Exercise 1: Determining How Places are Related: Cattle Grazing Allotments

Instructions
Use this guide and ArcGIS Online to reproduce the results of the exercise on your own.

Note: ArcGIS Online is a dynamic mapping solution. The screenshot graphics that you see in course materials may differ slightly from the version of ArcGIS Online that you will use.

Introduction

This exercise presents an approach to using ArcGIS to determine, for water quality monitoring, which hydrologic basin each grazing allotment is located within. The purpose of this example is to illustrate a type of problem that can be addressed using the spatial analysis approach of applying an overlay. Although the data is real, the scenario, analysis, and resulting decisions are hypothetical.

Scenario

The Department of Environmental Quality for the state of Oregon wants to monitor the impact of livestock grazing on water quality. Earlier studies by the department confirmed that sediment and animal waste can pollute streams that are located in grazing areas.

Much of the grazing in the state occurs on lands that are managed by the United States federal government. Federal agencies have divided the grazing areas into allotments. The agencies issue permits or leases to ranchers for individual grazing allotments.

While the federal agencies manage the grazing lands by allotments, the state's biologists monitor water quality by watersheds, or hydrologic basins (as the hydrologists refer to them). If testing shows that a basin has water quality issues, the biologists want to be able to identify all the grazing allotments that are located in that basin. The biologists can then work with the federal agencies to ensure that permit holders are following best practices.

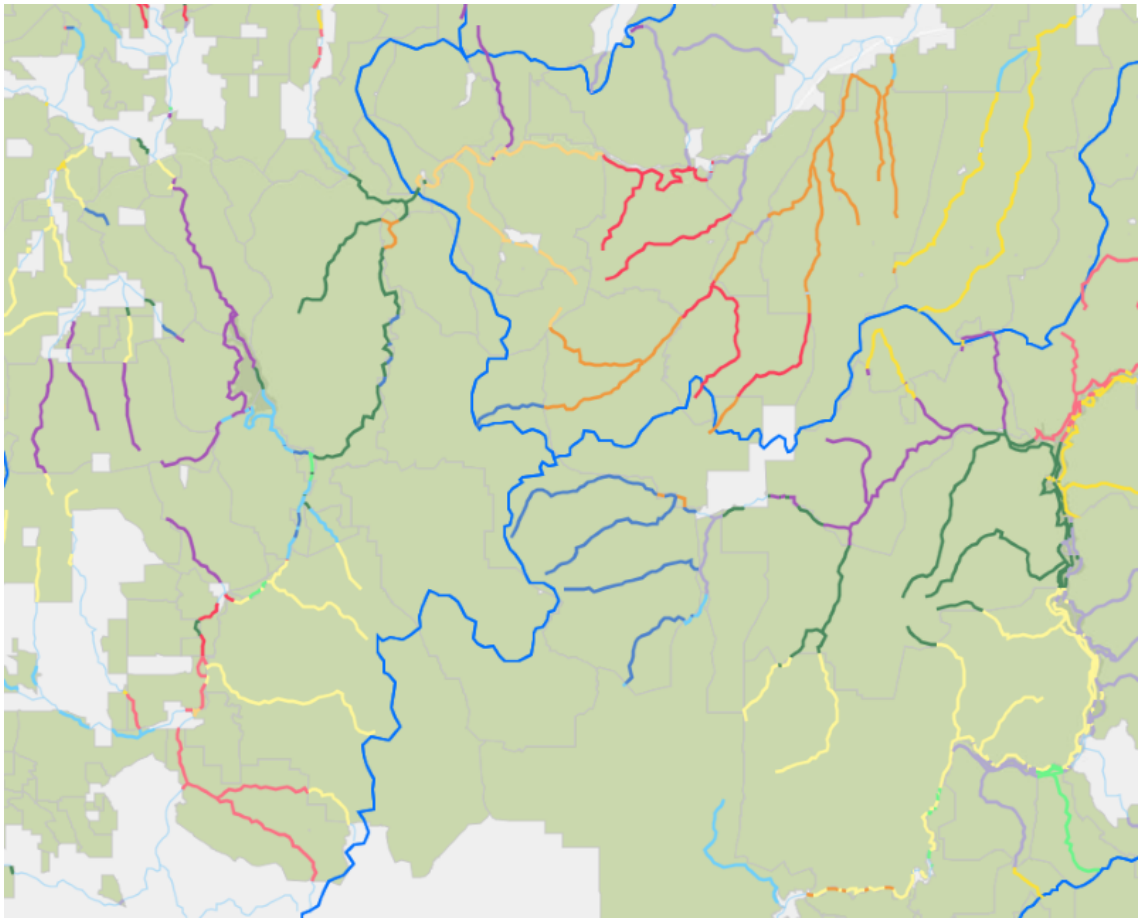
Imagine that you are one of the state biologists. You plan to use GIS to answer the following questions:

Which hydrologic basins and streams should be monitored based on the impact of livestock grazing on water quality?

What information do you need to answer this question? How can you use GIS to represent, analyze, and assess the criteria?

Consider the following questions:

- Where do livestock graze?
- Where are water sources located?
- Which grazing allotments are located in hydrologic basins?
- Which streams or basins might need to be monitored or tested?



This map shows streams passing through grazing allotments. Stream segments are symbolized differently in each allotment.

Note: This example provides a starting point. In the real world, an analysis like this would likely involve more factors and criteria.

Technical notes

1. You will make full use of web mapping services throughout this course. You will need a robust web connection to complete this exercise and the exercises that follow.
2. Use the latest version of Google Chrome or Microsoft Edge. Other web browsers may not display your maps and apps correctly.

   Note: For information on supported browsers, see ArcGIS Online Help: Supported browsers (https://esriurl.com/browsers).

Estimated completion time: Approximately 30-45 minutes

- Step 1: Open the map

Using ArcGIS Online, you can create a map with the provided layers to use for your analysis. For this exercise, the initial map has already been created.

Before opening the map, you will sign in to ArcGIS Online.

a Open a new private or incognito web browser tab or window.

To help prevent confusion between your ArcGIS Online accounts, we recommend that you open a private or incognito web browser window for all course work.

b In your private or incognito web browser window, go to https://www.arcgis.com/home/item.html?id=f6c14e64cb204861ae9e90a3a9a1b675 (https://esriurl.com/Sec3Map).

c On the top right of the page, click Sign In.

d Sign in to ArcGIS Online using your course ArcGIS credentials.

Note: Section 1, Exercise 1 explains how to determine your course ArcGIS credentials (username and password). If you have trouble signing in, please refer to the Common Questions list on the course Help tab.

e Click the thumbnail image to open the map.

Step 1e: Open the map.

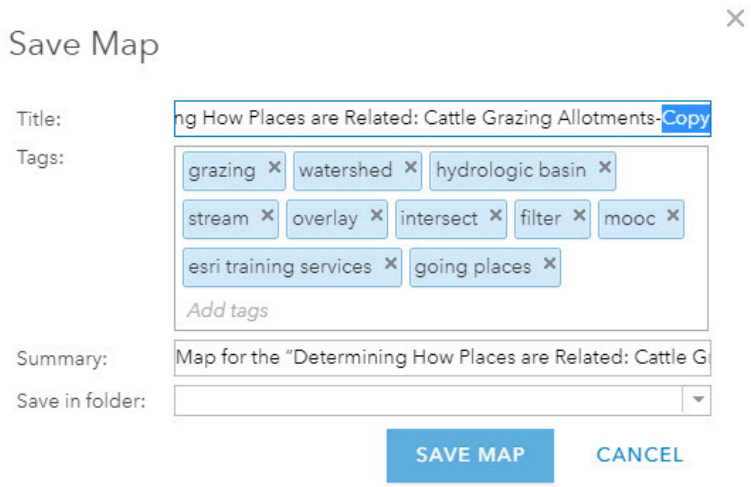
A map of the area of interest (https://esriurl.com/AOI) opens, showing the grazing allotments.

- Step 2: Open a copy of the map

For the purposes of this exercise, you will save a working copy of the map.

a On the ribbon above the map, click Save and choose Save As.

b In the Save Map dialog box, for Title, replace -Copy at the end of the name with your initials.



c Click Save Map.

A copy of the map will be saved to your My Content collection.

Note: ArcGIS Online does not automatically save maps; therefore, you should periodically save your map as you are working.

- Step 3: View layer information

Now, start to think in terms of spatial analysis. Ask yourself:

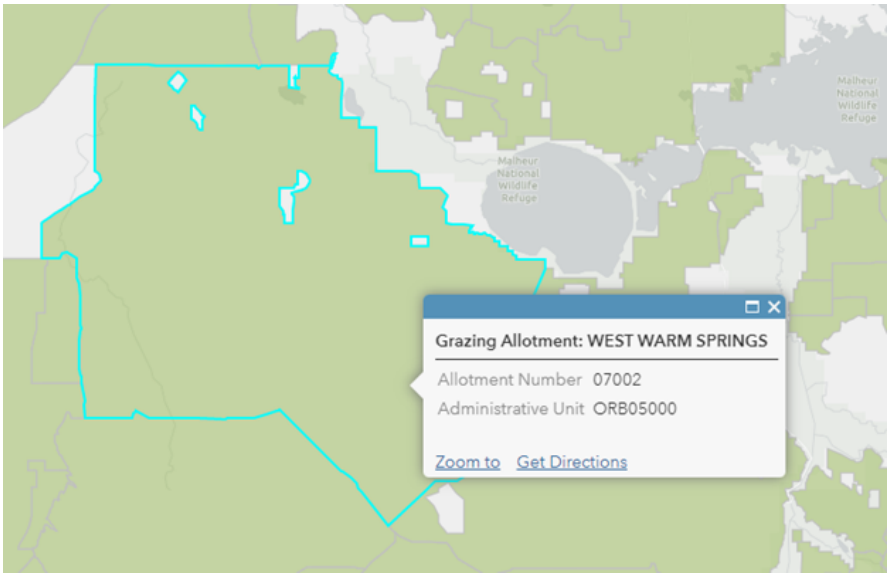
What information do I need to address this question?

For this exercise, the layers provide information related to the analysis question. In this step, you will examine the information associated with some of the geographic features on the map. This is the second step in the spatial analysis approach, explore and prepare data.

You have obtained a layer of the grazing allotments, or areas. The layer contains information for each allotment, including administrative units, or management districts. The layer does not include the hydrologic basin in which each allotment is located. Further, the grazing allotments were not created with basin boundaries in mind. For that reason, an allotment can either be located completely within one hydrologic basin or it can cross basin boundaries and be located within two or more basins.

a Zoom in several times so that you can more easily see the grazing allotments.

b To view the information associated with the grazing allotments, click any allotment area (green polygon) on the map.



Step 3b: View layer information.

The pop-up window displays the name, number, and administrative unit (management district) associated with the selected allotment area.

c Close the pop-up window.

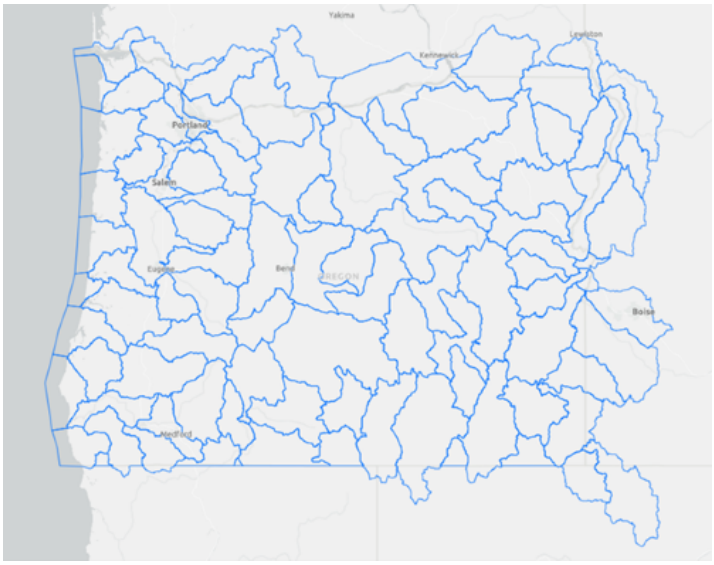
d Turn off the Grazing Allotment layer.

- Hint

  At the top of the Legend pane, click Content, and then uncheck the box to the left of the Grazing Allotment layer.

e Turn on the Hydrologic Unit layer.

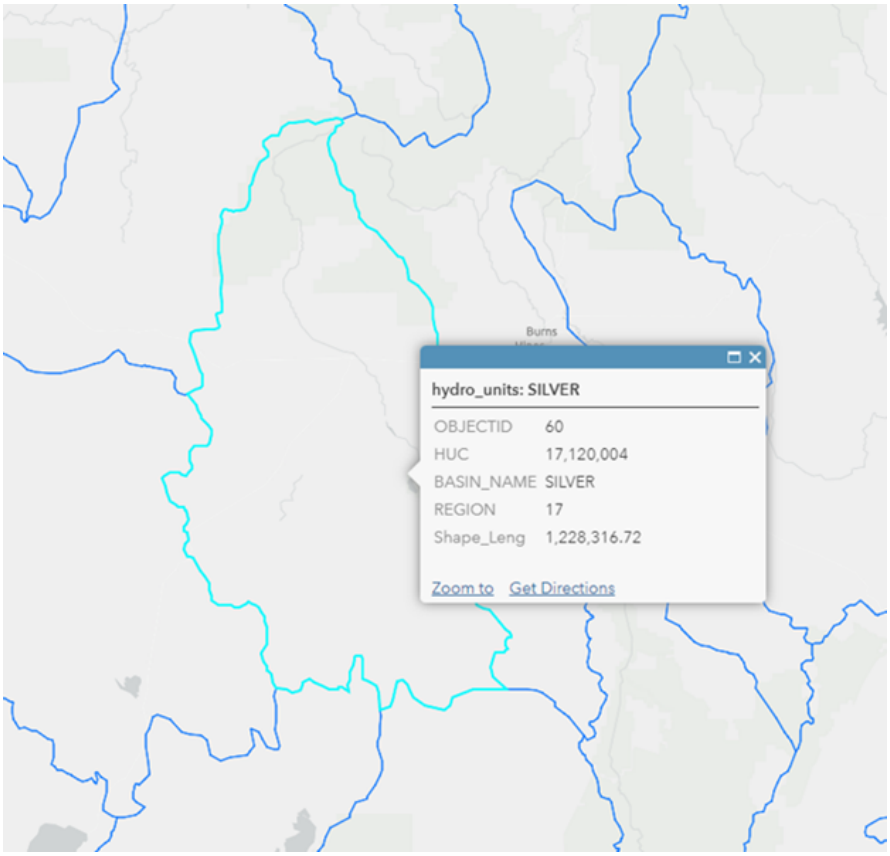
f Point to or click the Hydrologic Unit layer name, click the More Options button ••• , and choose Zoom To.



Step 3f: View layer information.

Your map zooms to the extent of the Hydrologic Unit layer. This layer shows hydrologic basins in the study area.

g To view the information associated with the hydrologic basins, click inside any blue-outlined area on the map.



Step 3g: View layer information.

The pop-up window displays the basin name, region, size, and other details associated with the selected area.

h Close the pop-up window.

i Turn the Grazing Allotment layer back on.

You will use the information from these two layers to determine which allotments are located within each basin.

- **Step 4: Combine information from different layers**

In this step, you will combine the information from two different layers into a single layer. This process will enable you to perform queries to determine the hydrologic basins in which each grazing allotment is located.

The result of combining these two layers is called an overlay. You will use the Intersect tool in ArcGIS Online to combine (overlay) the Grazing Allotment and Hydrologic Unit layers. The single new layer will contain new features indicating where the input features (allotments and basins) overlap.

a In the Contents pane, point to or click the Grazing Allotment layer name and click the Perform Analysis button .

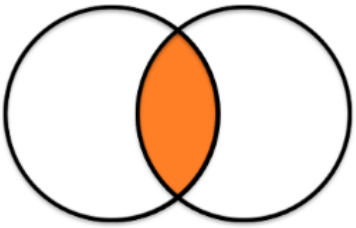
b In the Perform Analysis pane, expand Manage Data and click Overlay Layers.

c In the Overlay Layers pane, for Choose Input Layer, confirm that Grazing Allotment is selected.

d For Choose Overlay Layer, choose Hydrologic Unit, if necessary.

e For Choose Overlay Method, confirm that Intersect is selected.

In an intersect, the output layer contains only the parts of features from the two layers that overlap. You are only interested in areas where allotments intersect, or overlap, hydrologic basins. An intersect, or overlap, is represented in the following graphic.



f For Output, confirm that Areas is selected.

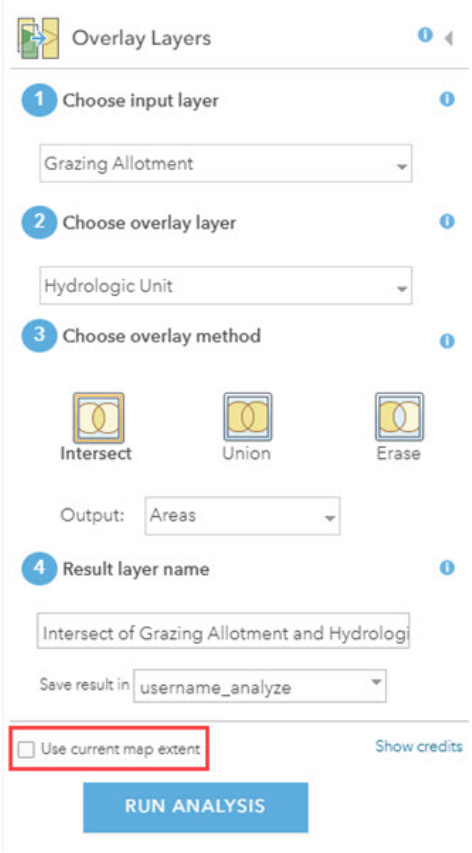
Note: Grazing allotments and hydrologic units are both area features, or polygons. The area associated with the overlap will be displayed in the result layer.

g For Result Layer Name, type **Intersect of Grazing Allotment and Hydrologic Unit_<your first and last name>**.

Note: The layer name must be unique within an organization. To avoid encountering an error, add an underscore and your first and last name. If you run the analysis multiple times, you will need to provide a unique result layer name each time.

The Save Result In field defaults to your account name. You do not need to change this value.

h At the bottom of the Overlay Layers pane, uncheck the box for Use Current Map Extent, as indicated in the following graphic.



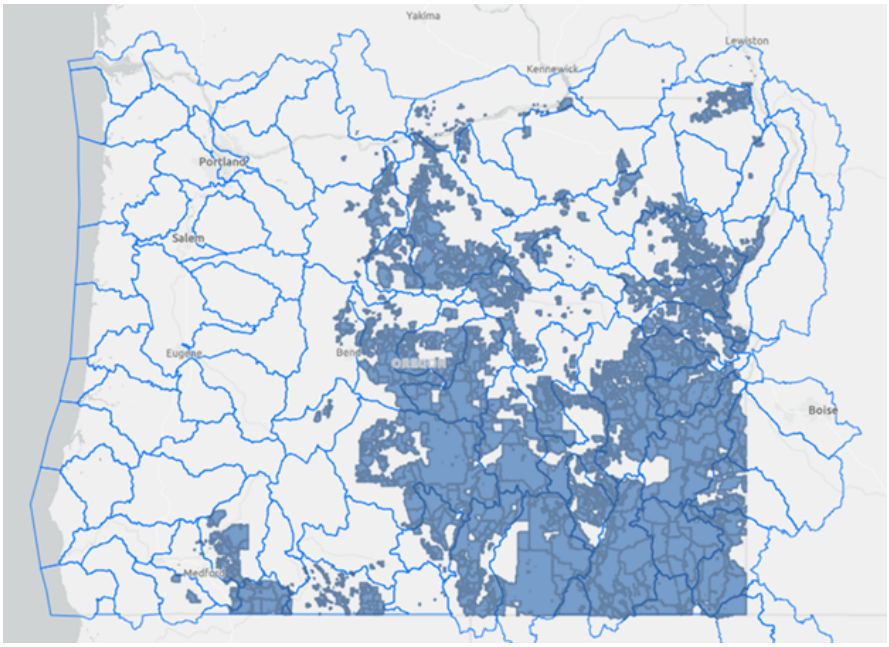
The box for Use Current Map Extent is checked by default. This setting limits the results to your current map extent. The map extent (https://esriurl.com/mapextent) refers to the portion of the map displayed on screen at a given moment.

In this case, you want to run the analysis on all the records in the Grazing Allotment layer, not just what is currently displayed.

i Click Run Analysis.

Note: If your analysis is not complete after 4 minutes, try saving the map and refreshing the page. You can also exit ArcGIS Online and try again later.

A new result layer with the name that you assigned appears in the Contents pane. The map display updates to show the areas where grazing allotments intersect with hydrologic basins.



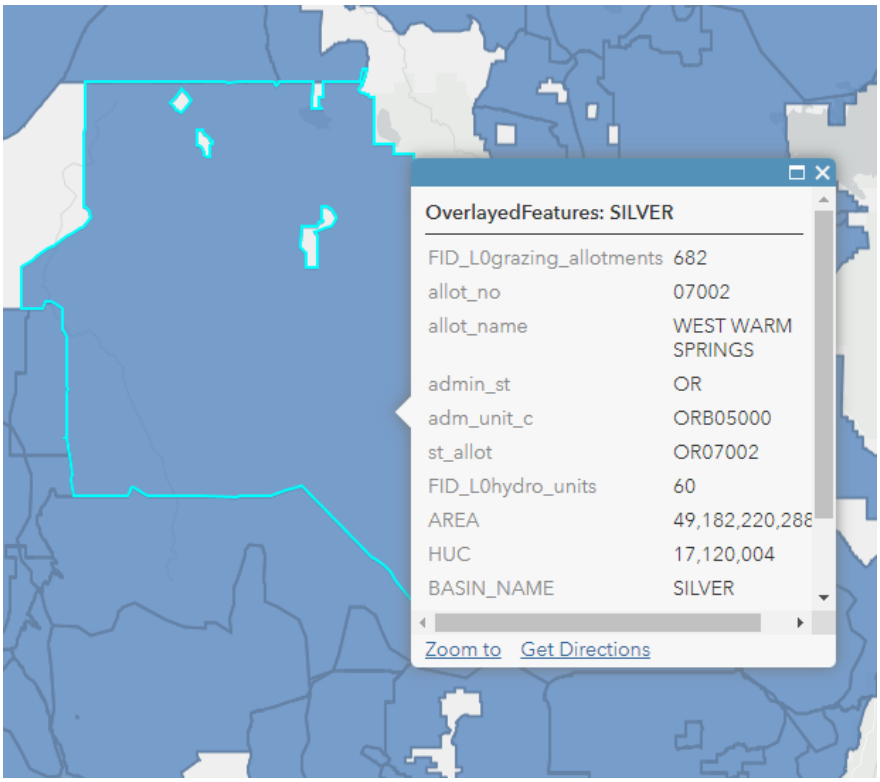
Step 4i: Combine information from different layers.

The overlap areas are symbolized in blue. Because the new Intersect result layer is listed first in the Contents pane, it will render on top of the other layers in the map. The order of the layers in the Contents pane will determine the drawing order of the layers in the map. You will see that most of the green areas representing grazing allotments are hidden.

j Turn off the Grazing Allotment and Hydrologic Unit layers.

k Zoom in a few times so that you can see the overlap areas more clearly.

l Click an area on the map to view the combined geographic information associated with the new layer.



Step 4l: Combine information from different layers.

The pop-up window contains information about the grazing allotment (from the Grazing Allotment layer) and the basin (from the Hydrologic Unit layer).

Note: You may need to scroll to the right in the pop-up window to view the layer information.

m Close the pop-up window.

To identify the allotments in a particular basin, you need to assign each allotment the name and number of the hydrologic basin in which it is located. The new features have all the attributes of the features in the input layers. In this case, the new allotment features are assigned the attributes of their containing hydrologic basin, including its name and ID. Allotments located within two or more basins are split at the basin boundaries. Corresponding attributes are assigned to each portion of the allotment accordingly.

Now that you have combined the two layers, you can map the grazing allotments by hydrologic basin.

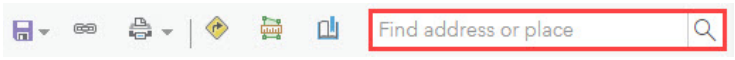
- Step 5: Filter the view of features in a layer

Your project managers have asked you to focus on the Middle Fork John Day basin area for the initial study.

In this step, you will filter your view of the layer's features to determine which allotments are in a particular basin.

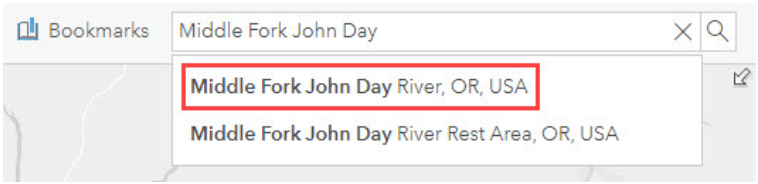
a Turn the Hydrologic Unit layer back on.

To find the area of the map that contains the Middle Fork John Day River, you will use the search field in the upper-right corner, as indicated in the following graphic.

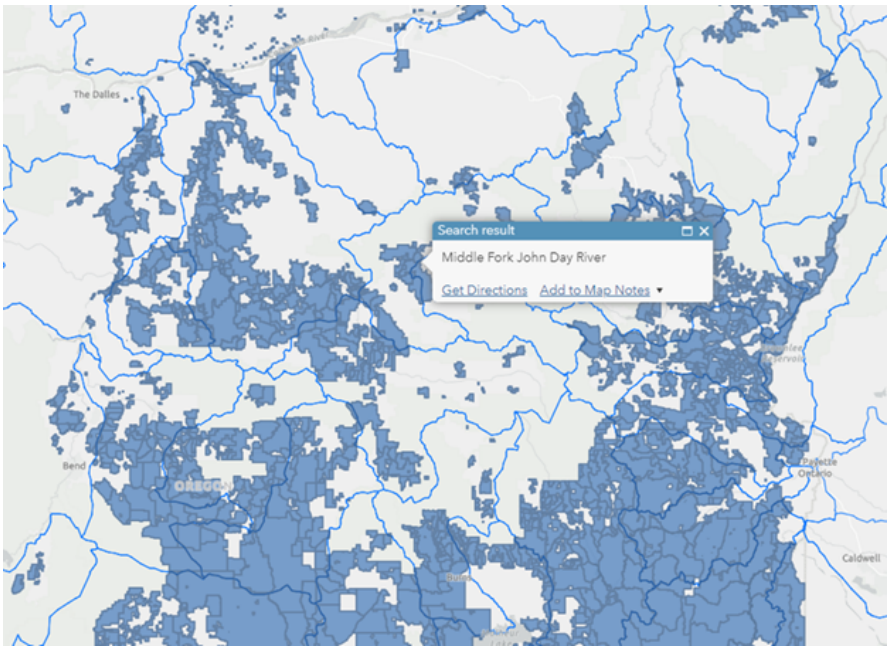


b In the search field, type **Middle Fork John Day**.

c In the search results list, click Middle Fork John Day River, OR, USA, as indicated in the following graphic.



The location of the Middle Fork John Day River in Oregon is displayed on the map.



Step 5c: Filter the view of features in a layer.

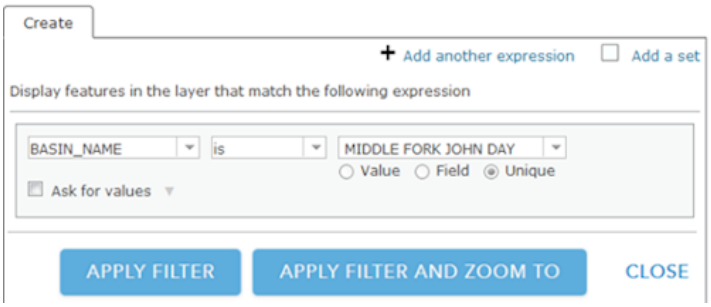
d Turn the Grazing Allotment layer back on.

e In the Contents pane, point to or click the Intersect Of Grazing Allotment And Hydrologic Unit layer name and click the Filter button .

f In the Filter dialog box, choose BASIN_NAME as the field to filter on.

g For the second field, choose Is, if necessary.

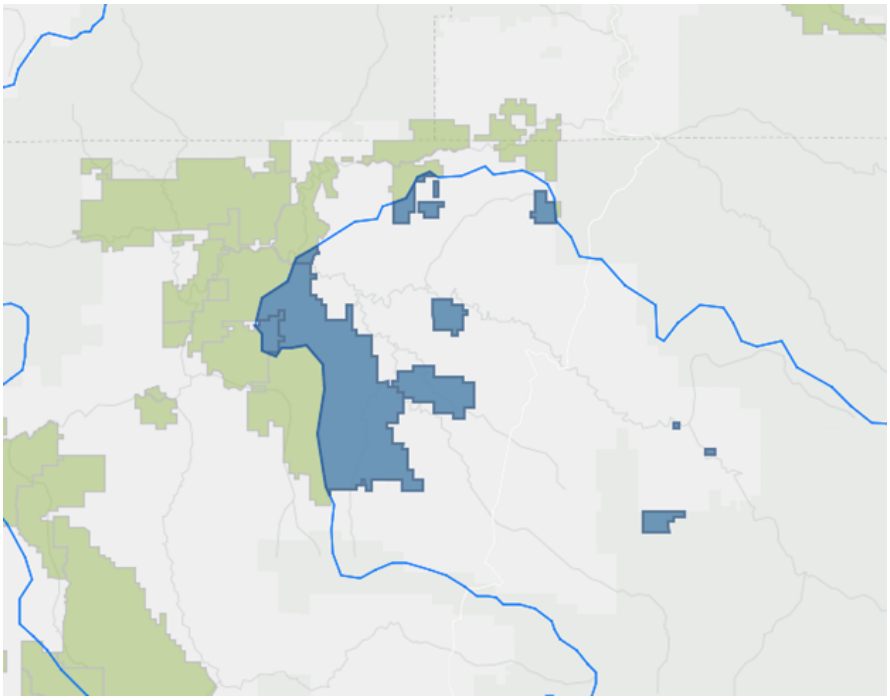
h For the third field, select the Unique option, and then choose MIDDLE FORK JOHN DAY from the drop-down list.



Step 5h: Filter the view of features in a layer.

i Click Apply Filter And Zoom To.

Note: You may have to zoom out or pan the map to see the results.



Step 5i: Filter the view of features in a layer.

The map zooms to the selected basin, showing all the grazing allotments (or portions of allotments) that it contains.

You can view information associated with the allotments in this particular basin by examining the attribute table.

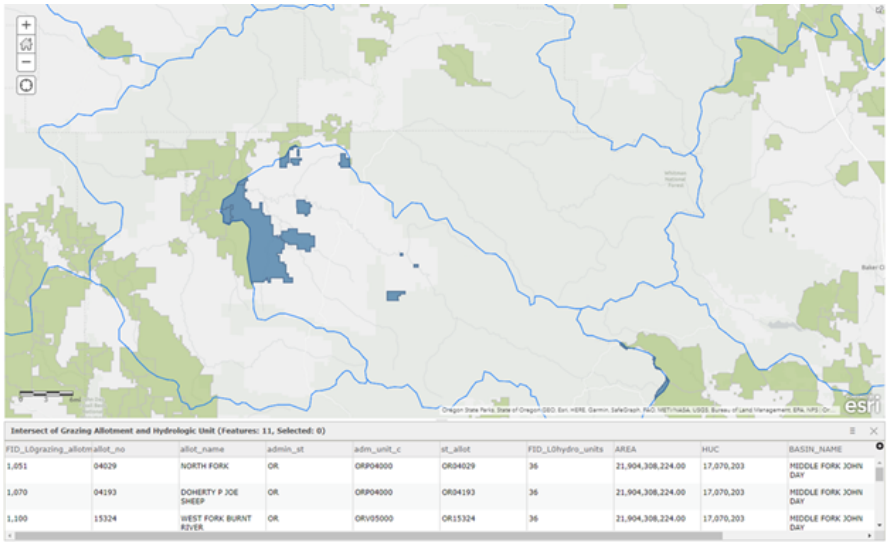
- Step 6: View the attribute table

In this step, you will look at the attribute data for the allotments within the Middle Fork John Day hydrologic basin.

a Open the attribute table for the Intersect Of Grazing Allotment And Hydrologic Unit layer.

- Hint

  In the Contents pane, point to or click the Intersect Of Grazing Allotment And Hydrologic Unit layer name and click the Show Table button .



Step 6a: View the attribute table.

Grazing allotments are filtered by a particular hydrologic basin (Middle Fork John Day, in the preceding graphic). The map shows all the allotments, or portions of allotments, that are in the basin (colored blue). The table lists the allotments along with their associated information.

The BASIN_NAME field shows the name of the basin. Because you filtered on a particular basin, the allot_name field shows only the 11 allotments in that particular basin.

b Click the allot_name field header and choose Sort Ascending to view the list of allotment names in alphabetical order.

As the biologist, you could use this method to identify allotments that that require research or follow up with federal agencies.

If you and the other biologists were researching a particular allotment, you could find basin locations by filtering the layer based on the name of an allotment.

c Close the attribute table.

Next, you will edit the filter to find out in which basins a particular allotment is located.

- Step 7: Filter data to limit feature visibility in a layer

In this step, you will limit the visibility of features in a layer by filtering the information in the new layer to determine in which basins a particular allotment is located.

a In the Contents pane, point to or click the Intersect Of Grazing Allotment And Hydrologic Unit layer name and click the Filter button .

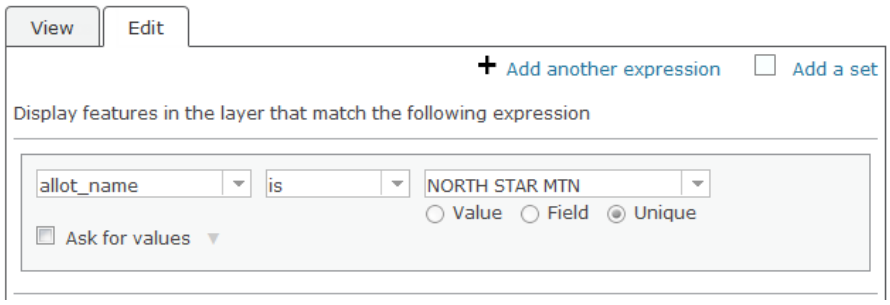
b In the Filter dialog box, click the Edit tab.

c For the first field, choose allot_name as the field to filter on.

Note: If you had a specific allotment number, you could filter on allot_no.

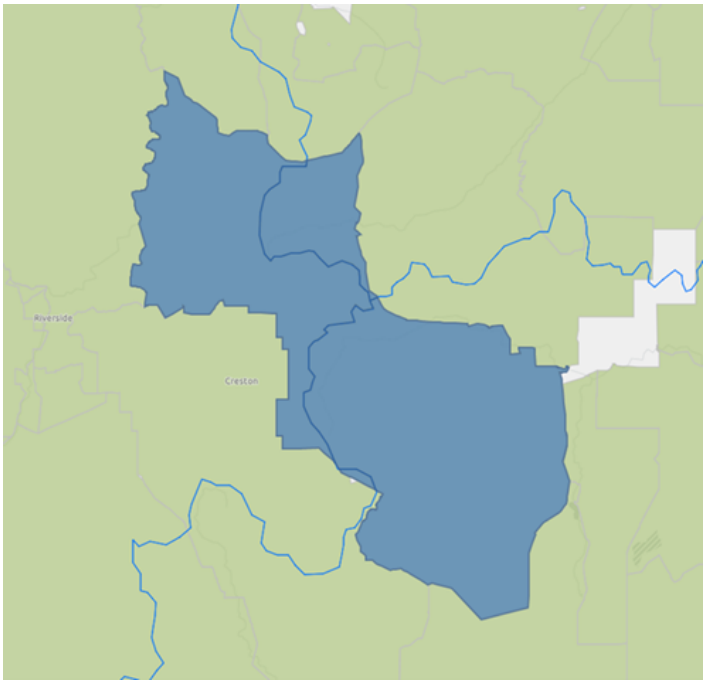
d For the second field, choose Is, if necessary.

e For the third field, select the Unique option, and then choose NORTH STAR MTN from the drop-down list.



Step 7e: Filter data to limit feature visibility in a layer.

f Click Apply Filter And Zoom To.



Step 7f: Filter data to limit feature visibility in a layer.

The map shows the selected grazing allotment and the overlap with what looks like three basins.

Because the biologists need an easy way to identify in which basins this allotment is located, you will open the attribute table.

g Open the attribute table for the Intersect Of Grazing Allotment And Hydrologic Unit layer.

h At the top of the attribute table, notice that the title bar shows four features, as indicated in the following graphic.

Intersect of Grazing Allotment and Hydrologic Unit (Features: 4, Selected: 0)

FID_L0grazing_allotm	allot_no	allot_name	admin_st	adm_unit_c	st_allot
1,259	00310	NORTH STAR MTN	OR	ORV04000	OR00310
1,259	00310	NORTH STAR MTN	OR	ORV04000	OR00310
1,259	00310	NORTH STAR MTN	OR	ORV04000	OR00310
1,259	00310	NORTH STAR MTN	OR	ORV04000	OR00310

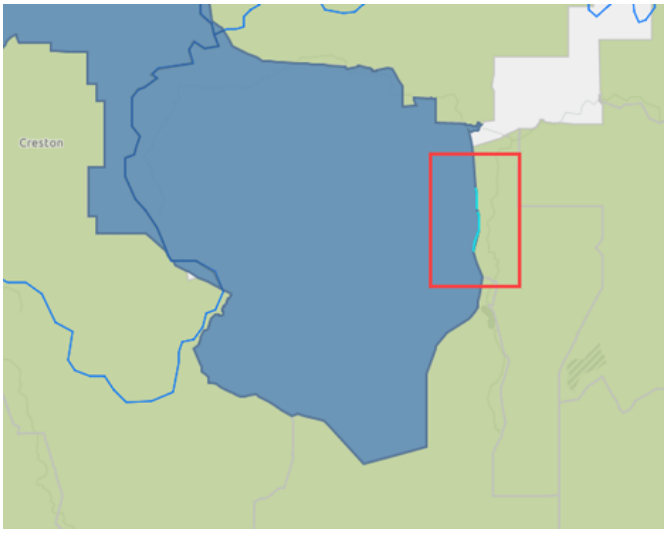
i Click each row in the attribute table to highlight the different basins on the map.

The map initially appears to display three features. There is actually a fourth feature, visible if you zoom in to the right side of the map, near the edge of the overlap between the basin and the allotment, as indicated in the graphic below.

Sometimes, the boundary of one dataset is intended to align with another but does not align precisely. This misalignment is often due to either errors in digitizing or inconsistencies in how historical boundaries were mapped.

Misalignment between datasets can result in two kinds of errors: gaps and slivers. Gaps are unexpected empty areas between neighboring polygons. Sliver polygons, or slivers, are areas where two datasets overlap when only one should be represented.

Correcting a gap or sliver polygon requires additional GIS data and other information not covered in this course, so you will not correct this sliver.



The allot_name field in the attribute table shows the name of the particular allotment. Because you filtered based on a particular allotment, the BASIN_NAME field lists only the basins in which a part of that particular allotment is located.

j Click the BASIN_NAME field header and choose Sort Ascending to view the list of basin names in alphabetical order.

The biologists could use the owner information from the federal database to contact the allotment owner.

k Close the attribute table.

- Step 8: Find overlapping features

Several months later, the biologists are finding the results of your analysis useful. They have identified several hydrologic basins that seem to have chronic water quality issues. The biologists are working with local officials and the Bureau of Land Management, which administers the grazing allotments, to find solutions.

To help identify the source of pollution in each basin, the biologists decide to assign the grazing allotment name and number to individual streams. This way, they will know which allotment each segment of each stream passes through.

In this step, you will use the Intersect tool to find out which grazing allotments each stream passes through, if any. You will identify where line features (streams) overlap polygon features (grazing allotments).

a In the Contents pane, turn off the Intersect Of Grazing Allotment And Hydrologic Unit layer.

b Turn on the Streams layer.

c Point to or click the Streams layer name, click the More Options button ••• , and choose Zoom To.

Step 8c: Find overlapping features.

The streams now display on the map in light blue; however, the streams are difficult to distinguish from the basemap and the grazing allotments.

You will adjust the map symbology using skills you have learned in previous sections.

d Point to or click the Streams layer name and click the Change Style button .

e Perform the following steps to change the color of the streams:

- Click Options.
- Click Symbols.
- Select a darker blue to represent the stream (#0070FF).
- Click OK twice.
- Click DONE.

f Following this same process, change the symbol outline color of the Hydrologic Unit layer to black (#1A1A1A).

Note: Because the Hydrologic Unit contains polygon features, confirm that you are changing the Outline color, not the Fill color.

Step 8f: Find overlapping features.

The symbols are now easier to interpret on the map.

Now that you can better distinguish the Streams and Hydrologic Units layers, you can use them to locate features that overlap.

g Point to or click the Streams layer name and click the Perform Analysis button .

h In the Perform Analysis pane, expand Manage Data and click Overlay Layers.

i In the Overlay Layers pane, for Choose Input Layer, confirm that Streams is selected.

j For Choose Overlay Layer, choose Grazing Allotment, if necessary.

k For Choose Overlay Method, select Intersect, if necessary.

l For Output, choose Lines.

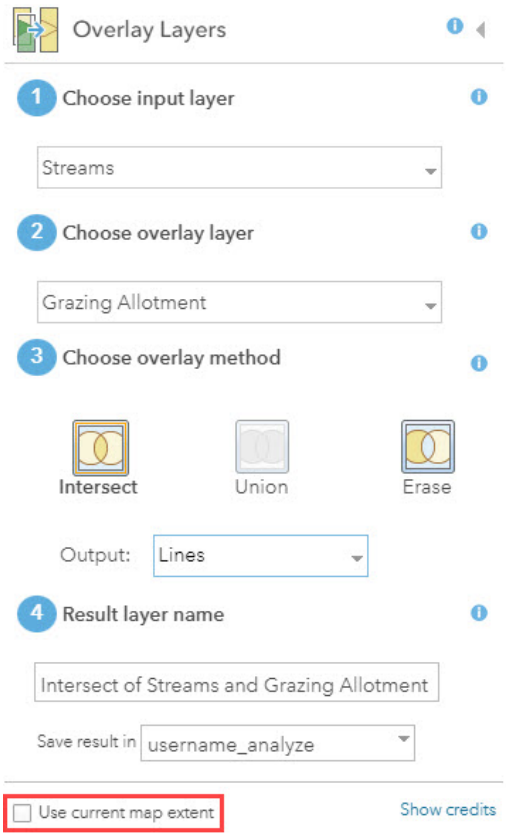
Note: Streams are line features. The area associated with the overlap will be displayed as lines in the result layer.

m For Result Layer Name, type **Intersect of Streams and Grazing Allotment_<your first and last name>**.

Note: If you run the analysis multiple times, you will need to provide a unique result layer name each time.

The Save Result In field defaults to your account name. You do not need to change this value.

n At the bottom of the Overlay Layers pane, uncheck the box for Use Current Map Extent, as indicated in the following graphic.



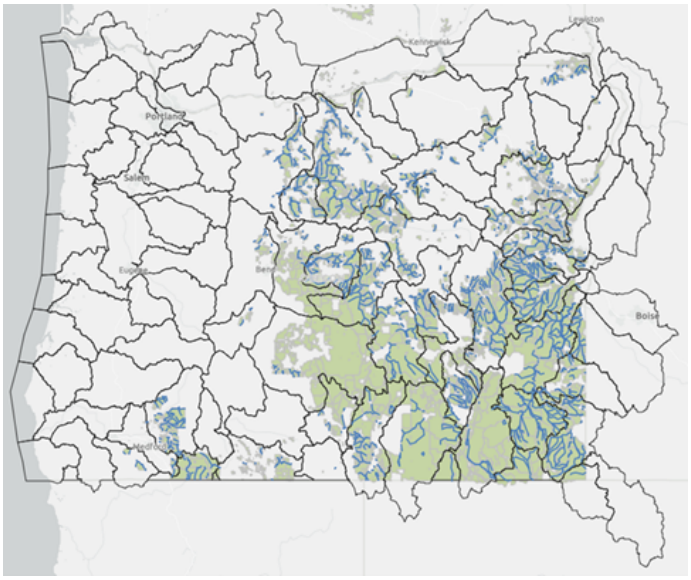
You want to run the analysis on all the records in the Streams layer, not just what is currently displayed.

o Click Run Analysis.

Note: If your analysis is not complete after 4 minutes, try saving the map and refreshing the page. You can also exit ArcGIS Online and try again later.

A new result layer, with the name that you assigned, appears in the Contents pane. The map display updates to show areas where the streams intersect, or overlap, the grazing allotments.

p Turn off the Streams layer.
Point to or click the Hydrologic Unit layer, click the More Options button ••• , and choose Zoom To to see the extent of the Hydrologic Unit layer.



Step 8p: Find overlapping features.

Next, you will filter the data to limit the number of features that are displayed.

- Step 9: Filter data to limit feature display

In this step, you will filter the information from the new output layer to find out which allotments are passed through by a particular stream.

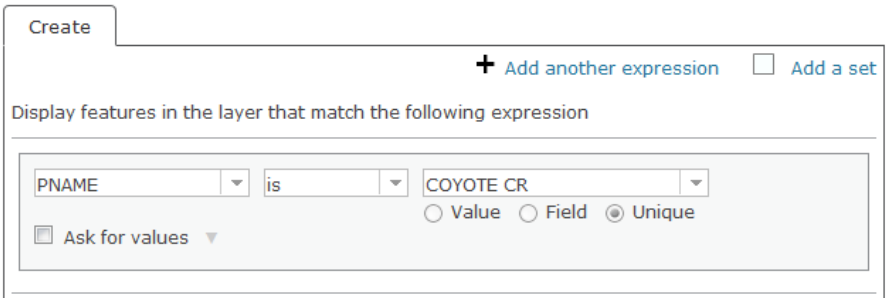
a In the Contents pane, point to or click the Intersect Of Streams And Grazing Allotment layer name and click the Filter button .

b In the Filter dialog box, choose PNAME as the field to filter on.

The PNAME field contains the names of the streams.

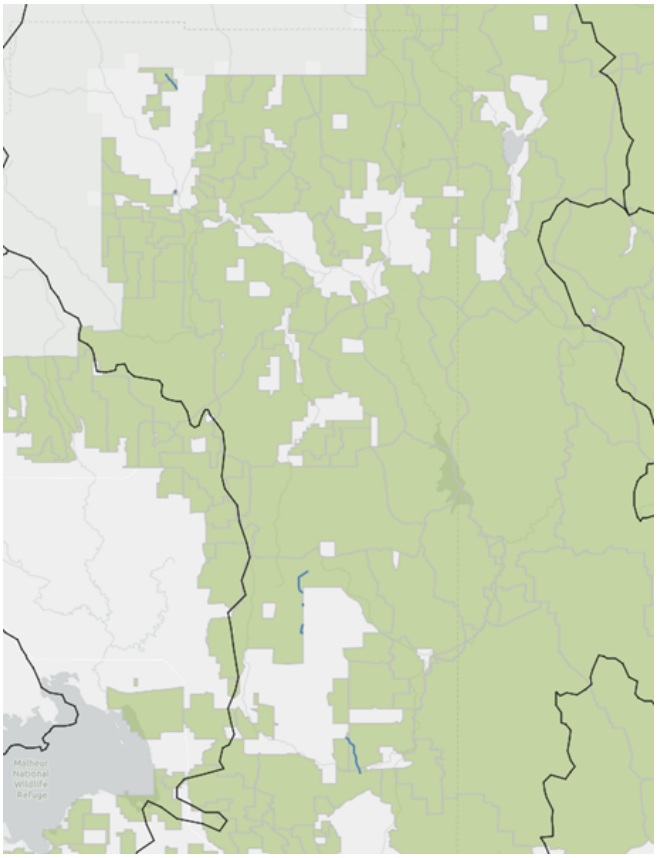
c For the second field, choose Is, if necessary.

d For the third field, select the Unique option, and then choose COYOTE CR from the drop-down list.



Step 9d: Filter data to limit feature display.

e Click Apply Filter And Zoom To.



Step 9e: Filter data to limit feature display.

The map shows the selected stream (Coyote Creek) and the allotments it passes through.

f Click the stream segment feature to view the pop-up with information about the selected stream.

To view the list of allotments that this particular stream passes through, you can open the attribute table.

g Open the attribute table for the Intersect Of Streams And Grazing Allotment layer.

Intersect of Streams and Grazing Allotment AB1 (Features: 7, Selected: 0)

PNAME	WRD_NO	RRN	TRIB	SCENIC	EPANUM	FID_L0grazing_allotm	allot_no	allot_name	admin_st
COYOTE CR	15168011100150080A	1705011605700.00	WOLF CR		17050116057	236	05508	BAKER KNOWLES	OR
COYOTE CR	15168011100150080A	1705011605700.00	WOLF CR		17050116057	349	05506	MUDDY CREEK	OR
COYOTE CR	15168011100150080A	1705011605700.00	WOLF CR		17050116057	991	05509	WILLIAMS DRIPP	OR

Step 9g: Filter data to limit feature display.

The attribute table displays at the bottom of the map. The PNAME field displays the name of the stream, Coyote Creek. The allot_name field lists the names of the seven allotments through which the stream passes.

h In the attribute table, scroll to the right to view the allot_name field to see which allotments this stream passes through.

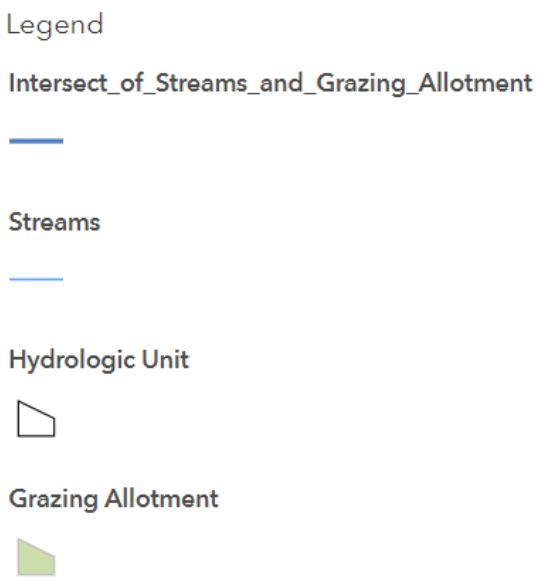
If the biologists were looking at a particular stream, they could obtain a list of all the allotments through which the creek passes. This information would allow them to take a closer look at the allotments and work with the owners to determine whether they were following best practices for water quality.

i Close the attribute table.

Next, you will view the changes in the legend.

j Turn on the Streams layer.

k Open the Legend pane.



Step 9k: Filter data to limit feature display.

Note: If you were to continue to zoom in to the selected streams (Coyote Creek), you will see Hydrologic Unit disappear from the Legend. This is because at a more zoomed in, larger scale, it is no longer displayed in the map.

The streams appear as light-blue lines. The portions of the streams that flow through, or intersect, the grazing allotments appear as a darker blue. The hydrologic basin boundaries appear as black. Changing the map style will make the map easier to interpret.

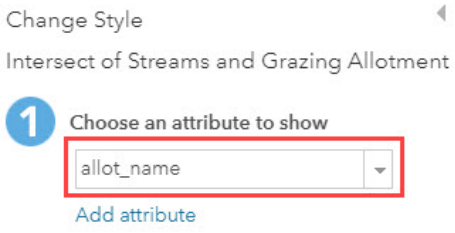
- Step 10: Change the map style

In this step, you will change the style for the new layer you just created so that the portions of streams within each allotment appear in a different color.

a Click Content to open the Contents pane.

b In the Contents pane, point to or click the Intersect Of Streams And Grazing Allotment layer name and click the Change Style button .

c In the Change Style pane, for Choose An Attribute To Show, choose allot_name from the drop-down list, as indicated in the following graphic.



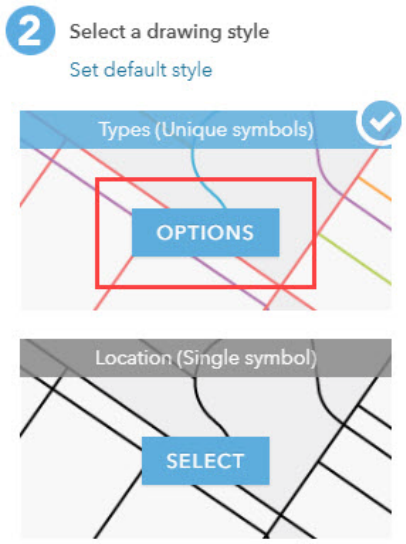
d For Select A Drawing Style, confirm that Types (Unique Symbols) is selected.

Note: The check mark indicates the current styling of the layer.

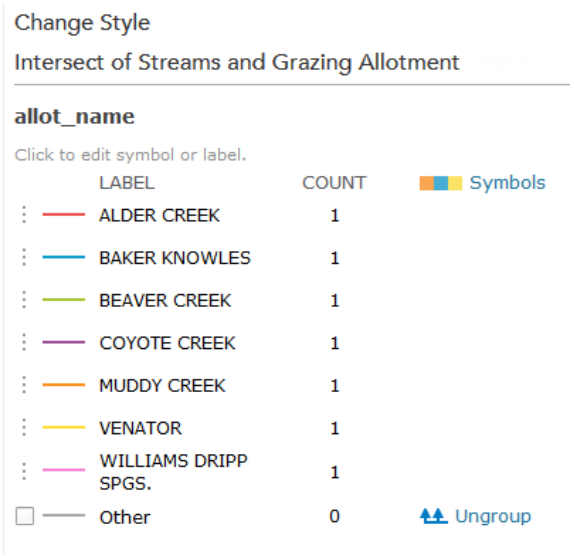
You can use unique symbols to show different kinds of things (categorical data). In this case, you can use different colors to represent the portions of streams within each allotment.

Note: By default, if your data has more than 10 categories, the 10 most common categories will be shown, with the remaining categories grouped into a single Other category.

e Click Options, as indicated in the following graphic.



The Coyote Creek allotment has fewer than 10 stream segments that intersect it; these stream segments are listed in the Change Style pane.



Step 10e: Change the map style.

Note: For streams that have more than 10 different stream segments, you could manually assign colors to them all. To do so, you would click the double arrow ( ) to the right of the

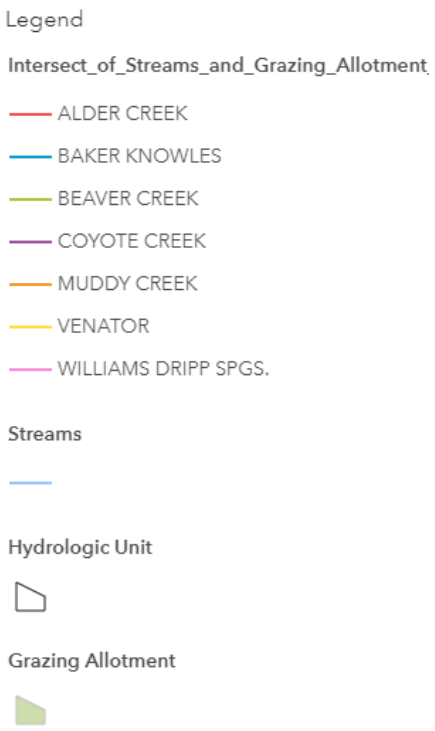
Other label in the Change Style pane to move the remaining features into the main list and assign them colors.

f Click OK, and then click Done to close the Change Style pane and view the updated map.

Note: You may need to pan or zoom the map to see the stream segments.

Next, you will view the changes in the legend.

g Open the Legend pane.

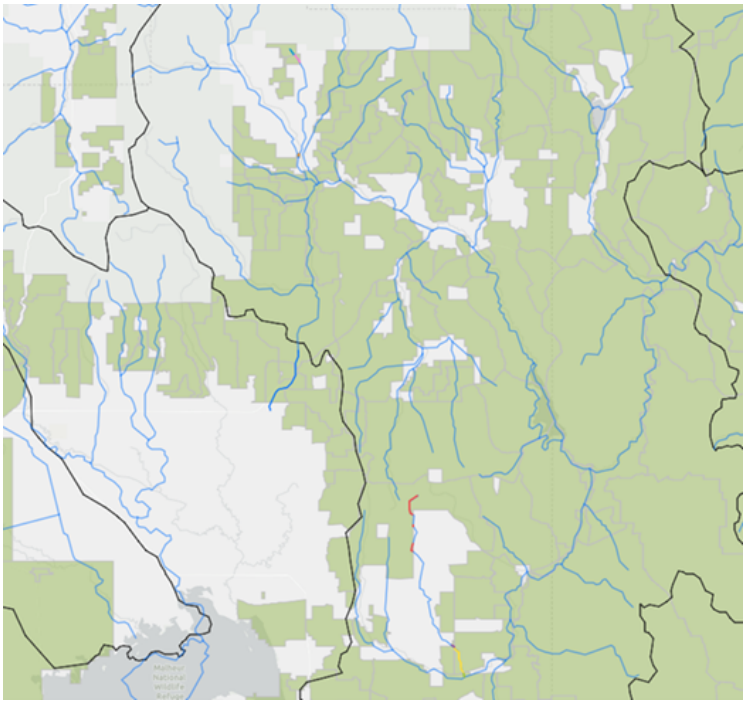


Step 10g: Change the map style.

The legend displays the segment of a stream that passes through an allotment in a different color.

These colors make it easier to see the portions of the streams that are located within the different allotments.

The original stream line features have been split into segments. Parts are symbolized by color based on the allotment in which they are located. Stream segments that do not pass through an allotment are not included in the new results layer. These segments are still visible on the map as light-blue line features in the original Streams layer.



Step 10g: Change the map style.

If field tests find a water quality issue with a particular stream, the biologists can filter the Intersect Of Stream And Grazing Allotment results layer to find out which allotments the stream passes through. The biologists can then link back to the federal database and get a report on each allotment (including information such as the type and amount of livestock, the owner information, and the administrating office). Through this process, the biologists should be able to determine the source of pollution.

- Step 11: Save the map

To complete your work on this project, you will save the map before exiting ArcGIS Online.

a In the upper-left corner of the map, click the Default Extent button .

b On the ribbon above the map, click Save and choose Save.

Your map will be saved to your My Content collection.

- Step 12: Conclusion

In this exercise, the spatial analysis approach was implemented, and you used overlay analysis to help your biologist team determine which hydrologic basins and streams should be monitored based on the impact of livestock grazing on water quality. Next, you will review how each step of the spatial analysis approach was used throughout this exercise.

Ask questions

For this scenario, the following questions were considered.

Which hydrologic basins and streams should be monitored based on the impact of livestock grazing on water quality?

- Where do livestock graze?

- Where are water sources located?
- Which grazing allotments are located in hydrologic basins?
- Which streams or basins might need to be monitored or tested?

Explore and prepare data

You explored the data by examining the attribute tables of the layers to understand and identify the information needed for analysis, such as the allotment number and the hydrologic basin and stream names.

Analyze and model

You analyzed and modeled the data by performing overlay analysis to combine information from the grazing allotment, basin, and stream layers. Additionally, you filtered data to limit visibility of features in a layer and changed the map style for appropriate visualization.

Interpret results

As you analyzed the data, you identified the answers to your spatial questions.

Which hydrologic basins and streams should be monitored based on the impact of livestock grazing on water quality?

The map displays which stream segments pass through the Coyote Creek allotment. Biologists will be able to filter the Intersect Of Stream And Grazing Allotment results layer to find out which allotments a stream passes through. The results will aid in determining the source of pollution and provide additional information that the biologists can use to get in touch with the appropriate contacts for solutions.

Using overlay analysis, you were able to identify the allotments located inside of the Oregon basins that were mostly within the central/western part of the state. If field tests find a water quality issue with a particular stream or hydrologic basin, the biologists can filter the results layer to find out which allotments are within a particular basin or which allotment the stream passes through.

Repeat or modify

The spatial analysis approach is intended to be iterative, and analysis may need to be modified or extended upon as more information is gained. For example, in step 9 of the exercise the biologists were finding the results of your analysis useful, but they needed to identify the source of the pollution. To help identify the source of pollution in each basin, they decided to assign the grazing allotment name and number to individual streams. This way, they will know which allotment each segment of each stream passes through.

Present results

After you are satisfied that your spatial questions have been answered, you can share the results with the Department of Environmental Quality for the state of Oregon.

Make decisions

If testing shows that a watershed has water quality issues, the biologists will be able to identify all the grazing allotments that are located in each hydrologic basin. The biologists can use the results of this analysis to work with the federal agencies, ensuring that permit holders are following best practices to maintain the quality of the state's water.

The Department of Environmental Quality for the state of Oregon is now requesting a prioritization map to determine which allotments are their highest priority based on the total length of the streams in each allotment.

a If you would like to create the prioritization map, proceed to the optional stretch goal.

b When you have finished your work for this section, close the private or incognito web browser window.

- Step 13: Stretch goal optional

Due to the success the biologists are having with the current analysis, you have been tasked with creating a prioritization map of the grazing allotments within the hydrologic basins. The map will need to show the grazing allotments with the longest summarized stream lengths. From the analysis results, the allotments with the longest total length of streams relative to allotment size will receive the highest priority for consistent water sampling. The map and results will be used to communicate the priorities with the team, local officials, and the Bureau of Land Management.

As you perform your analysis and create your map, keep in mind that you will determine the total length of the streams within an allotment by adding stream lengths together; you will not be totaling the number of streams in an allotment. For example, an allotment could have three streams, all of which are a mile in length. Another allotment could only have one stream, but it is five miles in length. In this scenario, the biologists would prioritize the second allotment as the stream impacts five miles versus the allotment that has three streams that only

impacts three miles. Therefore, the map should prioritize the allotments based on the sum of the length of the streams, not on the number of streams in each allotment.

Now, you will prioritize the allotments by using the spatial analysis approach to answer this question.

Which allotments are the priority for the Department of Environmental Quality for the state of Oregon?

The tasks for this stretch goal have been grouped to more clearly define the workflow that you are completing.

If you need assistance completing the following tasks, refer to these resources:

- ArcGIS Online Help: Summarize Within
- ArcGIS Online Help: Apply Filters
- ArcGIS Online Help: Change Style
- Watch the upcoming video in this MOOC by guest lecture John Nelson to learn more about classifying data.

You will use the spatial analysis approach to determine which allotments are the priority for the Department of Environmental Quality for the state of Oregon.

a If necessary, turn on the Intersect Of Grazing Allotment And Hydrologic Unit layer and the Intersect Of Streams And Grazing Allotment layer.

Recall that the Intersect Of Grazing Allotment And Hydrologic Unit are the grazing allotments within the Hydrologic Units or basins. The Intersect Of Streams And Grazing Allotment are the streams within those grazing allotments.

b Remove filters for both the Intersect Of Grazing Allotment And Hydrologic Unit layer and Intersect Of Streams And Grazing Allotment layer.

c For the Intersect Of Streams And Grazing Allotment layer, change the style to show location only.

d For the Intersect Of Streams And Grazing Allotment layer, open the attribute table and examine the Length in Miles field.

The Length in Miles field identifies each stream feature's length in miles within an allotment. Remember that a single stream could intersect multiple allotments, resulting in a separate stream feature per allotment.

Note: In the attribute table, there is a Length field and a Length in Miles field. To find the Length in Miles field, scroll all the way to the right.

e Run the analysis tool, Summarize Within, to summarize the lengths of streams in each allotment.

f Navigate to the Summarize Within results layer to examine the attribute table.

g Find the field Summarized Length in Miles.

The Summarized Length in Miles field provides the sum of the lengths of all of the stream features in a given allotment.

Note: As you examine the data for the Summarized Length in Miles field, notice that numerous features show 0.000 for their result. This indicates that the totaled lengths of the streams are too short to be reflected in the numeric range for this field.

h From the More Options icon on the top-right of the attribute table, click Show/Hide Columns to display the Area in Square Miles field.

The Area in Square Miles field now displays in the attribute table. To find the field, scroll all the way to the right. You will use the data from this field to complete your analysis.

Note: The AREA field in the attribute table is the area of the hydrologic basin that resulted when information was combined during overlay analysis earlier in the exercise. You will not use the AREA field data for the prioritization map.

i Close the attribute table.

The biologists want to narrow the results further to only display allotments that have the longest summarized stream length.

j Filter the Summarize Within results layer to visualize only the allotments that have more than five miles of streams.

k Open the attribute table and examine the Summarize Within results.

The Summarized Length in Miles field only contains features over 5 miles in length.

l Change the style of the Summarize Within results to create a choropleth map.

m Classify the data, specifying the number of classes and classification method of your choice.

You may notice that many of the larger allotments are visualized as a higher priority, having a higher sum of stream length. The allotments that are larger in area are more likely to have a larger sum of stream length. To consider this in your analysis, normalize the data in the Change Style pane.

n In the Change Style pane, divide by Area in Square Miles.

o Re-adjust symbology by re-classifying the data, specifying the number of classes and classification method of your choice.

p Post a screenshot of your prioritization map in the forum.

Below is an example result of the stretch goal. The color scheme selected, Cividis, is designed for those with color vision deficiency. Consider how color schemes can impact the experience people will have with your map. For more information, review the Esri Community blog, Designing Maps for Colorblind Readability.