **Open in Map Viewer**.



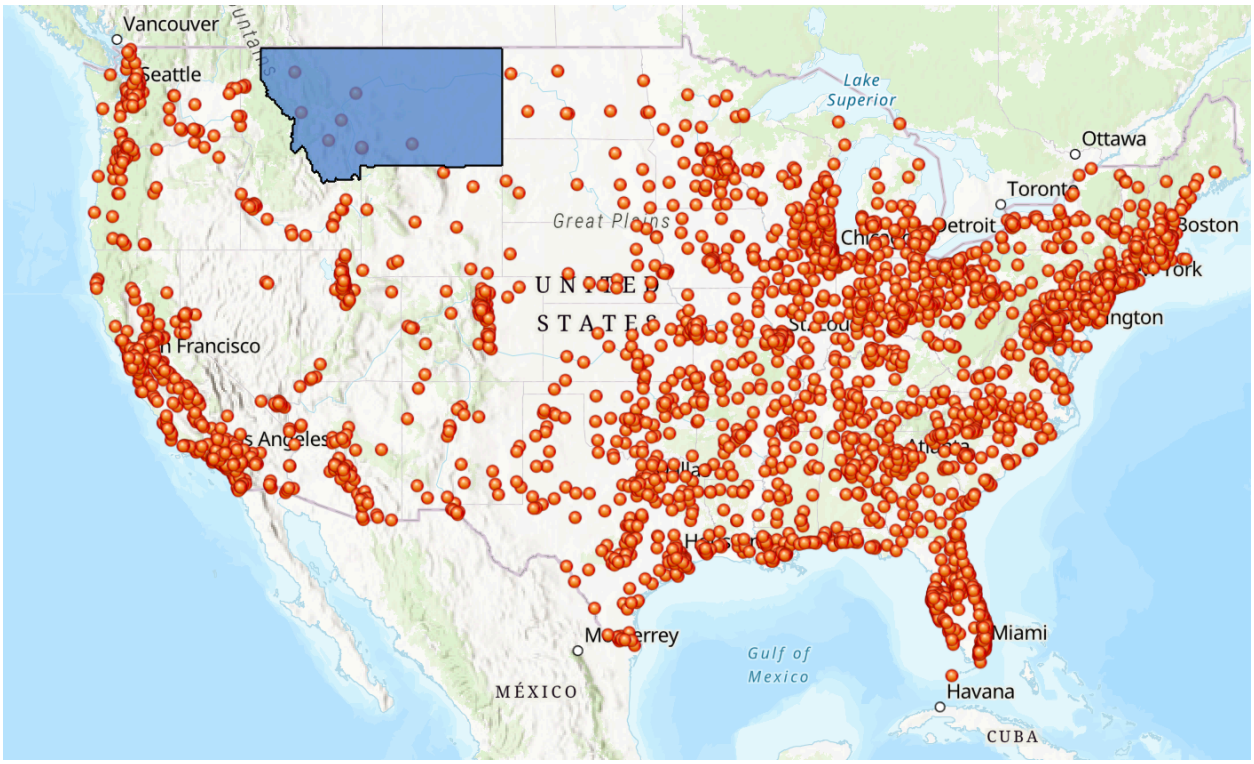
You will now see a map that includes your feature layer. The first thing we need to do is Save our map to our Wildfire_lab folder. Navigate to the left-hand options bar, and you will see the option Save and Open. Click **Save and open** and click **Save As**. Title your map Wildfires (or something similar). Save your map to your Wildfire_lab folder. Press **Save**.



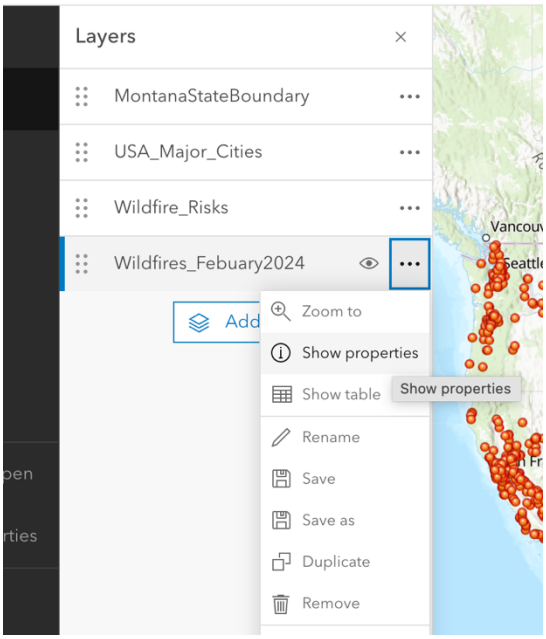
Next we will want to add the two other feature layers that we created to our current map. Navigate to Layers. Click the **Add** button (not the drop down arrow on the add button).



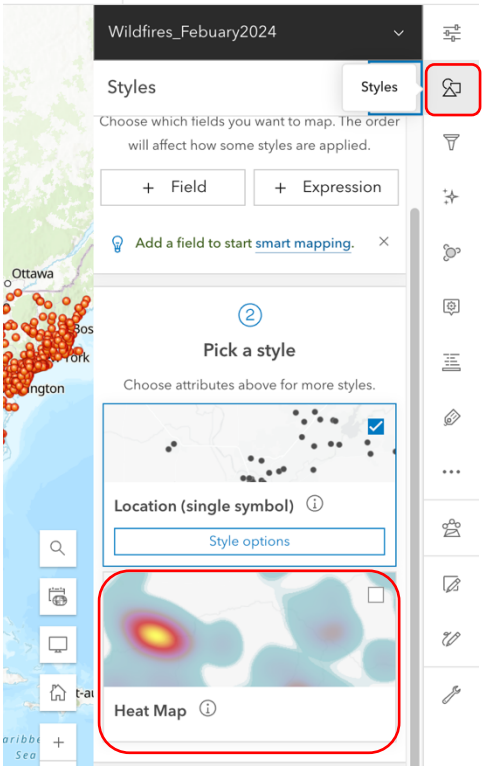
Add all of the feature layers we created (minus the one that is already on your map). Click the Add button next to each feature layer.



Now you have a map!! However, we have a problem…. Can you see what the problem is? All of our point data is symbolized the same exact way, so we have no idea what is what.
NOTE: when we symbolized our primary Wildfire_risks data (the ones we collected outside), we symbolized it on a map, and did not actually edit the feature layer itself. That's why your symbology for Wildfire_risk is not showing up on this map.

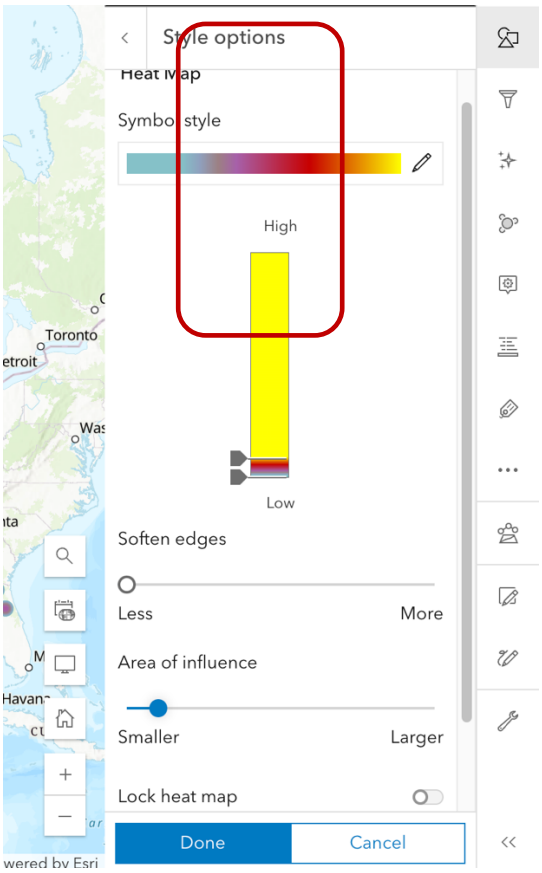


Let's do some symbology editing
First let's make our map a little less messy. Hover over the USA_Major_Cities. Click the eye on the right-hand side to hide the data points.
Now we can see a bit better.
Next, we will symbolize the February wildfires. Remember how to do this part? Let's start with Wildfires_Febuary2024. Click the show properties.

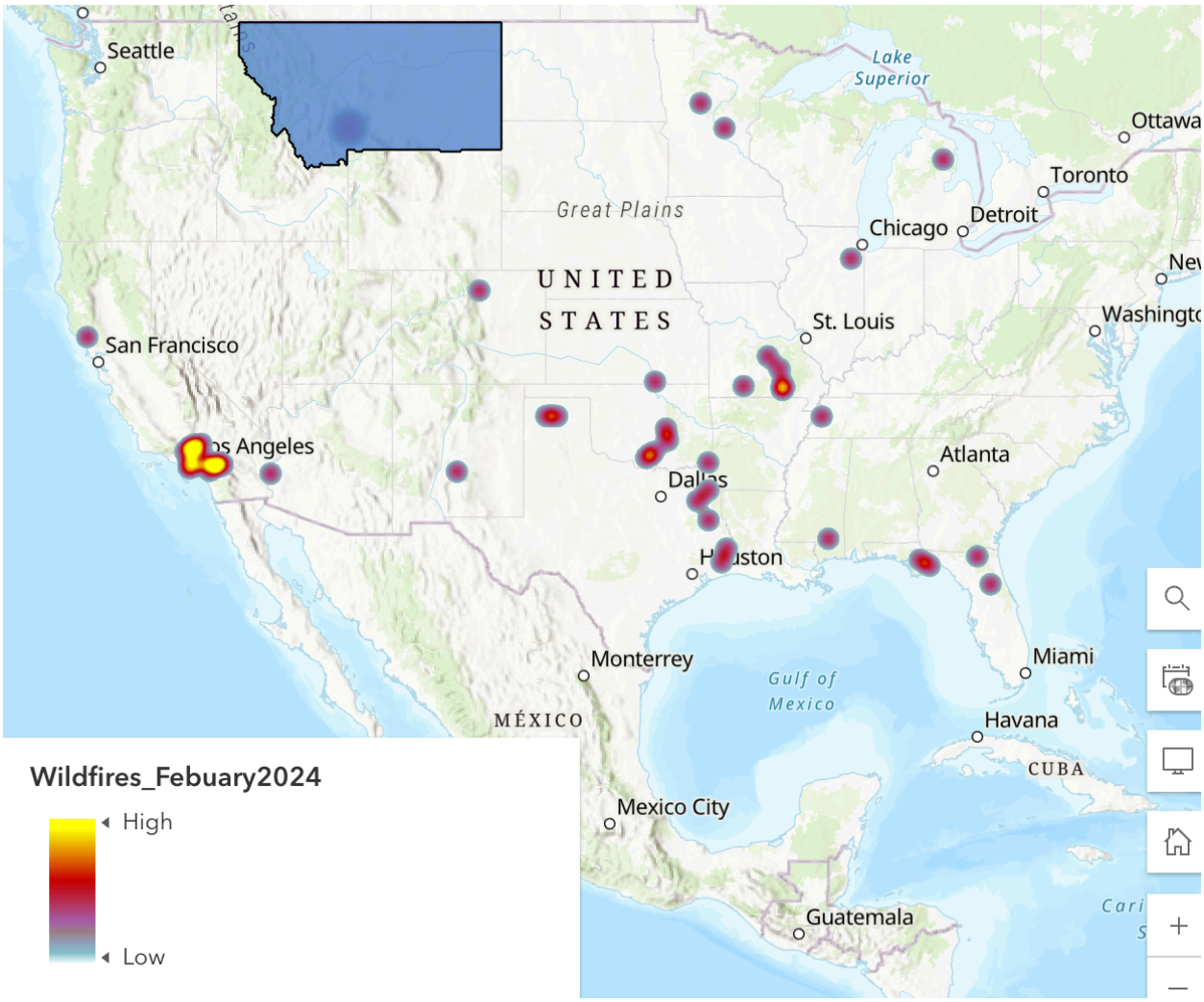


On the right-hand side of your screen, click on the **Styles** icon.
We will need to represent our data differently than a point layer if we want to look at areas with a high wildfire density.
Click the **Heat Map**. A Heat map is a cluster analysis and highlights how data points are related to each other. Areas with a high density of fires will show up as 'hot spots". This analysis works best when we have a lot of samples (in this case its fires) but for the context of what we are analyzing, it will work.
The heat map will not show up on your map until you press **Done**. With the heat map selected, press **Style options**.

Since this data represents fires, we will want to choose a setting that best visually describes our fires.

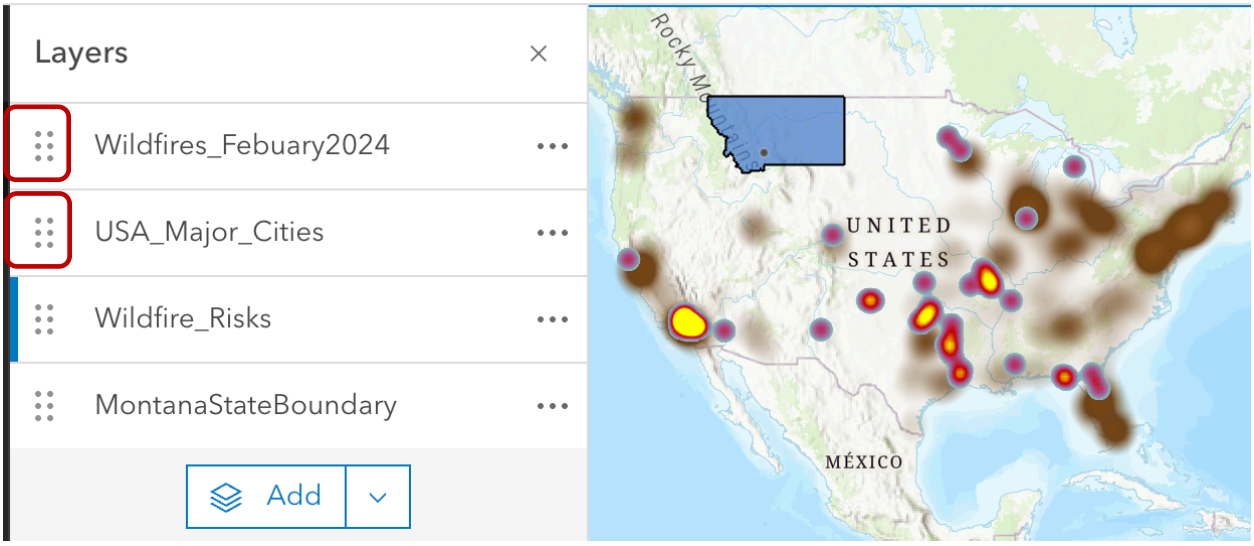


The symbol style looks pretty good, but you can keep the original color scheme or change it. Up to you!
Let's edit the color range (see the red box) so we can highlight our 'hot spots'. Move the arrows so they look like the image on the left.
Locate the Soften edges bar. Move the scale so that it is less. Since we don't have very many points compared to the cities we will want to see the fires well.
Locate the Area of influence bar. Play around with the scale and pick a setting where you can see your data clearly.
Once you are done, click done.



You should see a hot spot around Los Angeles.

Now we will edit the USA_Major_Cities. Make the data viewable by clicking the **eye** back on in the layers section on your screen. Then, click the properties for the layer.
Symbolize the USA_Major_Cities differently than the Wildfires_Febuary2024. You can choose a heat map, or stick with points. You will need to play around with the options so that you represent your data in the best way.



Order the Wildfires_Febuary2024 on top of the USA_Major_Cities by clicking the **four dots** on the left hand side of your **feature layer** in your Layers and dragging it to the top or bottom.

Symbolize the MontanaStateBoundary and your Wildfire_Risks layer that you created.

After you have completed your map, discuss your map with your group.

1. Talk about what you did with your symbology on your map, be specific!
2. Tell each person in you group your favorite thing about their symbology!
3. What geospatial patterns did you notice between the Wildfires_Febuary2024 and the USA_Major_Cities?

Great Job! This was a HUGE lab, and you accomplished so much. You should be proud of yourself!! You are a serous cartographer and geospatial scientist ☺

Lab 03.3 will teach you how to make a story map from the map you just made.

Identifying Human Wildfire Risks

Montana State University Geospatial Skills Camp

Lab 03.3: Making a Story Map

Introduction:

In part three of this Fire lab, we will be creating a ArcGIS Story Map. A Story Map is a web-based application designed for sharing your maps through narrative text and other multimedia content.

Visit the following link for a great example:

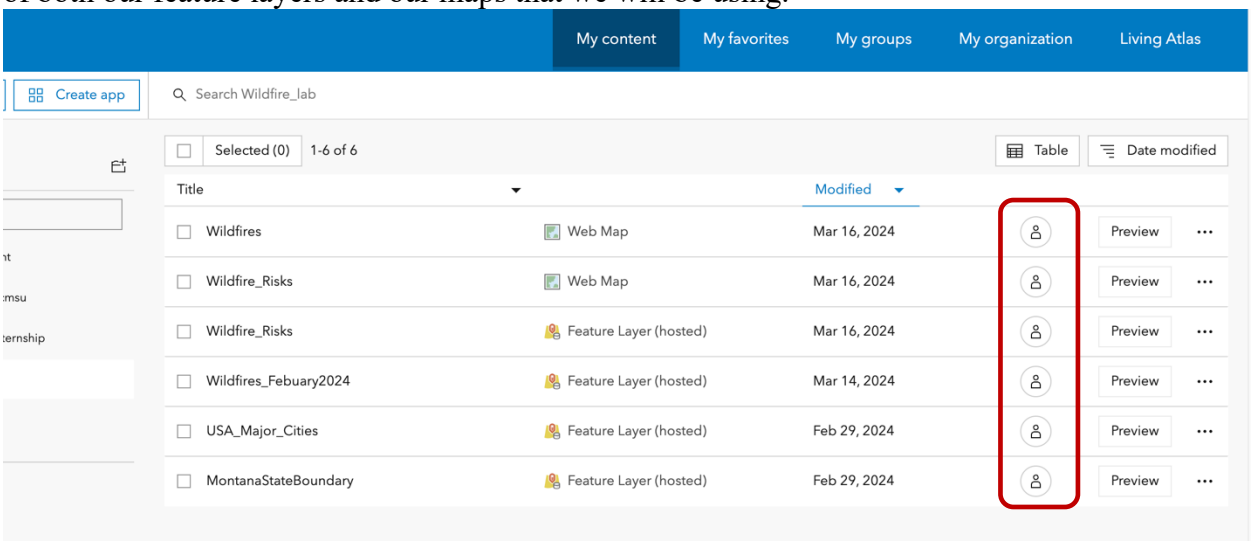
https://storymaps.arcgis.com/stories/0af82ec0fe7f4421b3fe4bd72cfe2c73

Objectives

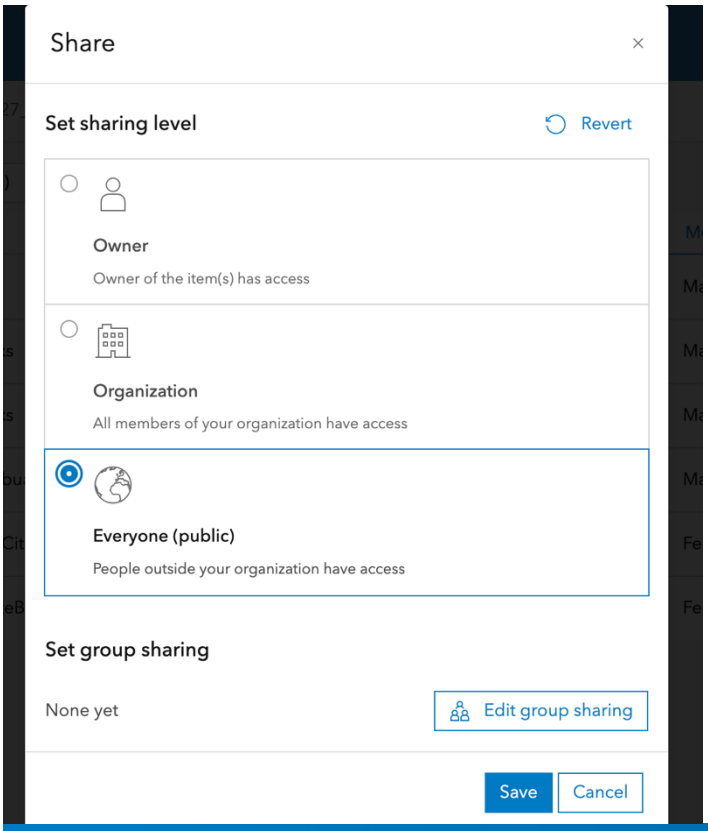
- This lab's objectives are to create a narrative presentation of your Wildfire data/ maps explaining the spatial relationships you observed.

Step 1: Making sure your Maps and Feature layers are Public

In order to create a story map that can be shared with the public, we need to update the visibility of both our feature layers and our maps that we will be using.

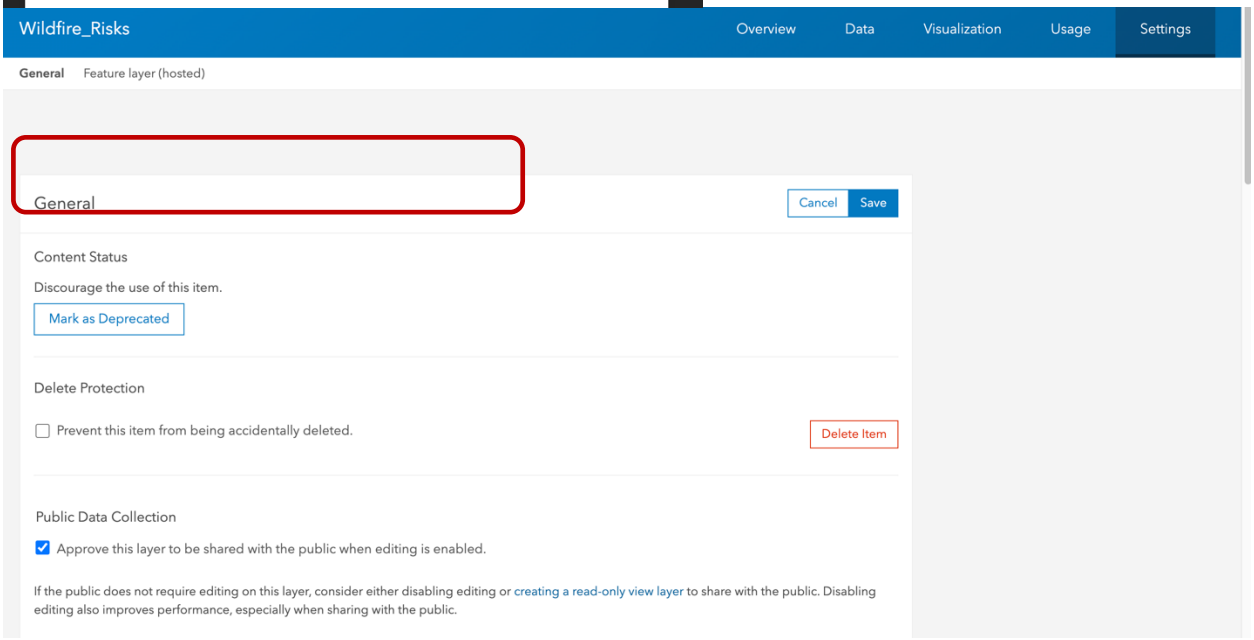


Open ArcGIS online and navigate to your Content, and into your Wildfire_lab Folder. Click the person icon.



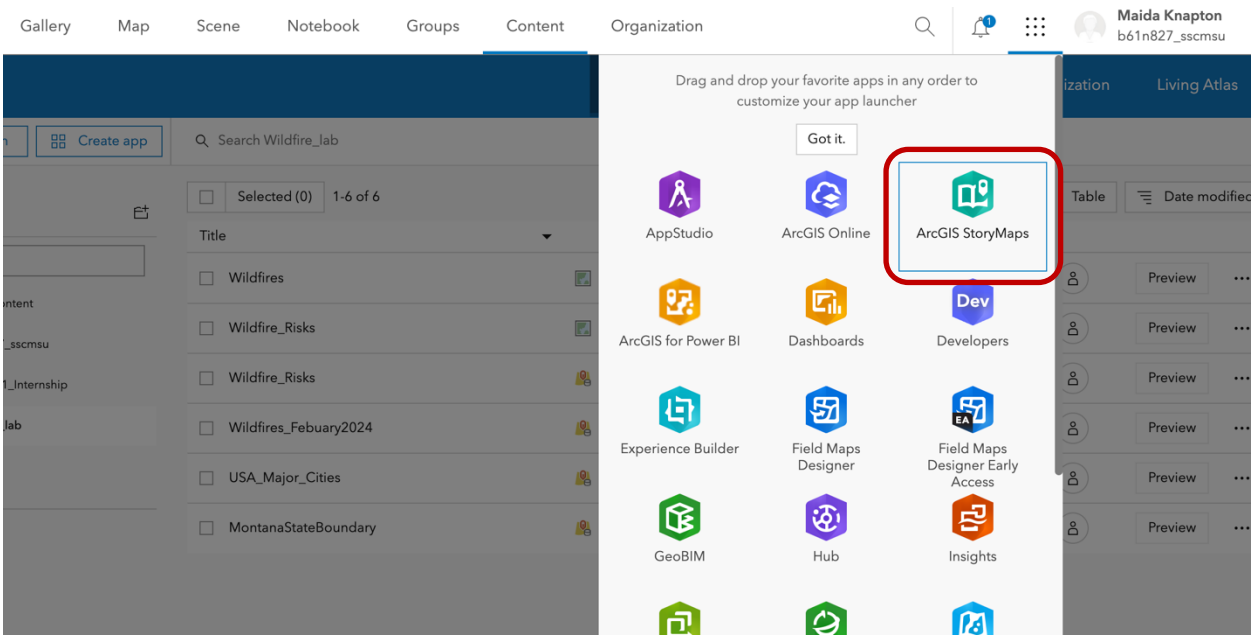
Update the sharing preferences from Owner to **Everyone (public).**
Repeat this for each Feature layer and Map you have created.
Hit **Save**.

NOTE: for the Wildfire_Risks data that you created, you will need to update the view settings differently.

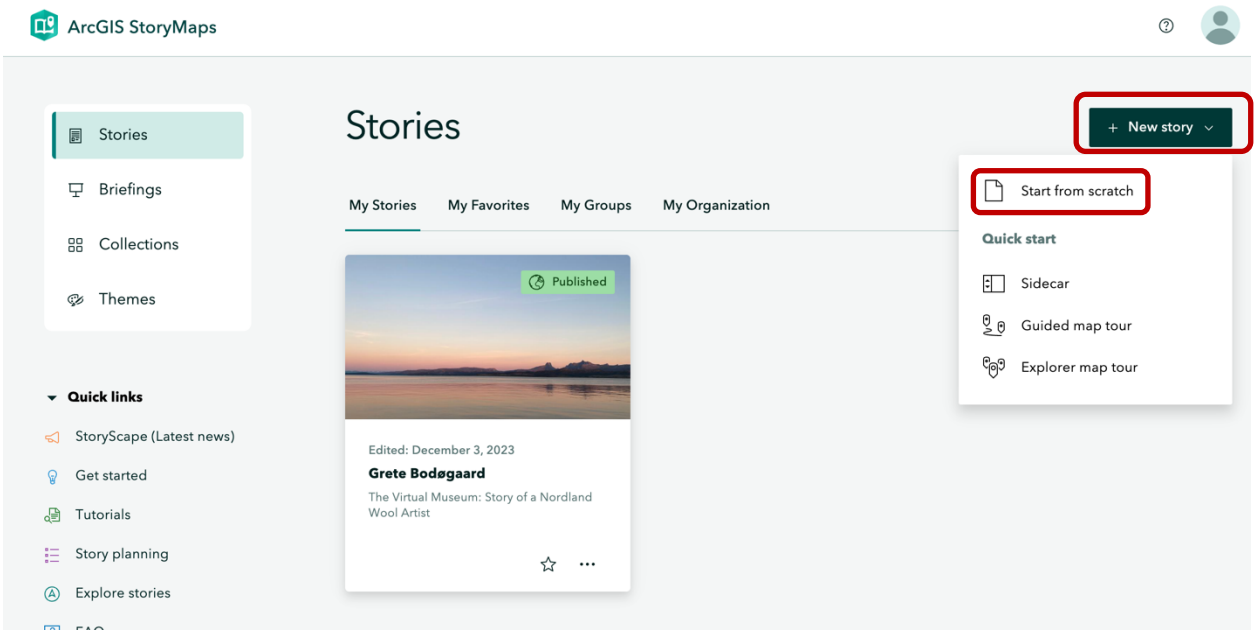


Click on the Wildfire_Risks feature layer. This will take you to the overview of the layer. Click **Settings and** select **Public Data Collection ON.** Then hit **Save**. Return to your content and update the Wildfire_Risks feature layer to public (same process as the first image on this page).

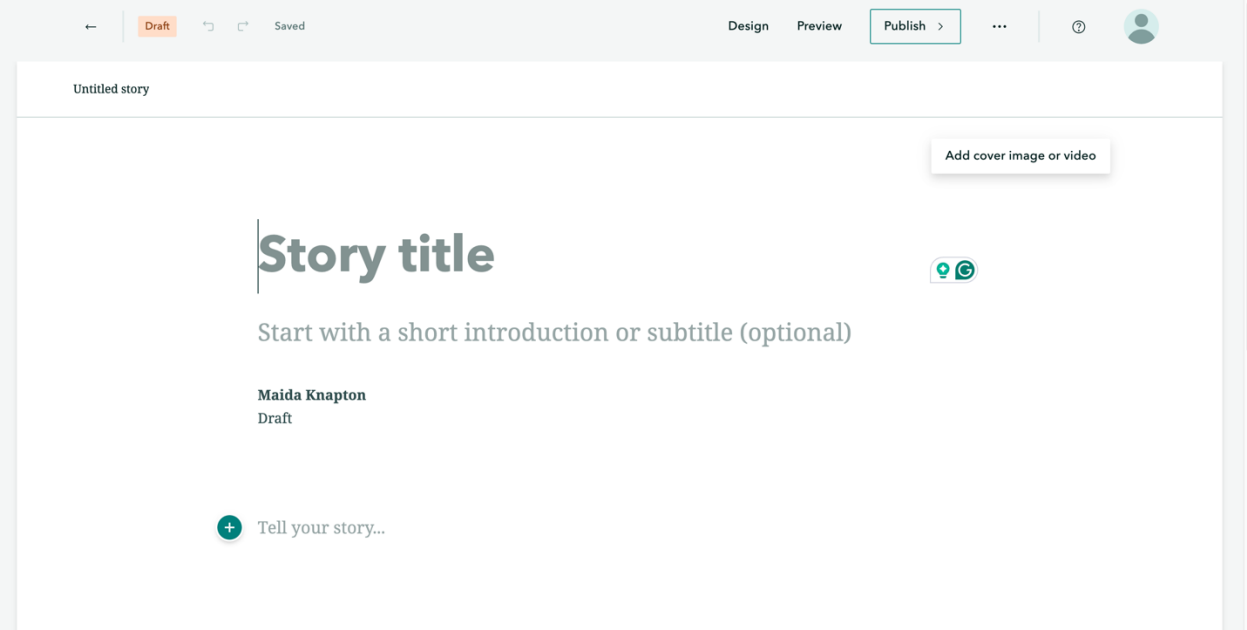
Step 2: Creating your Story Map



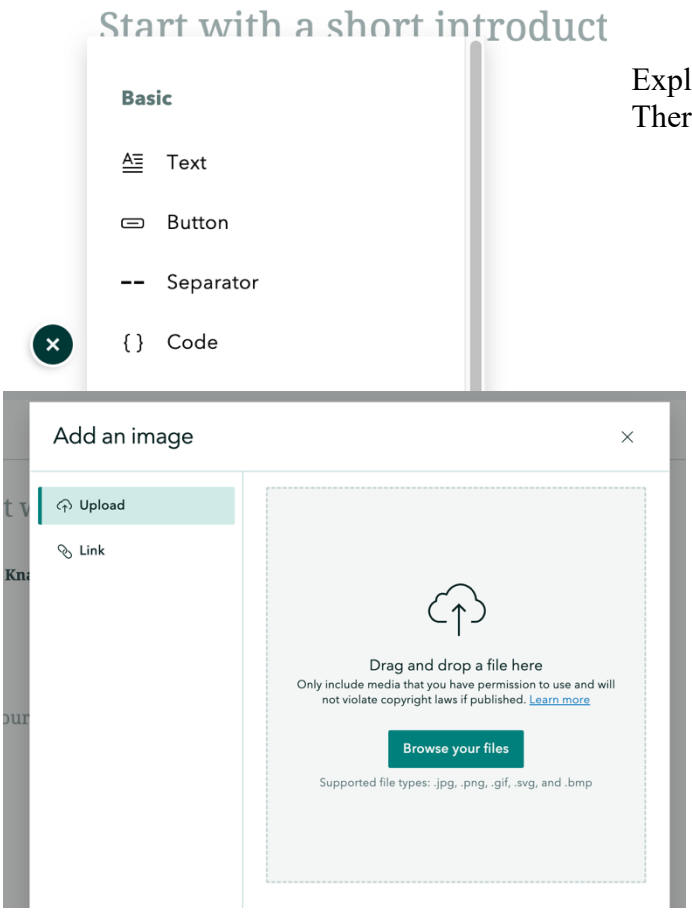
Log into ArcGIS online. In your content, click the nine dots in the top right-hand corner. Click the **ArcGIS Story Maps** Icon.



A new tab will open that looks like this. Click the **New Story** button, then Click the **Start from scratch**.



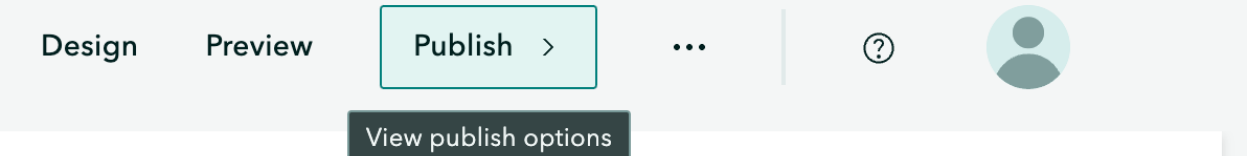
Your screen will look like this. To add text, images, transitions, videos, links, maps, and much more, click the **plus sign**.



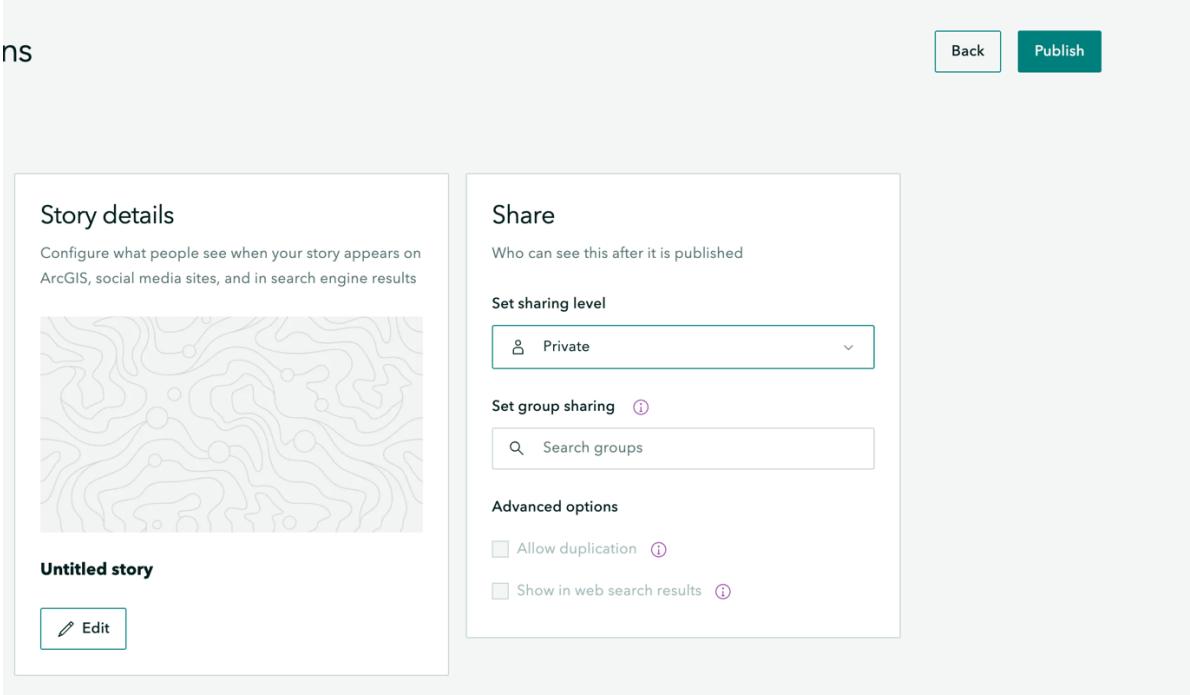
Explore the options in this window!
There are lots of ways to be creative here.

When you add images, they must be in the file format of .jpg, .pgn, .gif, .svg, or .bmp

You can **drag and drop** your images from OneDrive or **Browse your files.**



Once you are done with your story map, you will need to publish. Click the **Publish** icon.



Make sure you set the sharing level to **Everyone (Public)**. Then hit **Publish**. To share your work with others, you can copy the URL.

Great work! What a great way to present your data and geospatial skills ☺

Indigenous Perspectives: Battle of Arrow Creek

Montana State University Geospatial Skills Camp

Lab 04.1

Introduction:

In the 1860's when white settlers and the US Government began to encroach on Indigenous Nations and their territories in the west, the need for land among the tribes created an increase in territorial pressure. The Sioux (Lakota, Dakota, Nakota), Cheyenne, and Arapaho people were being pushed off of their land and into the territory of the Apsáalooke (Crow). This pressure caused tension between the nations, and eventually lead to the Battle of Arrow Creek in 1861 between the Apsáalooke, Sioux, Cheyenne, and Arapaho.

During the battle, the Apsáalooke were outnumbered 10 to 1, but they bravely held their ground, and eventually drove the Sioux, Cheyenne, and Arapaho off their land! How did the Apsáalooke do it? Well, in this lab we will learn about this important day in Apsáalooke history and create a map of what happened.

Currently, a digital map of the Battle of Arrow Creek does not exist, and today, we are going to change that. We will be looking at hand drawn maps of the battle, analyzing the battle terrain with 3D maps, and collecting data from paper and video resources to compile a map of the Battle. Your end map will be placed on the Battle of Arrow Creek historical marker sign, how cool!

Objectives:

- Create a map that shows the traditional territories of the tribal nations and their current territory to understand the pressure the tribes were under when white settlers encroached their land.
- Work as a group to research your Battle scenario and create a polygon or point to represent it.
- Compile everyone's scenarios into one ArcGIS online map of the Battle of Arrow Creek showing the warriors locations, camps, and the herd of elk/ buffalo.

Research Resources:

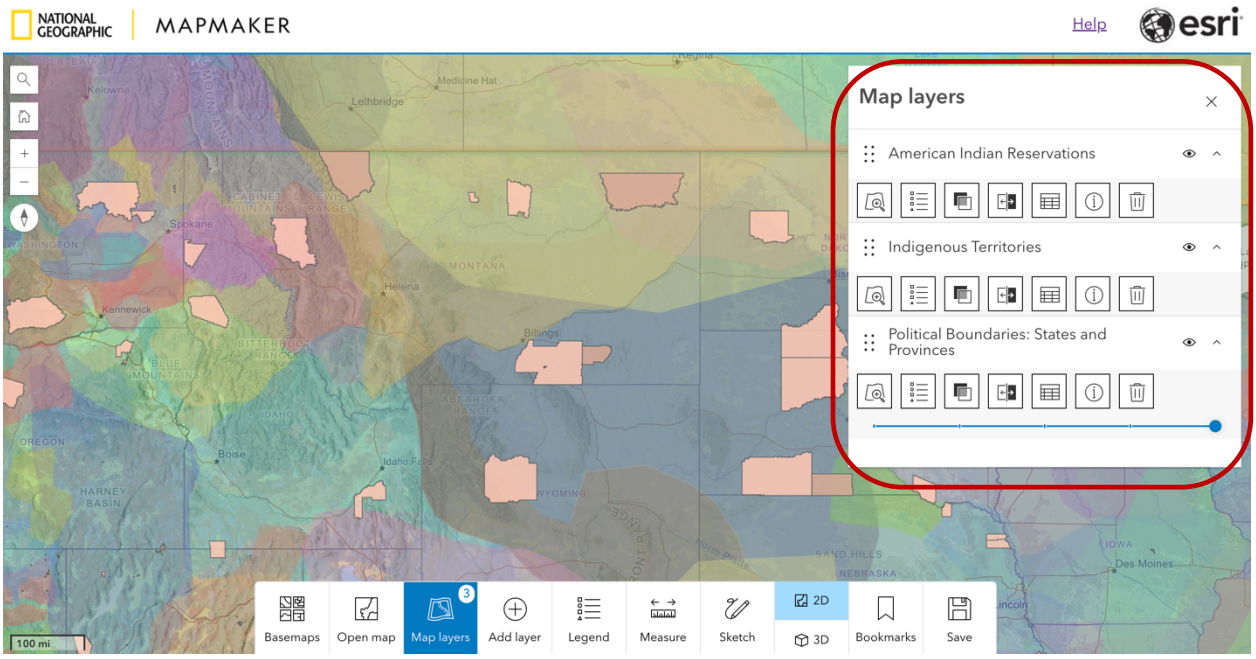
- Library @ the Little Big Horn College: Battle of Pryor Creek. By Joe Medicine Crow. http://lib.lbhc.edu/about-the-crow-people/history-and-culture/battle-of-pryor-creek.php
- Library @ the Little Big Horn College: Apsáalooke Then and Now Timeline. http://lib.lbhc.edu/about-the-crow-people/history-and-culture/aps%25C3%25A1alooke-then-and-now-timeline.php
- Arrow Creek Image by Bad Heart Bull: See Canva

- Crow Elders Recorded about the Battle of Arrow Creek: https://www.youtube.com/watch?v=gdmd7pPyVck
- Billings Gazette: Spirit Warior Credited for Crow Victory. https://billingsgazette.com/news/state-and-regional/montana/spirit-warrior-credited-for-crow-victory/article_94674e94-6eaf-5453-8b82-48f0504e94e8.html
- Video Map of the Battle: Minute 08:21. https://www.youtube.com/watch?v=Cew7SNy7LkM

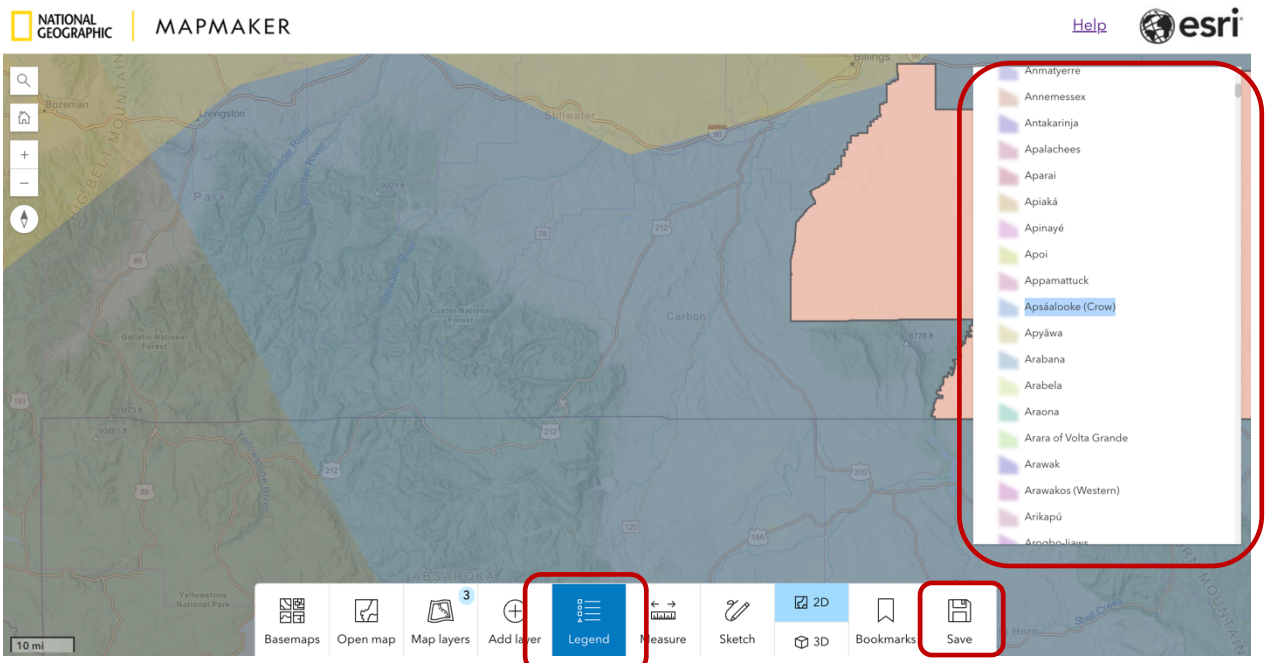
Map 1: How the Traditional Territory of the Apsáalooke has Shrunk.

The first map that we will create will be to build on our background knowledge of why the battle happened, and what the terrain of the Battle looked like.

In your browser, search **National Geographic Map Maker Launch Guide.**



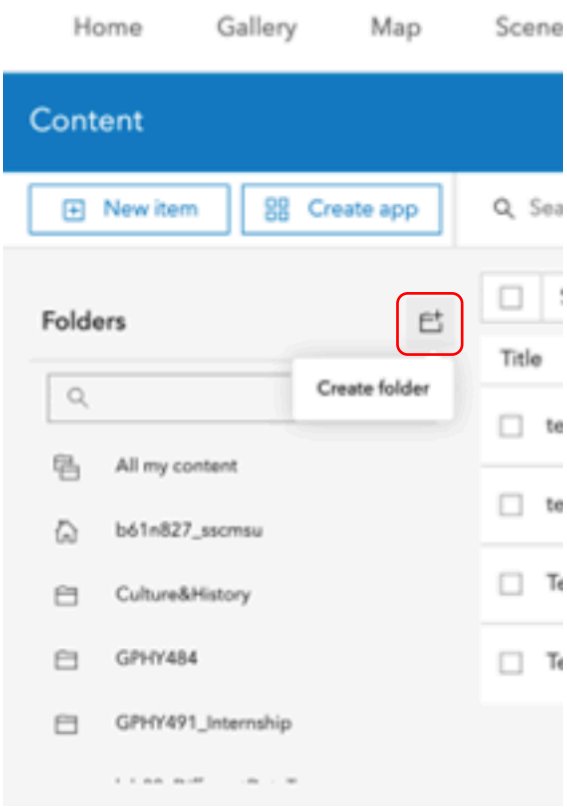
Once you are in your map, let's add three layers (recall how we did this from lab 2.2 where we went over different data types). Add **Indigenous Territories**, **American Indian Reservations**, and **Political Boundaries: States and Provinces**. Make sure that your layers are ordered similar to the image above, with American Indian Reservations being on top, and Indigenous Territories on the bottom.



How is the polygon representing traditional Apsáalooke territory symbolized (represented by color)?

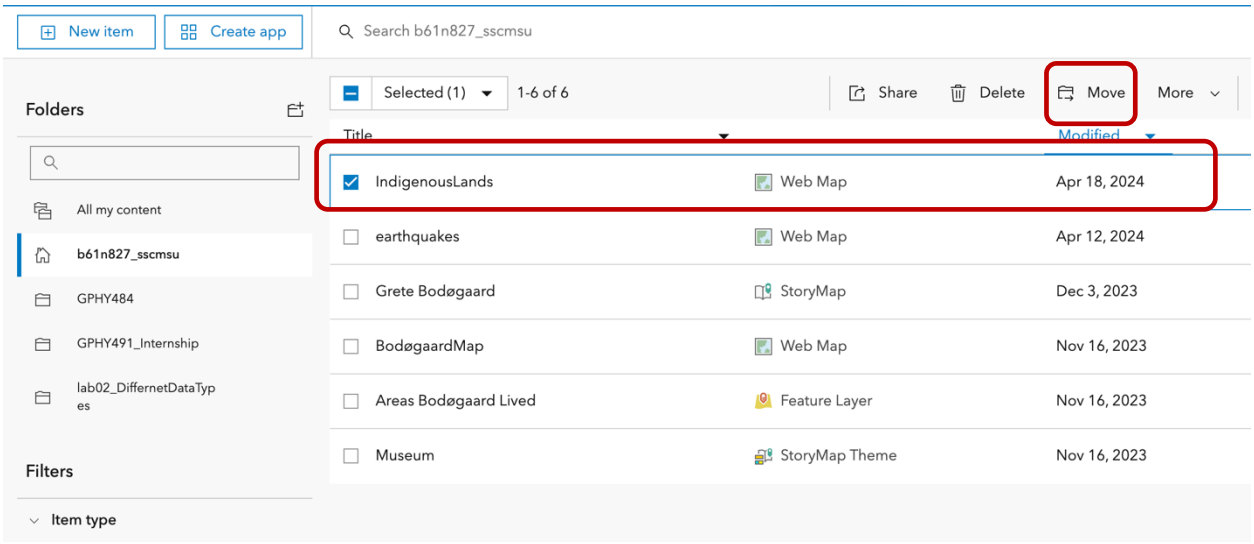
We will need to open the Legend in the Indigenous Territories Layer and scroll down until we see Apsáalooke (Crow). With all the other tribes, it is difficult to focus only on the change in territory of the Apsáalooke. To fix this, we will need to save our National Geographic Map to our ArcGIS online account and then filter out the other tribes and their territories in ArcGIS online.

Save your map to your ArcGIS online account by clicking **Save** on the tab at the bottom of your screen. Title your map with something relevant to the data. Once you have saved your map, open up your ArcGIS online account by typing **ArcGIS online Login** into your browser.



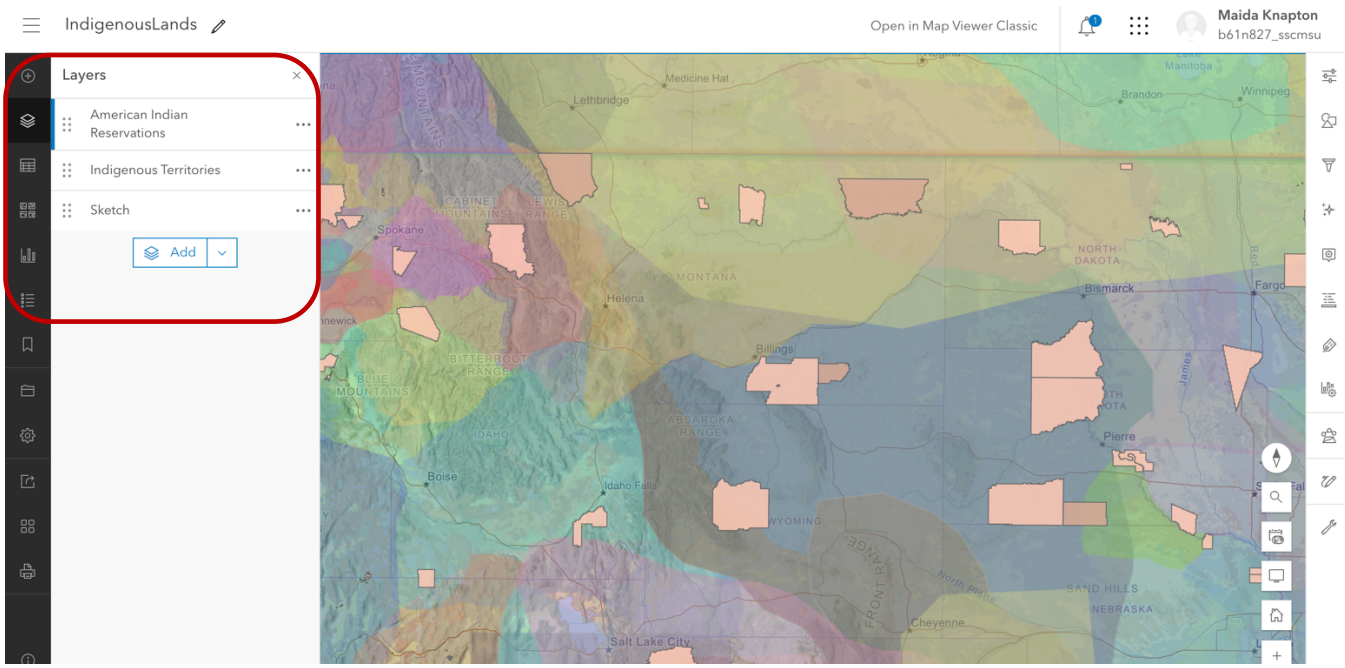
Navigate to your content page in ArcGIS online.

We will need to put our newly created map into a folder to keep our ArgGIS content page organized. Click **Create Folder**. Title your folder 'Lab04_IndingousPerspectives'.

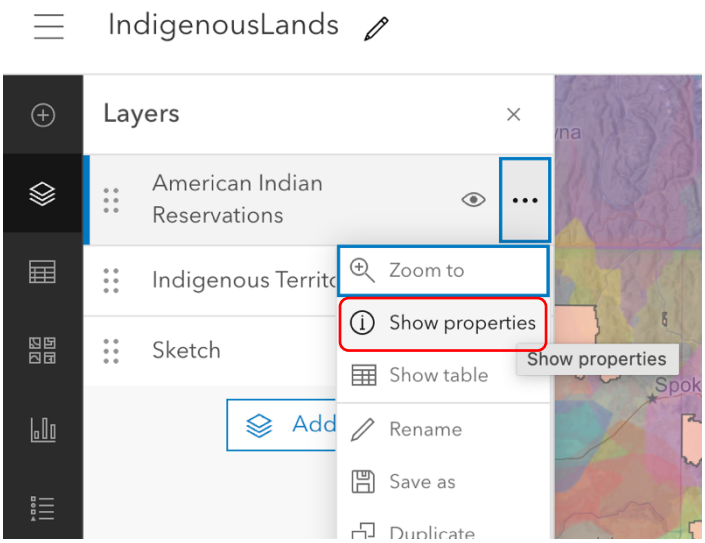


Under your home folder on the left had side of your ArcGIS online Content screen, we will need to move the map you created in National Geographic to your new Lab04_IndigenousPerspective folder. Click the box on the side of your title and then move it to your new folder.

Now, open your map.

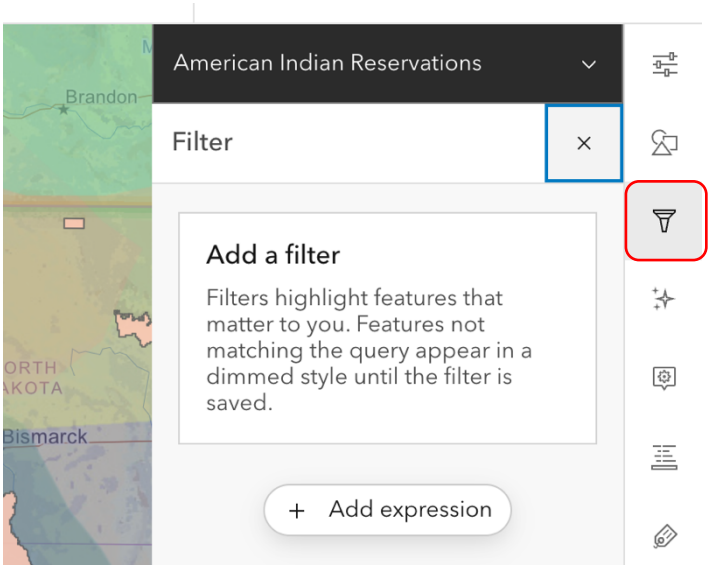


Your screen should look like this. You will be able to see all three layers you put into your National Geographic Map under the layers tab. Next, we will filter out all of the other tribes so we will only see the territory of the Apsáalooke.



We will first filter the American Indian Reservations layer.

Click on the three dots to the right of the layer. Click **Show Properties**.



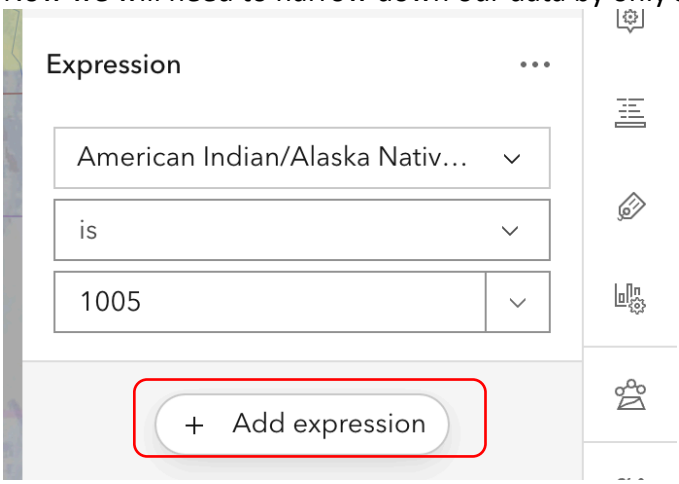
The Properties pane will pop up on the right-hand side of your screen. We want to be in the filter tab.

Click on the **Filter** tab.

Now, we will add an expression. Adding an expression is how we will tell ArcGIS that we only want the Apsáalooke land.

Click **Add Expression**.

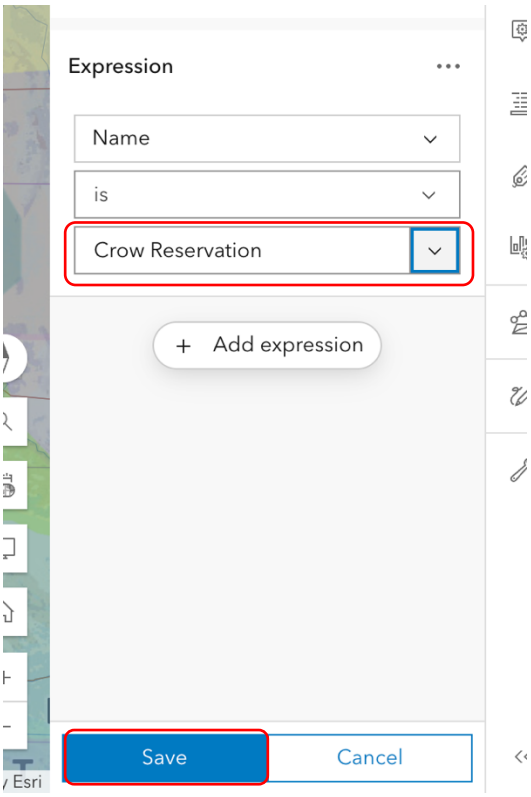
Now we will need to narrow down our data by only selecting the Apsáalooke.



We will need to switch the Object ID from the Census code, to the name of the tribe.

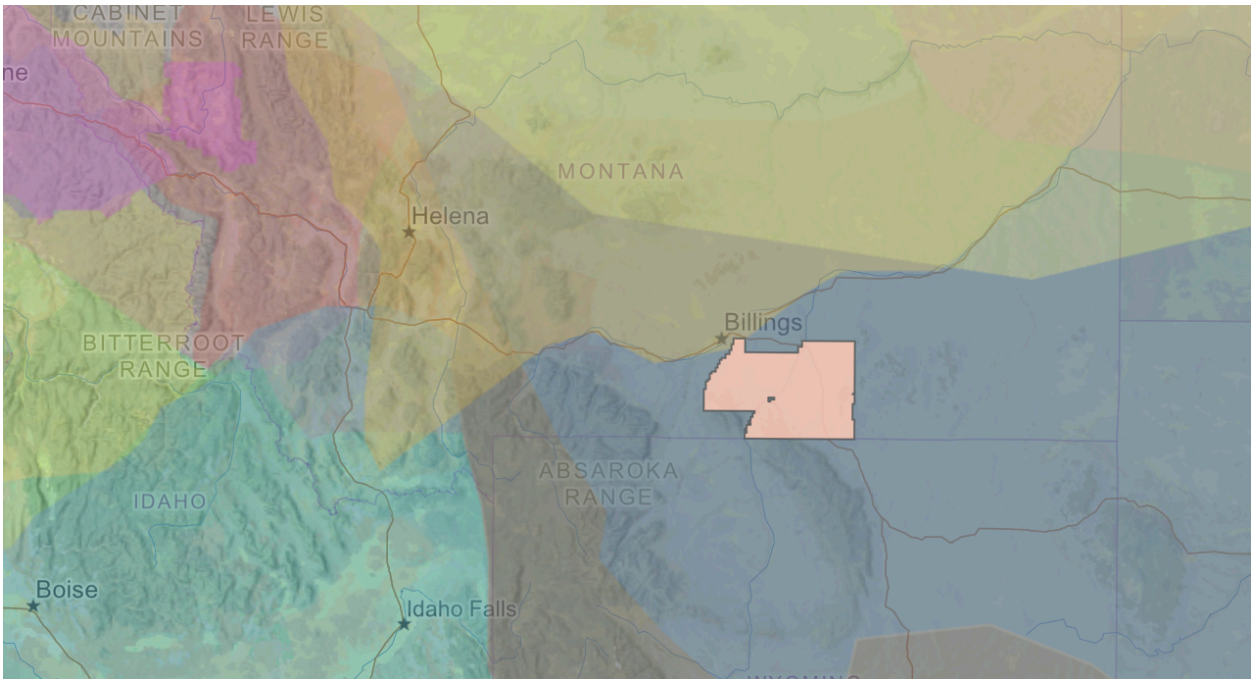
It is much easier to find a nation by searching for its name than its Governmental Census Code.

Click the drop down, and then scroll down to the name object ID option. Click **Name**.



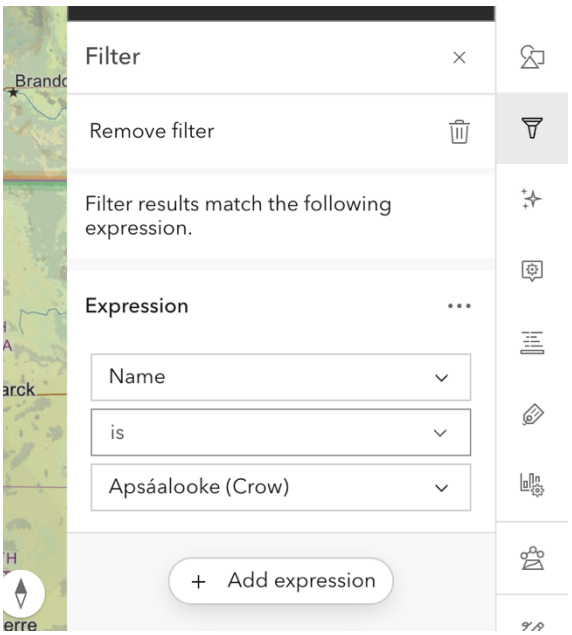
Now we will choose which reservation we will want to show on our map.

Click the drop down that is below the 'is' tab, and search for Crow Reservation. Click **Crow Reservation**. Now we will want to save our filter. Click **Save**.



Now, your map should look like this, where you can only see the Apsáalooke reservation. Next, we will filter the Indigenous territories layer so that we will only see the Apsáalooke territory. This will be the same filtering process!

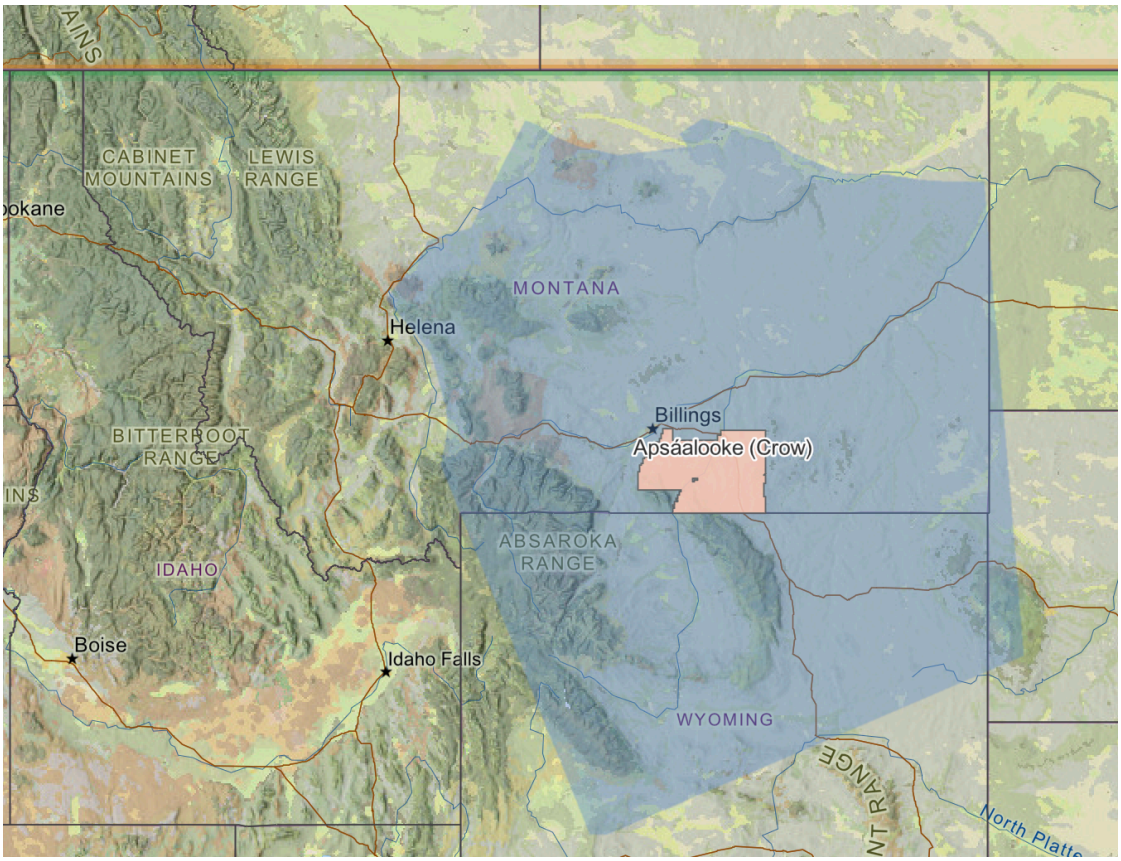
Navigate to the filter tab for the Indigenous territories layer. Click **Add expression**.



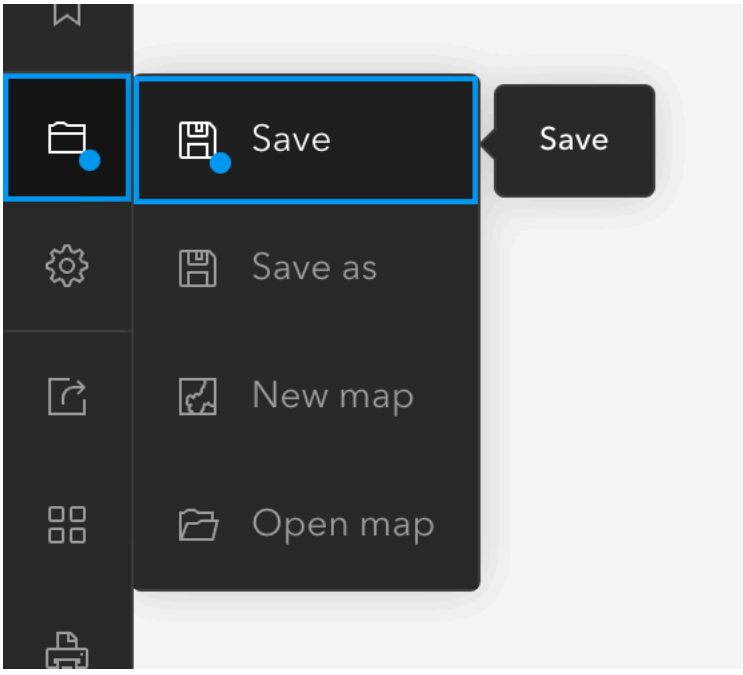
Your object ID needs to be **Name**.

Your value needs to be **Apsáalooke.**

Click **Save**.



Your map should now look like this! Can you visualize the change in territory from the 1800's to now? Discuss with your group.

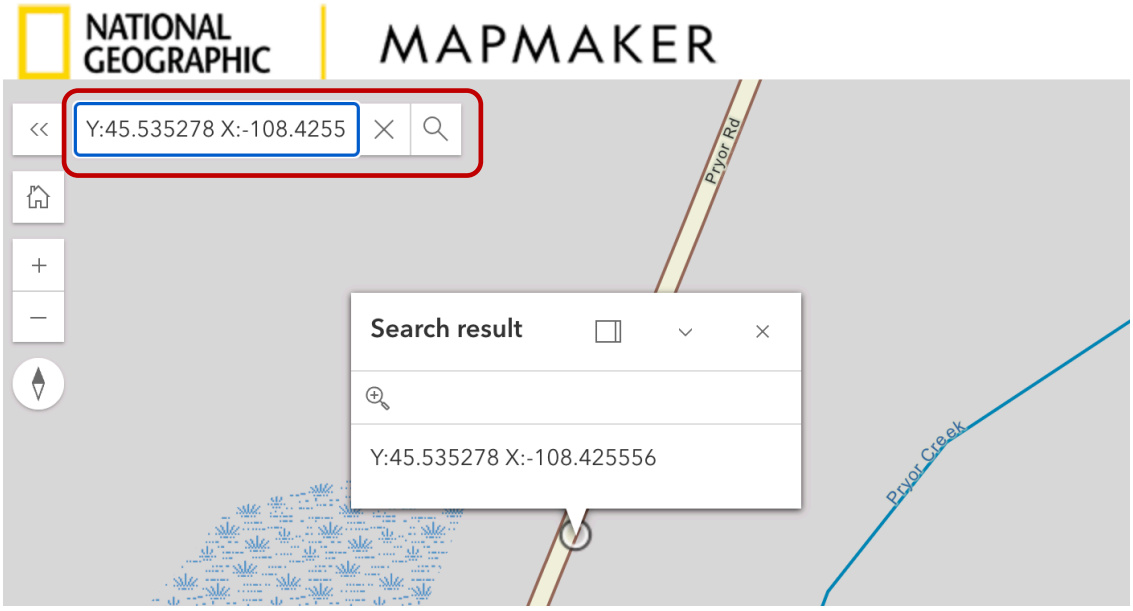


Make sure you save the updates you made to your map.

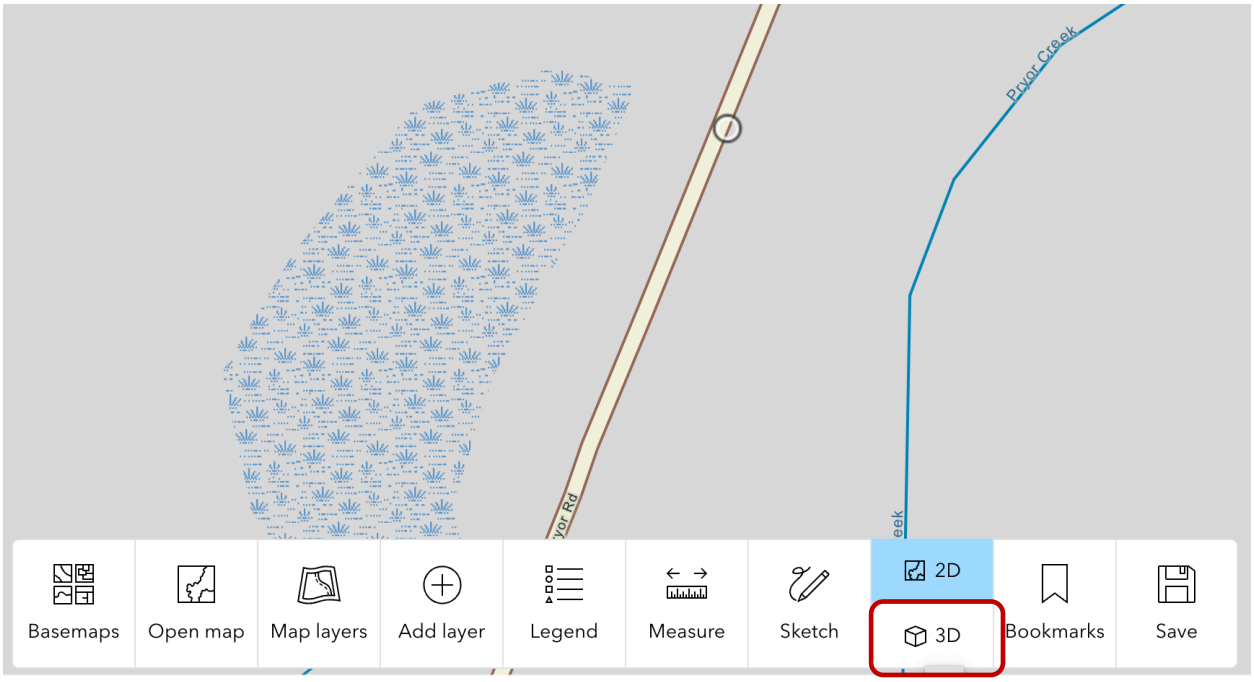
In the left-hand side of your screen, navigate to the save button. Click **Save.**

Map 2: Looking at the Landscape of the Battle in 3D

To look at the Battle ground in 3D, we will be using National Geographics Map Maker again. In your browser, type in **National Geographic Map Maker Launch Guide**.



In the location search bar type in these coordinates: **Y:45.535278 X:-108.425556** This will take you the Latitude and Longitude (recall what latitude and longitude is from lab 2.1: Map Projections and Coordinate Reference Systems) of the Battle of Arrow Creek Historical Marker Sign. Keep this in mind: The Battle occurred primary southeast of the in the valleys and hills across the road. Locate the Southeast area where the battle occurred on the 2D map.



Now we will switch to a 3D map and explore where the battle occurred. Click **3D**. Navigate around and note the location of the surrounding features: Arrow Creek, the hills to the west of the sign, the shape of the valley, and the hills to the east of the sign.

Next, we will start to piece together the battle using the resources at the beginning of the document and your personal knowledge. Use this 3D map as a resource, as how the battle unfolded had a lot to do with the shape of the landscape!

Part 1: The Location of the Apsáalooke and Their Camp

Research the location of the Apsáalooke warriors and their camp with the research materials at the top of the document and your own knowledge.

Next, we will open ArcGIS online and map out the approximate location of the Apsáalooke warriors and their camp based on your research.

See Part 4: Feature layer tutorial to learn how to map out your area!

Part 2: The Location of the Other Tribes

Research the location of the other tribes with the research materials at the top of the document and your own knowledge.

Next, we will open ArcGIS online and map out the approximate location of the other tribes based on your research.

See Part 4: Feature layer tutorial to learn how to map out your area!

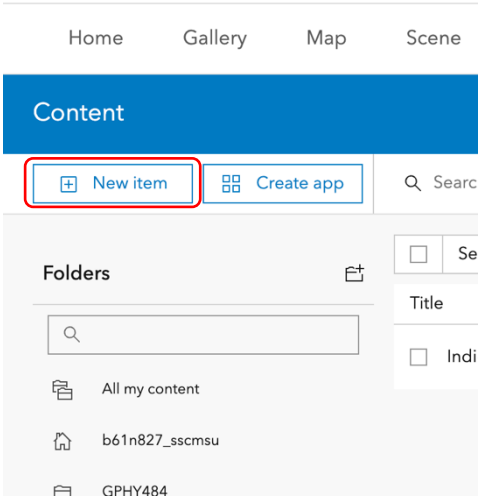
Part 3: The Location of the Elk Herd

Research the location of the elk herd with the research materials at the top of the document and your own knowledge.

Next, we will open ArcGIS online and map out the approximate location of the elk herds based on your research.

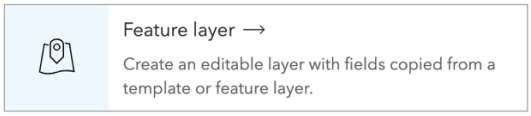
See Part 4: Feature layer tutorial to learn how to map out your area!

Part 5: Feature Layer Tutorial

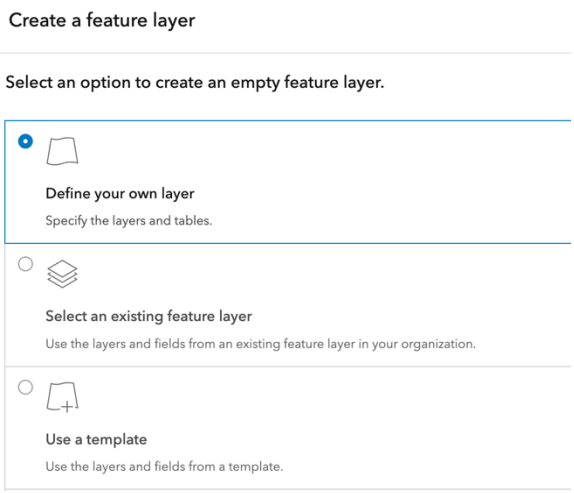


Once longed into ArcGIS online, we will need to create a Feature layer. Do you remember what a Feature layer is? A feature layer is a primary (you made the data) or secondary (someone else made the data) data layer that represents geographic features.

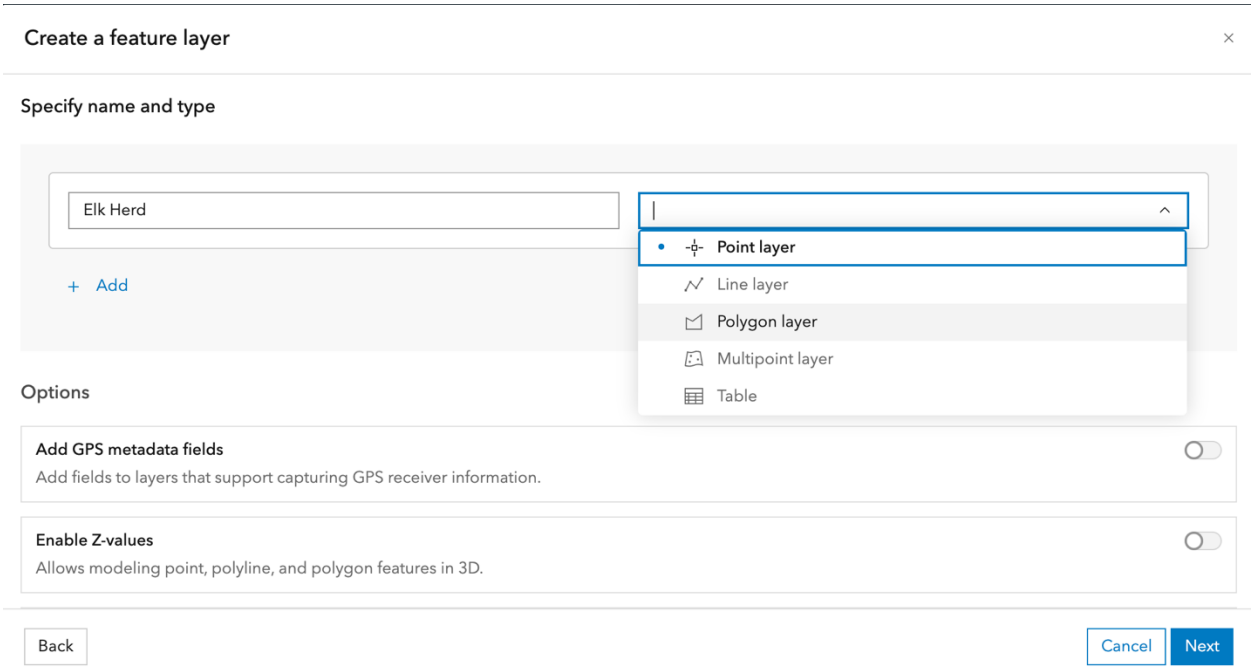
In your ArcGIS Content page, Click **New Item**.



Click **Feature Layer**.



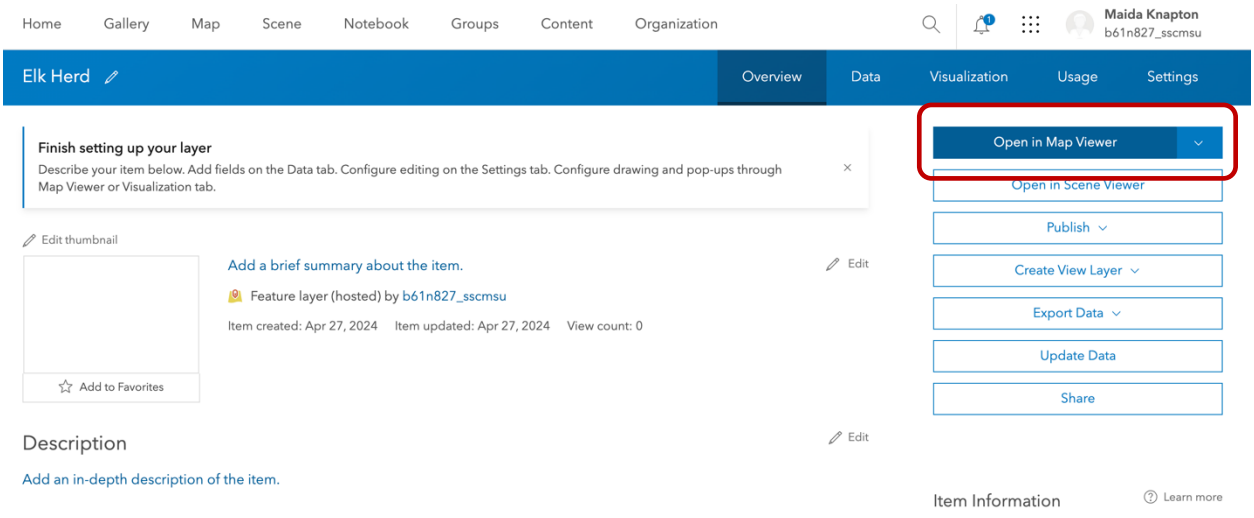
We will need to Define our own layer. Click **Define your own layer**. Click **Save**.



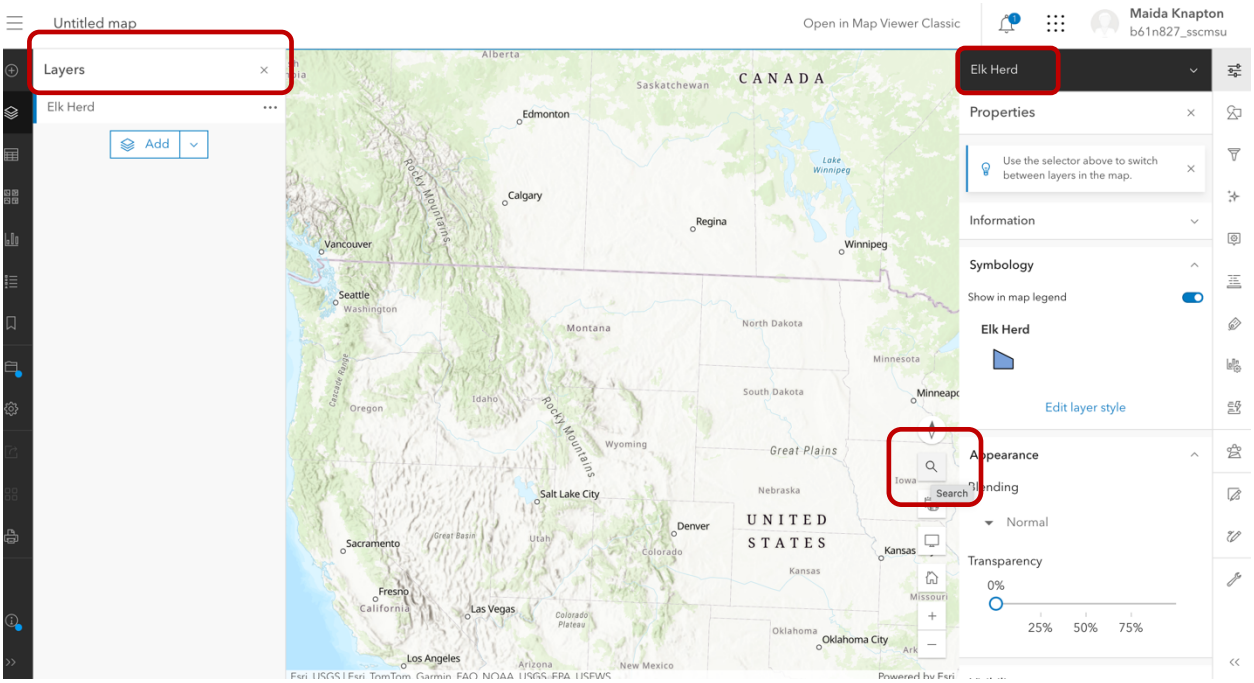
Next, we will need to name our feature layer and decide what type of Vector data you will use to best represent your scenario. Do you remember what vector data is from lab 2.2 Different Types of Data? Vector data includes Points, Lines, and Polygons.

Name your Feature layer something relevant to your scenario, and then choose what type of vector data you want. We will not need to add GPS metadata fields or enable Z or M Values. Click **Next**.

Save your feature layer to your Lab 04 Indigenous Perspectives. Add a summary for your feature layer that describes the scenario you are mapping. Click **Save**.

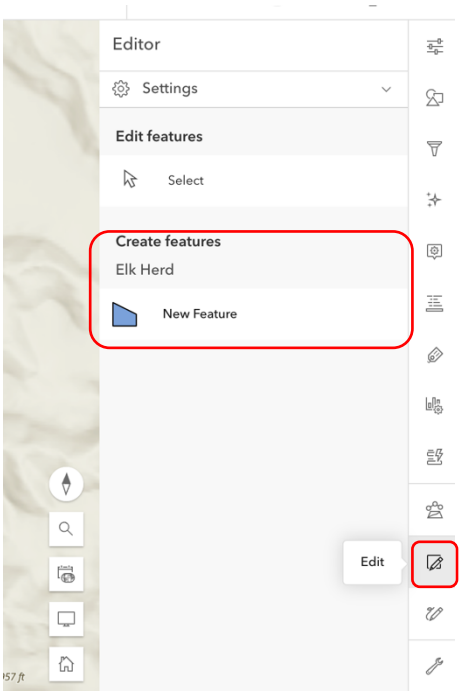


Now we will open our feature layer in map viewer and map our scenario. Click **Open in Map Viewer**.



Your map should look like the image above. Your feature layer will show up in the layers tab on the left-hand side of your screen, and the feature layers properties will be on the right-hand side of your screen.

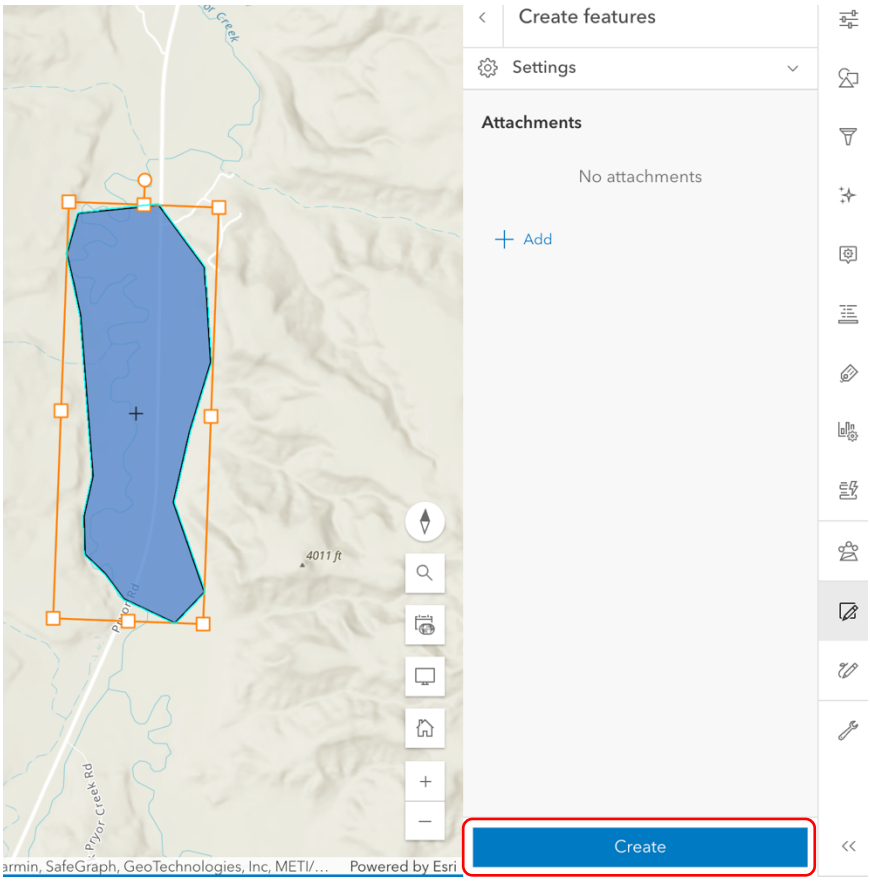
Next, we will need to type in coordinates for the location of the Battle of Arrow Creek. Click the **Search** icon that is to the left of the properties screen. Type in **Y:45.535278 X:-108.425556.**



Now that we are at the location of the battle, we will want to map out where our scenario occurred.

Click the **Edit** button on the right-hand side of your screen.

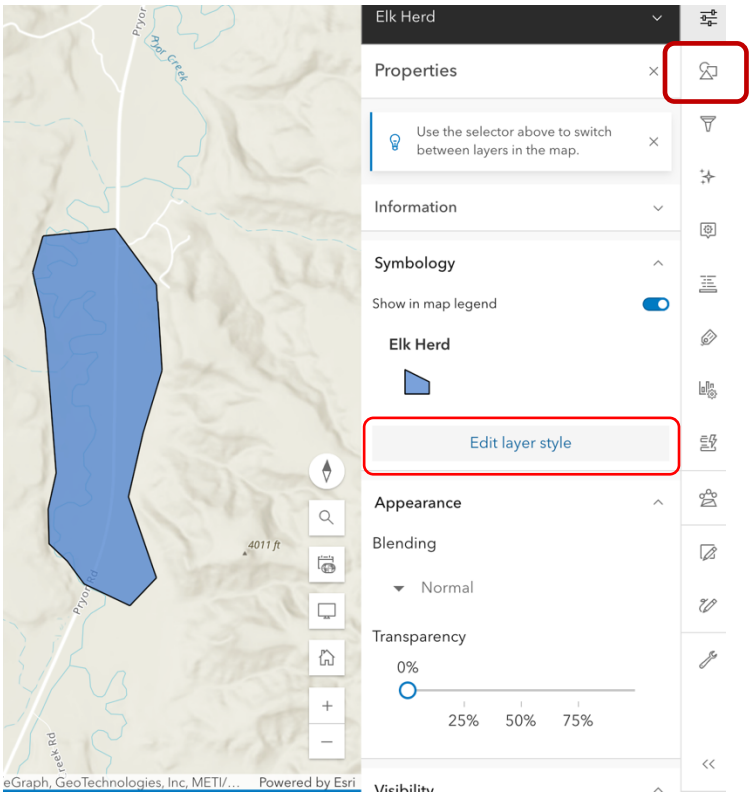
Next, Click your **created feature**. Now you will be able to create your data layer by clicking on the map and drawing out your polygon



Once you draw your polygon, click **enter** on your keyboard to stop drawing. Then Hit **Create**.

Now, you will have your scenario mapped out!

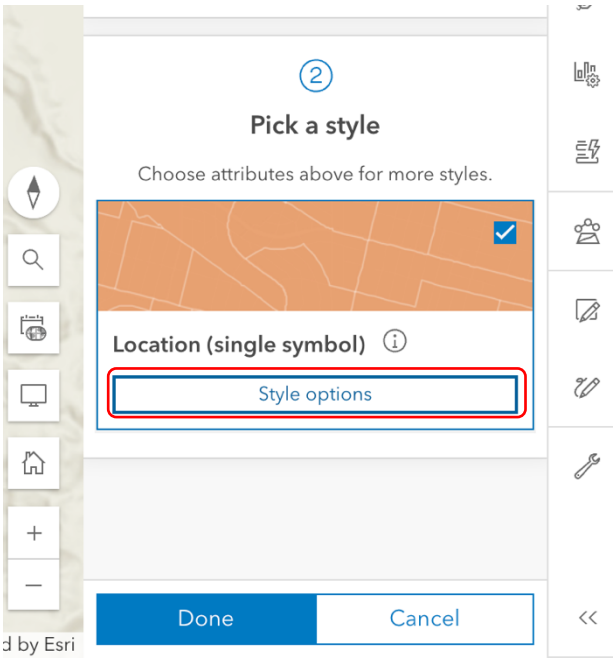
We will need to Symbolize our layer to make it look unique. Let's practice symbolizing.



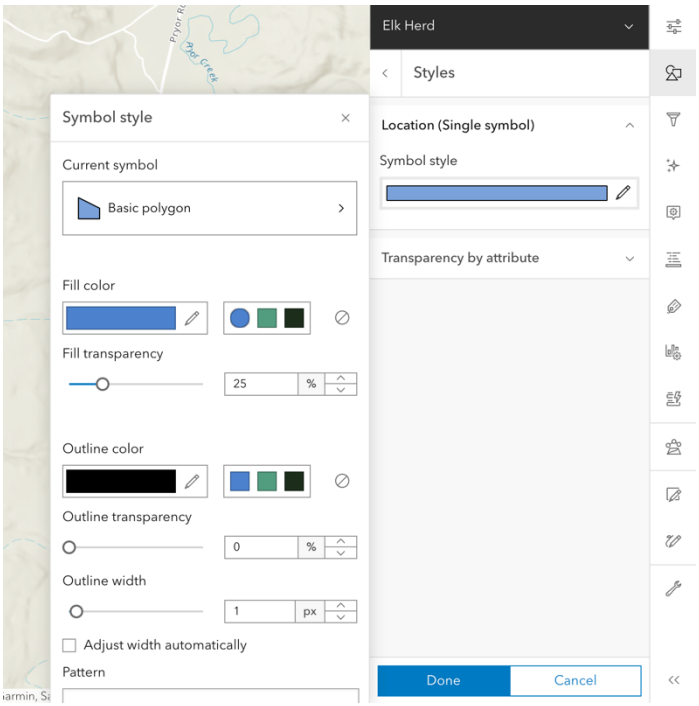
Return to the feature layer properties.

To change the symbology of your Vector data, Click **Edit Layer Style**.

NOTE: the symbology you are creating now will not show up on your final map, only the data (point, line, or polygon) will show up.



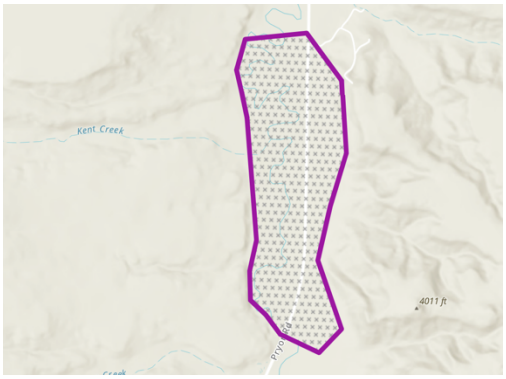
Click **Style options**.



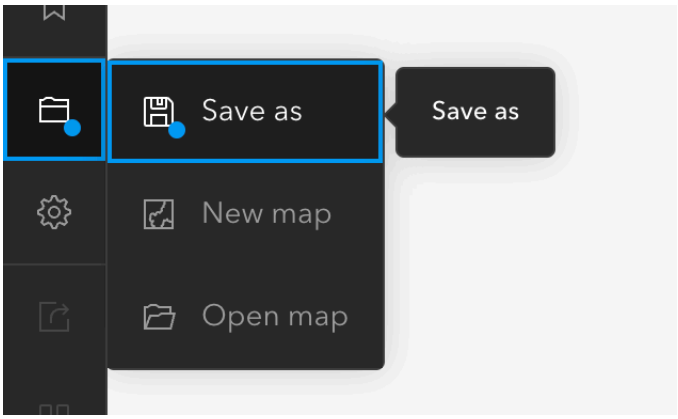
Play around with the Current Symbol, the Fill color, Outline Color, and Transparency until you get the look you would like.

It would be great if each scenario had different symbology! That way the legend of your final map will be easy to read and understand.

Once you are done, click **Done**.



Here is what my polygon looks like now!



Lastly, we will need to Save our map. In the left-hand side of your screen, click save as.

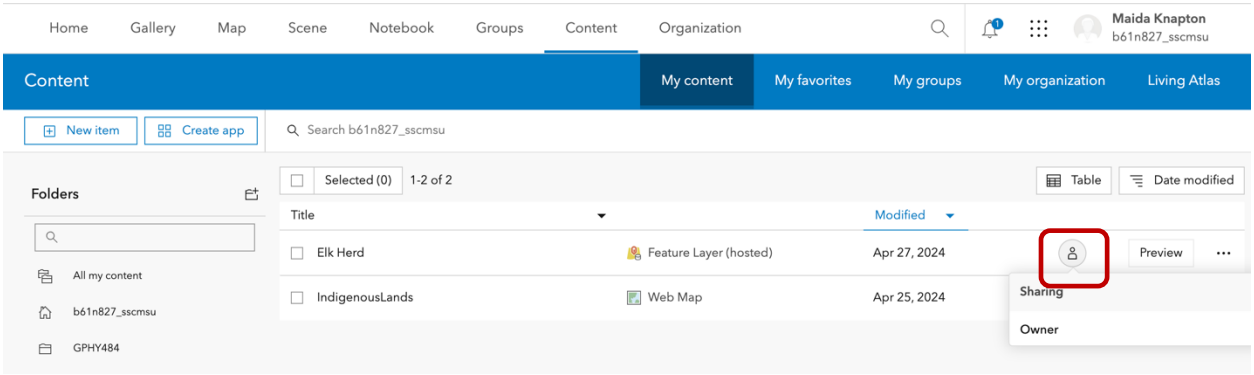
Name your map according to your scenario.

Great Job!!

Part 5: Create the Final Map of the Battle of Arrow Creek

In order to combine all three of your created feature layers into one map (if everyone used their own account to create a feature layer), we will need update the feature layer's share settings you created.

To update your feature layers sharing settings:



Navigate to your ArcGIS content page. In your Lab 04 Indigenous perspectives, you will see your created feature layer. Click the **person icon** on the feature layer. Update the setting to Your Organization

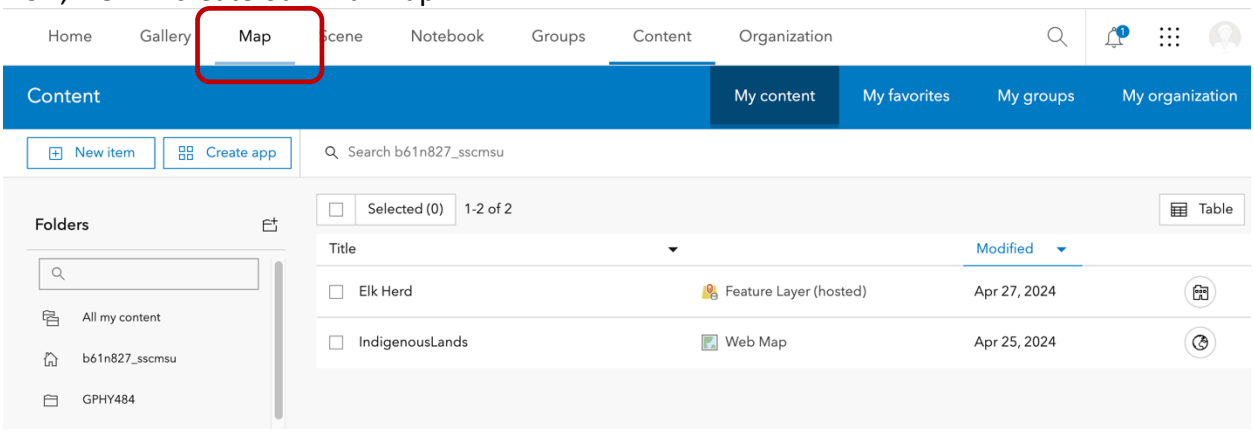
Did you get a pop up that says “to share publicly, first turn on the Public Data Collection option on the Settings tab of the layer's item page then share again. For optimal performance and data integrity, please consider disabling editing or using a non-editable view layer” you will likely need to change some of your settings. Ill walk you through it!

Click on your Elk Herd Feature layer. This will take you to the overview page. Once on the overview page, navigate to the settings. Check on the Public Data Collection button that says, ‘approve this layer to be shared with the public when editing is enabled’. Scroll down and turn Enable editing Off.

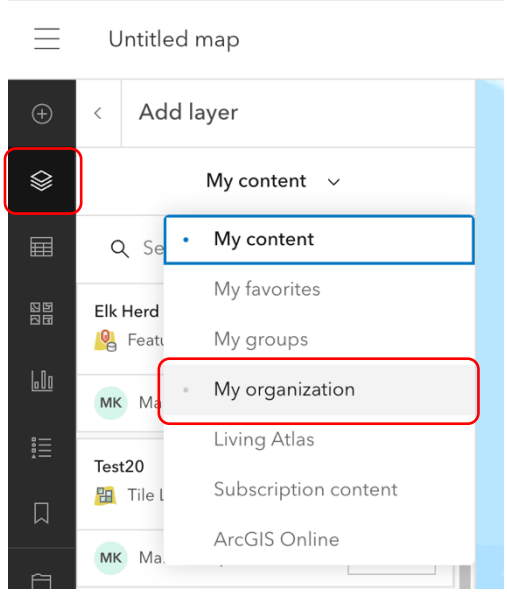
Navigate back to your content page (the image above) and update the sharing settings to **Public**.

Combining into one map:

Now, we will create our final map.

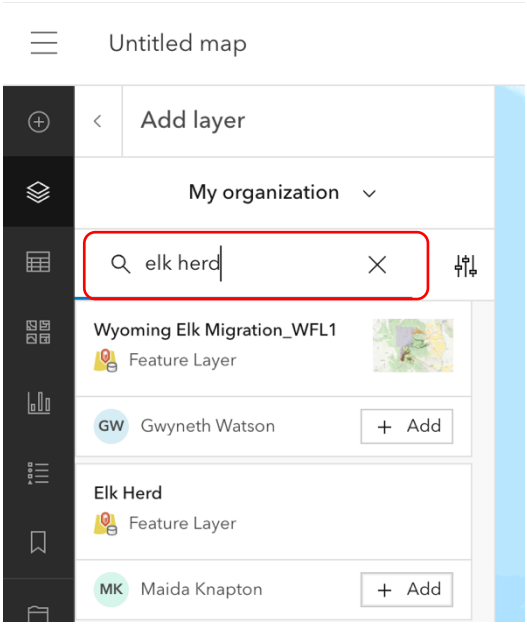


Click on the Map tab at the top of your ArcGIS online page.



In the left-hand side of your map screen, click **add layers**.

We will want to switch our layer search to My Organization since that is where everyone's feature layers will be.



Next, search for the titles of all of the feature layers and add them to the map.

You will need to redo the symbology. Change the base map if you like.

Save your map into your Lab 04 folder.

Requirements to making your final map publicly viewable:

All data feature layers must be set to public. All feature layers must not allow public editing.

Update your map description describing what the map includes.

Update your maps terms of use

- Not intended for legal use
- Credits, etc.

Save the link to the overview page and share it!

Indigenous Perspectives: Exploring the Native Land Information System (NLIS)

Montana State University Geospatial Skills Camp

Lab 04.2

Introduction:

In this lab, you will be researching how indigenous traditional lands have decreased and you will be exploring the Native Land Information system's data portal. The goal for the research part of this lab is to visualize and understand how a tribe's land has been significantly decreased by mapping a tribes traditional lands compared to their current lands. The goal for the Native Land Information System is to find a dataset you would like to spatially explore, download it, import it into your ArcGIS online account, ask your spatial question, and then use your map to answer your spatial question.

This lab will be independent on your end, so this should allow everyone to use the geospatial knowledge that they have to create a unique map!

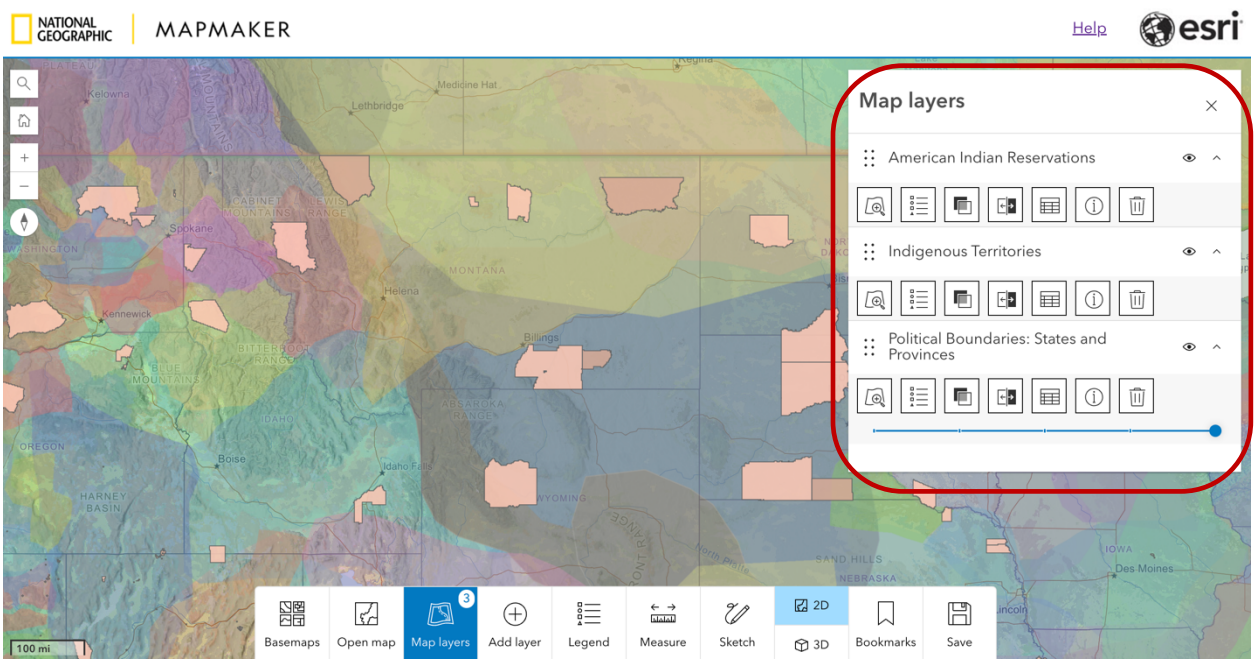
Objectives:

- Create a map that shows the traditional territories of the tribal nations and their current territory to understand the pressure the tribes were under when white settlers encroached their land.
- Learn how to filter data in ArcGIS online.
- Explore the NLIS Website
- Download your own data & create a map

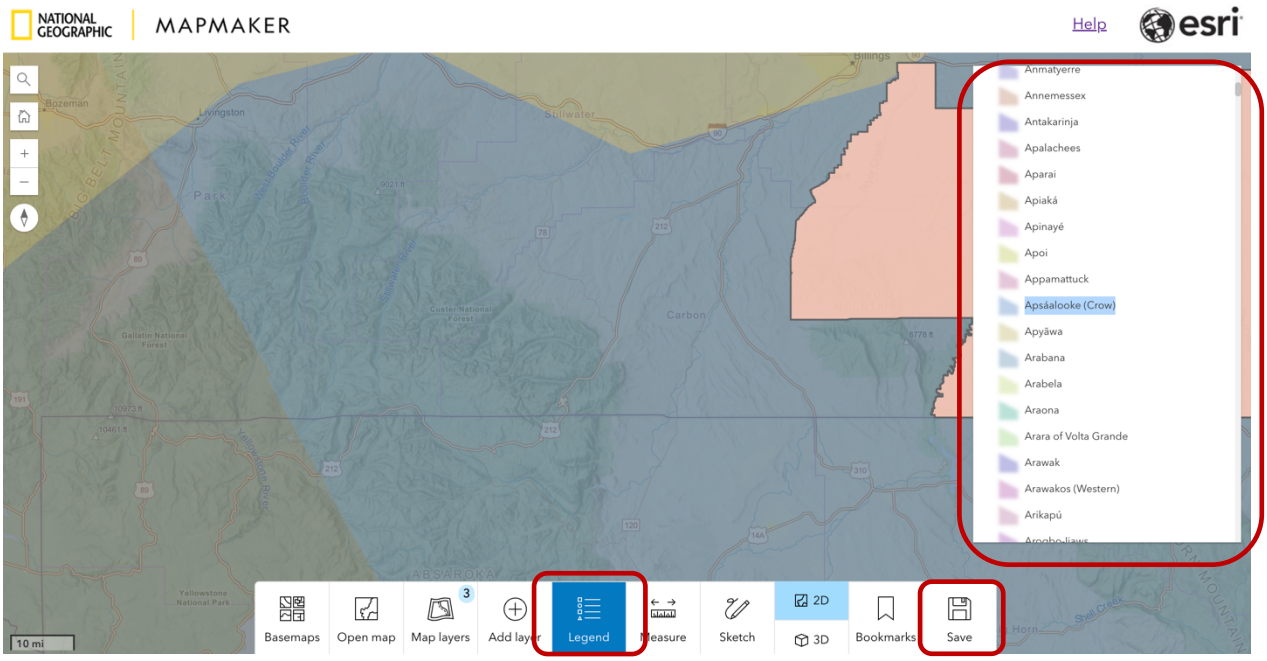
Part 1: How the Traditional Territory of a Tribe has Shrunk.

The first map that we will create will be to visualize how indigenous territory has shrunk over time. We will be looking at polygons that represent the traditional territory, and then looking at polygons that represent current territory. We will be getting our data from National Geographic Map maker for this first section.

Think about what tribe you are wanting to create your map on!



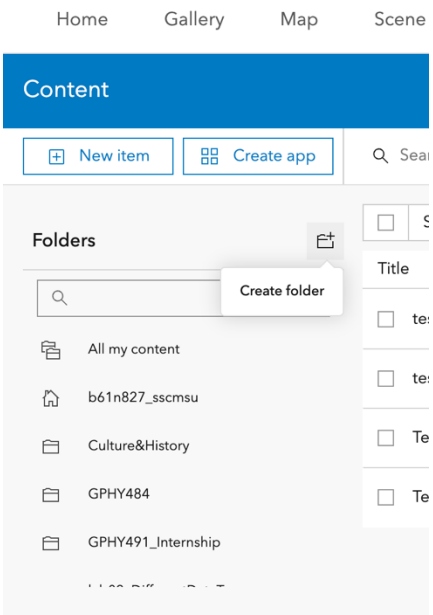
Once you are in your map, lets add three layers (recall how we did this from lab 2.2 where we went over different data types). Add **Indigenous Territories**, **American Indian Reservations**, and **Political Boundaries: States and Provinces**. Make sure that your layers are ordered similar to the image above, with American Indian Reservations being on top, and Indigenous Territories on the bottom.



For my example, I will be researching how the traditional lands of the Apsáalooke has changed. To check if the Apsáalooke (Crow) tribe is in the dataset, I can open the legend and see how the polygon representing traditional Apsáalooke territory symbolized (represented by color).

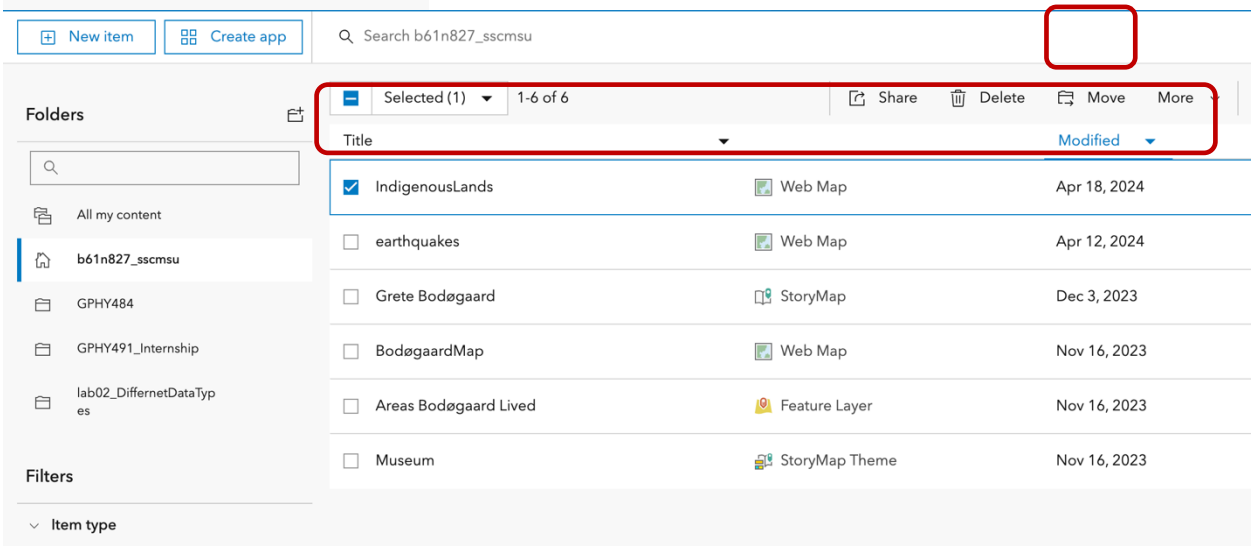
We will need to open the Legend in the Indigenous Territories Layer and scroll down until you the tribe you are researching. With all of the other tribes, it is difficult to focus only on the change in territory of just one tribal nation. To fix this, we will need to save our National Geographic Map to our ArcGIS online account and then filter out the other tribes and their territories in ArcGIS online.

Save your map to your ArcGIS online account by clicking **Save** on the tab at the bottom of your screen. Title your map something relevant to the data. Once you have saved your map, open up your ArcGIS online account by typing **ArcGIS online Login** into your browser.



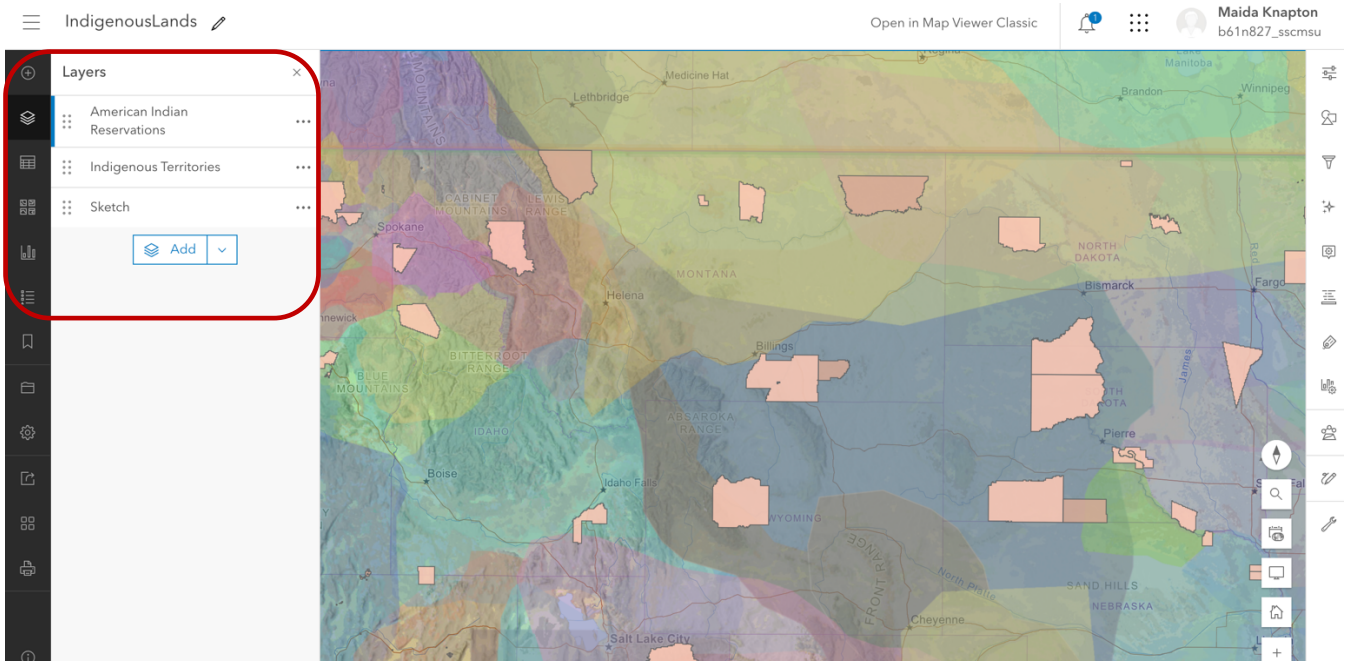
Navigate to your content page in ArcGIS online.

We will need to put our newly created map into a folder to keep our ArgGIS content page organized. Click **Create Folder**. Title your folder 'Lab04_IndigenousPerspectives'.



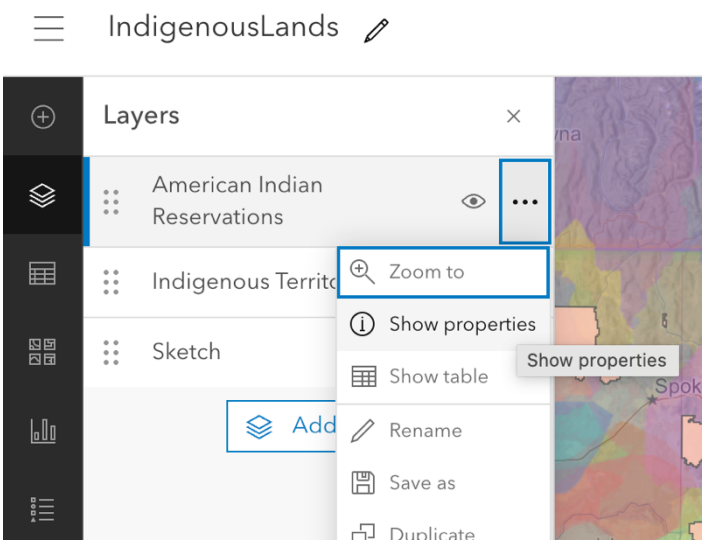
Under your home folder on the left had side of your ArcGIS online Content screen, we will need to move your map you created in National Geographic to your new Lab04_IndigenousPerspective folder. Click the box on the side of your title and then move it to your new folder.

Now, open your map.



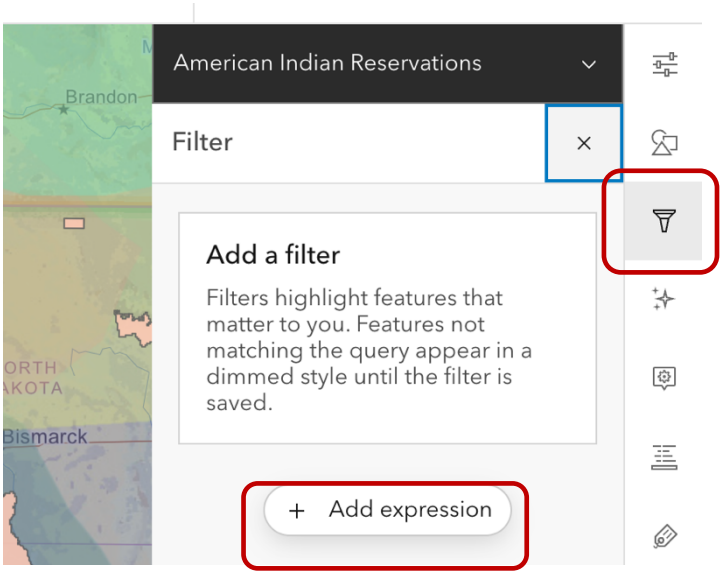
Your screen should look like this. You will be able to see all three layers you put into your National Geographic Map under the layers tab. Next, we will filter out all of the other tribes so we will only see the territory of the tribe you have chosen to research.

NOTE* I will be using the Apsáalooke Nation as my example, so the following directions will correspond to the Apsáalooke tribe. The directions and steps are the exact same for filtering down different tribes, so just follow the directions with the tribal nation that you have selected!



We will first filter the American Indian Reservations layer.

Click on the three dots to the right of the layer. Click **Show Properties**.

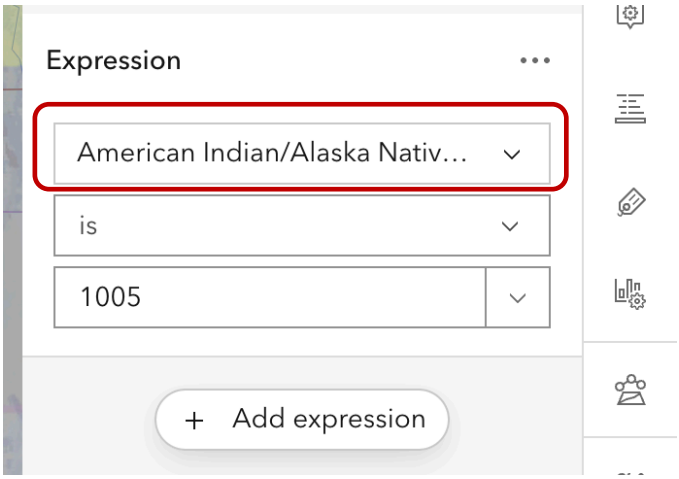


The Properties pane will popup in the right hand side of your screen. We want to be in the filter tab in order to filter down our data.

Click on the **Filter** tab.

Now, we will add an expression. Adding an expression is how we will tell ArcGIS that we only want the Apsáalooke land (or the tribe you selected).

Click **Add Expression**.

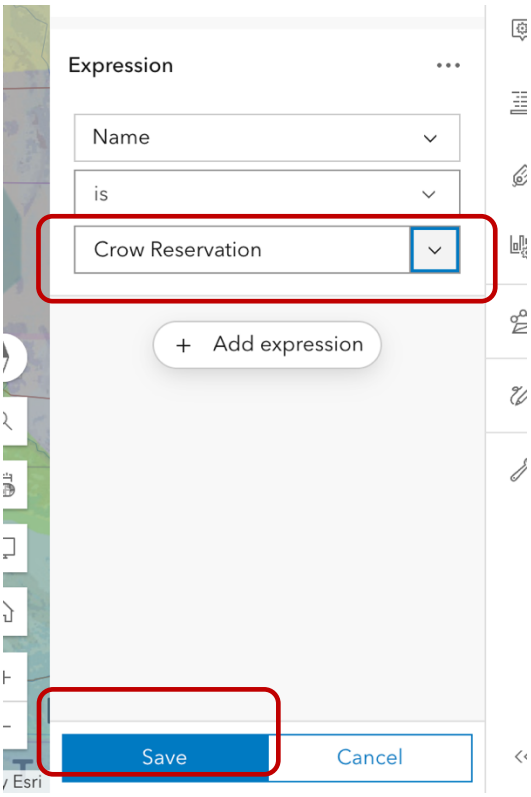


Now we will need to narrow down our data by only selecting the Apsáalooke.

We will need to switch the Object ID from the Census code, to the name of the tribe.

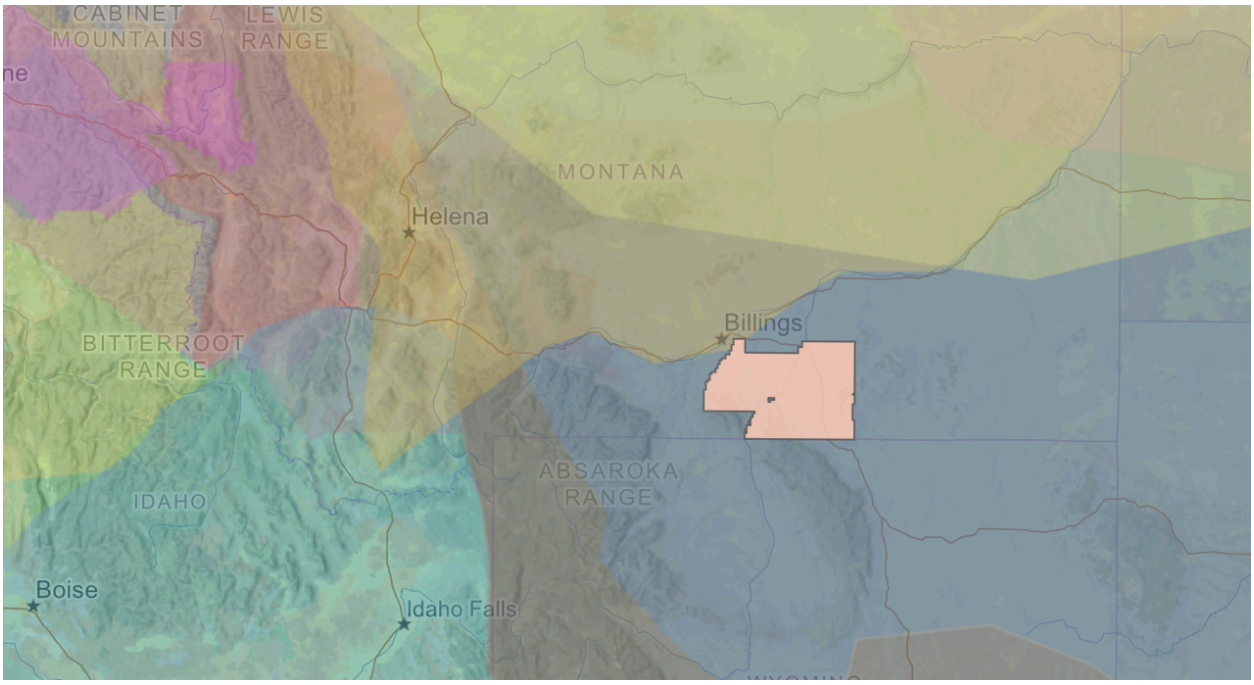
It is much easier to find a nation by searching for its name then its Governmental Census Code!

Click the drop down, and then scroll down to the name object ID option. Click **Name**.



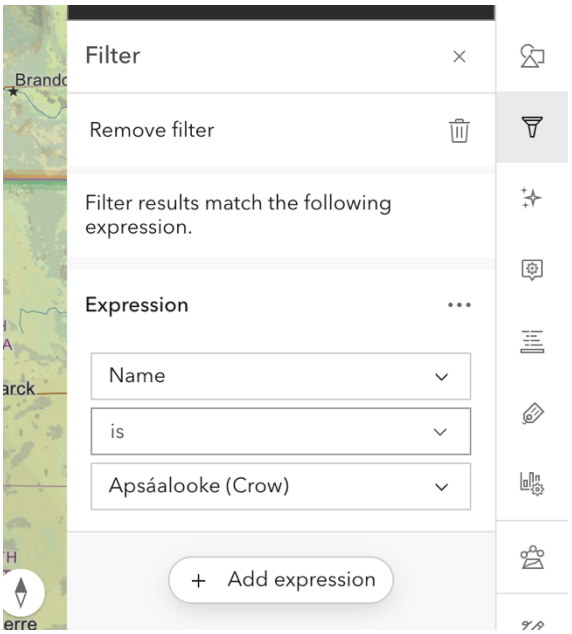
Now we will chose which reservation we will want to show on our map.

Click the drop down that is below the 'is' tab, and search for Crow Reservation. Click **Crow Reservation**. Now we will want to save our filter. Click **Save**.



Now, your map should look like this, where you can only see the Apsáalooke reservation. Next, we will filter the Indigenous territories layer so that we will only see the Apsáalooke territory. This will be the same filtering process!

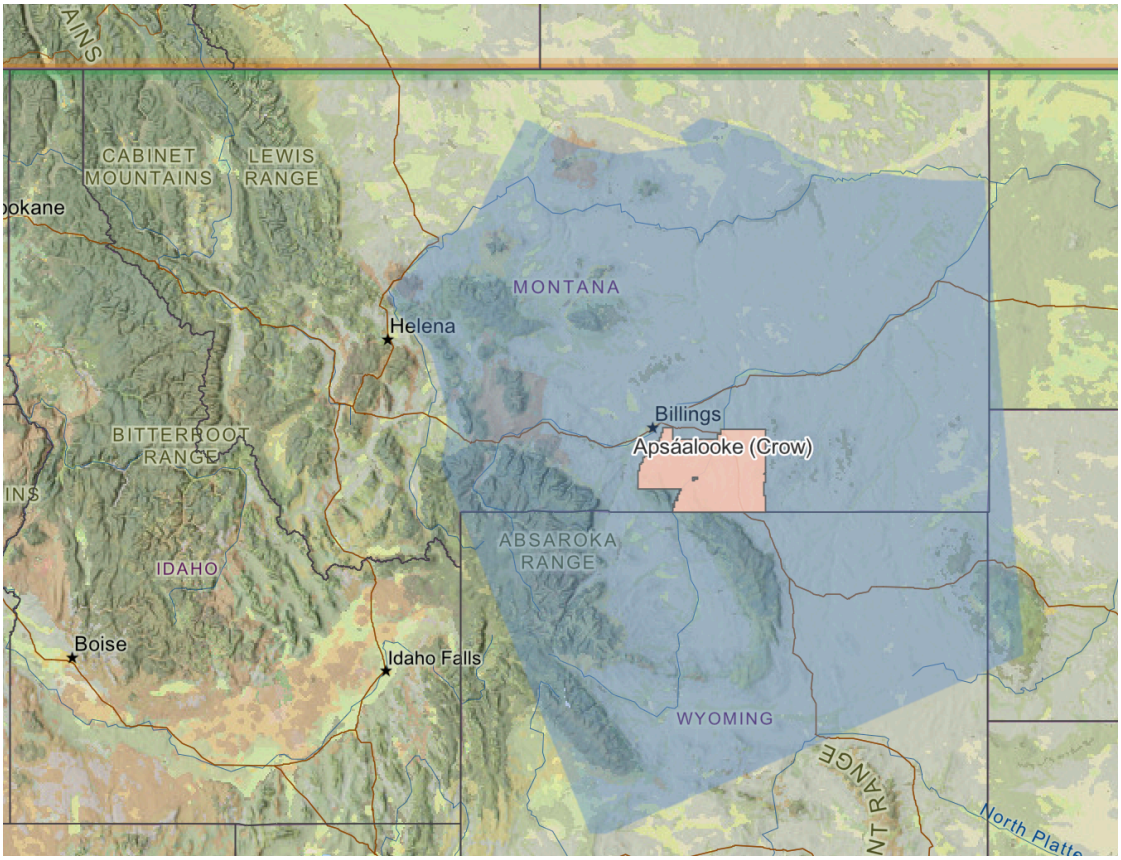
Navigate to the filter tab for the Indigenous territories layer. Click **Add expression**.



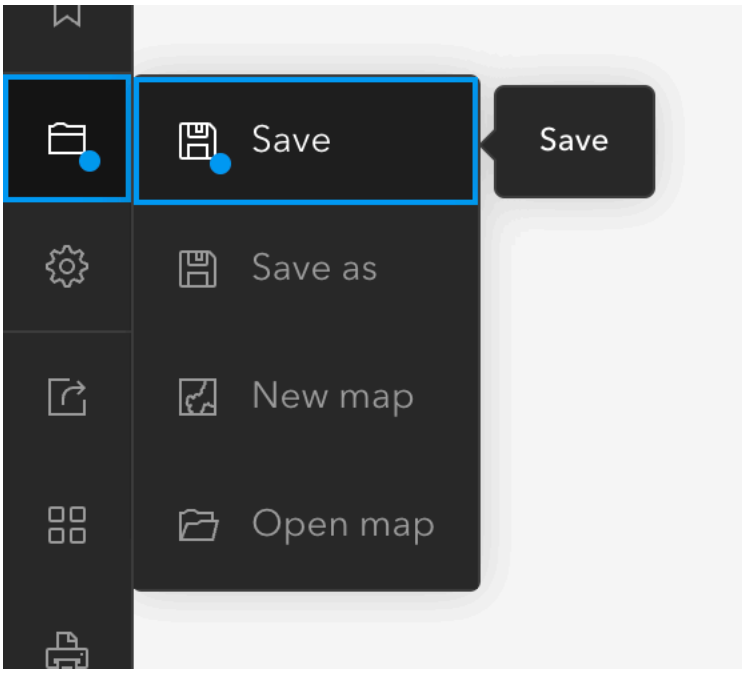
Your object ID needs to be **Name**.

Your value needs to be **Apsáalooke.**

Click **Save**.



Your map should now look something like this! Can you visualize the change in territory from the 1800's to now? Is the tribes current territory within their traditional land? Discuss with your group.

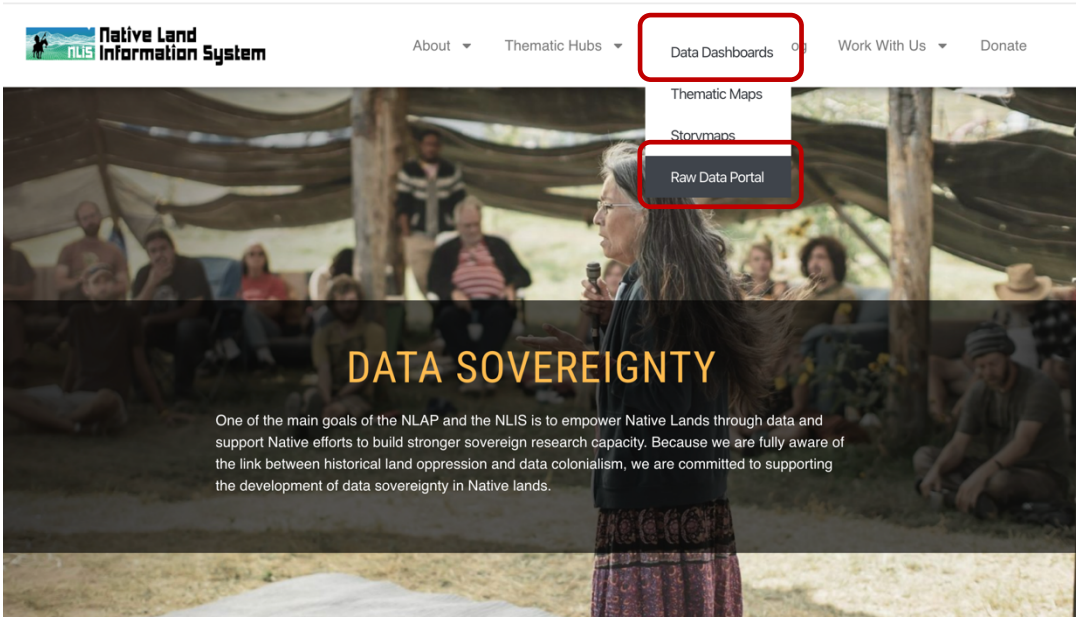


Make sure you save the updates you made to your map.

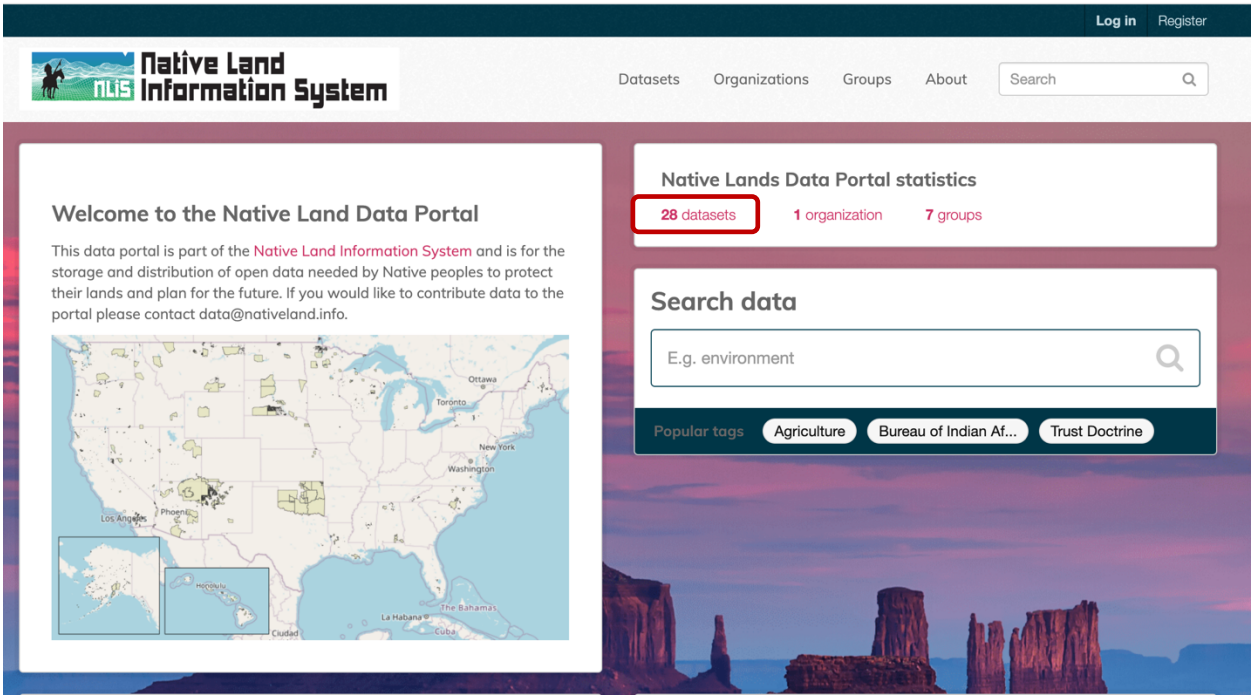
In the left hand side of your screen, navigate to the save button. Click **Save.**

Part 2 : Downloading the Data from the Native Land Information System

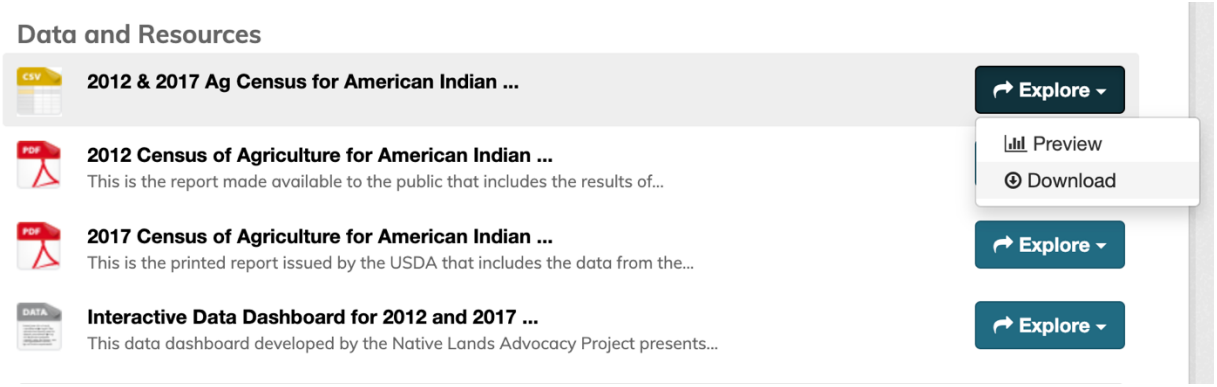
By searching in your browser Native Land Information System, or clicking the link below, access the website.
https://nativeland.info/about/data-sovereignty/



Explore the website first, and then click **Data Tools**, and then click **Raw Data Portal**.



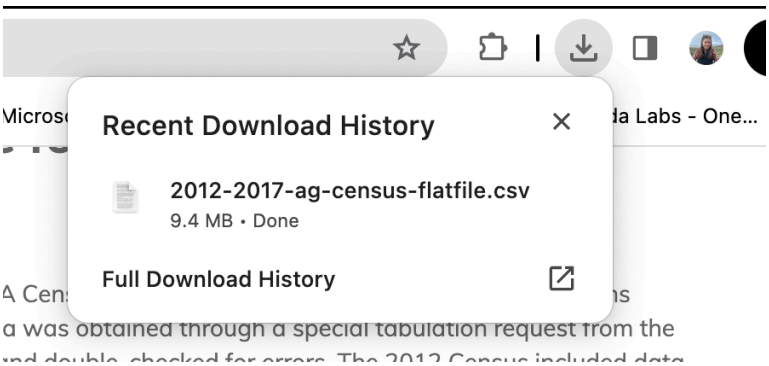
Lets explore all of the datasets, so click on **28 datasets**. Note: you cannot import a PDF into ArcGIS online. Recall what types of data we often import into ArcGIS online to create feature layers: Shape File(SHP), CSV, XLSX, TileJSON



Once you find a dataset you want to import into ArcGIS online to create a Feature layer, click on it. It will take you to where the data exists in different forms. Make sure it is an appropriate file before you download! Click **Explore**. Click **Download**.

Why did you choose this data set? What spatial question do you want to answer? Write down your spatial question on a piece of paper!

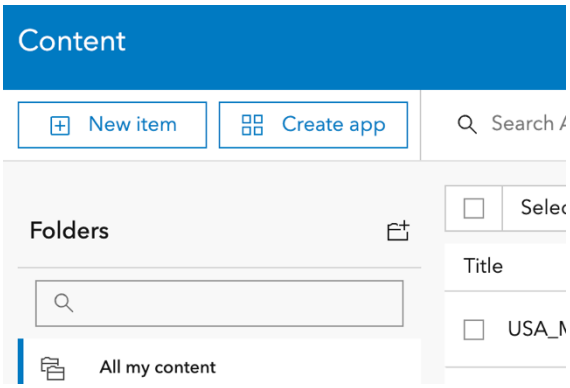
- Remember, sometimes our spatial questions are not as easy to answer as we might think, as the data might not have exactly what you are looking for. So you might need to adapt! Keep your original spatial question and adapt it if needed.



Once you download your file, it will show up in you downloads.

Part 3: Creating a Feature Layer

Sign into your ArcGIS online account and navigate to your content page. Remember to create a folder for your Lab 04 so you can save your feature layer into it!



Click New Item. Drag and drop your file into the window to create a new feature layer.

One you have created your feature layer, in the overview page of your feature layer click **Open in Map Viewer** to view your data.

From the past labs, you have learned how to symbolize data so that it best represents the attributes, filter data, download secondary data from the internet for creating maps, and creating your own data (primary data). Use these tools to answer your spatial question!

Feel free to download more data (From NLSI or the Montana Clearing House) and create feature layers in ArcGIS online if you have different spatial questions!

Share your final map and your workflow process with your group!

Great Job! ☺

Impacts of the Butte Mine

Montana State University Geospatial Skills Camp

Lab 05.1

Introduction:

During the time that indigenous nations were being pushed off their land by settlers and the US government, a large economy of resource extraction began to emerge. One location that had the biggest mining boom was Butte, Montana. The copper companies, known as the Copper Kings, were supplying jobs and copper to an industrialized world in exchange for a profit. Over a century of mineral extraction in what was the traditional territory and ancient homeland of the Niimiipuu (Nez Perce), Piikani (Blackfeet), Seliš (Salish), and Agai-deka (Shoshone) has created a permeant change in the landscape.

In this lab, we will be looking at how the landscape of Butte, Montana has changed in the past 150 years. One of the biggest obvious changes to the surface of the landscape was the Berkley Pit.

Have you ever visited the Berkley Pit in Butte Montana? The copper mine was opened in 1955 by the Anaconda Mining Company and operated for 27 years until its closure in 1982. During these years, the company moved 1.5 billion tons of material and extracted 290 million tons of copper ore, which gave the open pit its nickname: The Richest Hill on Earth. Despite its income and contribution to our anthropocentric (human) needs for copper, the mine has produced an enormous amount of toxic waste, making it one of the largest US superfund sites.

A superfund site is an area designated by the U.S. Environmental Protection Agency (EPA) as an area that is an environmental emergency due to its contamination level.

In this lab, we will look at a historic 1904 map from the USGS (US Geological Survey) and compare it to current satellite imagery of Butte Montana. We will quantify the change in land by creating polygons of the areas that look different than the 1904 map.

View a story map on the history of the Berkley pit:
https://storymaps.com/stories/bc926493d8634b3f9bf547ce120eaa41

Objectives:

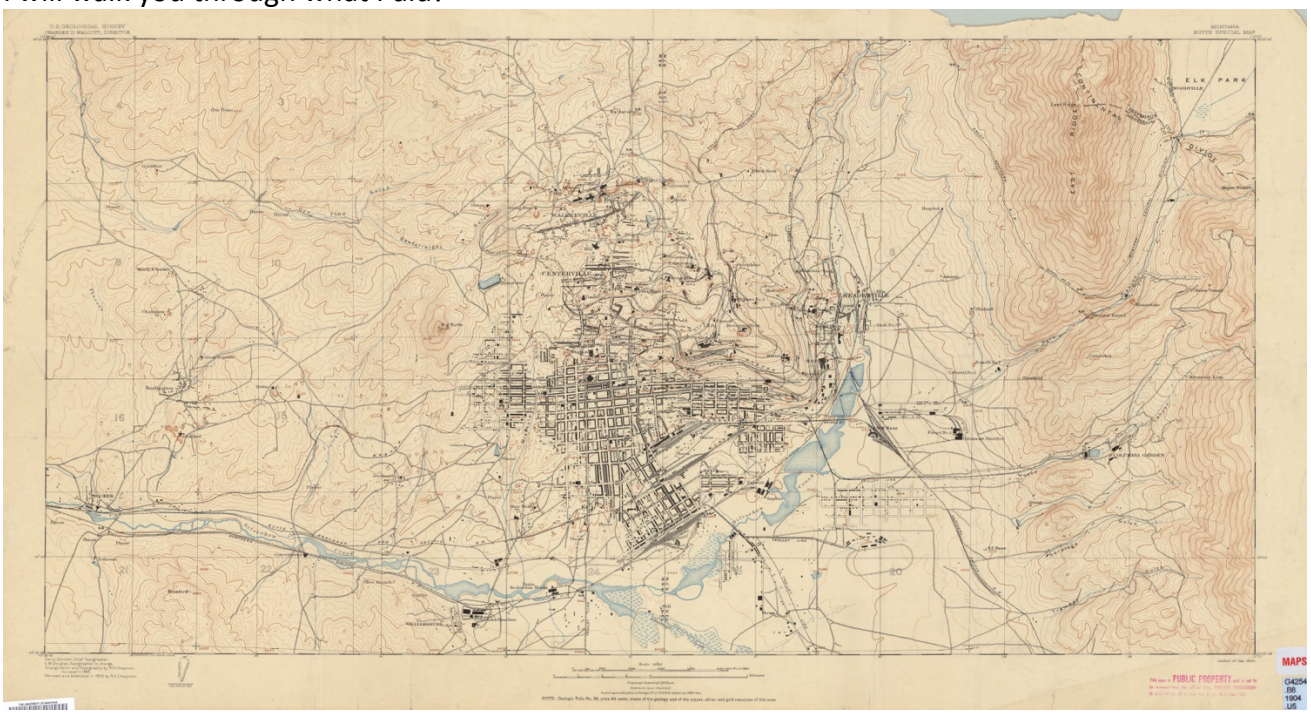
- Understand how old maps are digitized.
- Use Old maps, 3D maps, and current satellite imagery to identify land disturbances due to mining and then quantify the area of change.
- Identify the historic communities that were consumed by the Berkley Pit and other mining operations.

Part 1: How we Digitize Old Maps

Before you began this lab, I took an old paper map and turned it into a digital map.

- What does a digital map have that a paper map does not?

I will walk you through what I did!



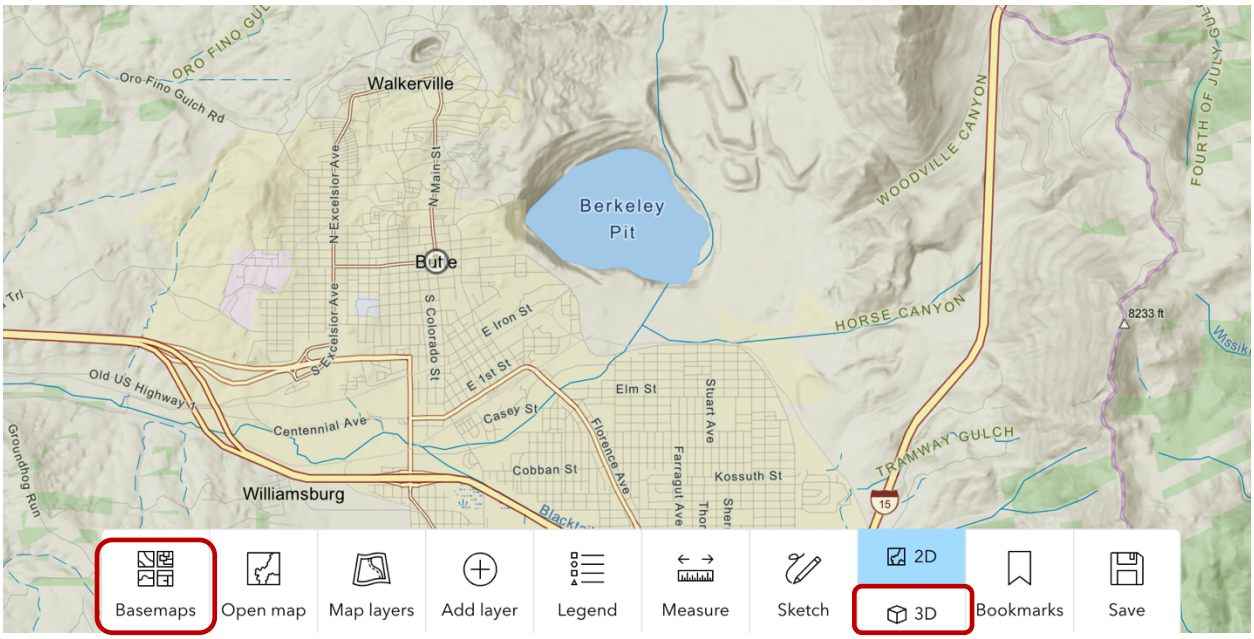
This map image above was created by the USGS (US Geological Survey) in 1904. There was no satellite imagery or computers during that time, so these maps were created using hand surveying, some aerial photography, and then hand drawing!

I imported the map above into ArcGIS Pro (a more high-tech ArcGIS online). Then, I turned the image into Raster data, as the computer does not recognize an image as a real map. Next, I added a coordinate reference system to the raster map so it would line up with current satellite imagery. After the image had been converted to a raster with a coordinate system, I exported it as a type of file called a tile package. Now, you can import this tile package into your ArcGIS online and quantify how the Berkley pit changed the landscape.

Part 2: Visualize the Areas of Mining Disturbance in 3D

Let's look at Butte's landscape in 3D and with different base layers.

In your browser, search **National Geographic Map Maker Launch Guide**. Once you are in the map, search for **Butte Montana** in the top left-hand corner of your screen.

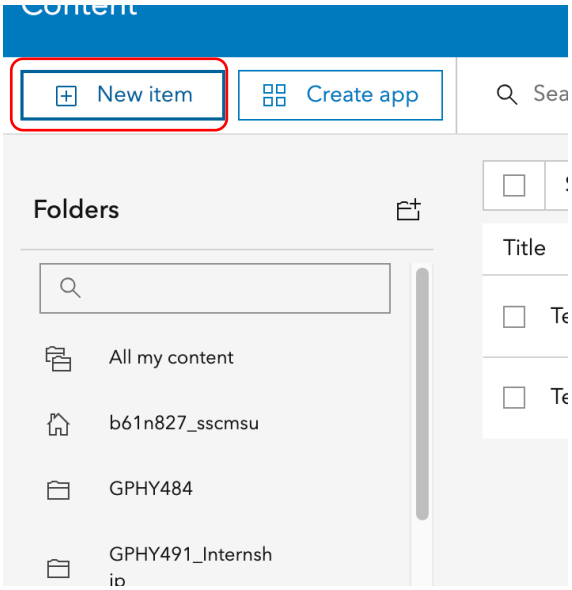


Next, switch your map from 2D to 3D and explore the mine. Choose three different base maps to switch to. Which base map is the best to view the mine with? Discuss with your neighbor.

Part 3: Create a Polygon that Quantifies the Area of the Land that Changed

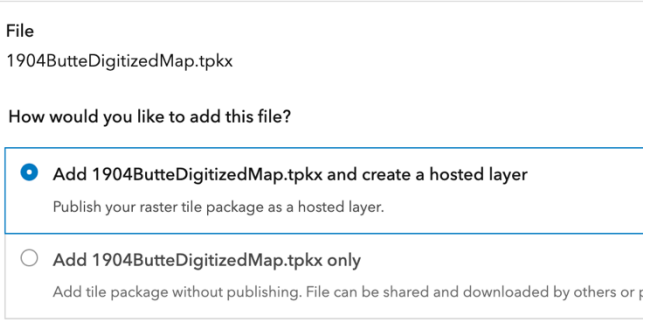
Open ArcGIS online and Navigate to your content page. Create a new folder titled Lab05_ButteMining.

Downloaded the tile package titled 1904ButteDigitizedMap from canvas onto your computer.

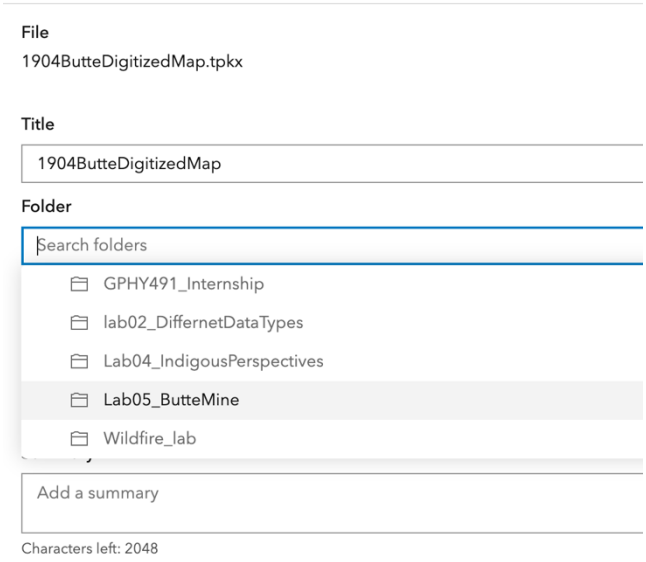


Import the tile package into your ArcGIS online account by clicking **New Item** in your content page.

Drag and drop the tile package into the drop area.



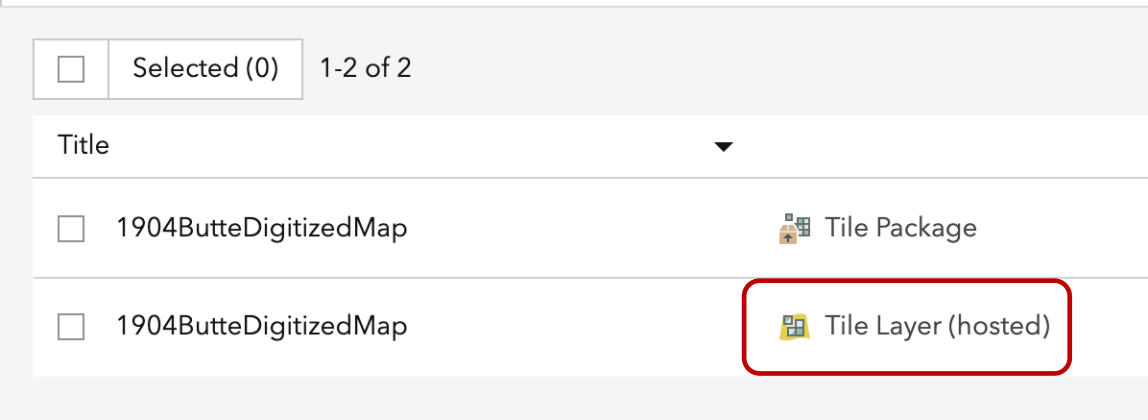
Add the file and create a hosted layer. Then Click **Save**.



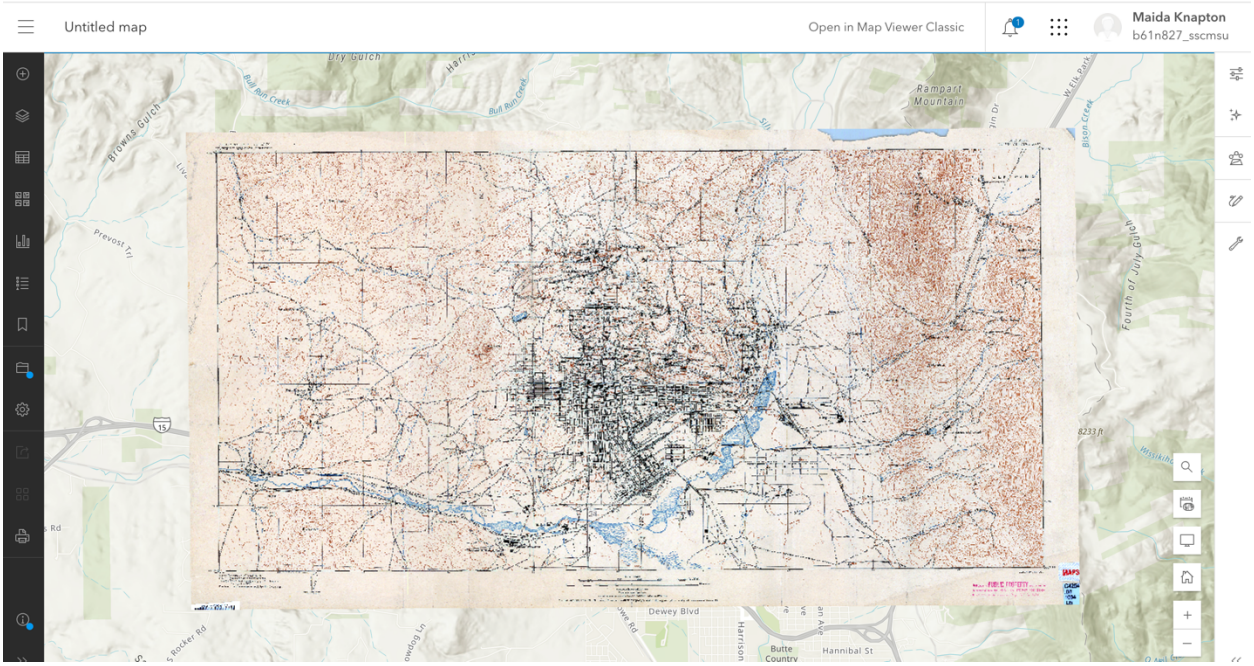
Save your tile layer to your Lab05_ButteMine. Click **Save**.

This is a large file, so it will take a while to upload. ☺

NOTE: If you are unable to download the tile packaged and import it into your ArcGIS online, you can use the one I have posted. When you are in your map, go to layers, add a new layer and search for 1904ButteDigitizedMap. Or you can copy this link and past it into your browser: https://sscmsu.maps.arcgis.com/home/item.html?id=d9932348f3da48b5b0747c87a47f6187



Once your tile package has been imported into your content, you will see the raw data (Tile package) and the feature layer (tile layer (hosted)). Click on **Feature layer**. Click on **Open in Map Viewer**.

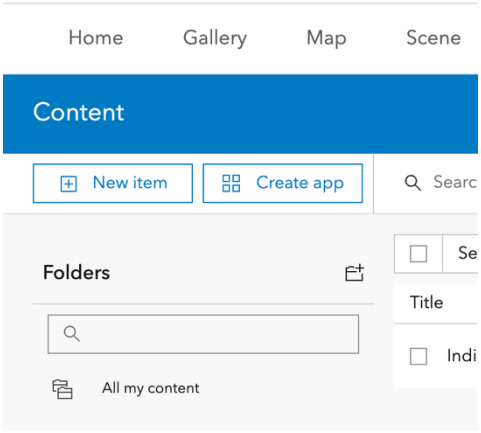


Your screen should look like this!

Part 4: Identify Communities that were Consumed by the Mine

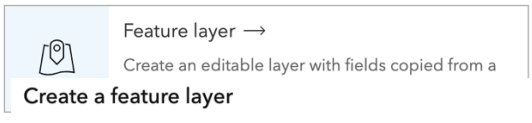
Now we will create a primary vector feature layer so that we can quantify how the land has changed. Do you remember what primary data is and vector data is? Primary data is data you create/ collect yourself, and vector data is composed of X and Y coordinates and represented by points, lines, and polygons.

Navigate to ArcGIS online and into your content page. Once in your content page, create a new folder and name it Lab05_ButteMine

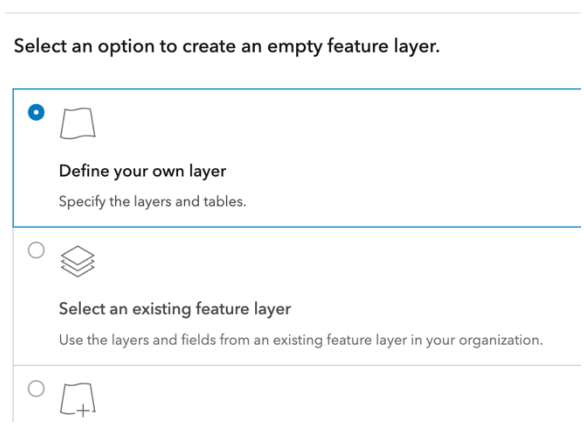


Once longed into ArcGIS online, we will need to create a Feature layer.

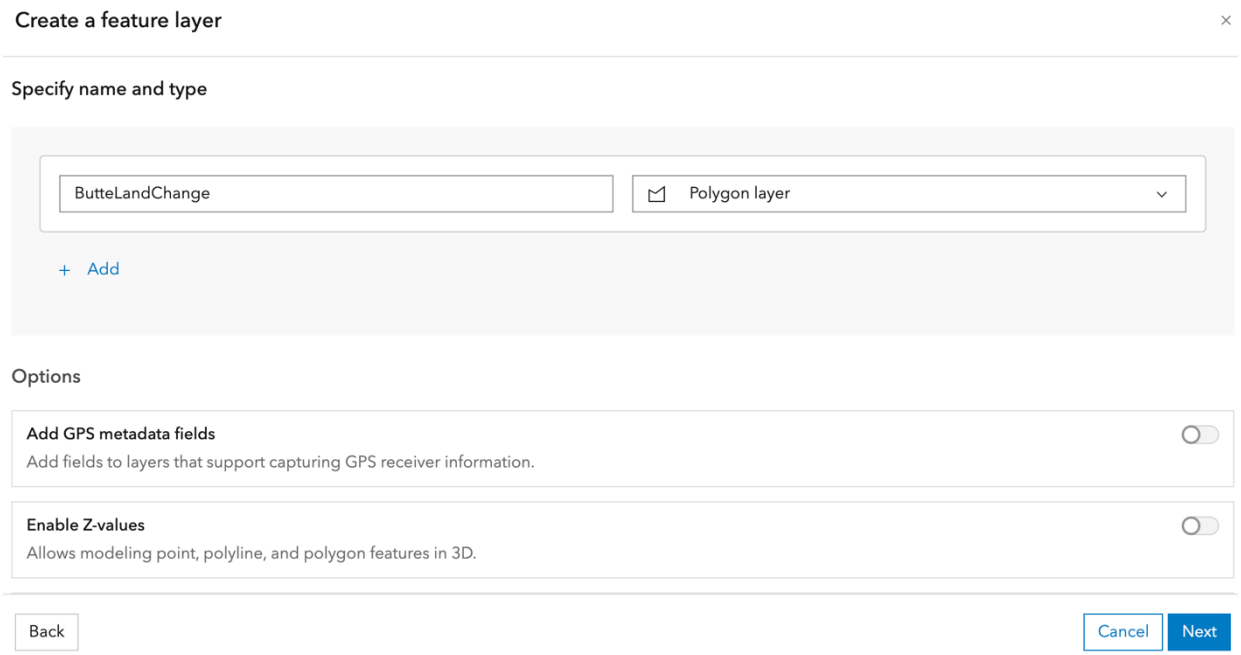
In your ArcGIS Content page, Click **New Item**.



Click **Feature Layer**.

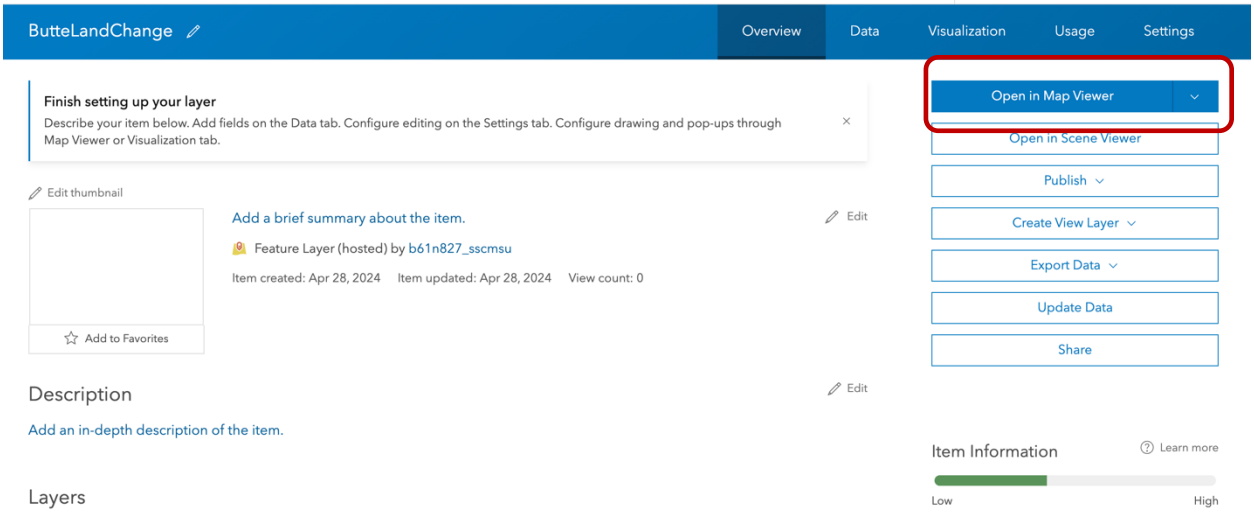


We will need to Define our own layer. Click **Define your own layer**. Click **Next**.



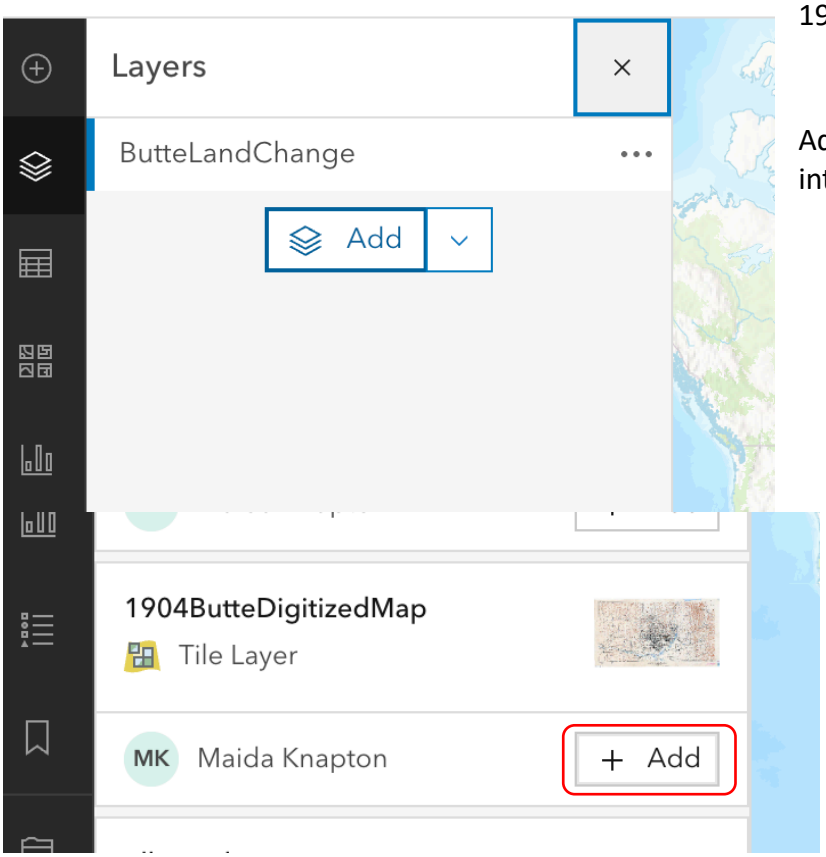
Here is where we will decide what type of vector data, we will use to quantify the land change. Name your feature layer ButteLandChange, and select **Polygon layer**. Click **Next**.

Save your feature layer to your Lab05_ButteMine folder and add a summary of your layer by answering these questions: What will your polygon represent, and what data did you use to create your polygon (mention the 1904 Butte USGS Map)? Click **Save**.



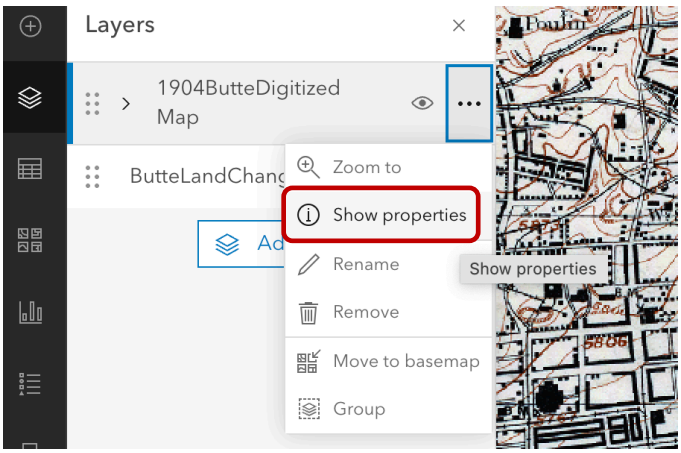
After you save your feature layer, you will be sent to your feature layers overview page. **Click Open in map viewer**.

Once you are in your map, you will need to save it to your Lab05_ButteMine Folder. In the left-hand side of your screen, navigate to the save button.



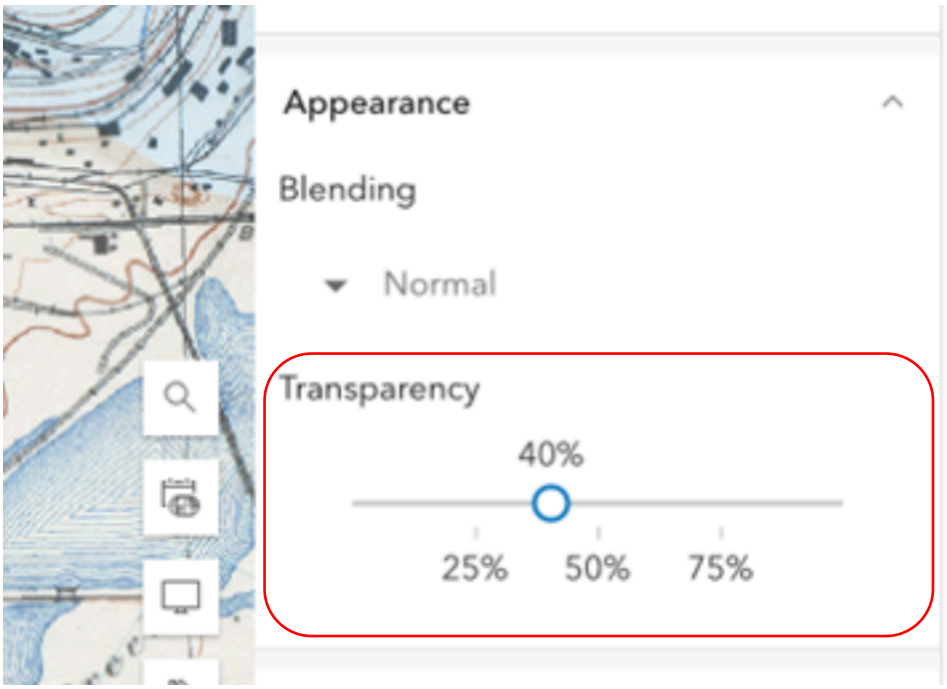
Next, we will need to add the 1904 digitized Butte USGS Map.

Add the Tile Package you imported into your ArcGIS online account.



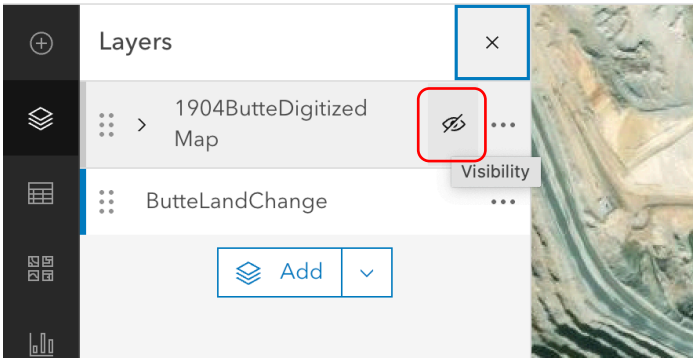
Next, we will need to make the Digitized map a bit transparent so that we can see the current landscape of Butte in addition to the old map.

In the layers tab, Click **Show Properties** for the 1904ButteDigitizedMap.



On the left-hand side of your screen, the properties screen will show up. Scroll down until you see the transparency. Edit the transparency so that you can see the old map, and the current pit.

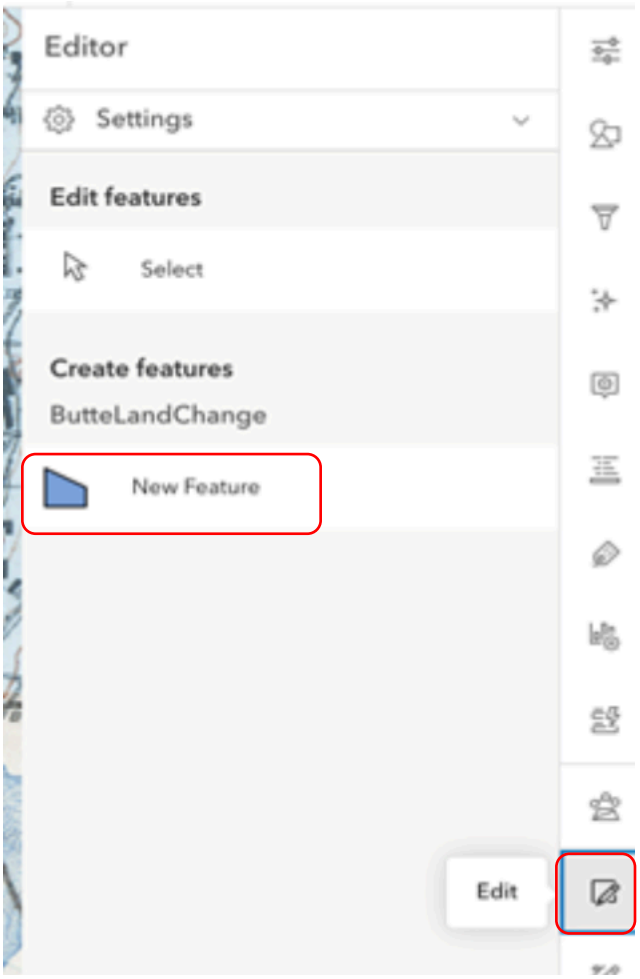
Explore the Butte area with this new transparency set.



Now, let's turn off the visibility of the digitized map layer so we can change our base map and draw our polygon easier.

Under layers, turn off the visibility for the 1904ButteDigitizedMap

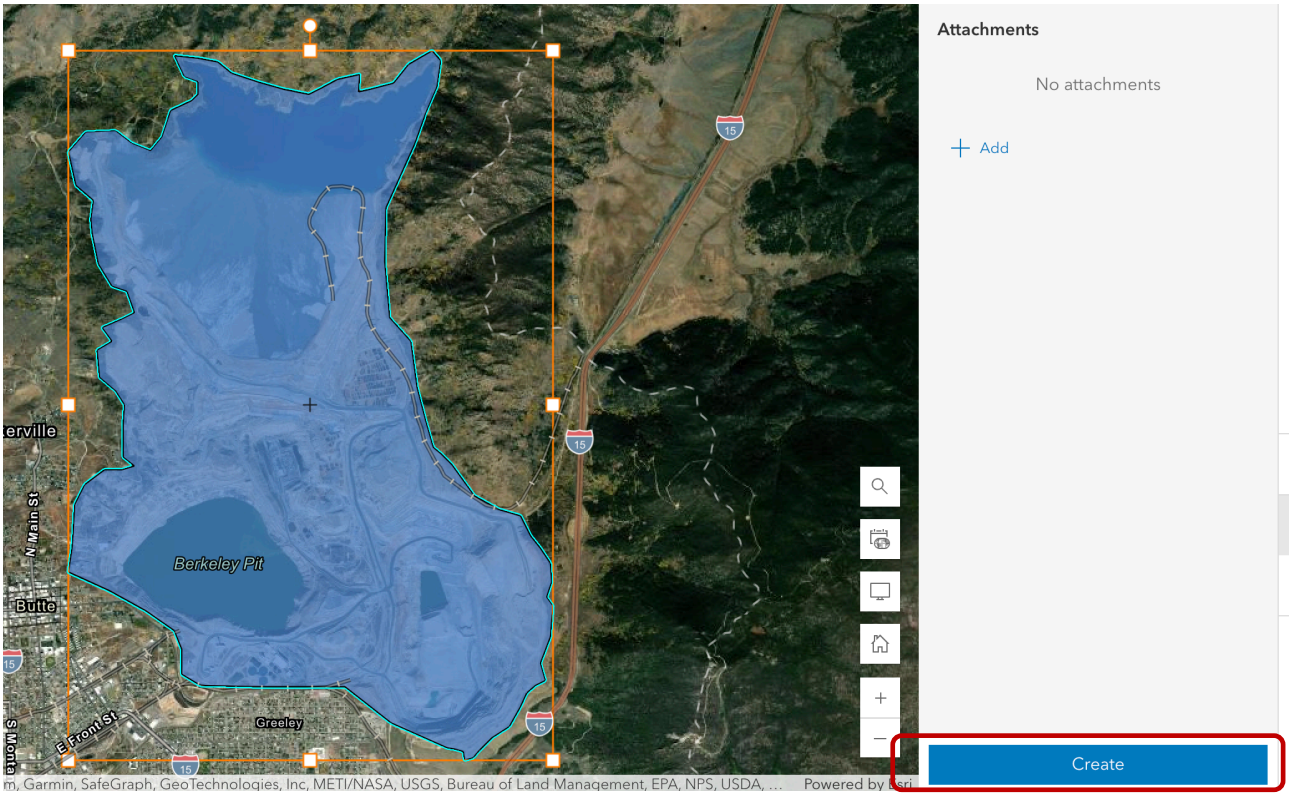
Next, explore different base maps and decide which base map shows the mine the best. Hint: try the *Imagery hybrid*.



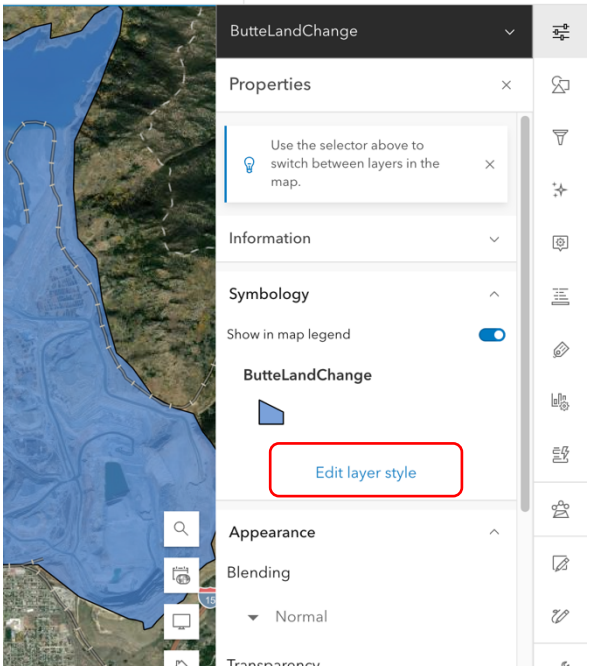
Next, we will draw a polygon around the mine using the feature layer we created. Navigate to the properties of your feature layer (same step we just did).

Click the **Edit Icon**.

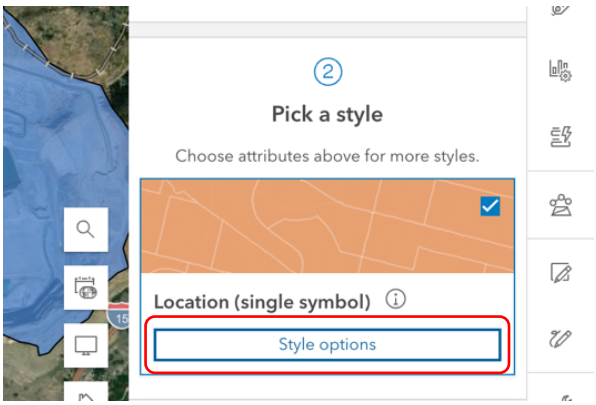
Under create features, click **New Feature.**



After you are done creating your polygon, hit enter on your keyboard to finish your polygon, and then hit **create**.

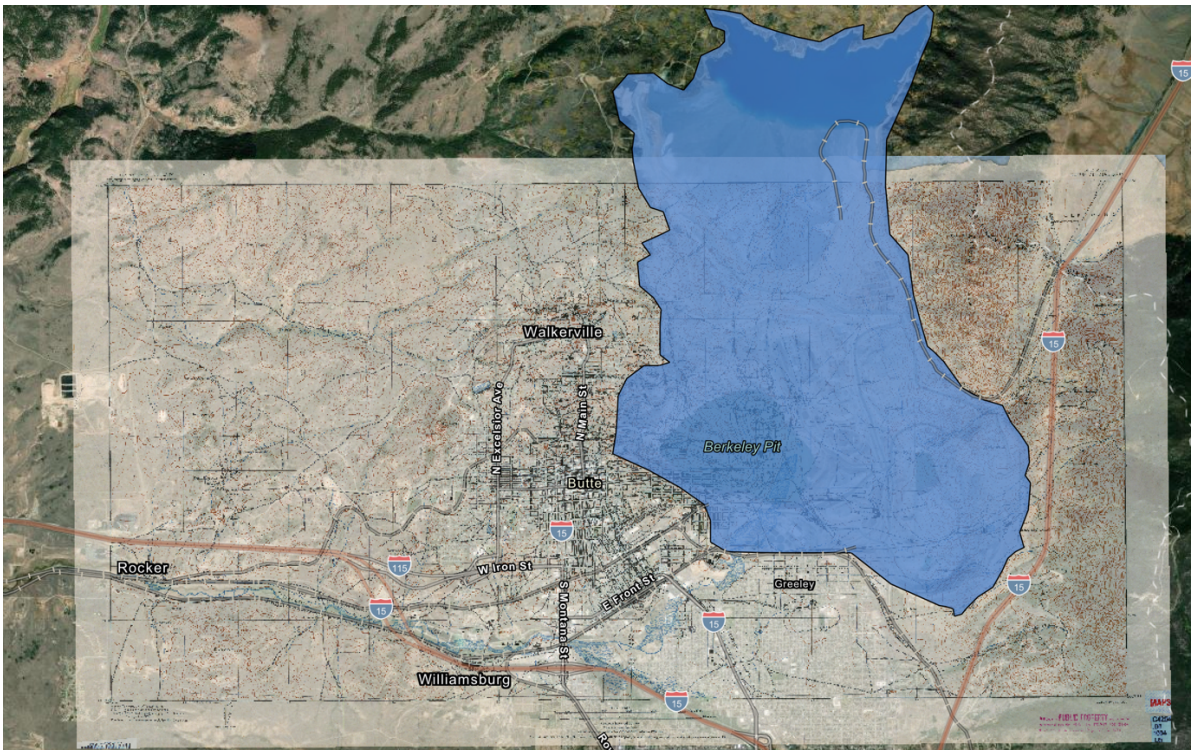


If you would like to change the color or pattern of your polygon, go to the properties of your layer and hit **Edit Layer Style**.



Then Click **Style Options**.

In the layers tab, turn back on your 1904ButteDigitizedMap. Reorder your layers so that the Butte land change feature layer is on top.



Your map should now look like this! Congrats, you have mapped the change in the land from 1904 until today. Good Job!!

Discussion Questions

1. One of the goals for this lab was to quantify the change in landscape due to the mine. We accomplished this by mapping out the area of change with a polygon. How big of an area and length was your polygon that you mapped? Click on your polygon and the pop up will show you the length and area. How do your numbers compare with your neighbors?
2. What communities and neighborhoods were destroyed by the mine? Zoom into your polygon and identify roads, houses, and neighborhoods that fall on or within your polygon.
3. How has the topography changed? Are there any hills or mountains that have disappeared?

Discuss your findings with your group!

Data privacy and Data Sovereignty

Montana State University Geospatial Skills Camp

Introduction:

Yesterday, you all shared a lot of data about yourselves. You shared height, birthplace, and if you have siblings. Did any of you have the same information in each column, or were you all unique? Today we are going to explore who "owns" data, who can access data, and how to be better digital citizens in terms of mapping data!

Objectives:
To be able to describe data privacy and data sovereignty
To identify ways to protect our own data
To identify principles to use data appropriately

Part 1: Exploring data privacy
We already mentioned that you shared information with each other at camp yesterday, but do you also share information online? As a group, discuss any information that you think might get shared online (no need to share your personal information here, we just want you to discuss the types of data that get shared, like location or user ID, etc).

Now, watch this video about data tracking and try to figure out how many times the video mentions data that would be tracked that counts as geospatial data.
https://www.youtube.com/watch?v=bqWuioPHhz0&t=4s



Check out this article about data tracking, and as a group you all can decide whether you think data tracking is Good, Bad, or Ugly: https://internethealthreport.org/2018/the-good-the-bad-and-the-ugly-sides-of-data-tracking/

Now, if you'd like to explore further it turns out that Montana has passed a Consumer Data Privacy Act that will take effect this October. We are adding a few links about it here, but you can also feel free to research on your own.

Part 2: Data Sovereignty

In addition to considering how our own personal data might be shared/stored, it is also important to understand at a more global level how data is managed. According to the National Library of Medicine "Data sovereignty refers to a group or individual's right to control and maintain their own data, which includes the collection, storage, and interpretation of data. Indigenous data sovereignty refers to the ability for Indigenous peoples to control their data and includes autonomy regarding a variety of data types such as oral traditionals, DNA/genomics, community health data, etc. Within the context of transnational indigenous sovereignty and self-determination movements, indigenous data sovereignty can be a powerful tool for those whom the data represents, which claims the rights of Indigenous peoples to use and interpret the data in a way that is accurate and appropriate given their circumstances, customs, and communal way of life."

Our camp has explored multiple data sets and mapping resources, and now we would like to discuss how geospatial professionals (and all data professionals) should use geospatial data responsible. The United States Indigenous Data Sovereignty Network



From *CARE principles for Indigenous data governance*, by Research Data Alliance International Indigenous Data Sovereignty Interest Group, 2013, The Global Indigenous Data Alliance, (https://www.gida-global.org/).

In January, for National Data Privacy Day the Native Land Information System posted this blog: https://nativeland.info/uncategorized/indigenous-sovereignty-on-national-data-privacy-day/Links to an external site.

Read through that blog and discuss with your team and/or community educator how you can apply the FAIR and CARE principles in your map. OR consider one activity that we have worked on this week and describe how the principles apply to that set of data.

Snow & Watersheds

Montana State University GIS Camp

Lab 06: Looking at Snow Water Equivalence and Summer Drought

Introduction:

Montana's watersheds are the lifeline for ecosystems and anthropocentric(human) use. This is because the presence of clean water affects every single trophic level, starting from the spring grass to the large herbivores, and then to the food that is on our plate. Montana's snowpack can be thought of as a water bank, where water is saved up during the winter and released in the spring and summers to feed our rivers and groundwater, which is needed by every single trophic level in our ecosystem.

Water is life! Especially in Montana, where precipitation can be a limiting resource for many species and ecosystems.

In this lab, we will be looking at snowpack data from this past 2023/ 2024 snow year in Montana in comparison to the average winter snowpack. The spatial data that we will be analyzing will help us to make inferences on the ecological impact each watershed will experience during the summer months. After we have looked at the average snow water equivalence (SWE) for Montana we will then be looking at the current June drought index trends in comparison to the SWE trends from this past winter.

Objectives

- Understand what effect the Snow water equivalence (SWE) has on our watershed.
- Use USGS data to observe watersheds in Montana that are below the average SWE.
- Think about the Geospatial effects this year's average SWE will have on the different ecosystems and anthropogenic(human) communities located in the Watersheds.

Learning Videos:

What processes occur in the Flathead lake Watershed. PBS learning video: https://montana.pbslearningmedia.org/resource/watershed-video/flathead-lake-park-parks-of-montana/

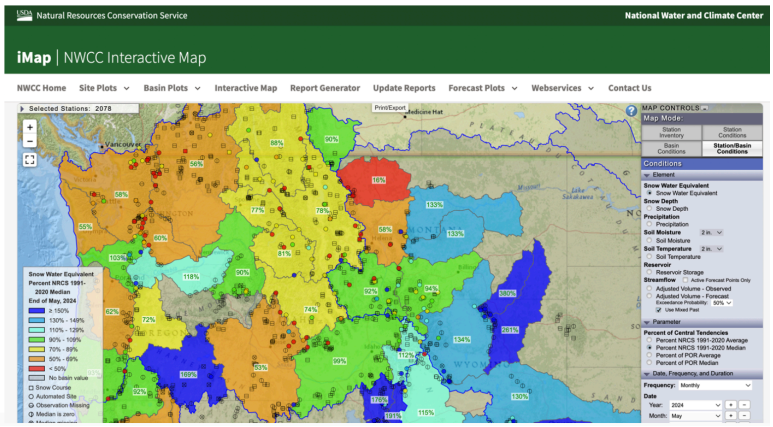
Why the winter snowpack is important in Watersheds. PBS learning video: https://montana.pbslearningmedia.org/resource/1f69106c-b540-44c4-ab6a-0030f3651ffc/watershed-episode-2-the-weight-of-water/

Part 1: Visualize the Average Snow Water Equivalence for this Past Winter

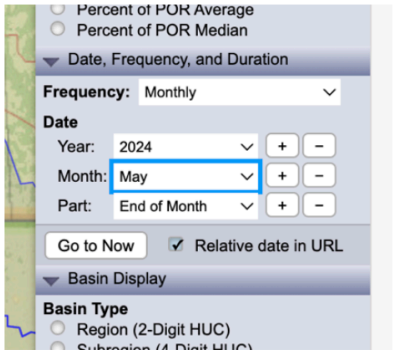
The Natural Resource Conservation Service is a government program that has monitoring stations in the streams and mountains across the US. These stations measure how much water is in a river, the amount of water that is in a snowpack (SWE), and the amount of precipitation an area gets. This data has been tracked over time, and the Natural Resource Conservation Service can then take the average of the previous year's data and compare it to this year data to help us understand what the water trends will be like for an area.

These variables can be visualized on the Natural Resources Conservation Service's interactive map. We will be exploring this map and visualizing how the snow water equivalence has compared to the past 20 year average. The link is here: click here.

Your screen should look like this! Familiarize yourself with the data and symbology on this page. On the left side of your screen, you can see the legend. On the right hand side of the screen you can see the month of the data being shown (you have to scroll down to the section titled **Data, Frequency, and Duration**).



In the Data, Frequency, and Duration section click through the months starting with January and look at how the colors and percentages change in the watersheds.

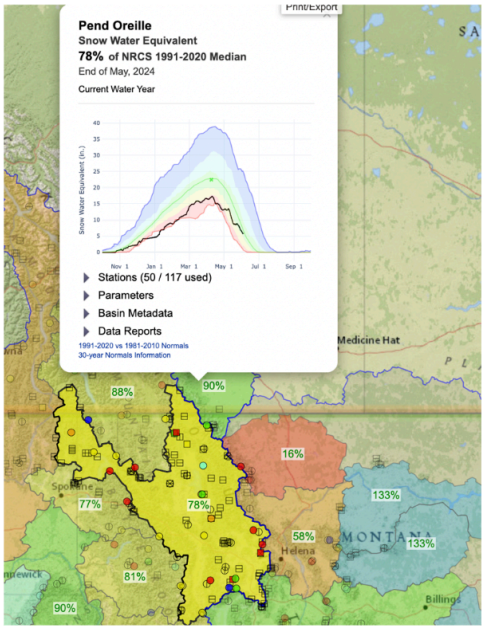


From your visual observations, how has the general change in average SWE varied overtime? Discuss with your group.

Each polygon represents a different watershed basin boundary and the snow water equivalence for the month of May compared to the past 20 year average.

Make sure that the month that the data shows is set to May. Next, click on the watershed where the Flathead lake is located.

When you click on the watershed, you can see the graph showing the SWE change over time. Notice that the colors on the map match the colors on the graph.



Note that this watershed boundary is named Pend Oreille.

Has the flathead lake watershed had a SWE that was below average all winter?

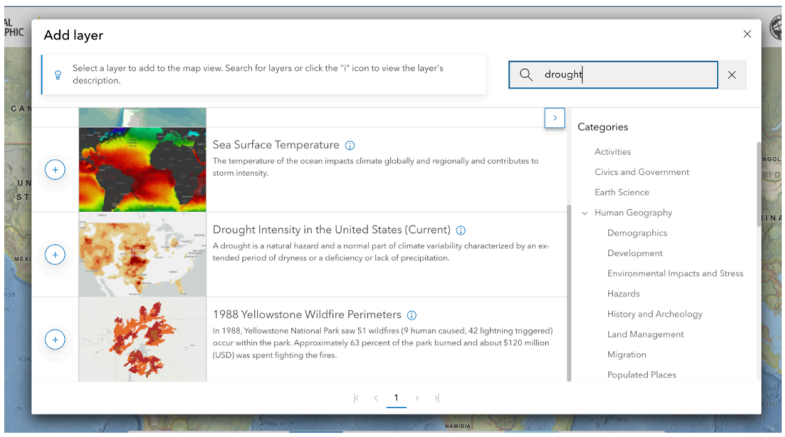
Next, find a watershed that is above the SWE 20 year average for the month of May. Has the watershed's SWE been above average all winter or has the trend changed as we enter the spring months?

Now, we will be looking at the current areas of high drought index for Montana and comparing it to watersheds that had a low snow water equivalent.

Part 2: Uploading the Current Drought Index into ArcGIS Online

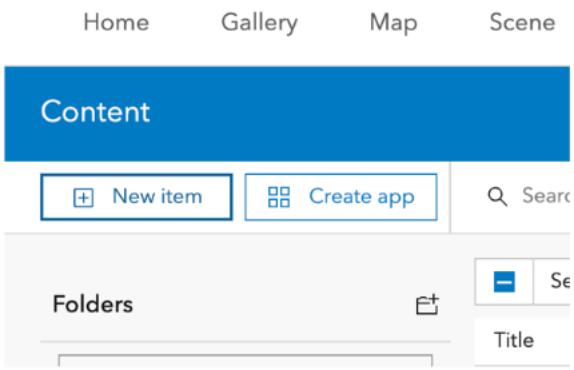
For this next part of the lab, we will be getting our data from National Geographic Map Maker. Type into your browser National Geographic Map Maker Launch Guide.

Once you are in your map, add the Drought Intensity in the United States (current) data layer to your map, and then save your map to your ArcGIS online account.



Can you already notice areas in Montana that have had a low SWE and are now experiencing drought?

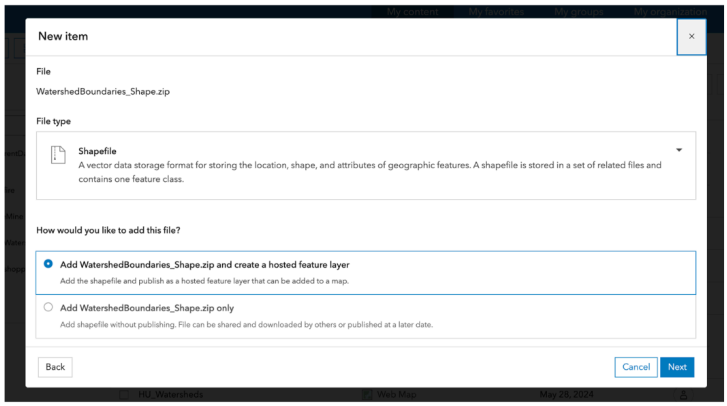
Open your ArcGIS online and create a folder titled **Lab06_SWEWatersheds** and save your new map here. The next step we will do is to import the watersheds boundary into your ArcGIS online account.



Part 3: Upload Watershed Boundaries into ArcGIS online and Create a Feature Layer.

Next we will download the data file titled **WatershedBoundaries_Shape.zip** off the Canvas page, onto your computer, and into your ArcGIS online account. Download the file in Canvas titled **WatershedBoundaries_Shape.zip**.

Navigate to your ArcGIS online account, and create a new item. Import the **WatershedBoundaries_Shape.zip**.

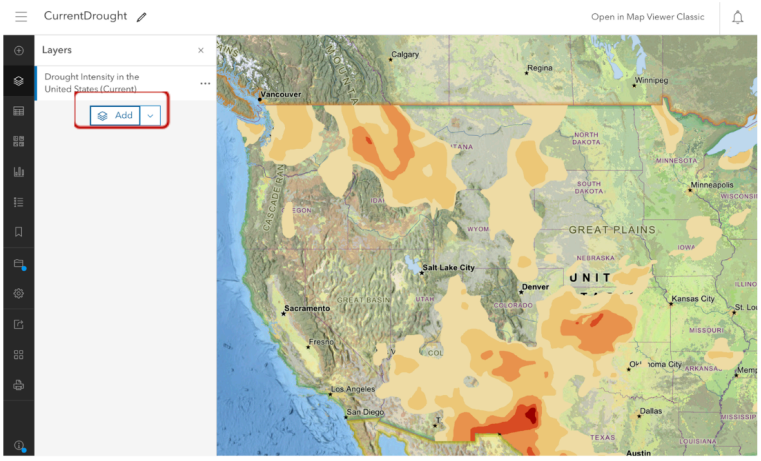


Add the **WatershedBoundaries_Shape.zip** as a hosted feature layer. Save your feature layer to your **Lab06_SWEWatersheds** folder.

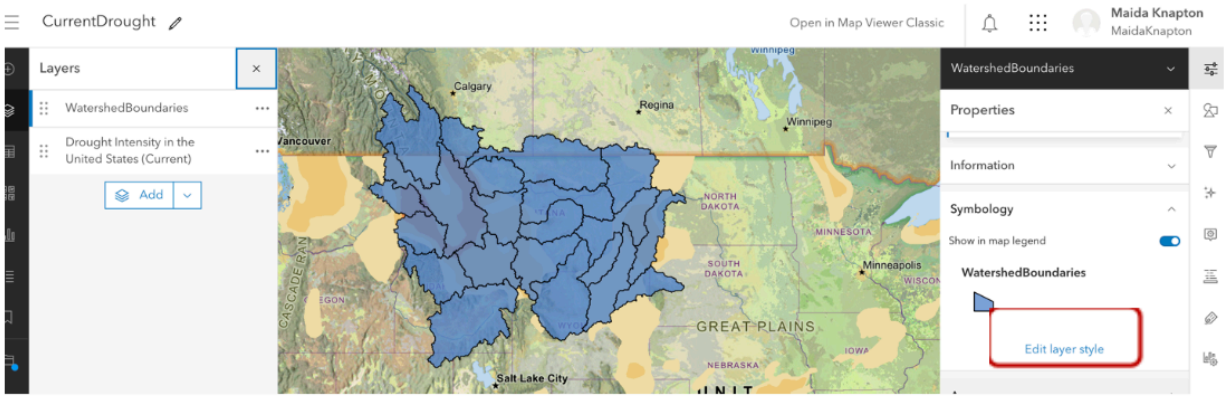
Part 4: Combine your Feature Layer and the Current Drought Index into One Map

Open your Current Drought Index map.

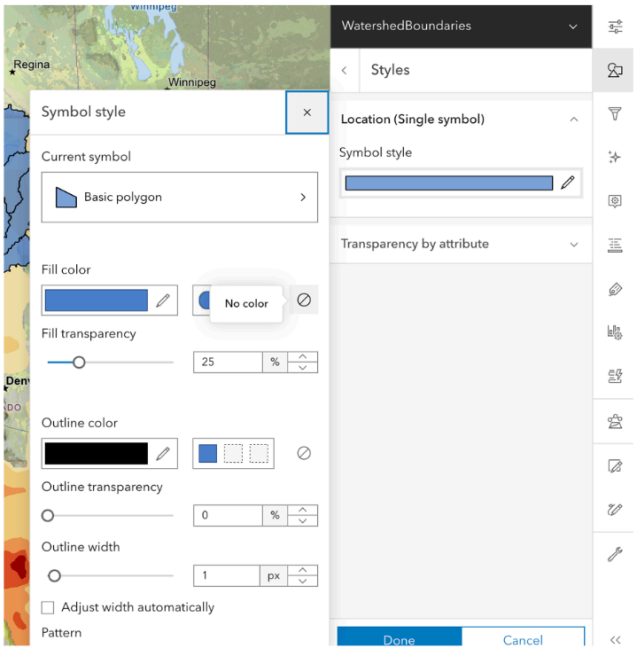
Your map should look similar to this! Next, we will want to add the watershed boundaries feature layer you created. Click **Add data**. Add the watershed data.



Your map should look like this. We will want to only see the watershed boundaries so that we can also visualize the current drought index.



Click **Edit Layer Style**. Click **Style Options**.



Make it so that the fill color is transparent for the watershed polygons by clicking the circle with the dash through it.

Click **Done**.

- How does the average SWE map compare to the current drought conditions?
- In the watersheds that are experiencing drought, can you think of any local ecosystems or water systems that will be affected?
- What are the agricultural systems in that area, and how do you think they will be affected?

Make sure to save your final map to your Lab06_SWEWatersheds folder!

Great Job! ☺

Grasshoppers & Agriculture

Montana State University Geospatial Skills Camp

Lab 07: Visualizing areas of high grasshopper density & identifying agriculture areas that are at risk of infestation.

Introduction:

The majority of Montana's agriculture falls in the Eastern half of the state, where beautiful flat lands of prairies and coulees dominate the landscape. Montana's agriculture systems are incredibly important to the economy and many folk's day to day lives, as our food system is needed by everyone of us!

Grasshoppers are a native species in this area of Montana in addition to 17 other western states. However, when grasshopper populations grow to infestations, they can consume and wipe out most of the vegetation on the land leading to large amounts economic and ecology damage. Thanks to mapping, we can use data on grasshopper numbers collected by the USDA (United States Department of Agriculture) to map the areas that have high grasshopper density and prepare for the risks of infestation.

In this lab we will be taking USDA grasshopper density dataset which includes point data and converting it into a map showing low and high density of grasshoppers across the West. This process in GIS is called **interpolation**.

Objectives

- Understand how Grasshopper infestations have a negative impact on Agricultural practices.
- Look through the attributes of USDA data collected on grasshopper infestations. This dataset is an XLSX (Microsoft Excel file).
- Import the USDA Grasshopper point data into ArcGIS online
- Create a map that shows areas of high and low grasshopper density across the entire Western US. Identify areas that have a high number of grasshoppers on the land and therefore will have a large impact on agriculture systems.

Likes to Learning Resources

- USDA: Rangeland Grasshopper and Mormon Cricket. https://www.aphis.usda.gov/plant-pests-diseases/ghmc

Part 1: Looking at the USDA 2024 Rangeland Grasshopper Hazard Map.

In Canvas under the Lab07 Grasshopper section, you will see a PDF titled **USDA_GrasshopperHazard.pdf.** Open this map and discuss with your group what the map is showing. Use the legend and text to understand the map!

In this lab we will be creating our own map using similar grasshopper data from the USDA, but it will be compiled from public lands in 2023 rather than private. Do you think we will get similar results?

Part 2: Looking at the Raw Data

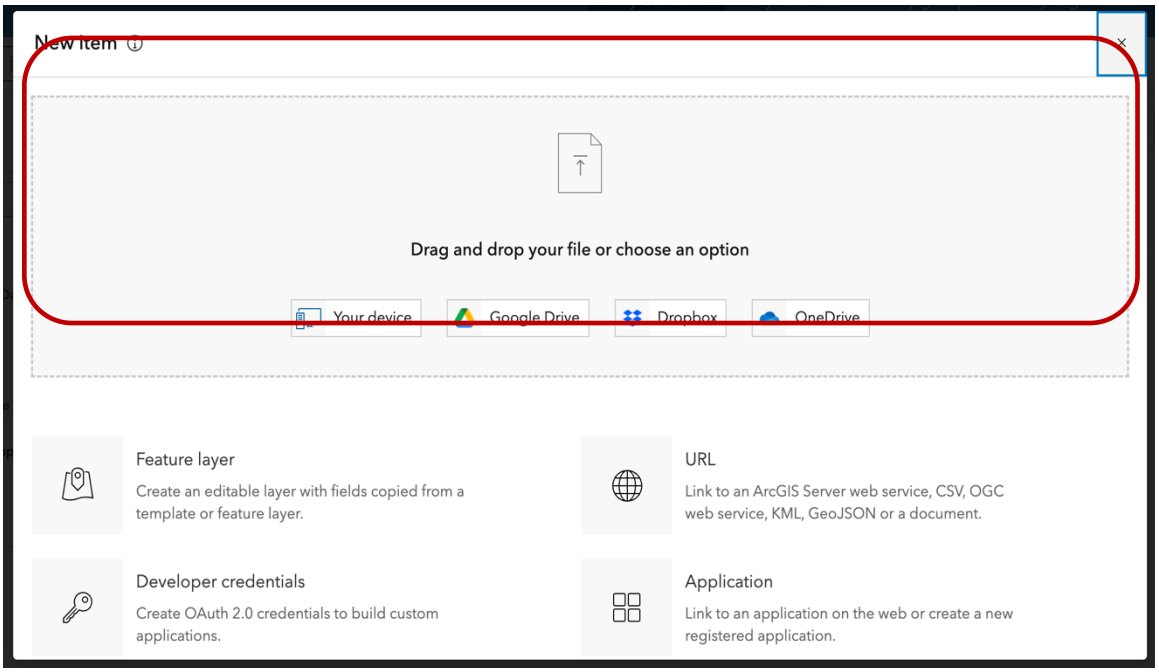
Our data provided by the USDA is in an XLSX format. Do you Rember what a XLSX file is?
In Canvas under the Lab07 Grasshopper section, find the data titled **PPQ_GHMCSurveys_PublicLand_2023.xlsx** and open it.

- What are a few of the columns that might be helpful that is in this data set that we can use in our map? Hint: find the **Pest_Density_SqYd** column and familiarize yourself with the values and what it means.

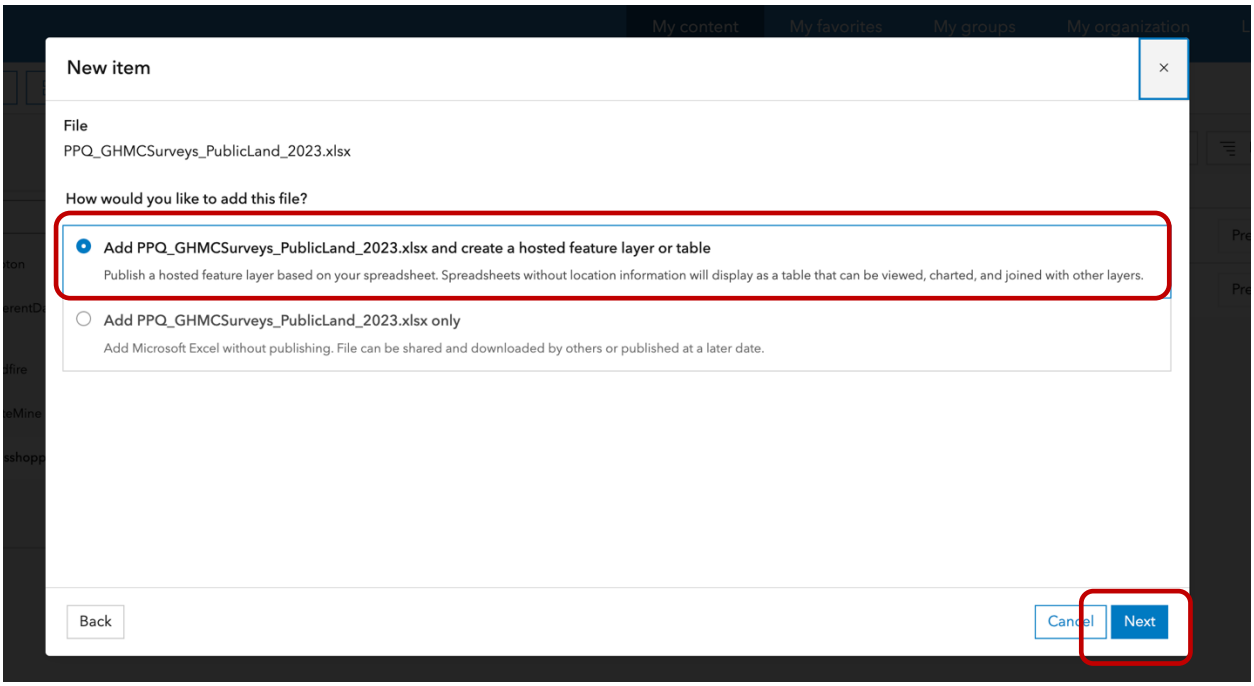
Great! Before we start any map making, we need to be aware of the attributes (for this dataset, the attributes are the different columns) in the dataset we are using.

Part 3: Importing our Data into ArcGIS Online

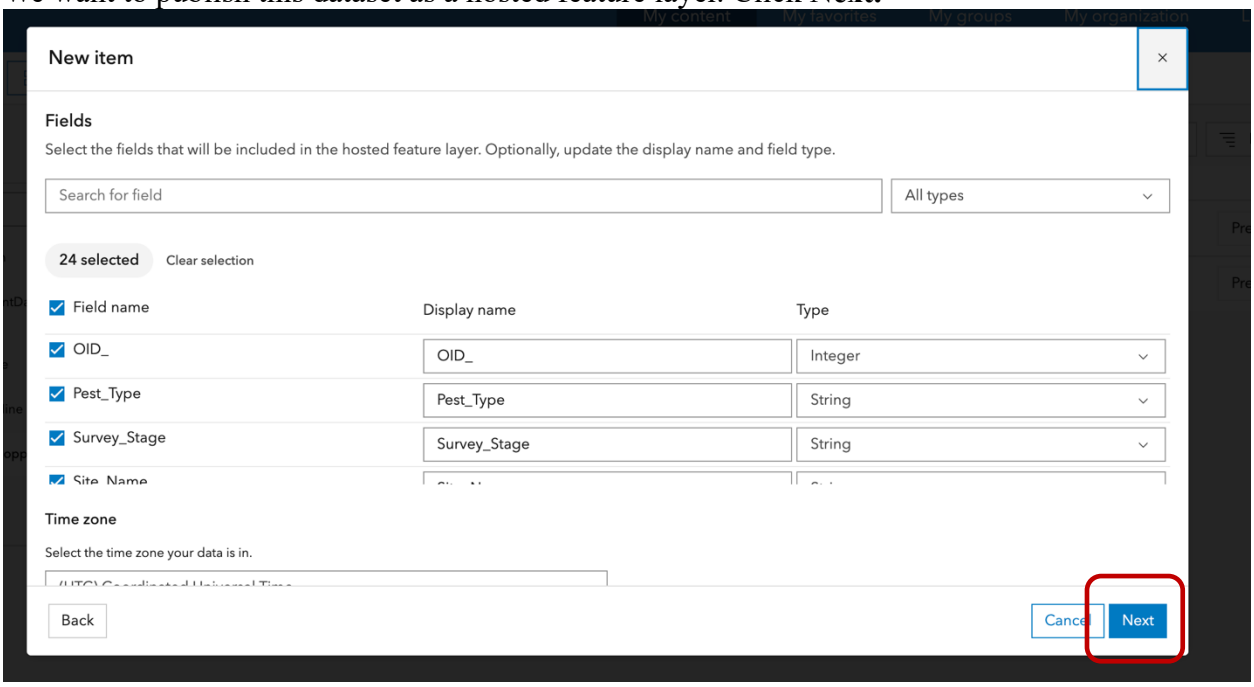
Login to ArcGIS online. Create a folder in your contents page to store your data and maps for this lab. Title your folder **Lab07_Grasshoppers**.
Next, will need to create a feature layer in ArcGIS online with the data file **PPQ_GHMCSurveys_PublicLand_2023.xlsx.**
Download the **PPQ_GHMCSurveys_PublicLand_2023.xlsx** dataset from Canvas onto your computer and import it into your content page by clicking **New Item** in the top left of the page.



Drag and drop the file into the **New Item box**.

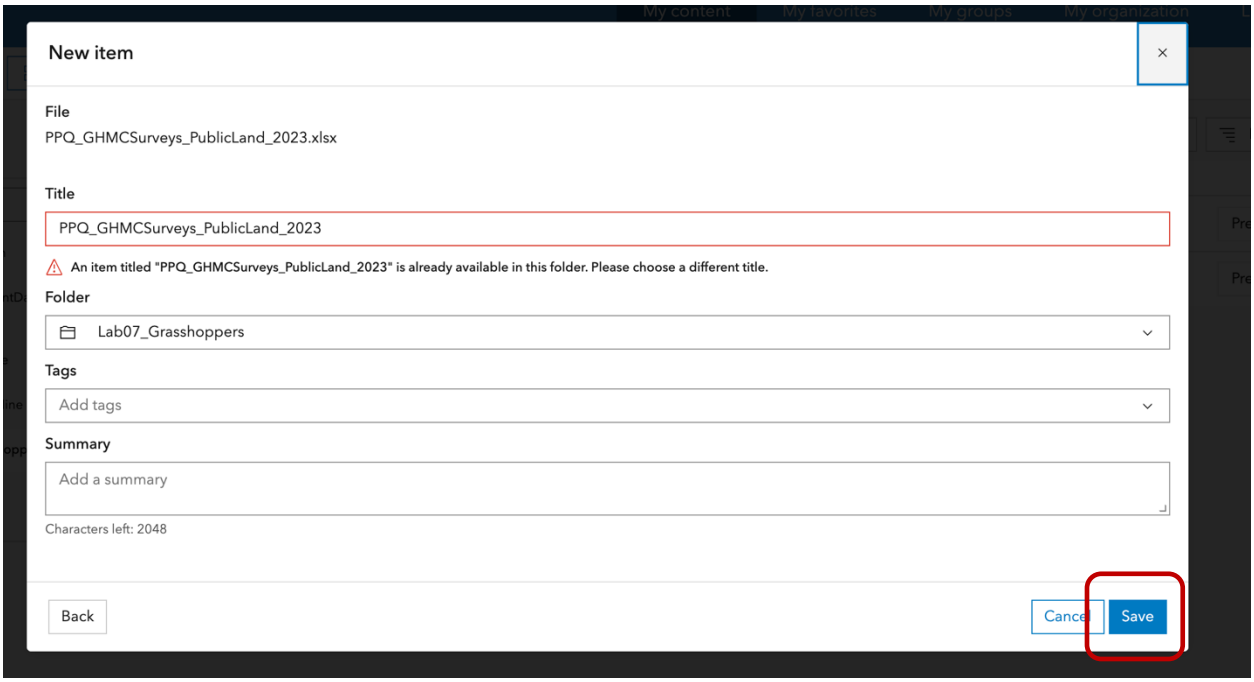


We want to publish this dataset as a hosted feature layer. Click **Next.**

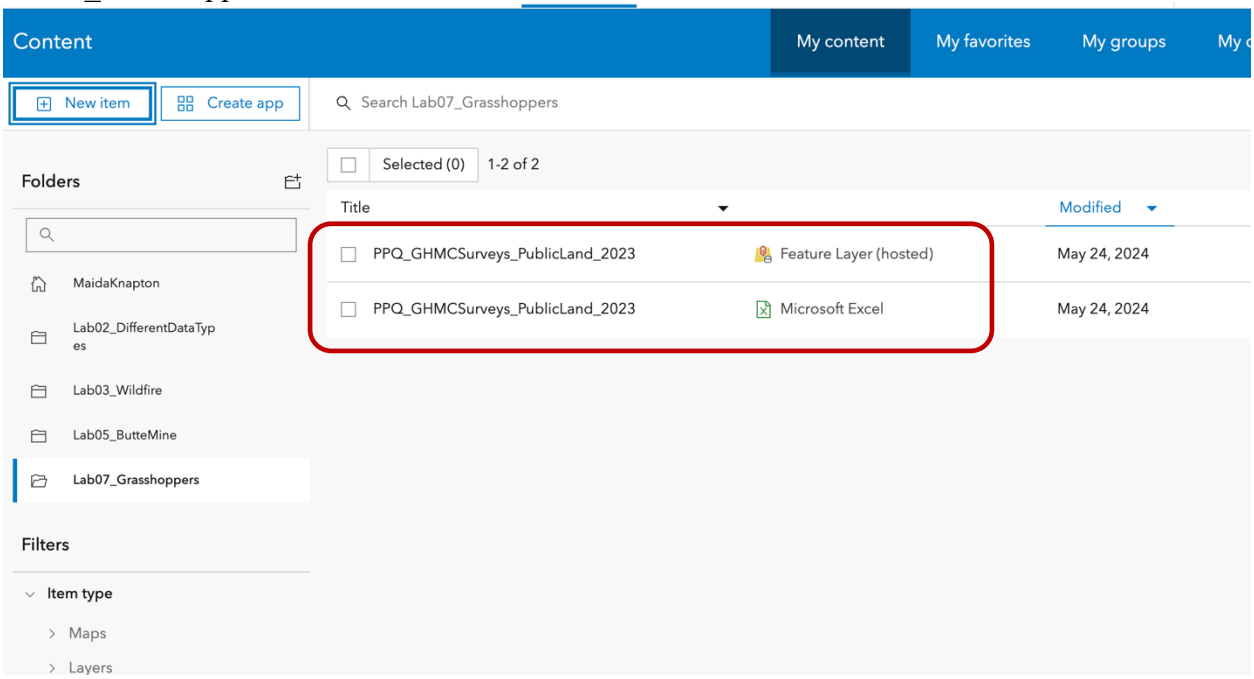


We want to keep all of the same fields (attributes). Recall that these are the columns of our spreadsheet. Click **Next.**

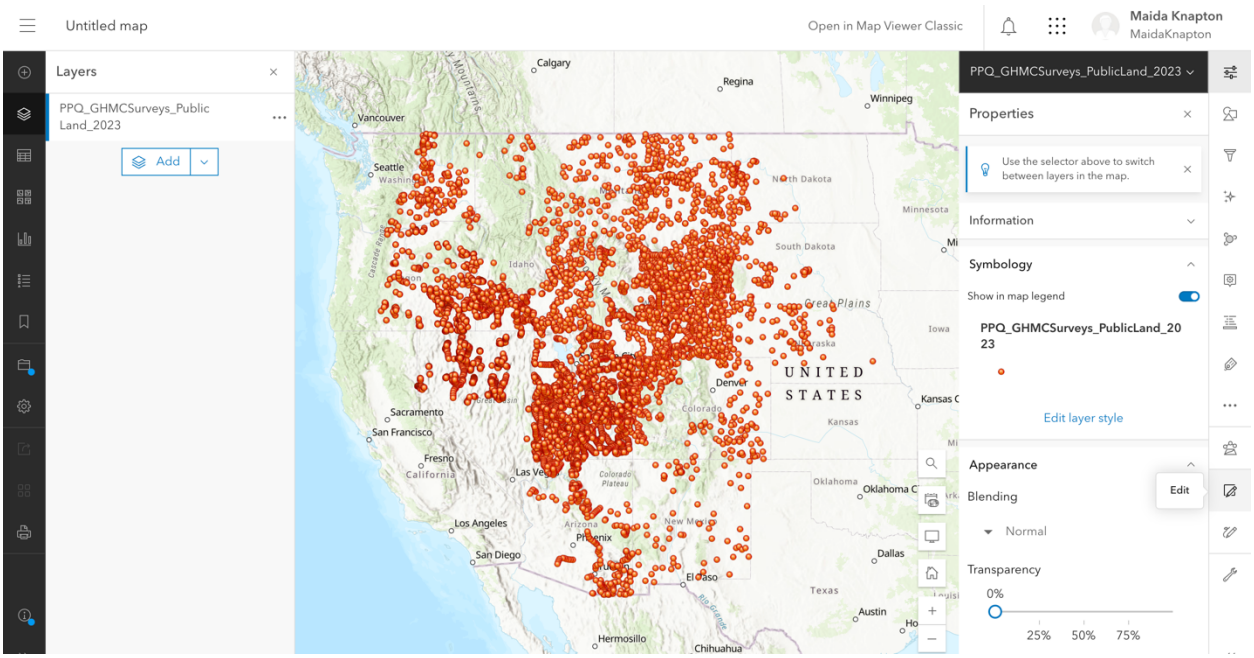
Once you get to the location settings, we want to keep the already set latitude and longitude. Click **Next**.



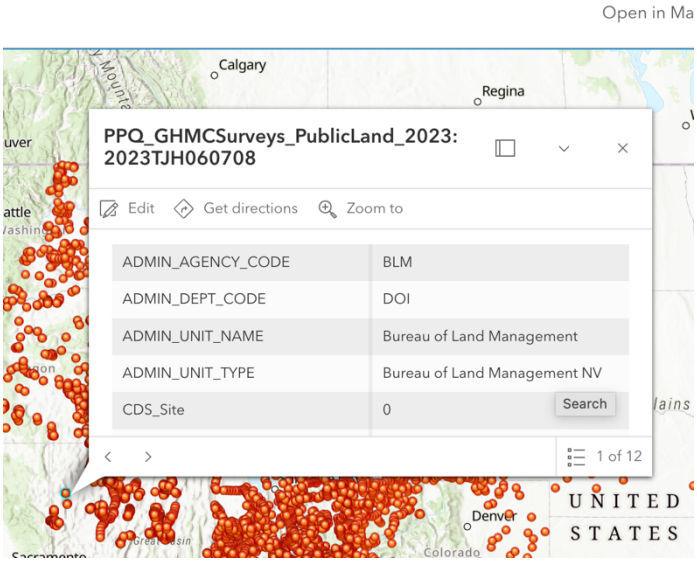
Keep the name of the dataset as your title and save the new feature layer to your Lab07_Grasshoppers Folder. Click **Save**.



Now your content page will show the raw Microsoft Excel file, and your newly created feature layer. Open your Feature layer and then click **Open in Map Viewer.**



Your map will now look like this. Each red dot shows a sampling site.

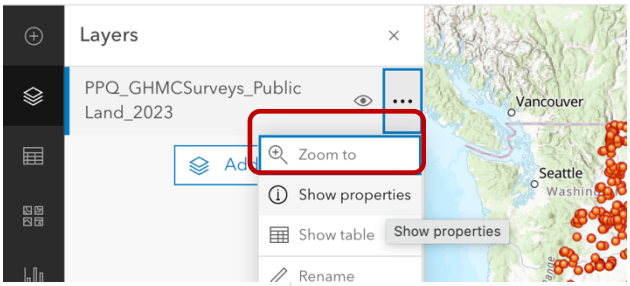


Click on 5 different dots in different locations and look through the attributes. How many grasshoppers were seen in **Pest_Density_SqYd** (pest density per square yard) in each of the five different points you selected? Discuss with your group your findings and see who had the highest pest density per square yard.

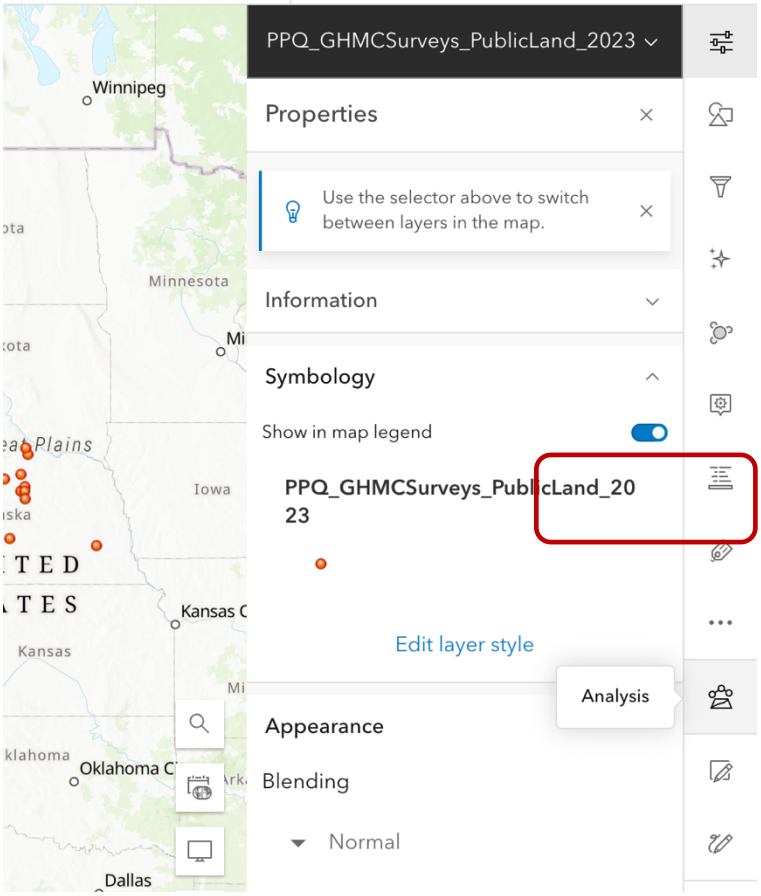
Now we will make our data into a map that looks like the **USDA_GrasshopperHazard.pdf** that you looked at in part 1 of this lab. To do this, we will use a geospatial technique called **Interpolation**.

- What is Interpolation? Spatial interpolation is the process of taking points with known values (in this case it is the density of grasshoppers per square yard at a location) and using them to estimate values in other areas. For example, it basically is taking the patterns of grasshopper infestation at a certain point and then estimating the amount of infestation in an area 5 miles away.

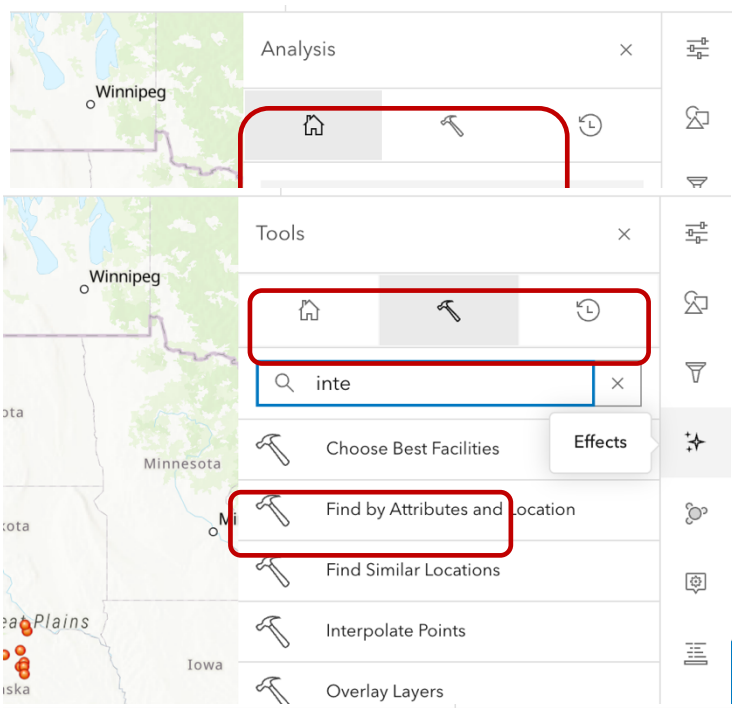
Part 4: Interpolating our points to create a map showing areas of high & low grasshopper infestation.



Under the layers tab, click **show properties** on your feature layer.

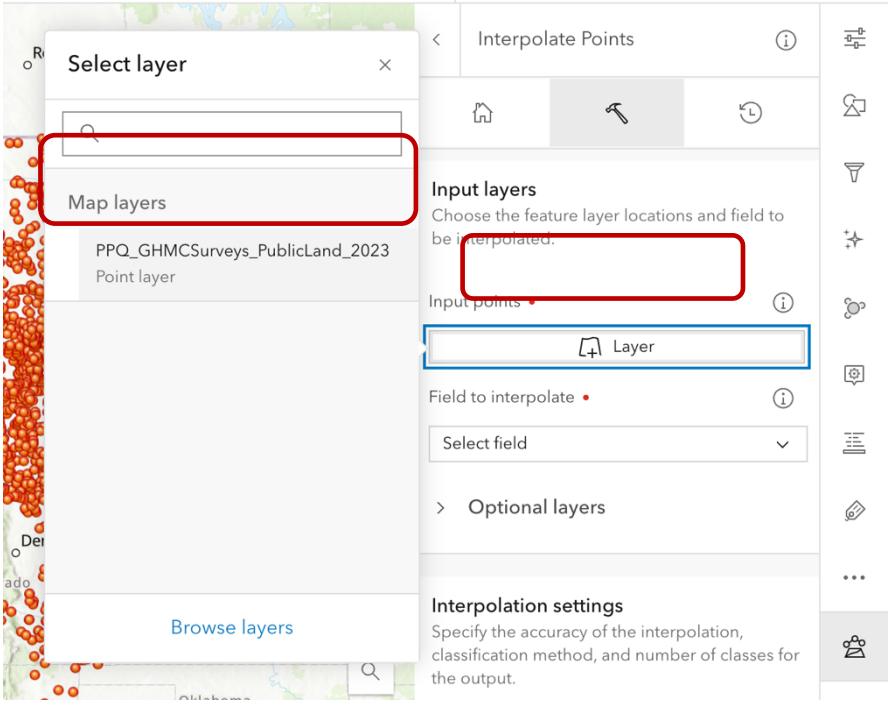


To start interpolating our data, we will need to go the analysis tab. In the right side of your screen, Click Analysis.



Click tools.

Type in **Interpolate Points** into the tools search bar. Click **Interpolate Points** once it pops up.

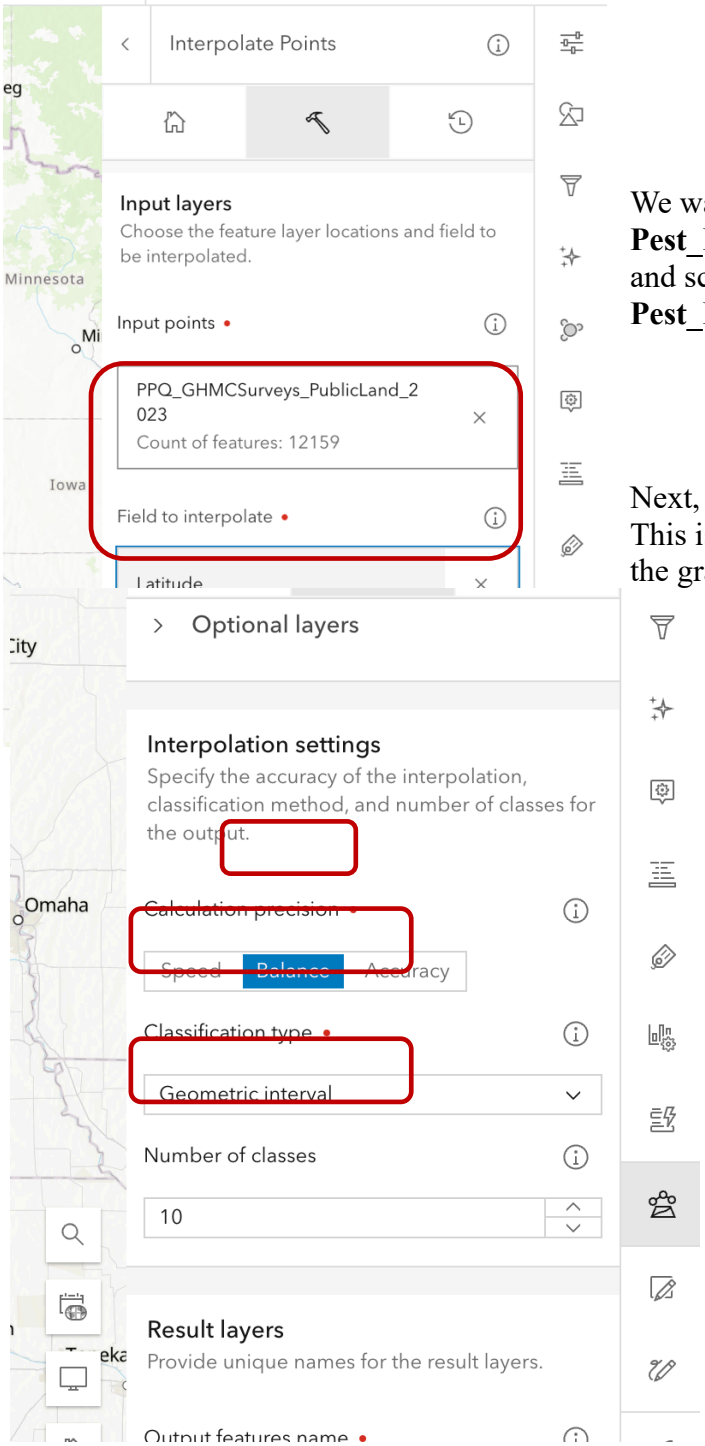


Now we will want to tell ArcGIS online what points (feature layer) we want to interpolate.

Click **Layer**. The add in **PPQ_GHMCSurveys_PublicLand_2023** layer.

Now we have selected the data we want to interpolate!

Next we need to tell ArcGIS online how we want to estimate our data (recall the interpolation explanation I gave at the end of Part 3). Since we are going to make a map that shows the areas of high/ low density grasshopper areas, we will want ArcGIS online to make estimates of grasshopper density in other areas based on the **Pest_Density_SqYd** (density of grasshoppers per square yard at a sampling site) attribute.



We want to change the field to interpolate to **Pest_Density_SqYd.** Click Field to interpolate and scroll down until you see **Pest_Density_SqYd,** and then select it.

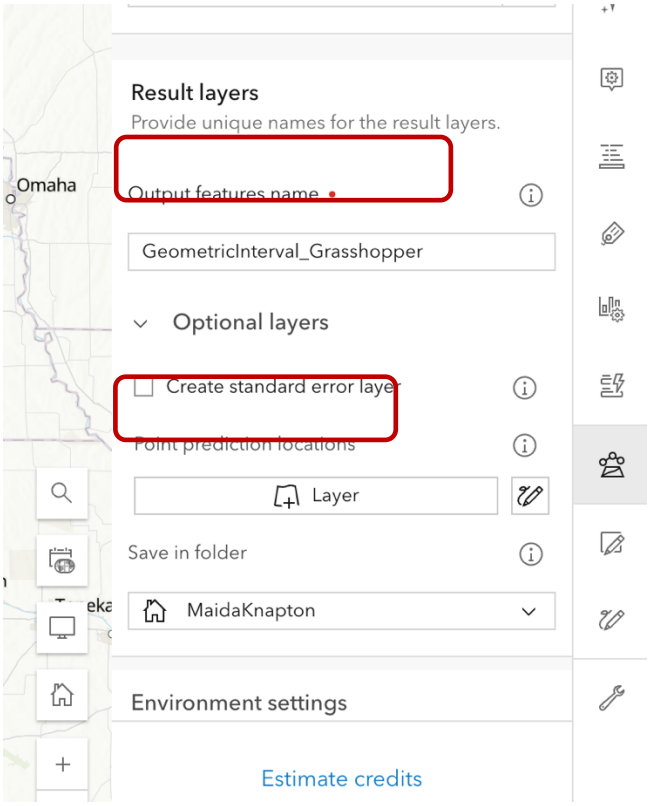
Next, we will adjust the interpolation settings. This is where we will tell ArcGIS how we want the grasshopper infestation to be estimated.

Scroll down to the Interpolation settings For the Calculation precision setting, **Select Balance**.

For the Classification Type, select **Geometric Interval**.

For the number of classes, keep it at **10**. This means that there will be 10 areas that the **Pest_Density_SqYd** will be classified into. 0 meaning there are no grasshoppers, and 10 meaning the highest density of grasshoppers.
Then on our map will look similar to the USDA map we were looking at in part 1 where different colors represent different densities of grasshoppers.

Now we will need to save our interpolation settings and create a new feature layer.



Scroll down to the results layers.

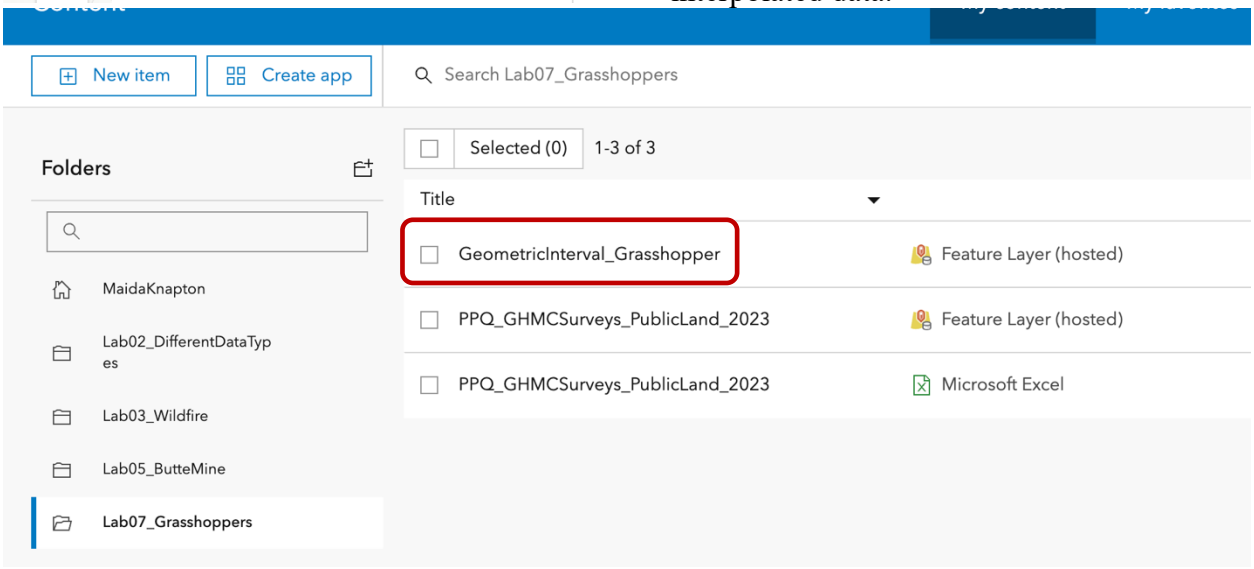
In the **Output Features Name** section, name your layer GeometricInterval_Grasshopper. Remember, No spaces!!

Then Save your new interpolated data (feature layer) to your **Lab07_Grasshopper** folder.

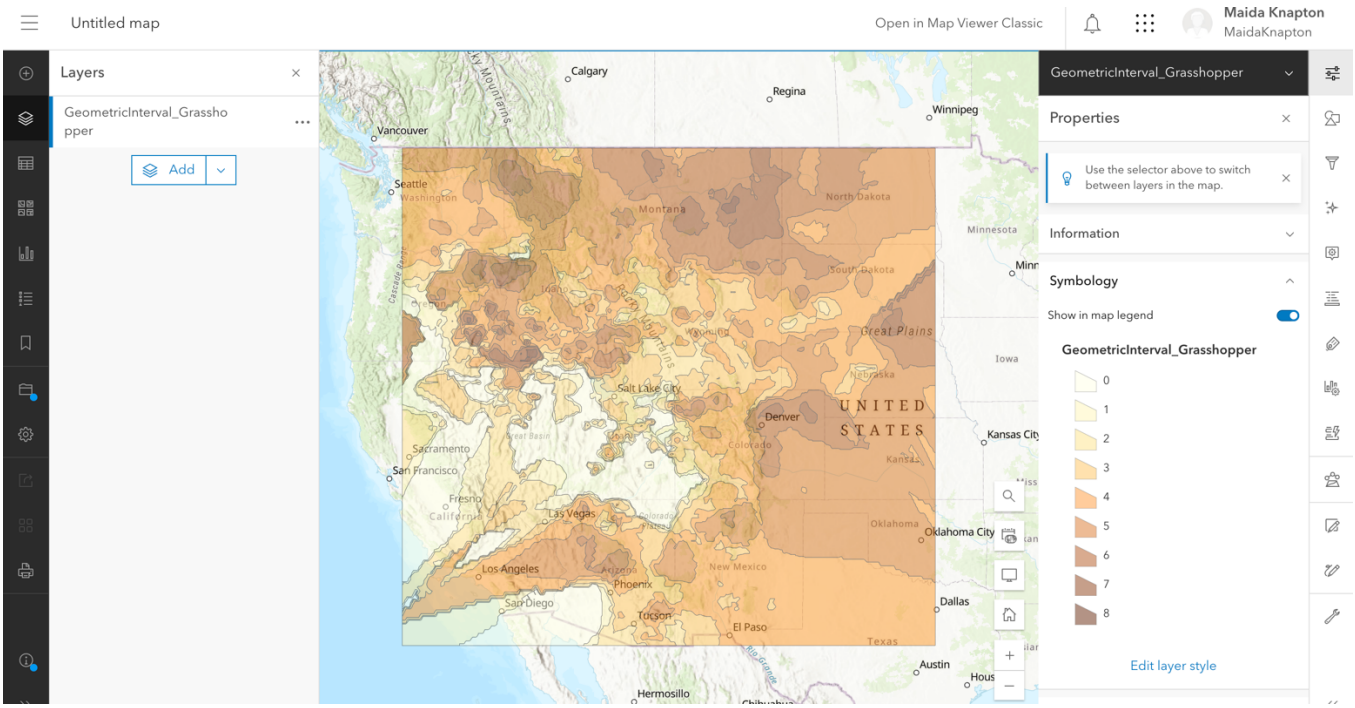
Then Click **Run**. This process might take a couple mints to complete.

Great Job!! That was the hardest part, and you can now say that you have done Geo-statistics! J

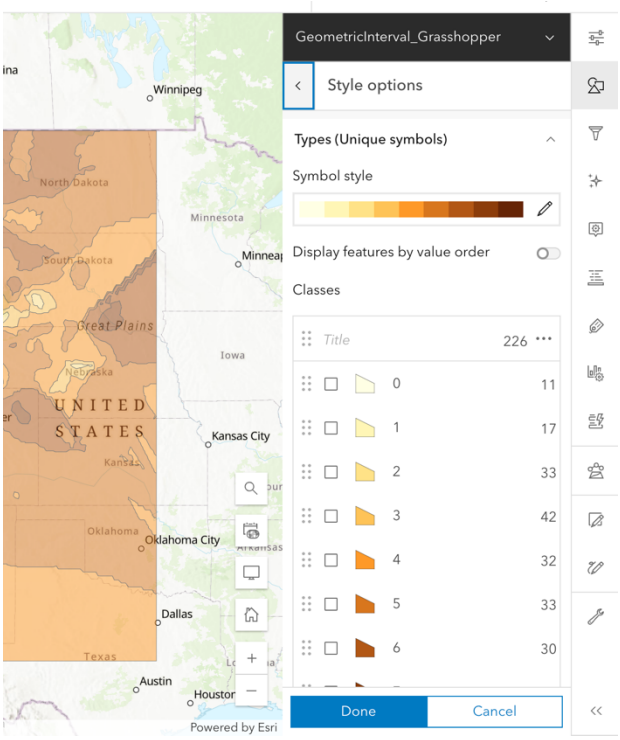
Now we will navigate back to our content page, and into our Lab07_Grasshopper folder. You can exit your map without saving, as we want to make a map from our interpolated data.



In your contents page, you will now see the new feature layer you just created by interpolating the **PPQ_GHMCSurveys_PublicLand_2023** data. Open the **GeometricInterval_Grasshopper** Feature layer in **Map Viewer**.



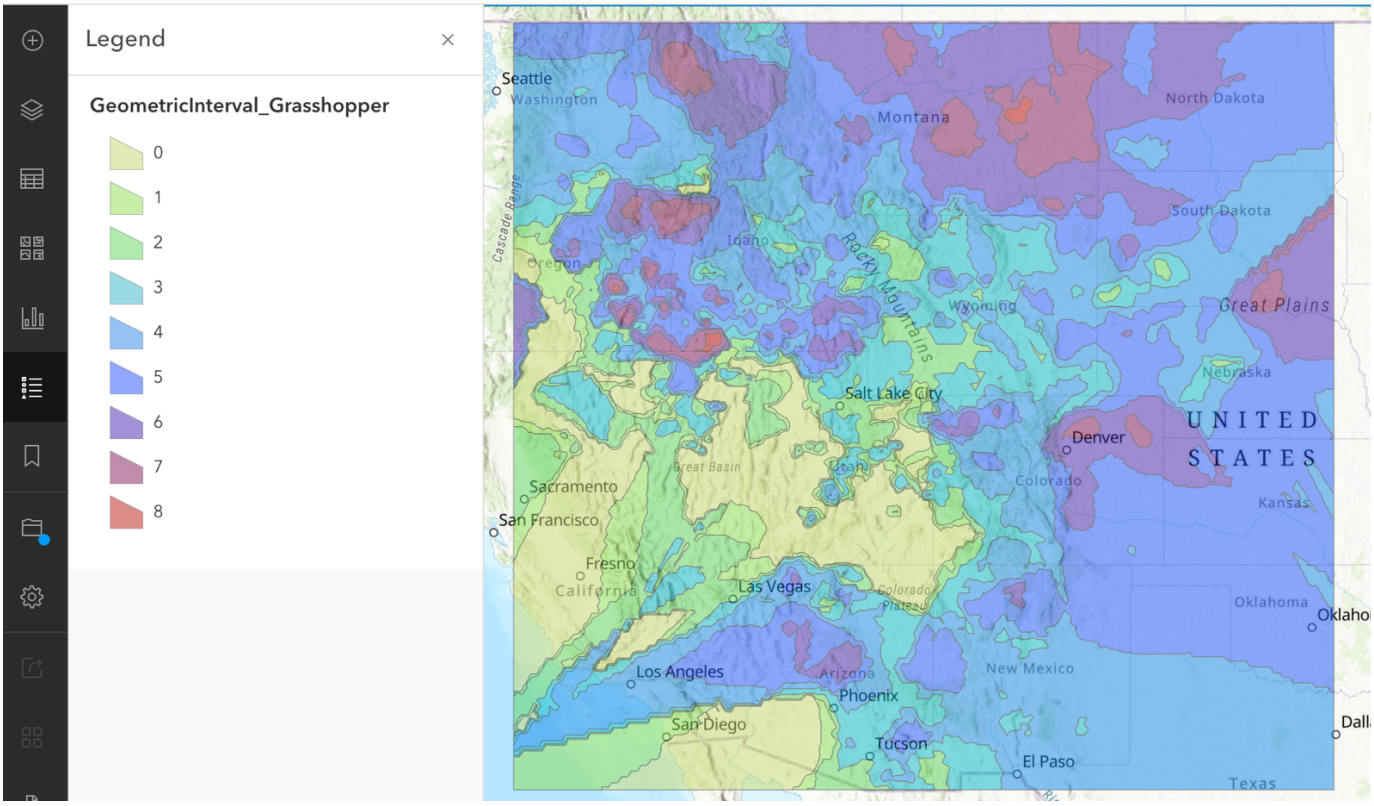
Your map should look like this! How cool!
Look at your newly created map and the legend, and then find the areas in the west that have the had the highest density of grasshopper infestation in summer of 2023.



Play around with the symbology (colors) of your data.

In your layers properties, click **styles**.
Click **style options** under the **Pick a Style Box**.

Then click Symbol Style (seen in the image to the left).
Once you have chose your colors, Click **Done**.



Here is my map! You can see the eastern Montana had a large grasshopper infestation in summer of 2023. **Great Job! J**

Discussion Questions:

1. How does your map compare/ contrast to the USDA map of infestations in 2024? Recall what is different about the data you used to create your map. What is similar?

2. Interpolation is type of estimation, and estimations are not always 100% correct. Look at your map closely and from your knowledge of grasshopper habitat what geographic areas on your map show grasshoppers where there likely is not? Think of water bodies, mountains etc.

3. What level of grasshopper infestation was estimated at your location in the summer of 2023?

Mapping our Community

Montana State University Geospatial Skills Camp

Introduction:

Now that we are almost done with our week of camp, we would like you to make a map that you find important for your community. You get to decide what *data* you want to include in your map and what *mapping tools* you want to include. For example, you could use ArcGIS or storymaps to showcase something meaningful for you and your community. Your camp could all make the same map, or you can break into small groups/partnerships. Our goal will be to give you all a chance to teach each other about your community by presenting this map at MSU at our GIS day!

Directions:

We are asking you to create a poster of your camp experience, using our sample powerpoint provided. The biggest task in this activity is to make a map (or multiple maps for your camp if you choose), so we will start there!

Step 1: Deciding what goes into the map

First, you will need to choose what data you would like to include in your map, and then how you would like to represent that data.

As a reminder, we have discussed multiple data types that go into ArcGIS and we talked a bit about how narratives or stories can also be used in mapping in storymaps. As a group or individual, decide what you will map and try to explain why. This is going to be included in your camp poster!

Step 2: Finding/creating the data for the map

Now that you know what you want to map, we have to make sure you have access to that data. If you want to map air quality, you have the sensors and could map your local area if you are interested! Cell phones also have a lot of built-in super cool sensors if you are interested in that! Feel free to check out this resource to learn more about cell phone sensors: https://www.societyforscience.org/research-at-home/using-smartphone-for-data-collection/

If you want to use secondary data, there are lots of sites that make this data available! For example, you explored the Native Land Information System NLIS earlier this week, but now you could check out the raw data portal that they have and you can download CSV files if you'd like! https://data.nativeland.info/?_gl=1*txfx34*_ga*MTE0NTgxOTYxNC4xNzEyNzYyMjc2*_ga_CR7S18E56W*MTcxNzA5MTI5Ni45LjEuMTcxNzA5MTI5Ni4wLjAuMA..*_ga_Z1HLDDJ0R4*MTcxNzA5MTI5Ni45LjEuMTcxNzA5MTI5Ni42MC4wLjA. They have data about agriculture, food sovereignty, and renewable energy on Native Lands.

Step 3: Determining which platform to map

This week we have had you use several platforms for mapping. Including ArcGIS, NatGeo MapMaker, and you explored but may not have made a story map at https://storymaps.arcgis.com/.
As a group, decide which system you'd like to use to make your map. If you have a lot of narrative that you would like to write to tell a story about you map, you might choose story maps. If you have a lot of point data that you want to explore to see if there is a spatial relationship, you may want to use ArcGIS. If you want to look at what MapMaker has in terms of data that already exists, you can use that system and add different pre-created layers. You might want to describe why you chose a system in your poster.

Step 4:
Working in either ArcGIS or StoryMaps (or any other mapping system) make your map! Use the data to tell the story you would like to tell with your map and add it to the poster template.

Reflection

Montana State University Geospatial Skills Camp

Reflective Activity

Introduction:

Throughout the past week, you have gained so many new geospatial skills and understandings. You have created lots of beautiful maps, and in just a few days, you will share them during GIS Day. Now, you have the chance to reflect on what you have learned and prepare with your peers through a gallery walk!

Part 1: Creating your Gallery Exhibit

We will begin by creating our gallery exhibits.

1. Start by considering which map you are most proud of creating– this could be your Wildfire, Indigenous Perspectives, or Story map, or any other map you created during camp! This map will be the main focus of your exhibit.
2. At the top of a notecard, write your name and the title of your map. This will be your "gallery label" which describes your exhibit.
3. Below your name and title, write 1-2 sentences about why you are proud of the map you selected.
4. Then, write 2-3 sentences about what you have learned at camp. What were the main takeaways? What are you excited to share with other people?
5. Set up your computer so that everyone can see your map and place your gallery label on your computer so that it can be read by your peers.

Part 2: Exploring the Gallery

It's time to explore each other's work! Take 15 minutes to walk through your gallery and explore your peers' work. In your notebook, write down observations about the maps being presented, and answer the following questions:

- What are three main takeaways written by your peers that you did not write on your own gallery label?
- Which map stood out to you? Why? Be detailed!
- What similarities and differences are there between your maps and your peers' maps?
- What questions came up for you while you were looking at the maps?
- What kind of symbology did your peers use? If it differed from the symbology of your map, why do you think that is the case?
- Pick one map and write a few words about it. What does this map represent? What is it showing us?

Flex time activities

Montana State University Geospatial Skills Camp

Flexible Activities

Introduction:

In this section, you will find short, optional activities that allow you to continue expanding your geospatial skills in flex time!

Option 1: Fantasy Maps

You have been given a book of fantasy maps which need a story to match!

- Explore the maps in your book. Which one catches your eye?
- Color in your selected map. As you color, think about who might live on this land– including people and animals. How would they determine their borders? In what way does the land influence how people live? Are there any landmarks that might be important?
- When you have finished coloring, write a short story about your map. Your story could be about how the land was discovered, what daily life looks like in your world, great battles that defined borders, or anything else that captures your interest. Be creative!

Option 2: Treasure Hunt

Have you ever heard of geocaching? Geocaching (gee-oh-cash-ing) is like a real-world treasure hunt! All over the world, items (like the geocache box shown below) are hidden, and players have to locate the items using global positioning systems (GPS), coordinate systems, and other navigational skills– just like the ones you have developed during camp!



Figure 1: A geocache box, found on the forest floor *(source: Britannica)*.

In this activity, you will create your own treasure hunt to share with a friend or campmate.

- Select an item to be your "geocache," and find a place to hide it.

- As you are hiding your item, make lots of observations to help you create a map. Are there any major landmarks nearby? How many paces did you walk before placing the item? Did you travel North, South, East, or West first?
- Once your item is hidden, create a map to help your friend find it! Consider what your friend might need to help them find the item.
    - How will they orient themselves on the map?
    - Will they need a compass or coordinates?
    - What landmarks may help them orient themselves?
    - Which features will be represented by a point? How about a polygon? Why?
    - What symbology will you use to communicate features on your map?
    - How will you convey scale to them?
    - Will your map need a legend to be understood?
- Nice work! You now have a treasure map to share! Give your map to a friend, or swap with someone who also completed this activity, and see if they can find your treasure!

Option 3: Maps of North America in the News

In this activity, you will explore how geography and current events are related!
You have been given the book "North American Maps for Curious Minds: 100 New Ways to See the Continent," which contains *lots* of interesting maps! Explore the book, and then return to this list when you are finished. We have selected a few maps of interest for you:

1. Choose a map listed above, and then navigate to this webpage: https://www.allsides.com/ (add MT news sources as well)
2. In the search bar, type in the geographical location represented in the map you chose.
3. Select an article about news in your geographical area, and write down the title of the article.
4. Write a short response to the following questions:
    - Summarize your article in 2-3 sentences. What happened and where?
    - How is this news related to the geographical features in the area you selected?
    - Make a connection between the article and the map you selected! How does this map expand your understanding of the news?
    - Generally, how can maps be used to improve journalism?