Choose a projected coordinate system

Alaska's Arctic Natural Wildlife Refuge (ANWR) has been at the heart of an ongoing debate over proposed oil and gas development, particularly along the coastal plain, in an area called 10-02. You will create a simple map of ANWR to show the affected area. Consider the spatial properties that you want to preserve, as well as the location, shape, and size of your area of interest.

Estimated completion time: 20 minutes

To complete exercises, you need the following:

- ArcGIS Pro 3.1 (Basic, Standard, or Advanced)

1 Download the data

To complete the exercise, you must download the data. If you have already downloaded and installed the data, continue to the next step.

Unable to find the data you downloaded?

After you have downloaded the data ZIP file, extract it to the C:\EsriTraining folder. The unzipped folder will have the same name as the ZIP file.

If you unzipped the data to a location other than C:\EsriTraining, browse to that location and locate the folder. You can also try searching for the folder in one of the following ways:

- Start > Search Programs And Files (Windows 7)
- Start > File Explorer (Windows 8, 10 or 11)

2 Determine spatial reference of geographic data

a. In ArcGIS Pro, return to the CoordSystemsIntro project file.

> **Note:** If you closed the project, start ArcGIS Pro, browse to **C:\EsriTraining\CoordSystemsIntro**, and then double-click the CoordSystemsIntro ArcGIS Pro project file to open it.

b. At the top of the map view, close the Assign_GCS map.

c. In the Catalog pane, expand Databases, and then expand CoordSystemsIntro.gdb.

d. Right-click AlaskaBoundary and choose Properties.

e. In the Feature Class Properties dialog box, expand Spatial Reference.

Is AlaskaBoundary a geographic or projected coordinate system?

Show answer

AlaskaBoundary is a geographic coordinate system.

f. Click Cancel to close the Feature Class Properties dialog box.

g. View the properties for the Boundary1002 and BoundaryANWR feature classes.

Are the coordinate systems for all three feature classes in the same coordinate system?

Show answer

Yes; all the datasets have the same coordinate system: WGS 1984.

3 Investigate feature attributes

You will add the data to a map.

a. On the Insert tab, in the Project group, click New Map.

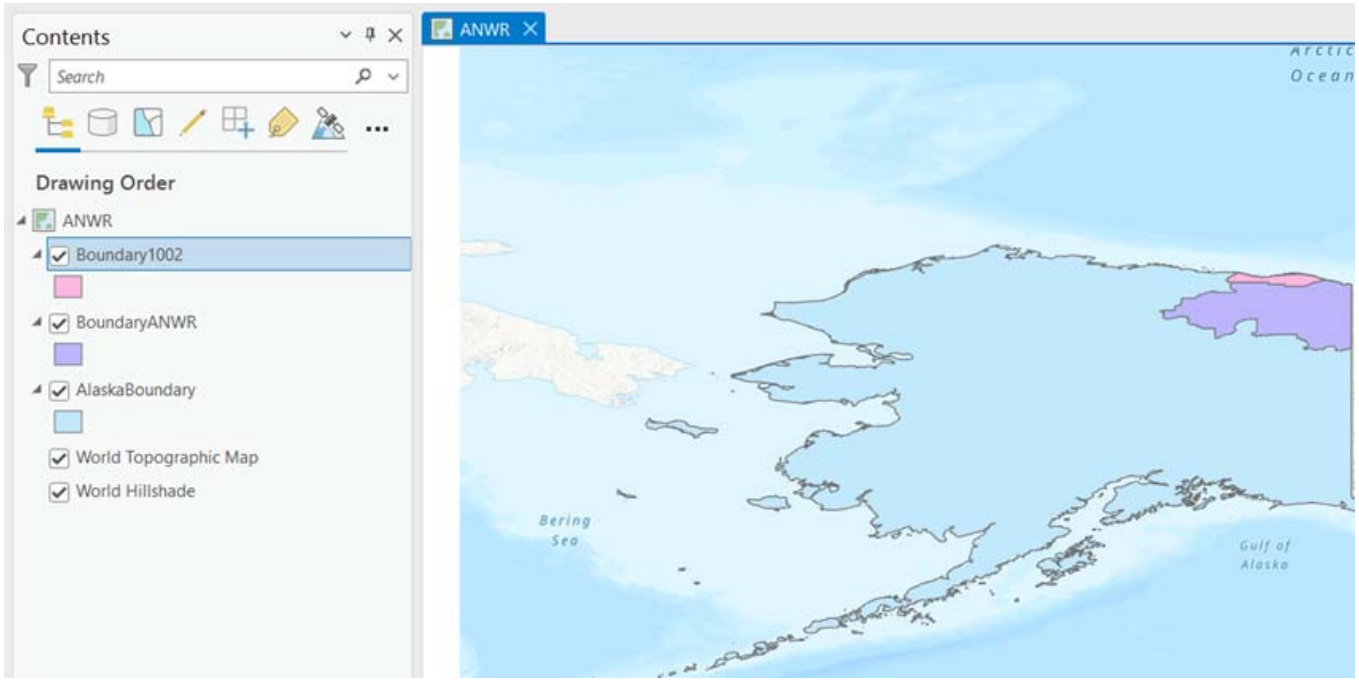
b. In the Contents pane, double-click Map to open the Map Properties dialog box.

c. On the General tab, for Name, type **ANWR**, and then click OK.

d. From the Catalog pane, add the AlaskaBoundary, Boundary1002, and BoundaryANWR feature classes to the map.

e. In the Contents pane, reorder the layers so that the Boundary1002 layer is at the top, followed by the BoundaryANWR layer, and then the AlaskaBoundary layer.

View result →



Step 3e: Investigate feature attributes.
Your colors may vary from this graphic.

f. If necessary, change the symbology colors so that each layer can be differentiated from the others.

How do I change symbology colors?

Click a layer's symbol, and then in the Symbology pane, click Properties, change the color, and click Apply.

g. In the map, click the Boundary1002 feature.

h. In the pop-up window, locate the Shape_Area field.

ArcGIS Pro automatically created and calculated this field. The area of this polygon is listed as 1.504091.

What is the unit of measurement for this feature class?

Show answer

The data is in a geographic coordinate system, specifically WGS 1984, so the values here are decimal degrees.

Although longitude and latitude can locate exact positions on the surface of the globe, they are not uniform units of measure. For this reason, decimal degrees cannot be used to

meaningfully represent distance or area.

Close the pop-up window.

④ Determine the spatial properties to preserve

One of the primary sources of debate regarding the development in ANWR is the total amount of land affected. Your map should accurately show how much land comprises the 10-02 portion of ANWR.

Which spatial property do you need to preserve in your map: shape, area, distance, or direction?

Show answer

Area; you are creating the map to show the area that comprises the 10-02 portion of ANWR.

If your map has a specific purpose, you may need to preserve a certain spatial property—most commonly shape or area—to achieve that purpose. In that case, an appropriate projection would be one that preserves that property.

⑤ Define the map's area of interest to help choose a coordinate system

A good projection minimizes distortion in your area of interest. A general guideline is to choose a projection according to the latitude of your area of interest.

- To map tropical regions, use a cylindrical projection.
- To map middle latitudes, use a conic projection.
- To map a polar region, use a planar (azimuthal) projection.

The map that you create will show where ANWR is located within Alaska and which portion of ANWR comprises the coastal plain of 10-02. The extent of your map would cover the state of Alaska, so you must make sure that you choose a projection that is suitable for that part of the world.

Which type of projection would be most appropriate for your area of interest: conic, cylindrical, or azimuthal?

Show answer

Conic; Alaska lies in the middle latitudes, so a conic projection would be most appropriate in this case.

⑥ Identify the shape and size of the area of interest

Alaska is a large state with a total area of 591,004 square miles, or 1,530,700 square kilometers. With the Alaska Peninsula and the Aleutian Islands, which stretch to the southwest, Alaska extends mainly east to west.

- For map areas that extend north–south, use a cylindrical projection.
- For map areas that extend east–west, use a conic projection.
- For map areas that have equal extent in all directions, use an azimuthal projection.

Following these guidelines, and based on what you think of Alaska's shape, which type of projection would you select: cylindrical, conic, or azimuthal?

Show answer

> Conic; Alaska generally extends east–west, rather than north–south or equally in all directions.

⑦ Apply an appropriate projection to the map

You have determined the following information:

- Spatial property that you want to preserve: Area
- Area of interest: Alaska, which lies between 50 degrees and 70 degrees latitude
- Shape and size of the area of interest: Large polygon that extends east to west

After considering the purpose of your map and the shape of your area of interest, you should be able to narrow down the possibilities for an appropriate projection—if not to a single projection, then at least to a short list of good choices.

ⓐ In the Contents pane, double-click ANWR to open the Map Properties dialog box.

ⓑ Click the Coordinate Systems tab.

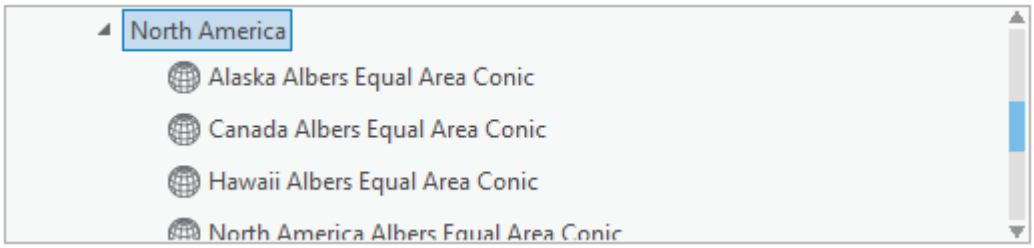
The Coordinate Systems tab allows you to search for a coordinate system by name.

ⓒ Next to XY Coordinate Systems Available, in the Search field, type **Equal Area** and press Enter.

ⓓ Expand Projected Coordinate System.

ⓔ Expand Continental, and then expand North America.

View result →



Step 7e: Apply an appropriate projection to the map.

You have already determined that a conic projection would be most appropriate, and you know that you want to preserve area, which is why you searched for Equal Area. Your area of interest is Alaska, and the first option is Alaska Albers Equal Area Conic, so this option is likely the best option.

ArcGIS provides a document that lists supported projections, including their type, properties, suitable extent, location or shape, and general purpose. You will look at that document now so that you can further evaluate this projection.

f. In File Explorer, browse to **..\EsriTraining\CoordSystemsIntro**.

g. Open the G37891_Projections_table.pdf file.

h. In the left column of the table, locate the Albers Equal Area Conic projection, which is the basis for the projection that you have selected.

Based on the information in this table, can you confirm that the Albers Equal Area Conic projection is suitable for this map?

Show answer

Yes; the columns are checked for Equal Area, Continent/Ocean, Regions/Sea, Medium Scale, East/West, Midlatitudes, Thematic, Presentation, and USGS. This projection, especially after it is tailored to Alaska, should work well for this map.

i. Close the G37891_Projections_table.pdf file and File Explorer.

(j) In the Map Properties dialog box, click Alaska Albers Equal Area Conic, and then click OK.

Step 7j: Apply an appropriate projection to the map.

View result →

The map updates, using the projection that you defined. The shape of the data changes, reflecting the spatial property that you chose to preserve.

(8) Project the data

(a) In the Contents pane, right-click Boundary1002 and choose Attribute Table.

(b) If necessary, scroll to the right to view the Shape_Area field.

The value for the Shape_Area field still reads 1.504091, as it did earlier.

This value is the same value that you saw when the data frame's coordinate system was set to GCS_WGS_1984.

The value did not update when you projected the data frame to Alaska Albers Equal Area Conic. Why not?

Show answer

Changing the data frame's coordinate system projects or transforms the data on the fly for display purposes only. It does not project the data itself and therefore does not change the values associated with that data.

Projecting the data frame is a good choice when the output that you are focused on producing is a map that will be used for visual analysis. If the map or data will be used for more in-depth analysis, or if the values for the Shape_Length and Shape_Area fields will be viewed or used by the map reader, you need the attribute values to be in meaningful units.

To change the values for measurements stored for the Shape_Length and Shape_Area fields in the attribute table, you will need to project the data itself. You will do that next.

c. Close the Boundary1002 attribute table.

You will use the Project tool to change the projection of a dataset.

d. On the Analysis tab, in the Geoprocessing group, click Tools.

e. In the Geoprocessing pane, in the search field, type **Project**.

f. In the search results, click Project (Data Management Tools).

You can use the Project tool to convert a dataset from one coordinate system to another. This tool creates a new dataset with the desired coordinate system. It does not alter the coordinate system of the existing dataset.

> **Note:** The name of the Project tool can be confusing because you can use this tool to "project" data into a geographic coordinate system as well, potentially unprojecting data. This tool actually allows you to change the coordinate system for a dataset, whether that coordinate system is geographic or projected.

g. In the Project tool, for Input Dataset Or Feature Class, choose Boundary1002.

h. Next to Output Dataset Or Feature Class, click the Browse button .

i. In the Output Dataset Or Feature Class dialog box, browse to **..\EsriTraining\CoordSystemsIntro\CoordSystemsIntro.gdb**.

j. For Name, type **Boundary1002_Proj**, and then click Save.

k. For Output Coordinate System, click the Select Coordinate System button .

You will use the same projected coordinate system that you applied to the data frame.

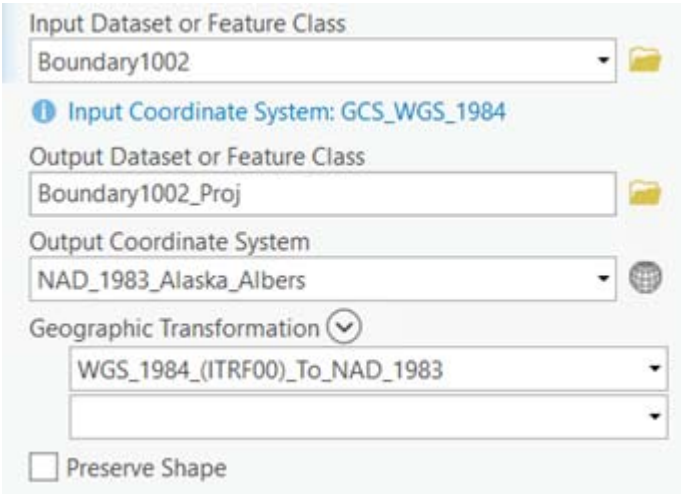
l. In the Coordinate System dialog box, in the Search field, type **Alaska** and press Enter.

m. Expand Projected Coordinate System, and then expand Continental.

n. Expand North America, and then click Alaska Albers Equal Area Conic.

o. Click OK.

View result →



Step 8o: Project the data.

(p) Click Run.

Step 8p: Project the data.

View result →

When the tool finishes running, the data is automatically added to the map.

(q) Open the attribute table for the Boundary1002_Proj layer.

The value for the Shape_Area field is now a much larger number because the units are in meters, which are the units of the projection that you just applied.

Most projections are in the most common linear units, such as meters or feet. When you project a dataset, the Shape_Length and Shape_Area fields, which the software automatically calculates, are updated to reflect the linear unit of the projection, making the data much more useful for analyses.

There is a significant difference between projecting your map and projecting your data. When you need your data to line up in your map display and any measurements that you make will be made within the map display window, you can project your map by applying a projected coordinate system to your data frame. However, if you need to perform analyses with your data that require that the data contain valid values for linear measurements, you must be sure that the data is in an appropriate projection.

r. If necessary, close the Symbology and Geoprocessing panes.

s. Save your project and exit ArcGIS Pro.

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