

Getting Familiar with the NASA RECOVER 2.0 Post-Wildfire DSS

RECOVER (Rehabilitation Capability Convergence for Ecosystem Recovery) is a decision support system (DSS) funded by NASA Applied Sciences with a GIS-based web map/dashboard interface designed to enable fire managers to develop better informed post-fire rehabilitation plans.

RECOVER has developed a database of current and authoritative geospatial data (land cover, natural resources, transportation, etc.) for the entire western United States¹. Initial layer selection was generated through discussions with fire managers and will continue to change as the project develops. Additional value-added analytical layers/products are also being identified and developed by the RECOVER team. The web map client was developed to allow our partners (you) to view and query these layers with nothing more than a desktop web browser.

Overview: This exercise is intended to allow you to acquaint yourself with the RECOVER interface and experience it from the fire manager's perspective. By analyzing an example fire, you will determine what areas need the most focus and resource deployment for ecosystem rehabilitation and recovery.

Note: The RECOVER 2.0 Post-wildfire Decision Support System is an evolving project. We will strive to maintain the tools in as much a static format as possible throughout the active fire season but need to balance that with the benefits of adding additional capabilities. Thus, when you revisit the RECOVER Dashboard and web maps in the future things may look a bit different. You can always reacquaint yourself with RECOVER using the most current tutorial, found either by clicking the menu in the upper-right corner of the dashboard or from our website at: https://giscenter.isu.edu/pdf/PDF_NASA_RECOVER2/GettingFamiliarWithRECOVER.pdf

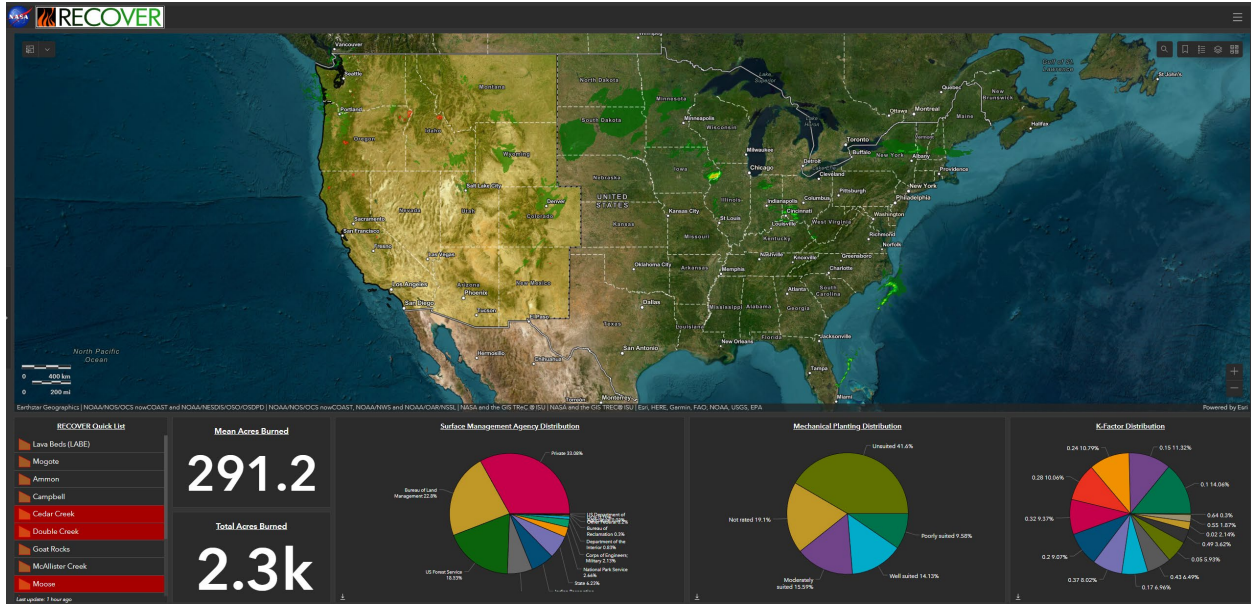
At a glance...


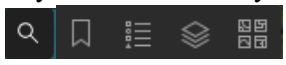


We will explore the features of the RECOVER interface and learn how to navigate the web map and dashboard, use its many features, and enable you to leverage the capabilities of the NASA RECOVER DSS.

Steps:


1. Let's begin with a tour of the RECOVER DSS graphical user interface (GUI).
 - a. Launch your web browser and navigate to:
<https://www.arcgis.com/apps/dashboards/19af90a8bc5d41188ed855d249bc1c72>
 - b. RECOVER was developed using a web map embedded with a dashboard. Once this site launches you will see a screen very *similar* to the figure below.

¹ The western United States includes the entirety of 11 states; Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.



- c. Across the top of the screen is the **Title Bar and Menu**.
- d. Click the menu  on the far-right side of the **Title Bar and Menu**.
- e. From this menu you can visit our 3D RECOVER map, view metadata for each layer used by RECOVER, open the most current version of this tutorial, bulk download RECOVER data packages, or contact the RECOVER team. We will explore these functionalities later in the exercise but for now, it is sufficient to be familiar with them.
- f. Below the **Title Bar and Menu** is the **Web Map Area**.
- g. You can zoom into and out of the web map using the mouse wheel or the +/- zoom buttons in the lower-right corner of the **Web Map Area**.
- h. Alternatively, you can pan around the **Web Map Area** by dragging the mouse around inside the web map.
- i. Near the upper-right corner of the **Web Map Area** is a set of very useful tools. They are the Search, Bookmarks, Legend, Layers, and Base Map tools.  We will use each of these later in the exercise.
- j. Below the **Web Map Area** is the **Widgets Bar**, a panel which displays various reporting information.
- k. On the left side of the **Widgets Bar** is the RECOVER Quick list which contains all incidents currently being tracked from the official interagency wildfire database.
- l. To the left of the **Web Map Area**, is an arrow button  that expands/contracts to reveal the **Fire Search Filter**. We will explore this capability next.
- m. Last, as you interact with the RECOVER dashboard, you will see a circular blue reset button  appear in the lower right corner of your screen. Clicking the button resets the entire dashboard back to its defaults.

Now that you are familiar with RECOVER's GUI, let's dig into its capabilities.

2. Identify a specific fire using the **Fire Search Filter**.
 - a. Select the **Fire Search Filter** button  on the left of the screen to expand the Fire Filters. Note the various fire attributes available to refine your search.
 - b. Select the **State** Fire Filter.
 - c. A dropdown menu appears with the 11 Western states listed as options. Multiple states can be selected as a filter, but for now, select Oregon. Note how the **Web Map Area** zooms to the spatial extent of that state. If multiple states are selected the map will respond similarly and show both/all selected states.

Filter options can be deselected by clicking them again, or resetting the filter altogether by clicking the Reset button at the bottom of each dropdown.


- d. With the State of Oregon selected, select the **County** Fire Filter.
- e. Type `Bannock` into the search text box (near the top of the County filter).
- f. You should see there are no matching options found. In other words, Bannock County (Idaho) cannot be found in Oregon. That makes sense!

The way the Fire Search Filter works is it builds a continuous SQL query until the filter is reset. Let's try this again.

- g. Use the **County** Fire Filter again and this time search for `Wallowa` county (you could also scroll through the list and select the desired county).
- h. This time, Wallowa County was found. Click the resulting text to select it.
- i. The **Web Map Area** zooms to that specific county.
- j. Is there a fire in this area?
- k. If so, which? (HINT: click the orange fire polygon(s) to learn more about these fires).



NOTE: you may need to contract the **Fire Search Filter** by clicking the  to allow you to view the pop-up window.

- l. Click the blue reset button in the lower-right corner of the screen.

3. Use the RECOVER Quick List widget
 - a. From the RECOVER Quick List on the **Widgets Bar**, locate and click the Kelly fire.
 - b. In about a second, the **Web Map Area** will change and zoom into this wildfire.
 - c. Click anywhere within the fire area polygon (NOTE: be sure no other dashboard tools are in use at the same time).
 - d. A pop-up window will appear providing details about this specific fire. Notice the Download RECOVER data package entry.
 - e. Click the `View` link and the entire RECOVER Data Package (ZIP) will be downloaded to your computer. We will work with these data later in the exercise but for now, simply downloading these data is sufficient.
4. From the Web Map Area, draw your attention to the Tools (upper-right corner).
 - a. Click the Layers tool 



- b. You will see the Layers list expand and since you are zoomed into a wildfire area, all the layer themes should be listed in a bold and bright white color. This means they are all currently viewable.

NOTE: If you were zoomed out a bit more, many of the layers would be listed with a dimmer, off-white or light-gray font. Try this by zooming out.


- c. If necessary, zoom back into the fire area so all layers are enabled (the font is a bold and bright white color).
- d. To the left side of the layers is a display icon that looks like an eye. This icon can be clicked to turn the display on  or off . HINT: It may be helpful to turn off the NOAA NWS Precipitation layer at this point.
- e. Even further to the left is what looks like an arrow. It allows you to expand and contract each layer theme group. Expand the Wildfire layer group.
- f. On the right side of the Layer List is a scroll bar. Based on your screen resolution and how many layer groups have been expanded, the scroll bar itself may be visible or not.
- g. Slide the scroll bar down to the bottom of the layer list to see the Terrain layer group.

There are currently 33 GIS data layers that are part of RECOVER. We refer to these as **RECOVER Base Layers**. The **RECOVER Base Layers** are acquired from authoritative sources like NASA, USGS, USDA Forest Service, the DOI BLM, and others. Additional layers may become available in the future or on a special basis relative to a specific wildfire. Please note, some layers are very dense/detailed and, depending on your current map extent, may take a few moments to draw.


5. Retrieving data and information from the **RECOVER Base Layers**.

- a. From the Layers list, locate and expand the Terrain Layer Group by clicking the arrow  to the left of the display icon.
- b. Turn on the Slope (Percent) layer by clicking the display icon to turn it on .


Note: this same process is used for all groups and layers. That is, individual layers are organized into thematic groups (Layer groups) and all groups are turned on (displayed) by default. However, all individual layers (e.g., slope or elevation) are turned off by default, save for the wildfire polygons.

- c. In just a moment, the slope percent layer will be displayed.
- d. Click anywhere inside the **Web Map Area** but outside the fire polygon.
- e. A pop-up will display the pixel value for this raster layer (Slope in percent rise).
- f. Click an area inside the wildfire area.
- g. Notice the same pop-up appears but in the upper right corner of the pop-up window you should see an indicator that data from more than one layer is available. To view the additional data, click the left/right arrows. .
- h. Clicking around this fire area, it seems like this area contains a lot of steep slopes.
- i. Let's see if our hunch is correct. Turn OFF the Slope percent layer and turn ON the Steep Slopes (30% or Greater) layer.

NOTE: Some layers may take a little while to be drawn. When a layer is being drawn you will see a small blue dot flash slowly to the right of each layer being drawn in the layer list.

- j. Click in these same general areas again.
 - k. The Steep Slopes layer is a Boolean layer and all pixels with a slope greater than or equal to 30% are given the value one (1) or true.
6. Turn off any Terrain layers currently displayed.
 7. Recovery following a wildfire is dependent upon many factors. One of those factors is the area's past fire history. Let's explore this next using the Historical Fires since 1950 layer².
 - a. Expand the Wildfires Layer Group
 - b. Turn on the Historical Fires (since 1950) layer.
 - c. As you will see, there has been a number of fires in this area over time. But have any of these fires occurred recently?
 - d. Click a few of the historical fire polygons that overlap this fire (HINT: remember to click through all the results shown in the pop-up window. You may also find it helpful to view the Legend, by clicking ).
 - e. What you should see is that not only has there been a lot of fires in this region since 1950 but several fires have occurred in the same area relatively recently (e.g., 2002).
 8. As we are getting to know this fire area, let's now turn our attention to the LANDFIRE layers.
 - a. Turn off the Historical Fires (since 1950) layer
 - b. Expand the Land Cover Layer Group
 - c. Turn on the EVT Existing Vegetation Type layer
 - d. Click around and within the fire polygon.
 - e. While you are doing this, pay attention to the pop-up window and the vegetation type descriptions provided by the LANDFIRE EVT layer. Use this information to build a picture in your mind of the type of ecosystem impacted by this fire.


NOTE: You can also learn more about the fire area using the aerial imagery base map

- f. Continue exploring the LANDFIRE layers like the EVC Existing Vegetation Cover, BPS Biophysical Setting, and FVT Fuel Vegetation Type layers.
9. Turn off any Land cover layers currently displayed.
 10. Return to the Wildfire Layer Group and expand it.
 11. Let's look at the Post-Wildfire Debris Flow Layer Group (this is a Layer Group within the Wildfire Layer Group). Recall a layer group is indicated by having a small arrow to the left of the display icon . This means you can expand the group and reveal a number of additional layers within the group.
 - a. Click the arrow to expand the Post-wildfire Debris Flow layer group
 - b. Turn on the group's display
 - c. Unfortunately, a post-wildfire debris flow layer has not been produced by the USGS for this particular fire. If you would like to explore the type of data provided by the USGS Landslide Hazards program, explore the Double Creek fire!
 - d. Turn off all Post-wildfire Debris flow layers/group
 - e. Make sure the RECOVER Fires layer is turned on and that you are viewing the area in and around the Kelly fire.
 12. We will now turn our attention to land management.
 - a. Expand the Boundaries Layer Group

² This layer is from the Historical Fires Database (HFD) <https://giscenter.isu.edu/research/Techpg/HFD/index.htm>

- b. Turn on the SMA Surface Management Agency layer.
- c. Using either the Legend or mouse inquiry (i.e., click the web map) you should see the vast majority of the fire burned on lands managed by the USDA Forest Service.
- d. Let's compare this to the Surface Management Agency Distribution Pie Chart in the **Widgets Bar**. This dynamic chart displays the distribution of managing agencies across the Western United States shown with the current map window. To view the percent total area that an agency manages, hover the mouse over a slice of the pie chart for a pop-up with that information.
- e. As you zoomed into the Kelly fire, the Surface Management Agency Distribution Pie Chart has changed. It now reports the distribution of management agency lands that are in the vicinity of the fire polygon. This is the same for all pie charts in the **Widgets Bar**.

Notice there are over four thousand square miles of US Forest Service lands according to the pie chart widget. Based on how AGOL functions, this is actually a correct answer, but it does not accurately represent lands within the fire perimeter or even the map window. Instead, this quick distribution pie chart is derived by selecting all SMA polygons that intersect any part of the map window view extent. The polygon(s) can extend well outside the fire area and even outside the map window. Later in the exercise, you will learn how RECOVER makes it easy to get the exact answer using the Data Package you already downloaded.

- 13. Continue exploring the data layers available to you in the RECOVER DSS (NOTE: The Hydrography layers such as NHD and WBD tend to draw and respond slowly).
- 14. Explore the various alternative base maps available in the RECOVER DSS by using the Base Maps tool .


Using RECOVER'S 3D VIEWER

Some individuals can learn about a landscape better by visualizing the data in 3D. Let's turn our attention now to the 3D Viewer.

- 15. From the RECOVER DSS Dashboard GUI, locate the **Title Bar and Menu** across the top of the screen. Click the menu (three horizontal bars or "hamburger") and choose **3D Viewer**.






The **3D Viewer** provides a great way to visualize the landscape and build your understanding of the landscape along with potential post-fire effects that may impact that landscape. Using these data layers along with your subject matter expertise and experience helps to support well-informed decisions for post-wildfire recovery.



The **3D Viewer** is not as powerful for querying data. For that, the primary RECOVER DSS dashboard and web map are far better.

We will use a number of different tools in the **3D Viewer** and in general they function in the same way. The tool will display a button allowing you to enable the tool and begin using it. Frequently, enabling a tool will open another window. To close a tool window or end the use of a tool, find and click the double-arrow button .



Learning the 3D Viewer GUI.

16. In the upper-left side of the screen you should see a **vertical tool bar** containing (HINT: hover the mouse cursor over the buttons to reveal each tool's name)

- a. Screen shot 
- b. Zoom in 
- c. Zoom out 
- d. Default map view (zoom out to full extent) 
- e. Reset map orientation (reset orientation to default) 
- f. Two toggle Pan/rotate buttons:



The pan tool is turned on by default as indicated by the arrow in the upper-right corner of the tool bar button . Compare this to the rotate button .

17. In this part of the tutorial, we will use the Double Creek fire. To find a specific fire in the 3D Viewer:


- a. Expand the Wildfire Layer group (located in the lower-right corner of the screen)
- b. To the right of the RECOVER Fires layer, click the tables button 
- c. From the Table that appears on the bottom of the screen, locate the Double Creek fire
- d. Turn on (check) the Double Creek fire
- e. To zoom into the selected fire, click the menu button in the upper right corner of the Table window  (NOTE: Be sure to look at the table window only to find its menu button)
- f. Choose Zoom to Selection
- g. Close the Table window by clicking the X in its upper-right corner


18. Zoom into the Double Creek fire polygon using either the zoom in/pan tools or by your mouse and scroll wheel.

19. Along the lower-left side of the screen is a **horizontal tool bar** containing a number of handy tools.


20. The first is titled the Toggle Coordinates tool 
- a. Using this tool shows you the coordinates of your mouse cursor's position in the map. You can also choose to view the coordinates in a variety of formats including XY (default), DD (Decimal degrees), DMS (Degrees Minutes and Seconds), as well as UTM and a number of other coordinate systems.
 - b. Click the default XY button  to reveal all the coordinate options.



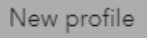
By itself, this is an interesting tool but there is even more to it.

Click the Expand arrow  on the right-side of the Coordinates tool.

A second part of the tool appears. A particularly interesting capability is the Capture mode tool . Click this tool to begin using it.

Click anywhere inside or near the Double Creek fire. Each time you click you will see a small circle appear at your last click position.

This tool captures the most current point location. If you want to save any of those point locations, you can click the Copy button  that appears to the right of the coordinates when you hover the mouse over it. This location can act as a waypoint for field sampling or other purposes. The point I captured was 45° 36.009738'N, 116° 42.151288'W.

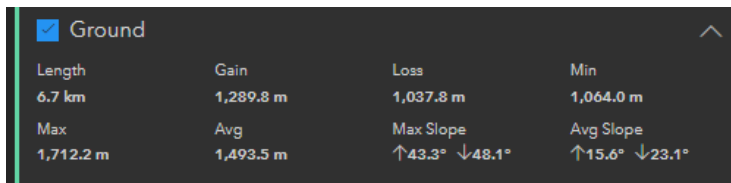
- c. The Input Coordinate tool  functions almost opposite of the Capture tool. With a pair of coordinates copied, click the Input Coordinate tool and paste (press CTRL-V from your keyboard) the coordinates you copied earlier.
 - d. Place a check in the Go to location checkbox
 - e. Click the Convert button (this tool's title is also misleading) and the circle indicator will reappear on your screen and will be panned to near the center of your screen.
 - f. Deselect the Capture mode tool and collapse the remaining tool to explore the other tools available on this tool bar.
 - g. Take some time to explore the other capabilities available with the coordinates tool.
21. The next tool that may be useful to you is the Elevation Profile tool . Let's explore it a bit right now.
- a. First, zoom into the Double Creek fire so the polygon nearly fills the screen.
 - b. Click the Elevation Profile tool to enable it.
 - c. This tool will try to help walk you through the process by displaying prompts. The first tells us to "Draw or select line to generate an elevation profile".
 - d. To draw a line, click the New Profile  button.
 - e. Move your mouse cursor into the map and draw a line by clicking once to start the line.
 - f. Click again to add a vertex or several vertices along the line.

NOTE: The elevation profile is drawn as you create the line.


- g. Finally double-click to indicate the line is finished.
- h. Expand the Ground portion of the tool by clicking the down arrow to the right of Ground.










- i. The tabular results of the elevation profile are displayed and your results will be similar to those shown below. Notice both elevation and slope results are displayed.




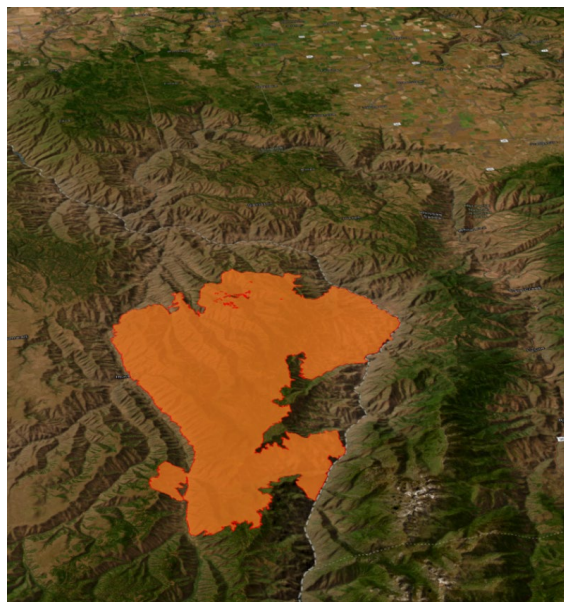
Ground			
Length	Gain	Loss	Min
6.7 km	1,289.8 m	1,037.8 m	1,064.0 m
Max	Avg	Max Slope	Avg Slope
1,712.2 m	1,493.5 m	↑43.3° ↓48.1°	↑15.6° ↓23.1°

- j. Close the Elevation Profile tool by clicking the double arrow button .
- k. Feel free to explore the other tools as you see fit.

22. In the upper-right side of the screen you should see the following tools:
 - a. Legend 
 - b. Open Overview map . Click it to see how it works.
23. Before moving on, click the Default Map View button  on the left side of the screen.
24. Now, zoom back into the Double Creek fire area and you will be able to see how the overview map functions.
25. Next, draw your attention to the lower-right side of the screen. Here, you should see the layer list . It is expanded by default but can be contracted/closed by clicking the double-arrow button  in the lower right corner of the screen. Close the layer list for the time being.
26. Another tool found in the lower-right corner is the Enter Fullscreen mode tool . Click it to see how the 3D Viewer looks in this mode (HINT: this can be very handy during meetings or presentations).
27. Press the ESC button on your keyboard to return to normal mode or click the Exit Fullscreen button .

Interacting with the 3D Viewer


28. Now that we have completed a tour of the 3D Viewer's GUI, let's learn how we can interact with the display to visualize the data layers.
29. Initially, the 3D Viewer may not look much different than the web map available from the dashboard. In this section, we will learn how to change this to better visualize the fire landscape.
 - a. From the vertical tool bar near the upper-left corner of the screen click the rotate button . Notice the small white arrow in the upper-right corner of the tool button. This indicates the Rotate tool is active.
 - b. Move the mouse cursor into the map area and then click/drag the window so the valley to the northeast of the Double Creek fire is visible.





- c. Zoom into the fire polygon so it nearly fills your screen.
30. We will interact with the RECOVER Base Layers in a way very similar to what you already learned using the main dashboard web map. To begin, open or expand the layers list.
- a. Scroll down to the bottom of the layer list.
 - b. You should see the same Layer Groups are available here as in the dashboard and main web map.
 - c. In addition, you may turn on/off these layers using the same display visibility tool.
 - d. A new feature available here is the open table tool. This tool is only available for vector GIS data layers (i.e., point, line, or polygon layers).
 - e. Expand Wildfire Layer Group
 - f. Expand the Post-wildfire Debris flow Layer Group.

NOTE: The USGS Landslide Hazards Program is making updates to their system throughout the spring of 2024. We have noticed the services are sometimes not available or not responsive. If you experience problems, please skip to next part of the tutorial, Using the RECOVER Data Package in ArcGIS Pro.

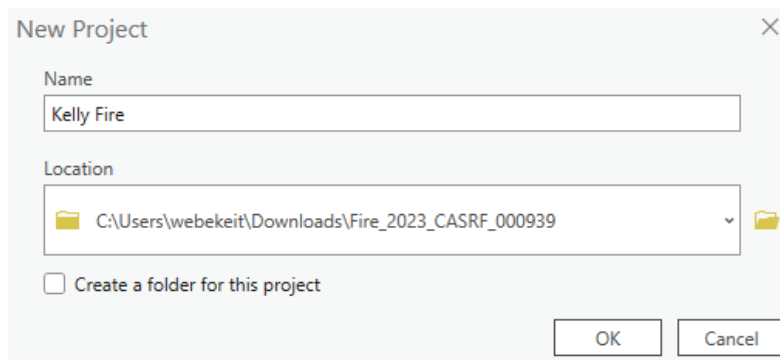
- g. Turn on display for this group and for the Basin Probability Estimates layer
 - h. Next, scroll up and turn off display for the RECOVER Fires layer.
 - i. You should be viewing the Post-wildfire Debris flow layer only at this time.
 - j. To interpret these data, open the Legend by clicking its button  near the upper-right corner of the screen.
 - k. Explore these data in 3D using the pan and rotate tools as well as the zoom in/out tools.
31. Continue exploring the Double Creek fire by viewing and interacting with other RECOVER Base Layers.

USING THE RECOVER DATA PACKAGE IN ARCGIS PRO DESKTOP

Earlier in this exercise you downloaded the RECOVER Data Package for the Kelly fire. We will use this data package for the remainder of the tutorial.

The NASA RECOVER post-wildfire DSS is evolving. The data layers found in the exercise data package were the current layers used in late summer and fall of 2023. The data packages available in the future may be slightly different as they will contain the most current version for each base layer. The data package for older fires (e.g., 2022) will not be retroactively modified however since post-fire rehabilitation decisions were likely made on the best data available at that time.


32. Minimize your web browser
33. Using Windows Explorer, navigate to the folder where the data package zip file was downloaded (HINT: by default, this should be your Downloads folder).
 - a. Locate the `Fire_2023_CASRF_000939.zip` file (NOTE: if you downloaded a different fire's data package, it will have a different name).
 - b. Extract the zip file to your hard drive (HINT: I like to have zip files extracted to a folder containing the same name. This makes file management for numerous wildfires much easier).
 - c. The path to the folder where these data exist should be similar to the following `D:\Downloads\Fire_2023_CASRF_000939` (HINT: It is best if there is the fire folder is not duplicated in the path)³.
34. Launch ArcGIS Pro on your computer.
35. Choose to create a new map project.
36. The completed Create New Project dialog should look very similar to the figure below (NOTE: be sure to uncheck the Create a new folder... checkbox).



37. Click OK
38. Once the new project launches, take a look at the Catalog pane on the right side of the screen
 - a. Expand the `Folders` section
 - b. Locate and right-click the `Fire_2023_CASRF_000939.gdb` geodatabase (NOTE: when you are working with other fires, the name of the fire folder and fire geodatabase will be different from the example used in this tutorial. The name `2023 CASRF_000939` is the name of the Kelly fire assigned by NIFC).
 - c. Click `Add to Project` from the fly-out menu that appears

³ For additional assistance, see <https://giscenter.isu.edu/pdf/unzipping.pdf>

- d. Expand the `Databases` section of the Catalog pane
 - e. Locate and right-click the `Fire_2023_CASRF_000939.gdb` geodatabase
 - f. Click `Make Default` from the fly-out menu that appears
39. Next, just a bit more housekeeping before we dig into these data. From the same Catalog pane in ArcGIS Pro:
- a. Expand `FOLDERS—FIRE_2023_casrf_000939`
 - b. Locate and expand the `RECOVERDataPackageTools` toolbox

 `RECOVERDataPackageTools.atbx`
 - c. Locate and double-click the `Repair Layer File Sources` tool⁴ (NOTE: this tool fixes path links that most likely were broken as the data package was moved from the RECOVER server to your PC).
 - d. Select the `Fire_2023_CASRF_000939` folder as the Fire Folder.
 - e. Click `Run`

If a Layer file is not fixed by this tool, you will see a red exclamation mark next to the layer name in the Contents pane when you add the layer file to a map. In this case, you can manually fix the data source fairly easily.

- Click the red exclamation mark (e.g., `EVT.tif`)
- Use the `Change data source` window to navigate into the `Project—Folders`
- Continue to navigate into the specific project folder until you locate the actual file (e.g., `EVT.tif`)
- Select the file
- Click `OK`

40. Lastly, from the Contents pane, select the `Map` (literally, click and select the word `Map`).
 - a. Press `F2` from the keyboard (`F2` nearly universally opens the “rename” tool)
 - b. Rename the `Map` to `Data Exploration`.
41. Save your ArcGIS Pro project by clicking the save button in the upper-left corner of the screen.
42. Now that we have taken care of some basic ArcGIS Pro housekeeping, let’s turn our attention to the wildfire data.
 - a. Expand the `Fire_2023_CASRF_000939.gdb` to view its contents
 - b. The layers in the GDB are all vector GIS data. In other words, each is either a point, line, or polygon feature class. The list of layers should be very familiar to you as you saw each of these in the `Web Map` and `3D Viewer` previously.
 - c. Right-click the `Fire_2023_CASRF_000939` layer and select `Add to Current Map`.
43. You should see the fire polygon in the map area.
44. If you wish, apply custom symbology to make the fire perimeter more meaningful to you. I applied an orange color to it and made it semi-transparent. None of this however affects the data or subsequent analysis and you can omit this step if you wish.

⁴ The current `Repair Layer File Sources` tool can only be used once per project. If used a second time it will show an error. This is being corrected and the updated tool will be automatically added to future RECOVER Data Packages.

45. Open the attribute table for the fire perimeter layer (HINT: You can do this very easily by holding the CTRL key on your keyboard and double-clicking the Fire perimeter layer from the Contents pane).
 - a. Notice this layer contains 47 different polygons more or less piled on top one another. This represents a new polygon each time the fire data was “refreshed” by NIFC or RECOVER. It allows you to rebuild this fire’s activity using the date and time fields within this layer.
 - b. To view the most current or final fire perimeter/polygon, right-click the poly_SourceOID field (near the left side of the table).
 - c. Choose Sort Descending

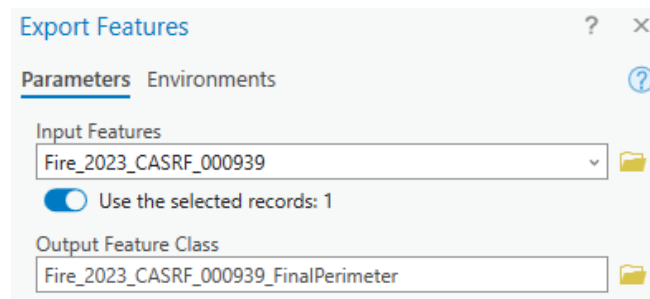
The final perimeter for this fire has a poly_SourceOID value of 46361 and poly_CreateDate of October 9th, 2023.

- d. Select this record (row) by clicking the number 1 to the left side of the table. Your screen should look like the figure below.

	OBJECTID *	Shape *	poly_SourceOID	poly_IncidentName	poly_FeatureCategory	poly_MapMethod	poly_GISAcres	poly_CreateDate	poly_...
1	46	Polygon	46361	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89324.521233	09-Oct-23 01:05:27 AM	09-O...
2	47	Polygon	46361	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89324.521233	09-Oct-23 01:05:27 AM	13-O...
3	44	Polygon	45853	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89322.179915	07-Oct-23 12:01:36 AM	07-O...
4	45	Polygon	45853	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89322.179915	07-Oct-23 12:01:36 AM	07-O...
5	42	Polygon	45842	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89352.34406	06-Oct-23 01:10:12 AM	06-O...
6	43	Polygon	45842	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89352.34406	06-Oct-23 01:10:12 AM	06-O...
7	41	Polygon	45812	Kelly	Wildfire Daily Fire Peri...	Mixed Methods	89351.586255	04-Oct-23 01:52:18 AM	04-O...

CREATE A FINAL FIRE POLYGON

46. You may wish to create a new layer representing the final fire polygon from this selection. To do this:
 - a. Make sure the final fire polygon (or fire area of interest) has been selected as shown above.
 - b. Right-click the Fire polygon layer from the Contents pane.
 - c. Choose DATA---EXPORT FEATURES
 - d. Complete the dialog as shown below (NOTE: Feel free to use your own naming convention for the output layer name or the one I suggested).




- e. Click OK

47. Click the Save button in the upper-left corner of ArcGIS Pro.

48. Next, let's generate an Executive Summary Report for this fire. This report gives the population living within the Fire Impacted Area (based on 2020 Census data), a breakdown of surface management agency areas within the fire perimeter, the primary land cover type within the fire perimeter (based on LANDFIRE data), and a summary of various topographic characteristics. Using the RECOVER Data Package Toolbox this is very easy to do. To begin, use the Catalog pane in ArcGIS Pro and:

- a. Expand FOLDERS—FIRE_2023_CASRF_000939
- b. Locate and expand the RECOVERDataPackageTools toolbox

 RECOVERDataPackageTools.atbx

- c. Locate and double-click the Generate Fire Report tool.
- d. The only input needed to run this tool, is to identify the Fire folder. Use the browse button and select the FIRE_2023_CASRF_000939 folder.
- e. Click Run.

This process takes just a few minutes to complete and the results will be available through the Windows file manager.

49. To view the completed Executive Summary report for this fire, open the Windows file manager (HINT: You can do this easily by pressing the Windows Key+E on your keyboard).



- a. Using Windows File Manager, navigate to the FIRE_2023_CASRF_000939 folder (NOTE: In my example, this folder is located within my C:\Users\webekeit\Downloads\ folder).
- b. Locate and double-click the Fire_2023_CASRF_000939_Report.html file that was just created (HINT: Sort by Data Modified and this file will “float” to the top).
- c. Review this report and feel free to ask for any clarification on the report's information. Personally, I like to print this to a PDF document to make it even easier to use, share, and reference later.

As fire managers and emergency managers, let us know what other summary elements you would like to see in the report. For example, would a cross-tabulation of fire severity with slope classes, or soil types be beneficial as part of this summary report?

What is the Fire Impacted Area? In essence it is the spatial extent of all HUC level 12 watersheds that intersect the fire polygon/perimeter. It is actually a bit more complicated than that as the fire polygon is first buffered by one kilometer and then intersected with the USGS National Hydrography Dataset (NHD) watershed boundary dataset (WBD). The rectangular spatial envelope extent of the selected watershed polygons is set as the Fire Impacted Area.


EXPLORING SPATIAL DATA IN THE RECOVER DATA PACKAGE

50. Let's move on now and take a look at some of the other layers found in the RECOVER data package. From the Catalog pane in ArcGIS Pro, open the Folders section.
51. Next, expand the fire geodatabase (FIRE_2023_CASRF_000939.gdb). Many of the same layers you worked with in the dashboard and 3D viewer can be found in this geodatabase as well. Let me point out a few that may be of general interest and encourage you to explore and use each of these layers as needed to help you in your post-fire planning, management, and monitoring.
 - a. The Fires1950_Present layer is a polygon feature class showing where previous fires occurred within the fire impacted area. Right-click this layer and choose Add to Current Map.
 - b. You should see a number of fires previously burned in this same area such as the 1952 Windy fire as well as a more recent 2022 wildfire.
 - c. It is also interesting how the 2020 Slater fire and an unnamed 2002 fire⁵ acted as fire breaks along the northeast and northwest perimeter of the Kelly fire.
 - d. The Soils_gSSURGO layer (superseded in 2024 by an updated Soils_SSURGO layer) provides a lot of information including erosion ratings and hydrologic soil group (HSG). Add this layer to the map and symbolize it using HSG. To do this:
 - Right-click the layer from the Contents pane on the left side of the screen
 - Choose Symbology
 - Using the Symbology pane on the right side of the screen change the Primary Symbology setting to Unique Values
 - Set the Field 1 drop-down list to Hydrologic Soil Group
 - Apply a Color Scheme of your liking or accept the default
 - e. By using this simple data visualization technique, it should become obvious that the majority of these soils belong to Hydrologic Soil Group C. This should resonate well with the Executive Summary findings reported earlier.
 - f. Explore other vector (point, line, and polygon) layers contained in this geodatabase as you wish.
52. The RECOVER Data Package also includes a number of additional layer files prefixed by the word WEBSERVICE. These layer files connect to a streaming web service provided by NIFC, the USGS, and other agencies/organizations.

⁵ This unnamed fire is the Biscuit Fire, which along with the Rodeo-Chidiski fire in Arizona were among the largest fires in US history at the time.

- a. From the Catalog pane, locate and add the `WEBSERVICE_NHD_SurfaceWaterBodies.lyrx` to the current map.
- b. Take a look at the features provided through this service.
- c. Turn on the WBDHU12 layer
- d. Explore these data by clicking a watershed polygon to view its associated attributes in a pop-up window.

Let's continue with our data exploration now.

53. Return your attention to the Catalog pane. Here you will find a number of raster layers, 19 raster TIF GIS layers in fact with each indicated by the  icon (NOTE: the PNG files are the graphics used to create the Executive Summary report).

- a. Add the Landfire `BPS.tif` file to the map (HINT: right-click the layer from the Catalog pane and choose Add to Current Map).

NOTE: You may need to allow ArcGIS to build pyramids.

The symbology (colormap) for this LANDFIRE layer may not look correct, however we can fix that quite easily!


In addition to the vector and raster layers, each RECOVER data package provides you with a number of layer files (`*.lyrx` files).

- b. Locate the `BPS.lyrx` file and add it to the current map. Using the layer files will provide you with the same data but will automatically configure the symbology and pop-up displays for you.

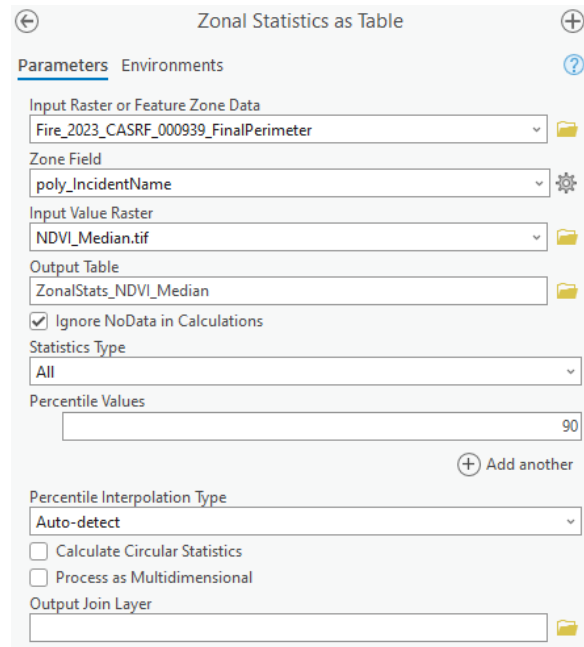
54. Beginning late in 2023, RECOVER began providing NDVI Baseline data for each wildfire. These data statistically describe a decade long record of plant photosynthetic activity and plant biomass production across the entire western United States. Because past disturbances will greatly influence the NDVI values for the disturbed area I recommend using the NDVI Median layer to help you understand past plant photosynthetic activity and biomass production and to compare or monitor current or future NDVI data for the burned area.

- a. Add the `NDVI_Median.tif` to the current map.
- b. If you are already familiar with NDVI you might have expected to see pixel values ranging between -1.0 and 1.0. However, these pixels have been scaled by a value of 10,000. If you wish, you can convert these using the TIMES geoprocessing tool and the value 0.0001. Otherwise, understand that high values (e.g., 5,051) indicate high photosynthetic activity and low values (e.g., -474) indicate the low photosynthetic activity or in some cases, no photosynthetic activity.

55. What is the range of median NDVI values within the fire perimeter? To determine this, we will use the Zonal Statistics as Table tool. To do this, open the Geoprocessing pane (HINT: If it is not already available along the right side of the screen, you can open it by clicking the View menu

and then click the Geoprocessing button  from the ribbon).

- a. Using the Geoprocessing pane's search text box, find and open the Zonal Statistics as Table tool.
- b. Complete the tool dialog as shown below.



c. Click Run

To learn more about the NASA RECOVER NDVI Baseline including additional powerful spatial analyses you can leverage with this huge multidimensional dataset, visit https://giscenter.isu.edu/research/Techpg/nasa_RECOVER2/NDVI_Baseline/index.htm


56. When finished the output table will be added to the bottom of the Contents pane. Locate it and open this table by right-clicking and choosing Open.
- a. This table provides a lot of quantitative *information* regarding the vegetation growing in this area prior to the wildfire. Coupled with the land cover *information* provided by the BPS (biophysical setting) and other Landfire layers, one can understand the landscape conditions before the fire occurred.
 - b. As current (and future) NDVI data becomes available, you can compare NDVI values to the long-term trend we are exploring now (HINT: Just remember to scale the new data by multiplying by 10,000).
 - c. The RECOVER team is working on a script that will automate the collection of NDVI data for you. We hope to make that available early in the summer of 2024.
 - d. Since much of the burned area was mixed conifer and evergreen forest we can expect recovery back to pre-fire conditions will take numerous years or even decades.
 - e. To prepare for the next part of the tutorial, you may wish to turn off all layers in the current map except the Fire Final perimeter layer.

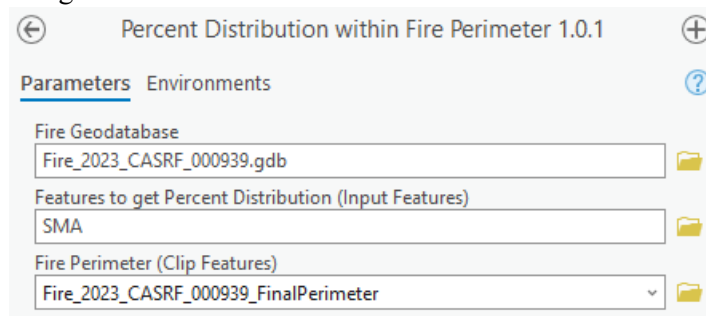
While there are many advanced spatial analyses you can perform with ArcGIS Pro, we will focus on just a few additional questions in this tutorial. Furthermore, understand that while the NASA RECOVER Post-wildfire DSS provides you with over two dozen Base Layers, you can add additional layers to this ArcGIS Pro project using data from your hard drive, network, or the internet. If you find you consistently need to add a specific layer to your ArcGIS Pro fire projects, that layer is probably a good candidate to become part of RECOVER's Base Layers. [Email us \(webekeit@isu.edu\)](mailto:webekeit@isu.edu) and let us know!

EXPRESSING DATA IN PERCENT AND ACRES

The first question we will answer is “how can I determine the number of acres of US Forest Service lands burned by this fire?”. Here is how we will do this:

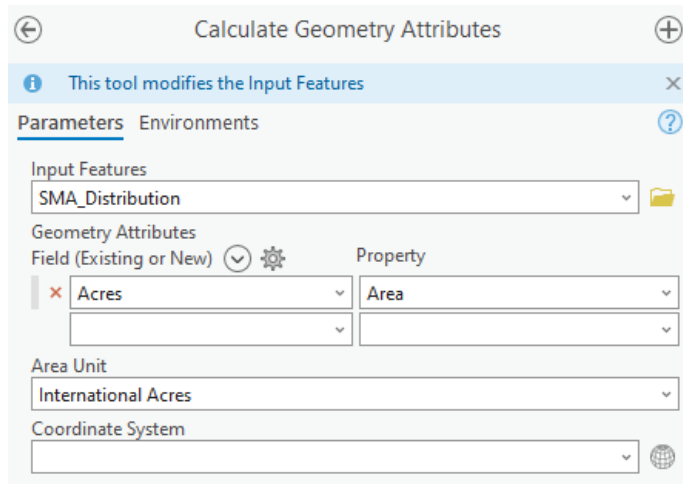
57. From the Catalog pane, add the SMA polygon layer to the map (HINT: it is stored in the GDB).
58. Select the SMA layer from the Contents pane on the left side of the screen.
 - a. Apply a symbology of your choice to help visualize land management in this area (HINT: Use the MGMT_AGENCY field).
59. Take a look at the map to get a feel for the surface management.
60. Next, let’s apply one of RECOVER’s tools to quickly answer our question.

- a. From the Catalog pane, expand the RECOVERDataPackageTools toolbox 
- b. Locate and open the Percent Distribution within Fire Perimeter tool
- c. Complete the dialog as shown below



- d. Click Run

61. Once completed a new layer will be automatically added to the map. Since we generated distributions from the SMA layer, the new layer is automatically named SMA_Distribution. You can use this same tool to generate distribution layers for other polygon feature class data (e.g., soils or geology layers) in the fire geodatabase as well.
 - a. Open the attribute table for the new SMA_Distribution layer.
 - b. The field on the right side of the tables gives you the percent distribution of SMA lands within the fire area (NOTE: there are three records describing USFS lands, totaling 95.5%).
62. We now know the percent of lands managed by each agency and we can see the area in the Shape_Area field, but we still do not know the number of acres of US Forest Service lands that were burned by this fire. Let’s tackle this part of the problem next.
63. From the Geoprocessing pane, open the Calculate Geometry Attributes tool
 - a. Complete this tool’s dialog as shown below (HINT: type Acres to create a new field)



b. Click Run

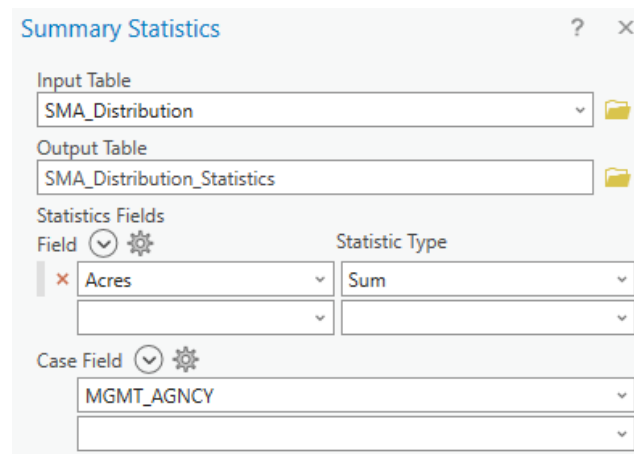
64. Refer back to the attribute table for the SMA_Distribution layer.

- a. You should see a new Acres field has been created for you. This is good data but still not quite the information we need to answer our question.
- b. To finalize the solution, we simply need to summarize these data by the MGMT_Agency field. To do this:

Right-click the MGMT_AGENCY field label/title

Choose Summarize

Complete the dialog as shown below. This tool will combine any records with the same case field value (our case field is the MGMT_AGENCY field) and then sum the number of acres.



Click OK to run this geoprocessing tool.

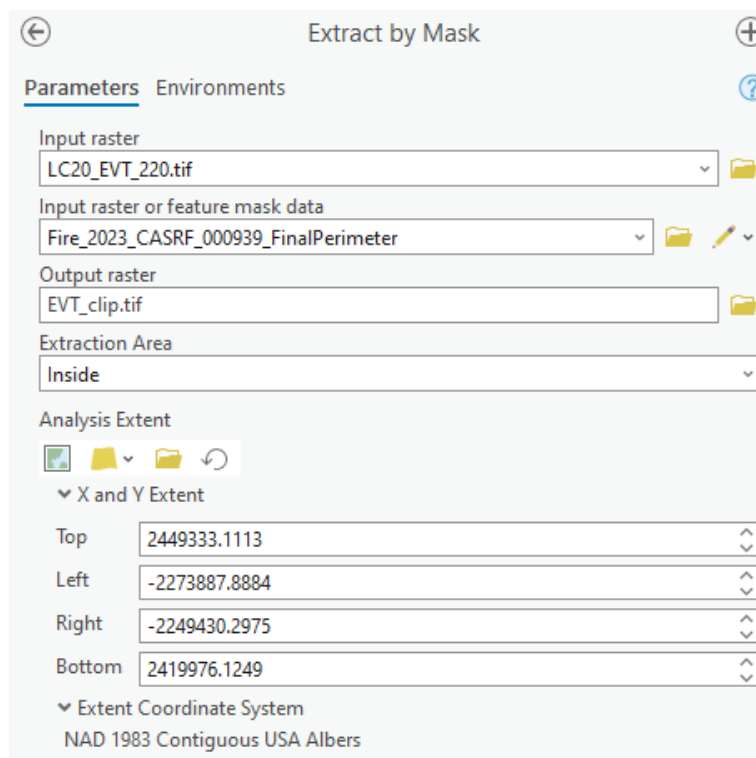
65. When you open the resulting table, you should see 85,294 acres of USFS managed lands were burned by the Kelly fire.

66. To prepare for the next part of the tutorial, you may wish to turn off all layers in the current map except the Fire Final perimeter layer.

WORKING WITH RASTER DATA (LANDFIRE, DNBR, AND OTHERS)

Let's continue now by exploring the vegetation type impacted by this fire using LANDFIRE's Existing Vegetation Type (EVT) data. Throughout this part of the tutorial we will create (write) various raster layers. It is a best practice to store all raster layer as TIF files. Further, do not write the output raster files within a geodatabase.

67. Add the `EVT_1yrX` layer to the map (NOTE: you may need to allow ArcGIS to calculate statistics or build pyramids, that is OK). Once again, we will use the zonal statistics tool to better understand pre-fire vegetation type.
 - a. From the Geoprocessing pane open the `Extract by Mask` tool
 - b. Complete this tool's dialog box as shown below.
 - c. Be sure to write the Output Raster Dataset to the fire folder, but not inside the project geodatabase.



- d. Click Run
68. In less than one minute the processing will complete and the output raster will be added to the Contents pane of the map.
 - a. The EVT layer contains categorical data and should have an attribute table just like the original layer
 - b. Open the attribute table (finally).
69. Which EVT Class (Value code) has the largest count value? (HINT: You can right-click the COUNT field and choose Sort Descending so the largest value appears first).
 - a. You should see the value code 7043 has the highest count of 222,439 (pixels).
 - b. The attribute table informs us the value code 7043 is Mediterranean California Mixed Evergreen Forest.

- c. Next, how many acres of Mediterranean California Mixed Evergreen Forest burned?

What we currently know is 222,439 pixels were burned. To understand this in a land management context we need to know real area such as acres or square miles as we cannot manage *pixels*!

- d. To determine the size of a pixel for any raster layer, right-click the layer and choose Properties (in this case, right-click the `EVT_Clipped` raster layer)
- e. From the left side of the Properties window, click Source
- f. From the right side of the Properties window, expand Raster Information by clicking it
- g. Make note of the Cell Size X and Cell Size Y values.

Raster pixels are always rectangular and typically square.

- h. Time to do a bit of math! Complete the worksheet below:

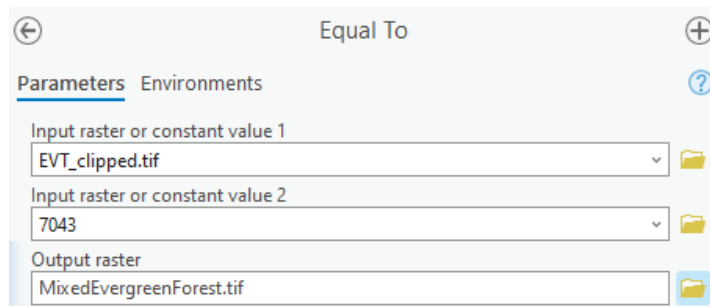
Line 1: Count of pixels = 222439
 Line 2: Size of pixel (m) = _____
 Line 3: Area of pixel (line 2 x line 2) = _____
 Line 4: Area of this cover type (line 1 x line 3) = _____
 Line 5: Acres of this cover type (line 4 / 4046.85642) = _____

- 70. Was this entire mixed evergreen forest actually destroyed by the fire? Perhaps not. What we know is approximately 50,000 acres of this land cover type existed inside the fire perimeter. Prior to a field visit, it might be wise to take a look at the preliminary fire severity layer (dNBR) (NOTE: if a final fire severity layer is available that is even better).

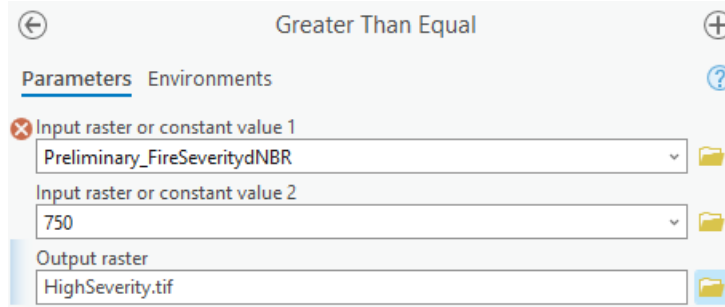
- a. From the Catalog pane, locate and add the `WEBSERVICE_PreliminaryFireSeverity` layer to the map (NOTE: To learn more about a layer, right-click it from the Contents pane and choose View Metadata).
- b. It may be helpful to identify areas of Mediterranean California Mixed Evergreen Forest (value 7043) with a high fire severity. Let's use the value 750 as our threshold for high severity. You can use a different value if your experience or field data supports that.


- 71. Let's complete this spatial analysis using a few geoprocessing tools.

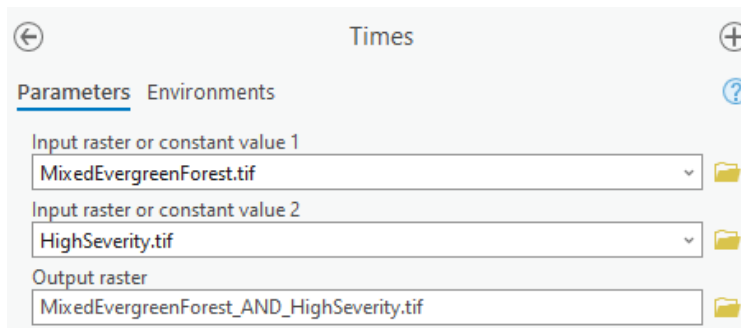
- a. We will isolate all Mediterranean California Mixed Evergreen Forests first. Open the `Equal To` tool in the Geoprocessing pane.
- b. Complete the input dialog as shown below and click Run (HINT: We need to use the numeric code 7043. Also, be sure to write the output file to the project folder and not within the geodatabase).



- c. Next let's identify all high severity fire pixels. Open the Greater Than Equal tool in the geoprocessing pane.
- d. Complete the input dialog as shown below (NOTE: We will fix the error shortly).



- e. Since this layer is a web service streaming into your computer it is quite large. To fix the input error identified by ArcGIS Pro, click the Environments tab near the top of this pane.
 - f. From the Processing Extent section, choose to process using the Extent as A Layer setting  (and choose the MixedEvergreenForest.tif layer we created just a moment ago). Similarly, you could choose the Current Display Extent or any other setting that simply reduces the amount of area analyzed by this tool⁶.
 - g. Return to the Parameters tab of the geoprocessing pane and the input raster error message should be gone. If not, feel free to ask for some help.
 - h. Click Run.
72. You will now have two Boolean layers in the Contents pane. The spatial union of all pixels with a value of one (1 = true) will identify areas of mixed evergreen forest AND high preliminary fire severity. Let's complete this step now.
- a. Open the Times geoprocessing tool.
 - b. Complete the tool dialog as shown below and click Run.



73. Explore these results.

There are additional analyses we could perform on these data (e.g., determine the number of acres of mixed evergreen forest identified as high severity fire) and some of these same steps were described earlier. In the time we have left in this workshop, let's move on to another topic: Long-term recovery and monitoring.

⁶ Different versions of ArcGIS Pro use different wording and icons for this setting. I am referring to version 3.2

LONG TERM RECOVERY AND MONITORING (Optional)

In this part of the tutorial we will again be using the NASA RECOVER NDVI Baseline⁷ data cube and its derived layers, some of which are part of the data package you already downloaded. We will compare the NDVI Baseline to current NDVI data to learn how this ecosystem has changed.

An additional tutorial is available describing use of the NDVI Baseline multidimensional mosaic dataset (i.e., data cube) and you are encouraged to learn how to apply this tool to your post-fire analysis and monitoring. That tutorial is available here:

https://giscenter.isu.edu/pdf/PDF_NASA_RECOVER2/TUTORIAL_UsingNDVIBaseline.pdf

In this workshop we will use the NDVI Baseline data provided in each fire's Data Package, and namely the NDVI Median layer.

74. The current map, named Data Exploration is getting pretty busy. Let's create a new map for our NDVI baseline work. To do this:

a. Click ArcGIS Pro's Insert menu

b. Click New Map 

c. Name the new map NDVI

75. Add the following layers to the NDVI map.

a. Fire_2023_CASRF_000939_FinalPerimeter

b. NDVI_Median.tif

c. Explore these data, understanding that the NDVI Baseline was created from many NDVI layers acquired between 2013 and 2022. We are using the median statistic from this data cube because median is not influenced by extremely high or low NDVI values which would have been introduced from a previous wildfire in this same area.

76. Save ArcGIS Pro.

77. Minimize ArcGIS Pro.

78. We are missing current NDVI data but never fear, we have already created a layer just for this tutorial. Download the RECOVER_Workshop.zip file using this link:

https://giscenter.isu.edu/research/Techpg/nasa_RECOVER2/zip/RECOVER_Workshop.zip

a. Using Windows File Manager, extract the downloaded zip file just like you did previously when working with the RECOVER Data Package.

b. The zip file contains just one layer named NDVI_post_KellyFire_20240224.tif

c. This TIF layer is comprised of five files. Each of them is named NDVI_post_KellyFire_20240224 but has a different extension. One has a TIF extension, another a TFW extension, etc.

d. Using Windows File Manager, locate and select all five of the files.

e. Copy and paste these files into your project folder (e.g., Fire_2023_CASRF_000939)

79. Return to ArcGIS Pro

⁷ To learn more about the NDVI Baseline you may want to read the whitepaper posted here https://giscenter.isu.edu/pdf/PDF_NASA_RECOVER2/RECOVER_NDVI_Baseline.pdf

80. From the Catalog pane, right-click the `Fire_2023_CASRF_000939` folder and choose Refresh.
- If the file copy process in the previous step completed correctly, you will now see the `NDVI_post_KellyFire_20240224.tif` layer in this folder.
 - Add the `NDVI_post_KellyFire_20240224.tif` layer to the NDVI map.
81. We will use the Zonal Statistics as Table geoprocessing tool to complete our analysis (NOTE: You completed a very similar process earlier in the exercise, but this time we are going to run the process in batch mode).
- From the Geoprocessing pane, search for the Zonal Statistics as Table.
 - Don't click it right away.
 - This time, we are going to run this tool in batch mode.
 - Right-click the Zonal Statistics as Table tool and choose Batch.
 - From the Choose a batch parameter setting, select Input Value Raster (NOTE: We will be using one input feature zone layer, the fire polygon and generating statistics from two input value raster layers, NDVI from the baseline data cube as well as current NDVI values).
 - Click Next.
 - Complete the dialog pane as shown below (NOTE: Notice the `%Name%` that is part of the Output Table name. This acts as a variable and will substitute the name of the raster layer into the name of output table as each layer is processed. One table will be named `ZonalStatistics_NDVI_Median.tif` and the other will be named `ZonalStatistics_NDVI_post_KellyFire_20240224`. Both will be written into the project geodatabase. Pretty cool eh?)

Batch Zonal Statistics as Table

Parameters Environments

Input Raster or Feature Zone Data
Fire_2023_CASRF_000939_FinalPerimeter

Zone Field
poly_IncidentName

Batch Input Value Raster

- NDVI_Median.tif
- NDVI_post_KellyFire_20240224.tif

Output Table
ZonalStatistics_%Name%

Ignore NoData in Calculations

Statistics Type
All

Process as Multidimensional

Percentile Values
90

Percentile Interpolation Type
Auto-detect

Calculate Circular Statistics

Circular Wrap Value
360

Output Join Layer

- h. Click Run
82. Once completed, open the resulting tables and compare the long-term median NDVI to the NDVI for the same area.
- a. As expected both the mean and median for the current NDVI is lower than the long-term NDVI values. This is expected as this particular fire burned just a number of months prior to the collection of the Landsat imagery used to calculate the NDVI_post_KellyFire layer.
 - b. Notice also, the mean and median for the post-fire NDVI is quite different and the standard deviation of NDVI values is very large in comparison to the long-term NDVI data. This also is expected in a post-fire scenario and it tells us there is a high degree of variability in vegetation response following the fire (statistically, these data do not follow a normal distribution). By looking at these data I suspect there are islands of unburned vegetation with the fire perimeter. This agrees well with the variability in preliminary dNBR we looked at earlier.
 - c. If you would like to discuss your interpretation of these data or any of the other data we have worked on in this tutorial, please be sure to bring this up during the QA session of your hands-on workshop or send an email to the RECOVER team using webekeit@isu.edu

There are many spatial analysis capabilities enabled by the data provided in the RECOVER data package and even more capabilities when one accesses other sources of data to understand the effects of the wildfire and potential post-fire effects. In addition, these spatial data enable you to improve rehabilitation plans and provide the basis for long-term, post-fire monitoring of the burned landscape.

I hope you enjoyed this workshop and exercise. If you have questions (now or in the future), please let the RECOVER Team know by emailing me at webekeit@isu.edu. Thank you.

END