Developing Pre-Planned Response Zones and Fire Danger Rating Areas

1. INTRODUCTION

A. Pre-Planned Response Zones

Pre-planned response zones are delineated geographic areas within the overall planning area/dispatch zone. These pre-planned zones are developed to support local-level Initial Pre-planned Response Plans, also referred to as "Run Cards". The pre-planned response specifies the fire management response (e.g., number and type of suppression assets to dispatch) within the defined geographic area to an unplanned ignition, based on fire weather, fuel conditions, fire management objectives, and resource availability.

[**NOTE:** ***It is important to develop response zones prior to the creation of Fire Danger Rating Areas (FDRAs).***]

B. Fire Danger Rating Areas

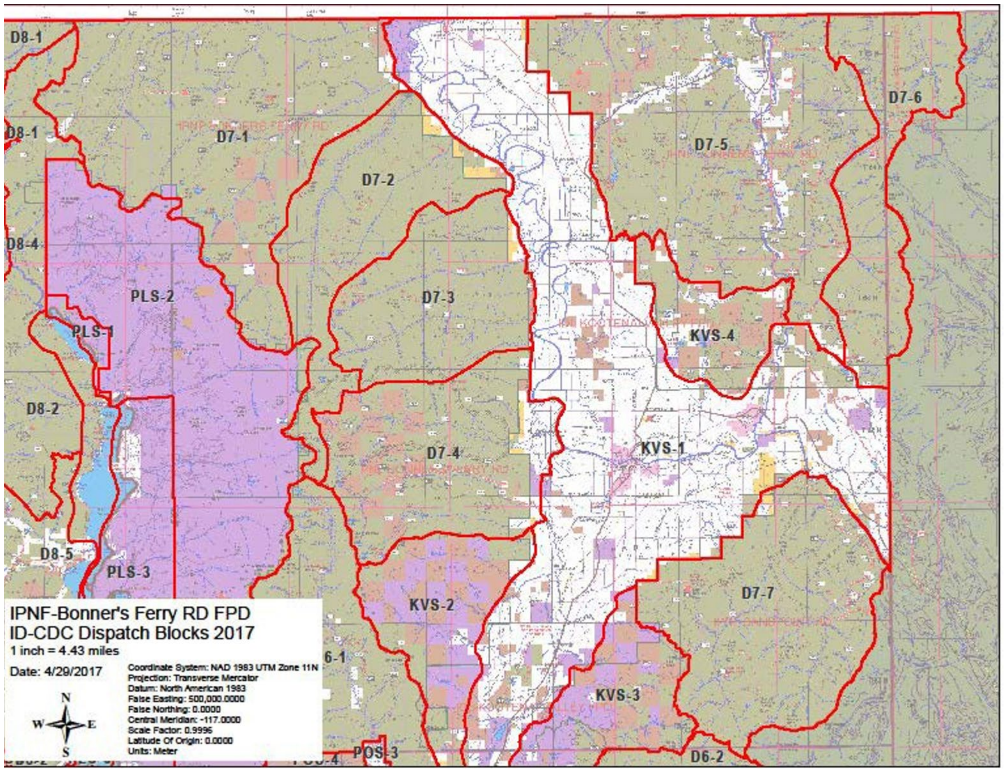
Before National Fire Danger Rating System (NFDRS) fire danger rating outputs can be applied, the concept of a Fire Danger Rating Area needs to be understood. A Fire Danger Rating Area (FDRA) is best described as the classification of a geographic area relatively homogenous in *climate*, *vegetation* and *topography*. It can be assumed that the fire danger within these regions, within the planning area is relatively uniform.

FDRAs are the smallest spatial measure used to translate NFDRS outputs from a point source (such as a weather station observation) to a spatial area that can be used for operational and planning purposes. FDRAs are areas of 'uniform fire danger', they are the *footprint* of NFDRS on the ground.

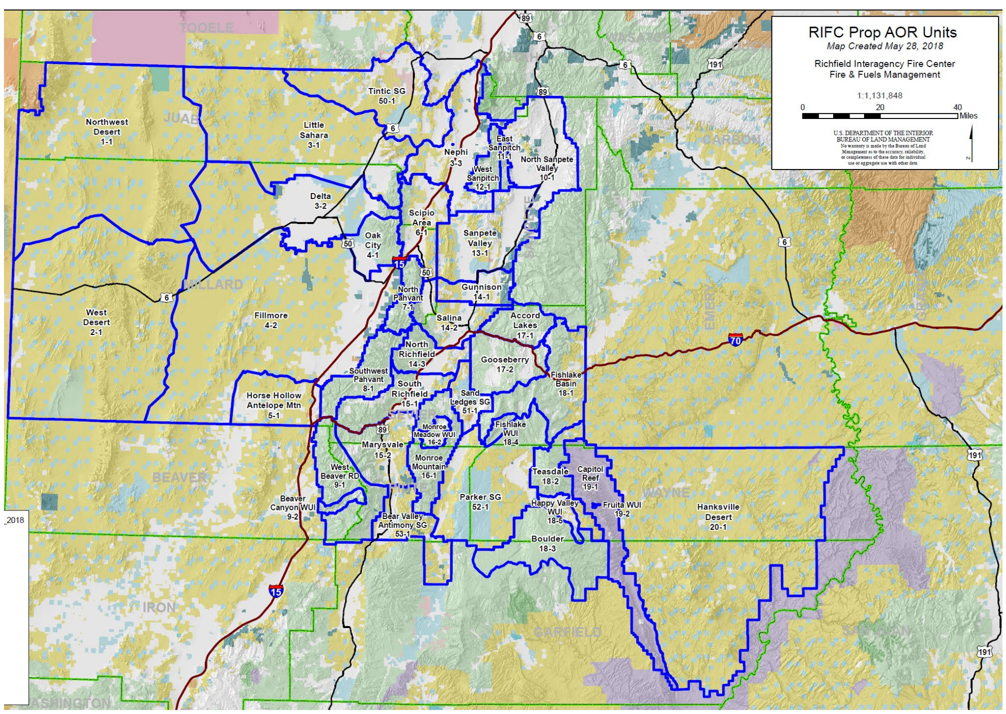
C. Developing Preplanned Response Zones

1. Response Zones

Response zones may be based on various criteria such as: common management objectives, land use, fire load, dispatch locations, estimated response times, WUI locations, topographical features, vegetation communities, jurisdictional boundaries, roads, etc. (Examples 1 & 2). It is important to include dispatch personnel in the working group when developing pre-planned response zones for the planning area. Assistance from a GIS Specialist (GISS) is also highly recommended. The GISS can be very helpful, save time, and properly format the Response Zone layers in ArcMap.



Example 1. Pre-planned dispatch zones for the Idaho Panhandle NF, Bonner's Ferry Ranger District.



Example 2. Pre-planned dispatch zones for the Richfield Dispatch Center.

2. Potential Operational Delineations (PODs)

Potential wildland fire operations delineations (PODs) are polygons whose boundary features are relevant to fire control operations (e.g., roads, ridgetops, and water bodies). PODs are created by local fire experts with the help of analytical tools that highlight landscape features with control potential and provide information on their likely effectiveness. PODs are useful for summarizing wildfire risk and planning strategic response to unplanned ignitions accordingly. In an operational response context, POD boundaries can be used to guide and communicate choices of where to construct or hold fire line as well as where to conduct burnout operations. PODs may also prove useful for strategic fuels planning, with potential applications for designing controlled burn units, reinforcing existing POD boundaries, or prioritizing treatment opportunities within PODs. Vetting and mapping POD boundaries essentially formalizes and institutionalizes the knowledge of fire management experts. The basic idea of delineating "boxes" within which to manage fire has long been around; the POD concept uses risk-based analytics, ground-truthing, and expert consensus to take that concept much farther, and moves it into the pre-fire planning world to buy more time.

PODs are delineated in a GIS platform by digitizing existing landscape features that could be used operationally to control a fire. By connecting roads, trails, drainages, fuel treatments, and other features, polygons can be created to depict a user-defined box for containing a wildfire. Additionally, the Rocky Mountain Research Station (USFS) has developed several analytical tools to help evaluate landscape conditions, determine areas of high suppression difficulty, and identify potential control locations. For additional information, visit https://www.fs.fed.us/rmrs/projects/facilitating-pre-season-planning-identify-control-opportunities-and-high-priority-areas

Improved Situational Awareness

- PODs can incorporate other information, such as values at risk, topography and vegetation.
- The process incorporates these data into models that then help stakeholders understand the difficulty of suppression, the likelihood of a given control line's effectiveness, and the ecological effects fire could have under a range of conditions.
- Combining information on one map allows stakeholders to better understand potential risks and benefits and to develop fire management strategies.
- This process frontloads much of the planning associated with wildfire response, control features and wildfire behavior.

Heightened Communication, Stronger Relationships

- Because these maps are developed collaboratively, they also help improve relationships and stakeholder buy-in.
- This process results in improved communication among resource specialists, line officers and the public.
- This effort serves to empower firefighters to make decisions that not only encourage safe and effective fire response but also promote ecosystem health.
- Because the maps are developed collaboratively and utilize detailed risk assessments, local firefighters know they are making smart decisions and that their actions will be supported by the line officers, agency administrators and communities.

D. Developing Fire Danger Rating Areas

The purpose of classification is to organize a set of data or information about something to effectively communicate it in an informative way. The process of classifying FDRAs within a planning area (i.e. dispatch zone), users must be able to classify geographic areas with respect to three basic criteria: climate, topography, and vegetation. This classification process will be performed by evaluating the three fundamental standards exclusive of each other. In other words, a classification of *topography* should be independent of climate and vegetation; a classification of *vegetation* should be independent of climate and topography; a classification of *climate* should be independent of topography and vegetation.

3. Climate Classification

When considering the Earth's climate, there is such an enormous amount of information that one has to break it down into areas of commonality to easily understand it. Climatologists have therefore created several ways to organize the wealth of information about Earth's climate to bring order and understanding to it. The fire climate region is a large geographical division within which the character of the fire season is relatively uniform. Several methods and sources of information pertaining to the fire climate have been published:

A. **Thornthwaite**. The Thornthwaite climate classification method monitors the soil water budget using the concept of evapotranspiration. It monitors the portion of total precipitation used to nourish vegetation over a certain area. It uses indices such as a humidity index and an aridity index to determine an area's moisture regime based upon its average temperature, average rainfall, and average vegetation type. The lower the value of the index is any given area, the drier the area is.

B. **Koeppen**. The Koeppen system is one of the most widely used systems for classifying climate because it is easy to use and data requirements are minimal. The Koeppen Climate Classification grid coverages were produced using gridded estimates of precipitation, temperature, and elevation from the PRISM model. http://snow.ag.uidaho.edu/Clim_Map/koppen_usa_map.htm

C. **Gridded Climate Information – PRISM** (**P**arameter-elevation **R**egressions on **I**ndependent **S**lopes **M**odel) is a system that incorporates point weather data, digital elevation models, and expert knowledge of complex climatic extremes, including rain shadows, coastal effects, and temperature inversions. http://prism.oregonstate.edu/

D. **Fosberg and Furman** (1-hour timelag fuel moisture isopleths).

E. **Trigg** (variation of Thornthwaite): Calculated values of precipitation effectiveness index and temperature efficiency index for 48 weather observation stations on the Alaska mainland are used to delineate areas that have different climatic sub-classifications during the wildfire season. http://www.treesearch.fs.fed.us/pubs/25487

4. Vegetation Classification

It may be helpful to think in terms of the four main vegetation types used in NFDRS. These are grass, brush, timber, and slash.

A. **Ecoregions** are areas with generally similar ecosystems and with similar types, qualities, and quantities of environmental resources. Ecoregion boundaries were determined by examining patterns of vegetation, animal life, geology, soils, water quality, climate, and human land use, as well as other living and non-living ecosystem components. http://nationalatlas.gov/atlasftp.html#ecoregp

1. **Baily's Ecoregions**. Bailey's ecoregions distinguish areas that share common climatic and vegetation characteristics. A four-level hierarchy is used to differentiate the ecoregions, with the broadest classification being the domain.

2. **Omernik Ecoregions.** The Omernik ecoregion system is hierarchical and considers the spatial patterns of both the living and non-living components of the region, such as geology, physiography, vegetation, climate, soils, land use, wildlife, water quality, and hydrology.

B. **Kuchler's Potential Natural Vegetation (PNV).** PNV is the "climax" vegetation that will occupy a site without disturbance or climatic change. PNV is an expression of environmental factors such as topography, soils and climate across an area. Where cover type is a classification of existing vegetation, PNV is a site classification based on climax vegetation. Because the existing cover type at any particular location and time may reflect a vegetation community anywhere along its successional pathway - from seral to climax - the cover type may be the same as the PNV. http://www.fs.fed.us/fire/fuelman/pnv.htm

C. **Gap Analysis Program (GAP) Vegetation.** National landcover data derived from satellite imagery using the USGS Gap Analysis Program (GAP) is available for vegetation. The purpose of the GAP is to provide broad geographic information on the status of vertebrate species and their habitats to land managers, planners, scientists, and policymakers so they can make better-informed decisions. The GAP uses a scientific strategy referred to as "gap analysis" for identifying the extent to which native animal species and natural communities are protected. Information about this program can be viewed at: http://gapanalysis.nbii.gov/

D. **LANDFIRE.** LANDFIRE data products include layers of vegetation composition and structure, surface and canopy fuel characteristics, and historical fire regimes. LANDFIRE National methodologies are science-based and include extensive field- referenced data. Information about LANDFIRE can be found at: http://www.landfire.gov/index.php

5. Topographic Classification

For topography, a shaded relief map may work best. However, topographic maps with USGS data will also work. Separate a relief map into "areas" with similar terrain, such as extremely mountainous areas and large valleys and plateaus.

A. **Digital Line Graph (DLG)**. DLGs are digital versions of paper topographic maps. The

a. U.S. Geological Survey's (USGS) digital line graph (DLG) files are digital vector representations of cartographic information. (http://eros.usgs.gov/guides/dlg.html)

B. **Digital Orthophoto Quadrangle (DOQ).** DOQs are aerial photographs that can be used like a map. An orthophoto may serve as a base map onto which other map information may be overlain. (http://online.wr.usgs.gov/ngpo/doq/)

C. **Digital Elevation Model (DEM**). A digital elevation model is a digital representation of ground surface topography or terrain. It is also widely known as a digital terrain model (DTM). A DEM can be represented as a raster (a grid of squares) or as a triangular irregular network. DEMs are commonly built using remote sensing techniques; however, they may also be built from land surveying. DEMs are used often in geographic information systems, and are the most common basis for digitally-produced relief maps. http://data.geocomm.com/dem/demdownload.html

D. **National Elevation Dataset (NED).** The National Elevation Dataset (NED) is a relatively new raster product assembled by the U.S. Geological Survey. NED is designed to provide National elevation data in a seamless form with a consistent datum, elevation unit, and projection. Older DEM's produced by methods that are now obsolete have been filtered during the NED assembly process to minimize artifacts that are commonly found in data produced by these methods. Artifact removal greatly improves the quality of the slope, shaded-relief, and synthetic drainage information that can be derived from the elevation data.. (http://ned.usgs.gov/)

E. **Digital Raster Graphic (DRG).** A digital raster graphic (DRG) is a scanned image of a U.S. Geological Survey (USGS) standard series topographic map, including all map collar information. The image inside the map neatline is georeferenced to the surface of the earth and fit to the Universal Transverse Mercator projection. (http://statgraph.cr.usgs.gov/viewer.htm).

6. Developing Fire Danger Rating Areas (FDRAs)

The delineation of Fire Danger Rating Areas involves a comprehensive evaluation of climate, topography, and vegetation within the specific project area. Since a FDRA must be relatively homogenous with respect to these three elements, GIS becomes an invaluable tool for making decisions and documenting rationale when delineating Fire Danger Rating Area boundaries.

A. Interagency coordination is essential during the development of FDRAs. Fire danger does not change with respect to administrative/political boundaries. Therefore, all affected agencies should be involved with decisions regarding FDRA boundaries.

B. Vegetation, topography and weather/climate designate the fire environment that is being classified within the fire danger rating area. Political boundaries (including fire weather forecast zones, county boundaries, land ownership, etc.) should not influence the development of the fire danger rating area.

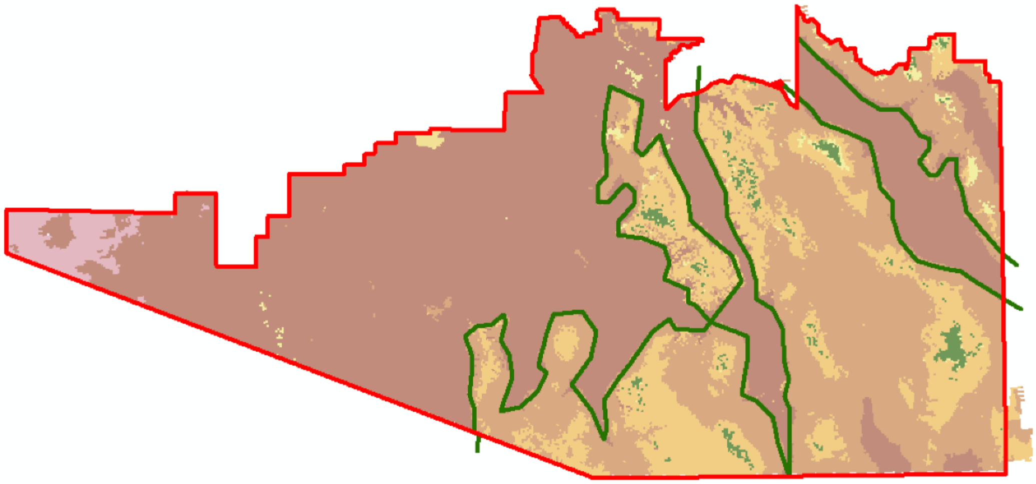
C. Edge-match FDRAs to response (dispatch) zone boundaries as a final step in the delineation process. Ensure that response zones are not split by FDRA boundaries.

The development of FDRA layers can be accomplished using ArcMap or ArcGIS On Line (AGOL). The AGOL process is described in a separate technical note. For this example, the user will utilize three GIS layers in ArcMap (Vegetation, Climate, and Topography) to help define the new Fire Danger Rating Areas (FDRA) layer.

It is important to understand that this is a subjective process. This subjective process works best in a group/team setting. Assistance from a GIS Specialist (GISS) is also highly recommended. The GISS can be very helpful, save time, and properly format the FDRA layers in ArcMap.

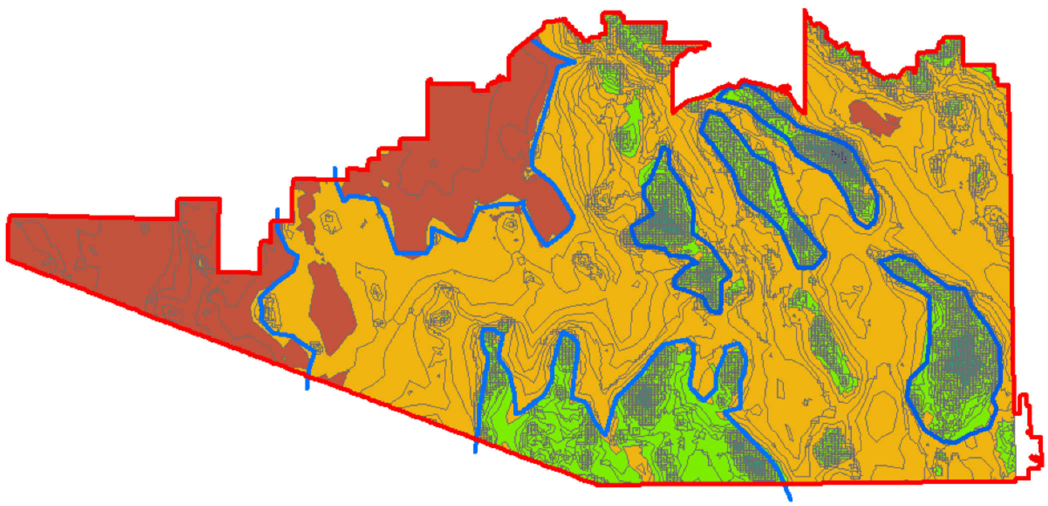
The following examples are intended to illustrate the FDRA development process and will assume that a GISS is available to assist. The examples display the following:

1. Using the Potential Natural Vegetation (PNV) layer, Example 3 illustrates potential delineations of homogenous areas of vegetation. There are additional vegetation layers available to assist with this process. Work with the GISS to evaluate which vegetation layer works best. To reiterate, this is a subjective process and does not have a “correct” or “incorrect” way of delineating areas. Users should work with their GISS to assist with creating a properly formatted vegetation feature class in ArcMap.



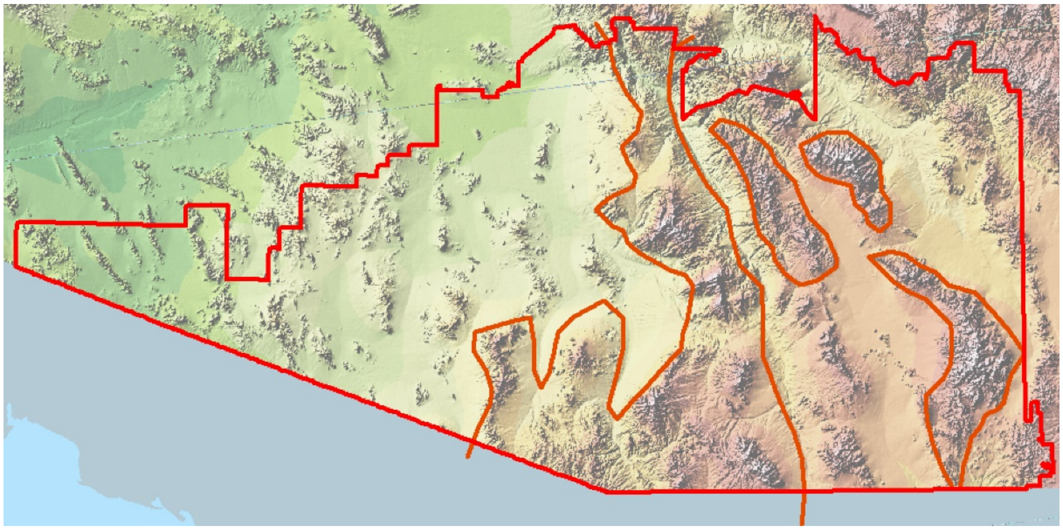
Example 3. Potential vegetation delineations using the Potential Natural Vegetation layer in ArcMap.

2. Using the Thornthwaite Climate Classification Zones layer, Example 4 illustrates potential delineations of homogenous areas of climate. There are additional climate layers available to assist with this process. Work with the GISS to evaluate which climate layer works best for this process.



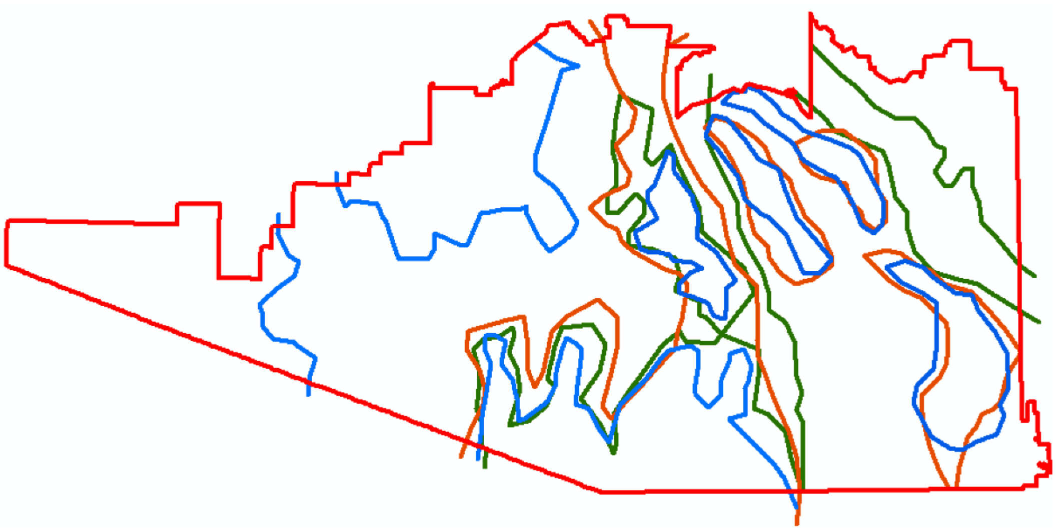
Example 4. Potential climatic delineations using the Thornthwaite Climate Classification Zones layer in ArcMap.

3. Using a color relief map layer, this example illustrates potential delineations of homogenous areas of topography. There are additional topographic layers available to assist with this process. Work with the GISS to evaluate which topographic layer works best for this process.

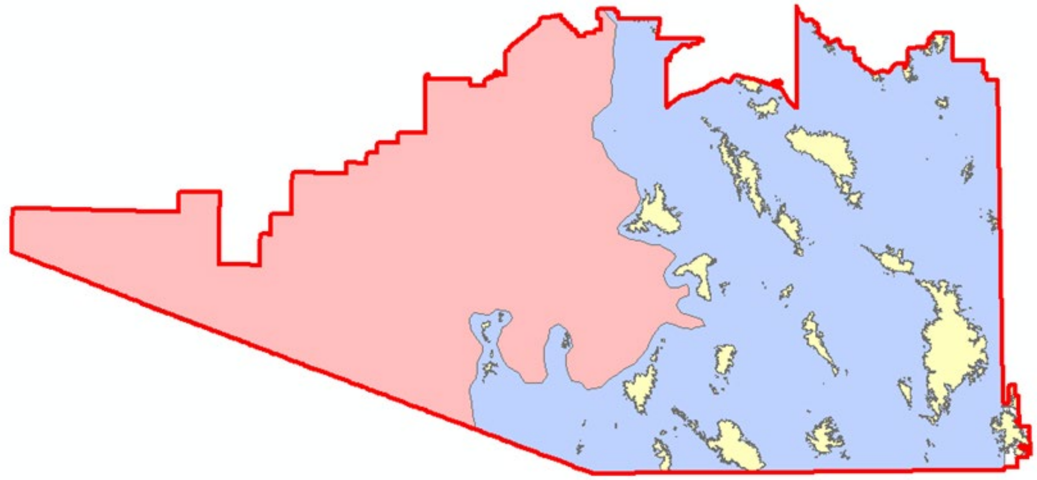


Example 5. Potential topographic delineations using a topographic color relief layer in ArcMap.

4. The size of the delineated FDRA should be based on the degree that fire managers would be willing to make different fire management decisions to the delineated area, and to the degree that fire would be affected by the change in the fire environment.
5. Throughout the process, users need to document the rationale for the delineated areas of vegetation, climate, and topography of the analysis area. This information will be included in the Fire Danger Operating Plan (FDOP) Template.
6. Using the three layers (Vegetation, Climate, and Topography) developed earlier (Example 6), work as a group with the GISS, develop new polygon layers as needed to represent the potential FDRAs for the study area. Turn layers on and off to help determine where the line(s) should be. Discuss within the group how each Fire Danger Rating Area should be defined spatially and why (Example 7). Document the rationale and include this information in the Fire Danger Operating Plan (FDOP) template.

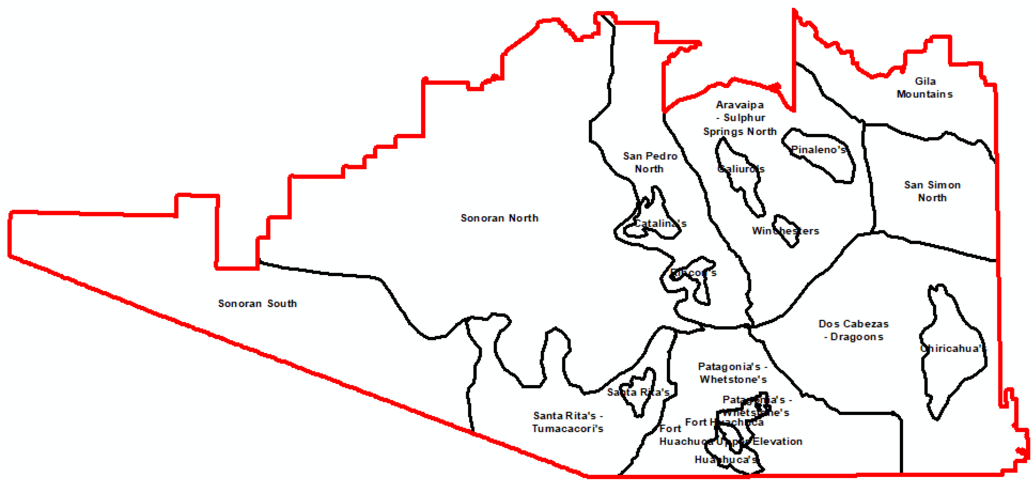


Example 6. Vegetation (green), climate (blue), and topographic (brown) delineations. Work as a group to determine potential FDRAs within the planning area.

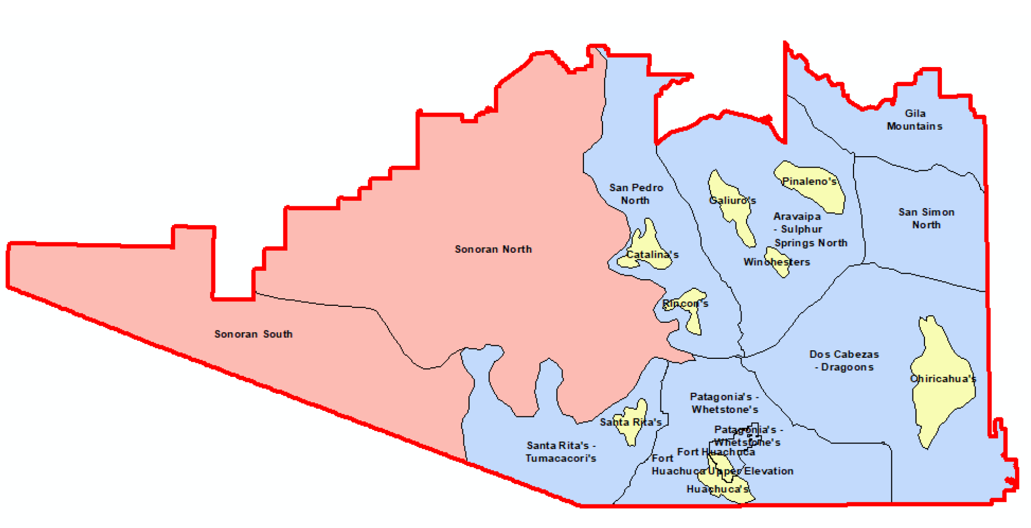


Example 7. FDRA boundaries before edge-matching with pre-planned response zones.

7. At this point, FDRA's need to be edge-matched with the pre-planned response zones (Example 8). Note that *response zones cannot be located in more than one FDRA*. Work with the GISS to ensure that response zones do not overlap into more than one FDRA. Discuss within the group which pre-planned response zones should reside within each respective FDRA (Example 9).



Example 8. Pre-planned response zones layer. FDRA's need to be edge-matched with the pre-planned response zones.



Example 9. Final FDRA boundaries after edge-matching with pre-planned response zones.

Work with the GISS to ensure that the FDRA column in the ArcMap attribute table is correctly populated. Each FDRA needs to have a unique number (i.e. 1, 2, 3) assigned in each row or record . Also, assign a name for each FDRA (Example 10). This information will be used when the FireFamilyPlus database is created for the planning area (see Creating a Custom Agency in FireFamilyPlus technical note).

Table

SEZ_All-FDRAs_040319

FID	Shape *	ID	GRIDCODE	Acres	Shape_Leng	Shape_Area	FDRA	ZONEID	ZONENAME	Perimeter
0	Polygon	1	2	941980	5258344.22967	3812058968.81	3 Forest/Woodland FDRA	0	SEZ	3267.377088
1	Polygon	0	0	8109867	6202863.97198	32835307787.299999	2 Desert Grasslands FDRA	15	SEZ	3853.212293
2	Polygon	0	0	6378862	1193246.57949	25824805177.299999	1 Sonoran FDRA	14	SEZ	741.815636

1 (0 out of 3 Selected)

SEZ_All-FDRAs_040319

Example 10. FDRA layer attribute table. Each FDRA is assigned a unique number and name/descriptor.