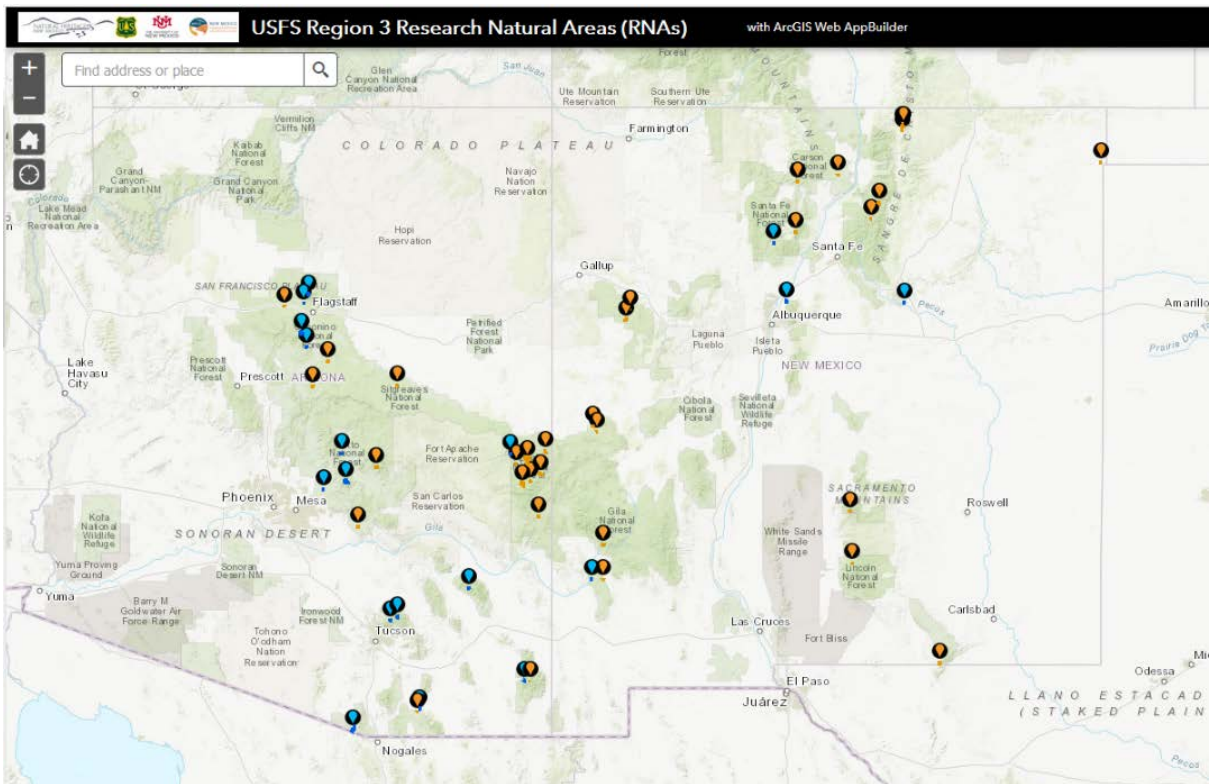


Using Research Natural Areas to Assess and Monitor Effects of Climate Change on Ecosystems in the Southwest

The RNA Climate-Change Monitoring Network Database



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Using Research Natural Areas to Assess and Monitor Effects of Climate Change on Ecosystems in the Southwest: *the RNA Climate-Change Monitoring Network Database*¹

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Introduction

Research Natural Areas (RNAs) of the US Forest Service (USFS) can play an important role in understanding and monitoring alterations in ecosystem conditions due to climate change (Massie et al. 2016; Solomon et al. 2009; USDA Forest Service 1992). That is, given that RNAs by design exclude the interacting effects of grazing, woodcutting, and other human activities, they can provide long-term and reliable reference points for detecting ecosystem change against the backdrop of climate and other environmental factors. In addition, with sufficient numbers, RNAs can be organized into a network of monitoring sites distributed across a broad array of ecosystem types and geographies, and particularly sensitive to climate change. A first step towards building such a network in the USFS Southwest Region (Region 3) was to locate and collect all available historic data taken on RNAs that could provide a baseline for comparison with current and future ecological measurements. Accordingly, Natural Heritage New Mexico (NHNM) worked with the Region 3 RNA coordinators to locate all known files and photographs on 51 RNAs in the region (Figure 1). We then created a database and digital archive of those materials, and developed an online GIS viewer to make the materials available to the USFS and the public to support the research in ecosystem change in RNAs. We report here on the database content and structure and provide a webpage with instructions on accessing the data through an online spatial GIS viewer.

Study area

The study area covers USFS Region 3 lands in Arizona and New Mexico (see Figure 1). Within this domain, there are 51 RNAs among 11 national forests (Table 1 & 2). Of these, 18 were statutorily established with completed establishment records and designation orders as indicated in the Region 3 Research Natural Areas Assessment (Periman et al. 2009) spatial geodatabase.² The remaining 33 are provisional RNAs that either had establishment records without signed designation orders, or were identified for consideration in forest management plans or other USFS documentation. Regardless of status, each has strict covenants on their management as natural areas specified in the establishment record or forest management plans and associated environmental assessments (i.e., the prevention of any activities that may impinge on natural processes and patterns).

¹ NHNM Tech. Rpt. 418 Submitted in partial fulfillment of Joint Venture Agreement # 14-JV-11221632-045 between the University of New Mexico and the USDA, Forest Service, Rocky Mountain Research Station.

² Periman, R., and K. Hawkos. 2008. Region 3 research natural areas assessment [geodatabase]. USDA Forest Service 1:24,000 map available on file. Regional Office, Albuquerque NM.

Southwest Research Natural Areas (RNAs)

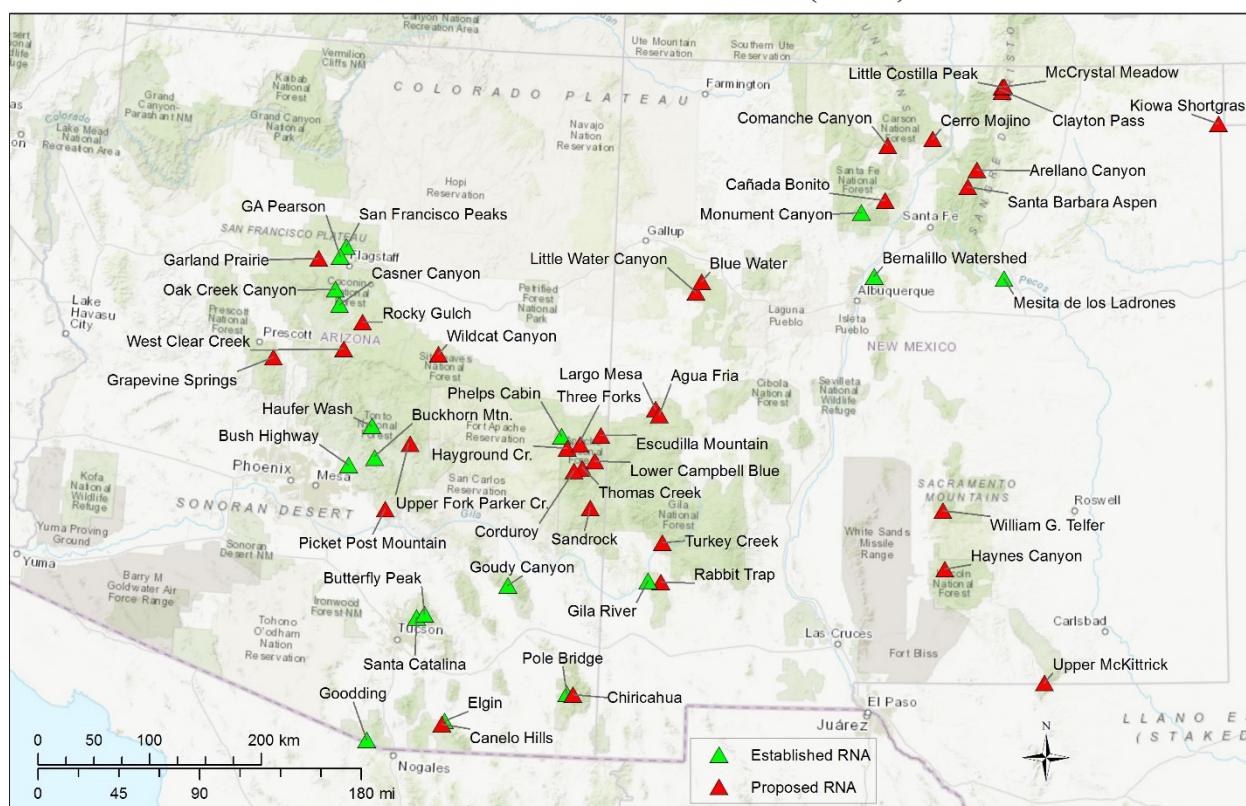


Figure 1. Distribution of Research Natural Areas (RNAs) in the southwest US (USFS Region 3). Green triangles are statutorily designated as established; red triangles are proposed for establishment.

Table 1. Established Research Natural Areas in USFS Southwest Region. Date refers to the establishment date.

RNA Name	AREA (ac)	STATE	FOREST	RANGER DISTRICT	DATE
Bernalillo Watershed RNA	1036	NM	Cibola	Sandia	1997
Buckhorn Mountain RNA	2800	AZ	Tonto	Tonto Basin	1988
Bush Highway RNA	516	AZ	Tonto	Mesa	1973
Butterfly Peak RNA	1058	AZ	Coronado	Palisade	1935
Casner Canyon RNA	610	AZ	Coconino	Red Rock	1973
Elgin RNA	645	AZ	Coronado	Patagonia	1974
G A Pearson RNA	150	AZ	Coconino	Peaks	1950
Gila River RNA	394	NM	Gila	Silver City	1972
Goodding RNA	2207	AZ	Coronado	Nogales	1970
Goudy Canyon RNA	548	AZ	Coronado	Mt. Graham	1973
Haufer Wash RNA	751	AZ	Tonto	Tonto Basin	1988
Mesita de los Ladrones RNA	705	NM	Santa Fe	Las Vegas	1991
Monument Canyon RNA	604	NM	Santa Fe	Jemez	1932
Oak Creek Canyon RNA	1853	AZ	Coconino	Peaks	1931
Phelps Cabin RNA	286	AZ	Apache-Sitgreaves	Springerville	1970
Pole Bridge RNA	582	AZ	Coronado	Douglas	1931
San Francisco Peaks RNA	1200	AZ	Coconino	Peaks	1931
Santa Catalina RNA	880	AZ	Coronado	Santa Catalina	1927

Table 2. Proposed Research Natural Areas in USFS Southwest Region. Date refers to the proposed date.

RNA Name	AREA (ac)	STATE	FOREST	RANGER DISTRICT	DATE
Agua Fria RNA	175	NM	Gila	Quemado	1982
Arellano Canyon RNA	965	NM	Carson	Camino Real	1987
Bluewater RNA	200	NM	Cibola	Mt. Taylor	1982
Canada Bonito RNA	824	NM	Santa Fe	Espanola	1988
Canelo Hills RNA	387	AZ	Coronado	Sierra Vista	1988
Cerro Mojino RNA	504	NM	Carson	Tres Piedras	1982
Chiricahua RNA	303	AZ	Coronado	Douglas	1971
Clayton Pass RNA	318	NM	Carson	Questa	1987
Comanche Canyon RNA	574	NM	Carson	El Rito	1992
Corduroy RNA	3311	AZ	Apache-Sitgreaves	Alpine	2014
Escudilla Mountain RNA	962	AZ	Apache-Sitgreaves	Alpine	1987
Garland Prairie RNA	373	AZ	Kaibab	Chalender	1983
Hayground Creek RNA	331	AZ	Apache-Sitgreaves	Springerville	1988
Haynes Canyon RNA	600	NM	Lincoln	Cloudcroft	1987
Kiowa Shortgrass RNA	317	NM	Cibola	Kiowa/Rita Blanca NGs	1992
Largo Mesa RNA	213	NM	Gila	Quemado	1988
Little Costilla Peak RNA	601	NM	Carson	Questa	1998
Little Water Canyon RNA	1093	NM	Cibola	Mt Taylor	1993
Lower Campbell Blue RNA	579	AZ	Apache-Sitgreaves	Alpine	2014
McCrystal Meadow RNA	212	NM	Carson	Questa	1987
Picketpost Mountain RNA	1294	AZ	Tonto	Globe	1988
Rabbit Trap RNA	306	NM	Gila	Silver City	1993
Rocky Gulch RNA	926	AZ	Coconino	Mogollon Rim	1987
Sandrocks RNA	525	AZ	Apache-Sitgreaves	Clifton	2014
Santa Barbara Aspen RNA	551	NM	Carson	Camino Real	1972
Thomas Creek RNA	499	AZ	Apache-Sitgreaves	Alpine	1988
Three Forks RNA	2901	AZ	Apache-Sitgreaves	Alpine	2014
Turkey Creek RNA	1242	NM	Gila	Wilderness	1993
Upper Fork Parker Creek RNA	1330	AZ	Tonto	Pleasant Valley	1988
Upper McKittrick RNA	794	NM	Lincoln	Guadalupe	1992
West Clear Creek RNA	769	AZ	Coconino	Red Rock	NA
Wildcat Canyon RNA	526	AZ	Apache-Sitgreaves	Black Mesa	1987
William G. Telfer RNA	645	NM	Lincoln	Reggie CD	1982

Methods

We gathered all available paper and digital files held in archives of the Region 3 office in Albuquerque, NM. Hard copy reports, site photos, and maps were scanned into digital files, which, along with legacy digital files, were stored in the University of New Mexico Digital Repository.³ Initially, a Microsoft Access relational database was designed to track the digital files and summarize site information about each RNA extracted from the files. We then transferred the content to the NHHM Biotics database, which is part of the international database system managed by NatureServe for Natural Heritage Programs in the western hemisphere. Biotics has tabular and spatial components designed specifically to capture information on managed areas including RNAs, plus supplemental tables for RNA-specific data such as establishment dates and status.

For the database, 15 core attributes were defined for data that we captured from the narrative documents and five related tables that carry supplemental data about the RNAs and links to documents and photos (Table 3). Some of these attributes are specific to RNA establishment reports such as Society of American Foresters (SAF) Cover Types (Eyre 1980) and Kuchler (1964) Potential Natural Vegetation Types (PVTs). In compliance with the FGDC Subcommittee on Vegetation Classification recommendations, we also provided updated vegetation composition at the Macrogroup level of the US National Vegetation Classification (USNVC; <http://usnvc.org/>) using the [Southwest ReGAP](#) vegetation map as the base that was cross-walked from Ecological Systems to Macrogroup⁴ (Lowry et al. 2005).

The Biotics database is a technical repository that is not designed for direct web-based access by users within agencies or the public. While a web-based direct database tool would be ideal, its development is resource intensive. Alternatively, we chose to deliver the database content through a spatial ArcGIS web platform. That is, a web map application where all RNAs are displayed in a viewer and information on each RNA made available through dropdowns when a site is highlighted. The viewer includes all attributes in Table 3 along with the links to source files in the UNM Digital Repository.

Results and Discussion

The RNA database content is freely available from the [RNA Climate Change Monitoring Network](#) webpage as part of the [New Mexico Conservation Information System](#) (Figure 2). There you will find the spatial viewer along with project files and spatial layers available for download. Within the viewer, when the user highlights an RNA, a dropdown of RNA attributes will appear with links to photos and documents in the UNM Digital Repository, which are in themselves available for download (Figure 3).

³ <https://digitalrepository.unm.edu/nhnm/>

⁴ Per. Comm. Ken Boykin, Center for Applied Spatial Ecology, New Mexico Cooperative Fish and Wildlife Research Unit, New Mexico State University.

Table 3. Core attributes and related tables for the RNA Climate-Change Monitoring Network Database.

Core Attributes	
Primary Features	Brief description of defining features of the RNA developed from establishment reports and other documents.
RNA Status	Status as either statutorily "Established" or "Provisional" in process of designation.
Status Date	Most recent known status date of from reports.
Protection Status	Established RNAs are considered "Semi-Protected"; Provisional RNAs are "Semi-protected" as specified in forest management plans.
Forest	National forest where the RNA is located
Ranger District	Forest ranger district responsible for management of the RNA
State	Arizona
County	Navajo (AZ)
Area (Acres)	Area of the RNA based on the most recent GIS boundary layers.
RNA Description	Expanded description of the RNA from report narratives.
Minimum Elevation (Feet)	Minimum elevation if noted in the establishment reports; otherwise the average.
Maximum Elevation (Feet)	Maximum elevation if noted in the establishment reports; otherwise the average.
Centroid Latitude (Y)	RNA center point latitude calculated from the GIS
Centroid Longitude (X)	RNA center point longitude calculated from the GIS
RNA Comments	Additional comments on the RNA
Related Tables	
Documents	Links to RNA documents in the UNM Digital Repository
USNVC Habitats	List of US National Vegetation Classification macrogroups per RNA with acreage and links to descriptions at UNNVC.org.
Photos	Links to RNA photos in the UNM Digital Repository
SAF/Kuchler Vegetation Types	List of Society of American Foresters forest types and Kuchler Potential Natural Vegetation Types.
NM/AZ Heritage Tracked Elements	List of sensitive species with an RNA per Natural Heritage databases for AZ and NM along with links to descriptions in NatureServe Explorer

Besides the main attributes, there are the related table extensions at the bottom of the drop down that lead to additional data. For example, “Documents” provides web links to documents about that RNA that are viewable and downloadable from the UNM digital repository (Figure 4). The files are aggregated into a single PDF file of all documents relating to the RNA. The “USNVC Habitats” table provides a list of vegetation communities and their acreage at the “macrogroup” level of the USNVC (Figure 5). The “More info” links to the full descriptions for the macrogroups at the USNVC.org website and an overview of structure of the classification. The “Photos” table links to photos from the RNA that can be viewed and downloaded from the UNM Digital Repository (Figure 6). Each photo is provided as a labeled jpeg file. “SAF/Kuchler Vegetation Types” provides SAF forest types and Kuchler PVTs lists (Figure 7). The acreages reported are from the establishment reports, not from a GIS calculation. “NM/AZ Heritage Tracked Elements” is an added attribute table that provides a list of sensitive species known

from the RNA from Natural Heritage databases (Figure 8). “More info” provides a link to the global descriptions for these species from the NatureServe Explorer website.

In addition to the spatial viewer, the database content is available for download in a spreadsheet form along with this report and the project spatial geodatabase. The spatial layers are provided as a courtesy for general use only and may not reflect the exact legal boundaries of the RNAs. As part of the NM-CIS, the spatial data layers will be updated as new data becomes available or RNAs are added to the system.

The screenshot displays the website for the New Mexico's Conservation Information and Research Center. The main heading is "Research Natural Areas Climate-Change Monitoring Network". Below this, it states "A regional network of monitoring sites that are:" followed by a list of four bullet points:

- Public lands places available for research and monitoring of environmental change in New Mexico and Arizona.
- Protected from human-caused disturbance.
- Representatives of the major ecological communities in the Southwest.
- Find an RNA through our online map below.

 The interface features a map titled "Southwest Research Natural Areas (RNAs)" and "USFS Region 3 Research Natural Areas (RNAs)". The map shows various geographical features and monitoring sites marked with colored icons. To the right of the map is a sidebar with sections for "RNA information available" (Project Summary, Report, citation), "Downloads" (1, 2), and a search bar at the top. The website footer includes the text "A project supported by the Fo".

Figure 2. The RNA database content is available in this spatial viewer from the [RNA Climate-Change Monitoring Network webpage](#).

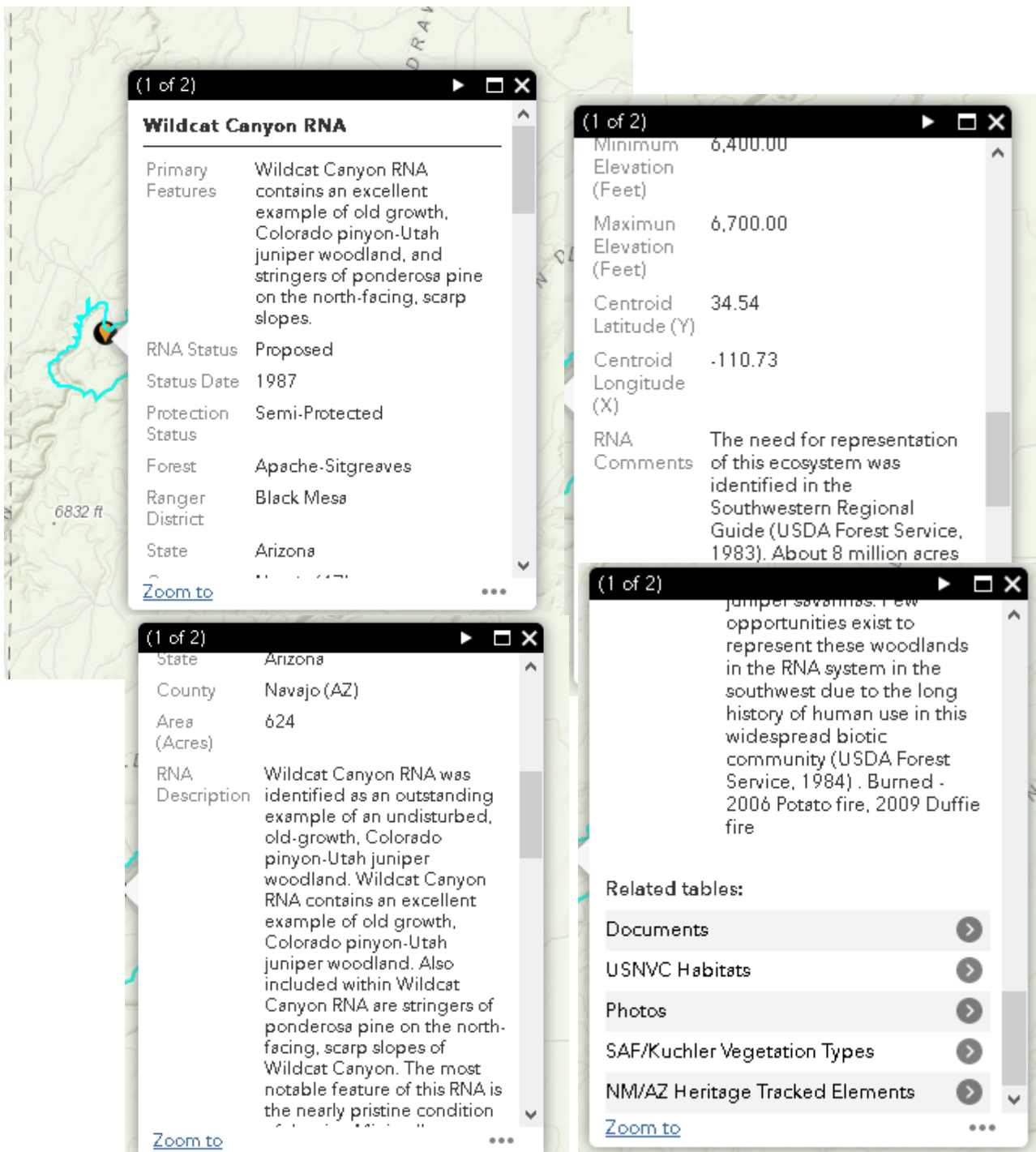


Figure 3. When an RNA site is highlighted in the spatial viewer, data about the RNA is made available through a hierarchical dropdown menu per the attributes in Table 2. The “Related tables” provide additional information on each RNA (see Figures 4 through 8).

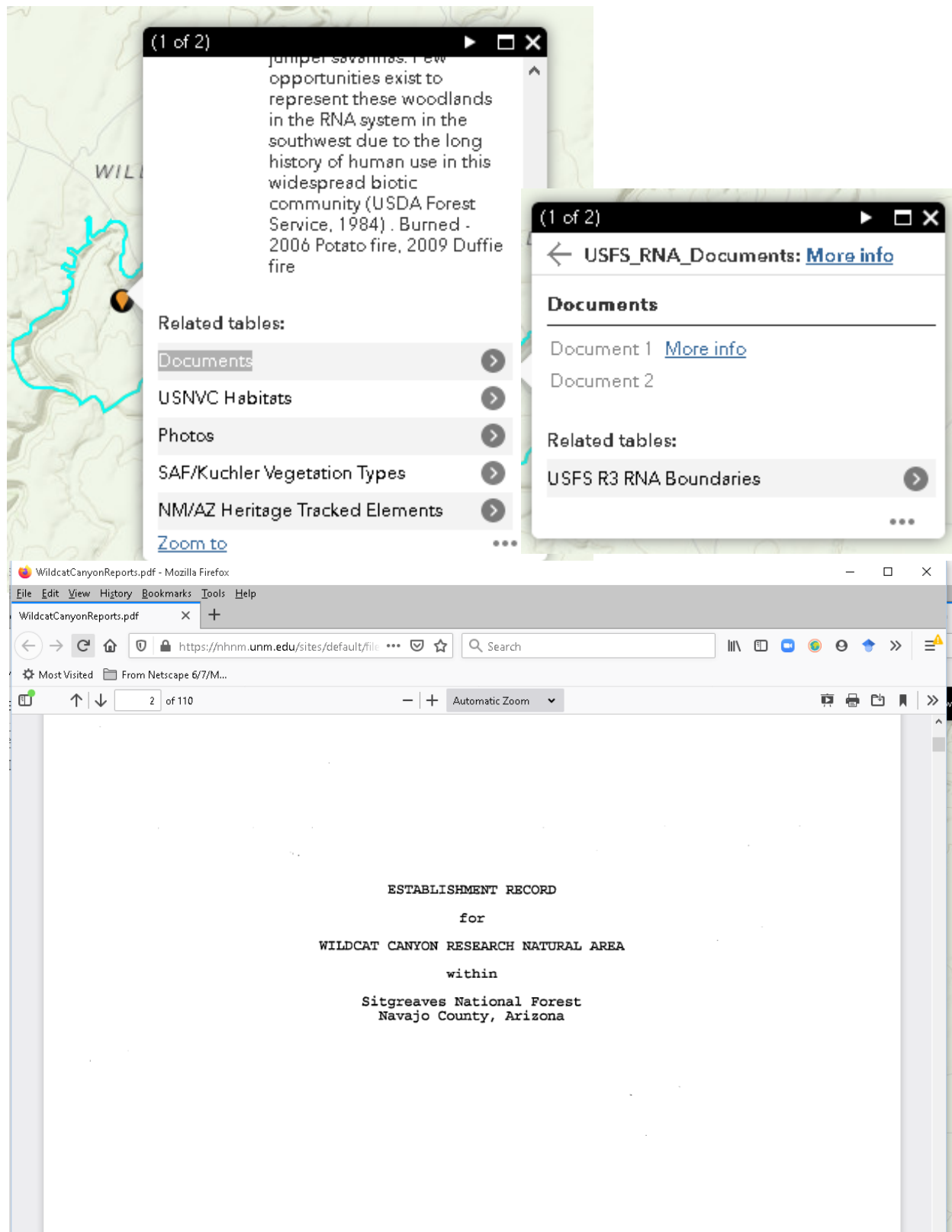


Figure 4. The “Documents” table provides web links to documents about that RNA which are available for download from the UNM digital repository.

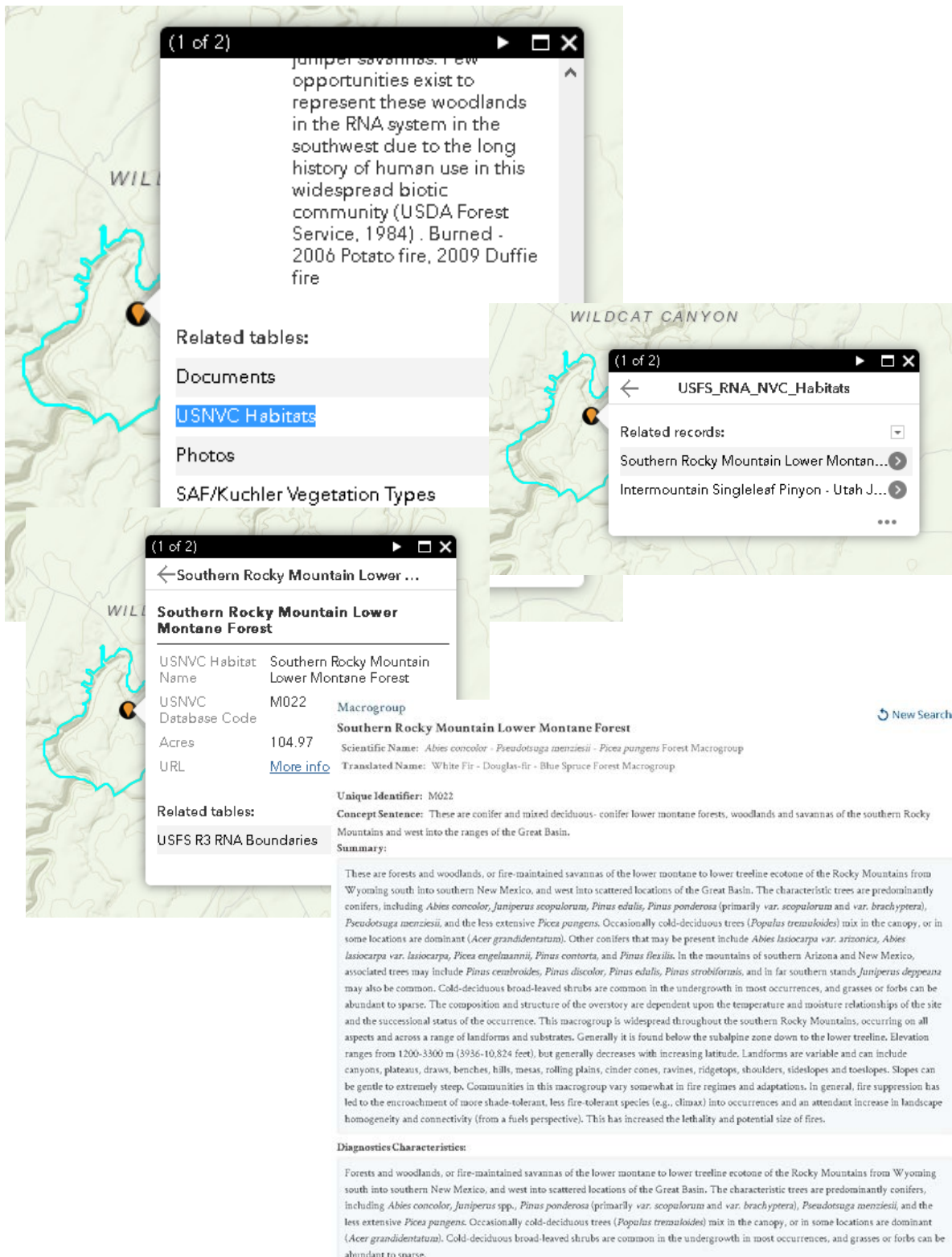


Figure 5. The “USNVC Habitats” table provides a list of vegetation types and their acreage at the macrogroup level of the US National Vegetation Classification. In addition, the “More info” links to the full description for the macrogroup at the USNVC.org website.

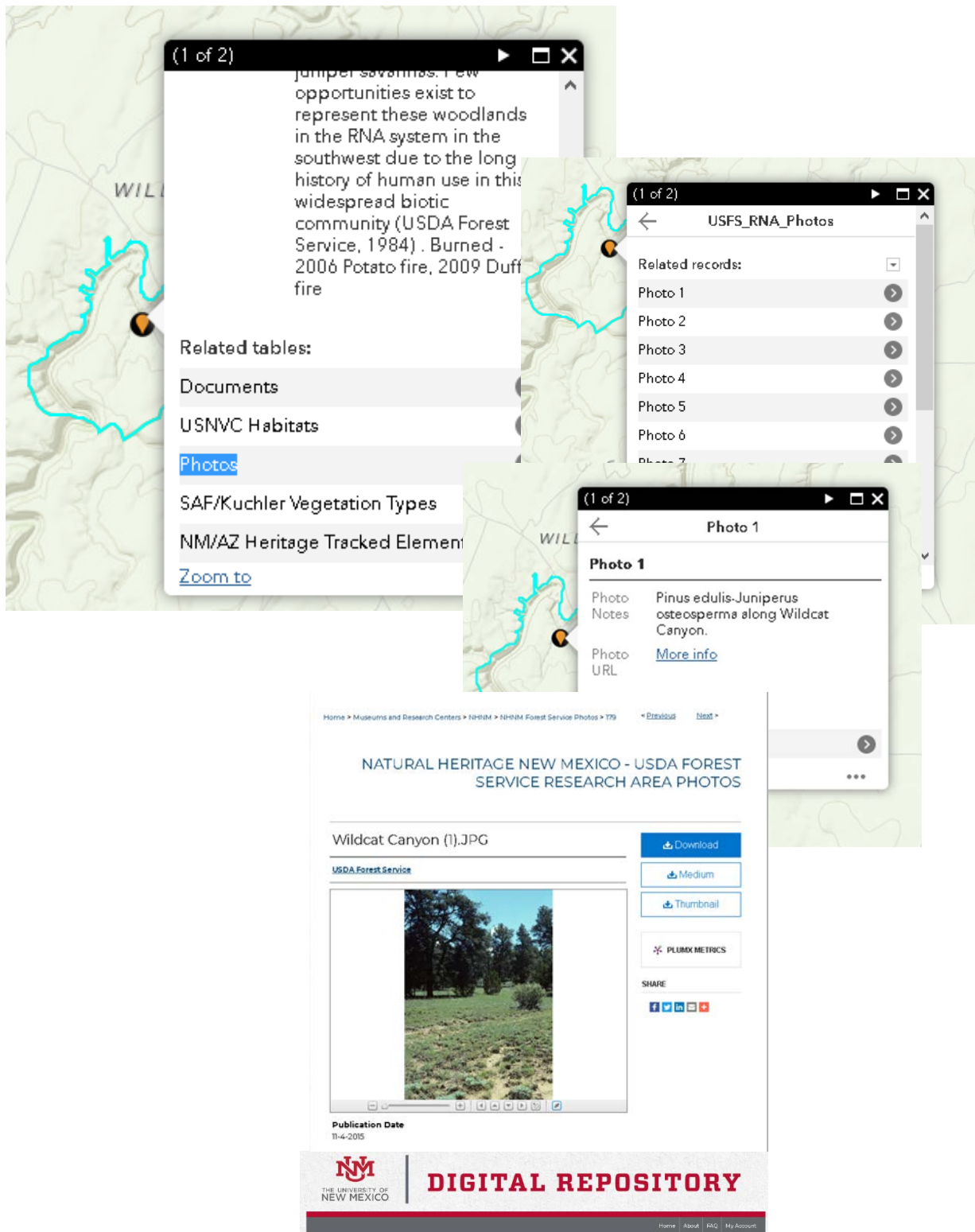


Figure 6. The “Photos” table links to individual digital images from the RNA that can be viewed and downloaded from the UNM Digital Repository.

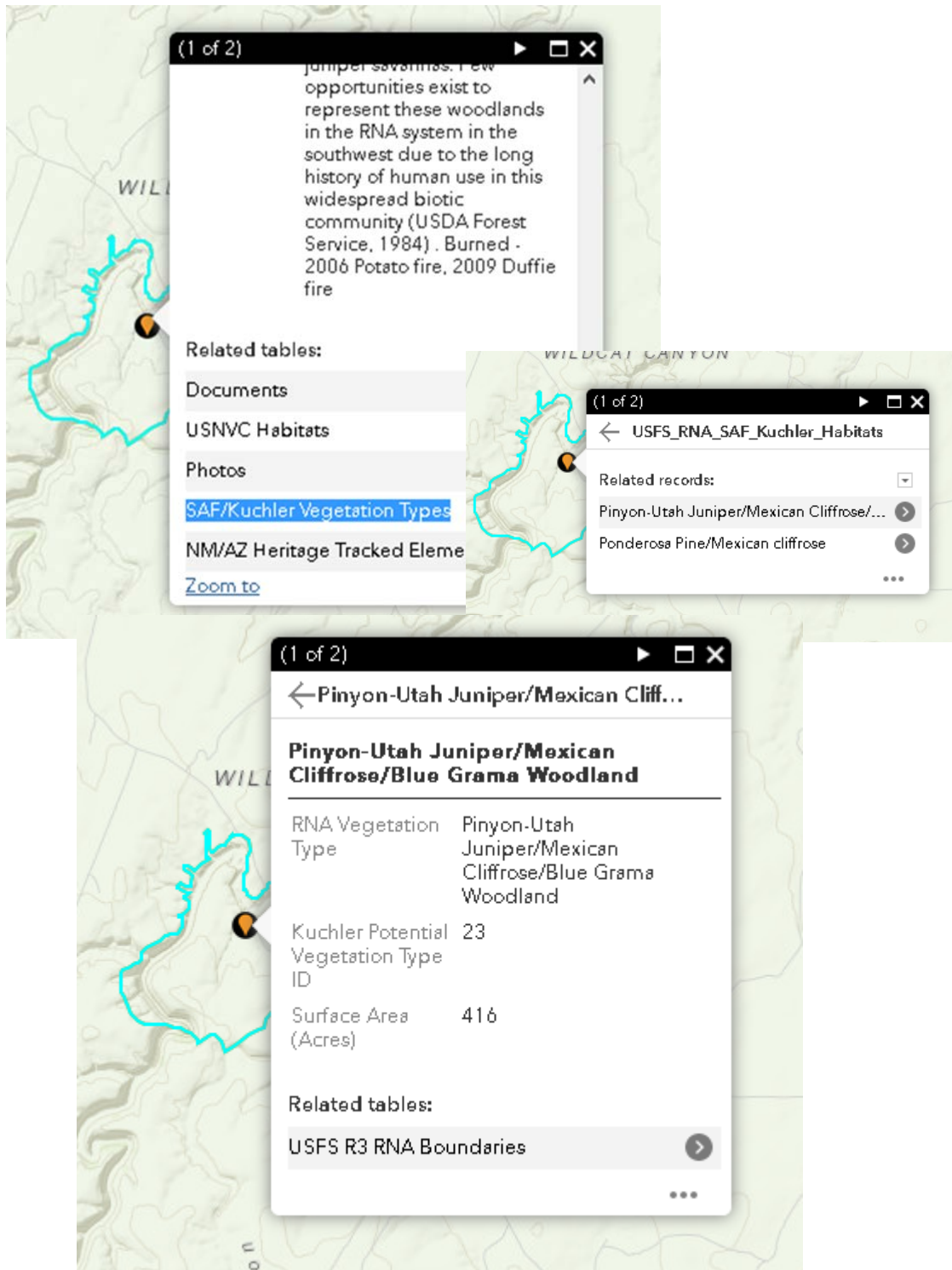


Figure 7. The “SAF/Kuchler Vegetation Types” table provides a list of those vegetation types by area.

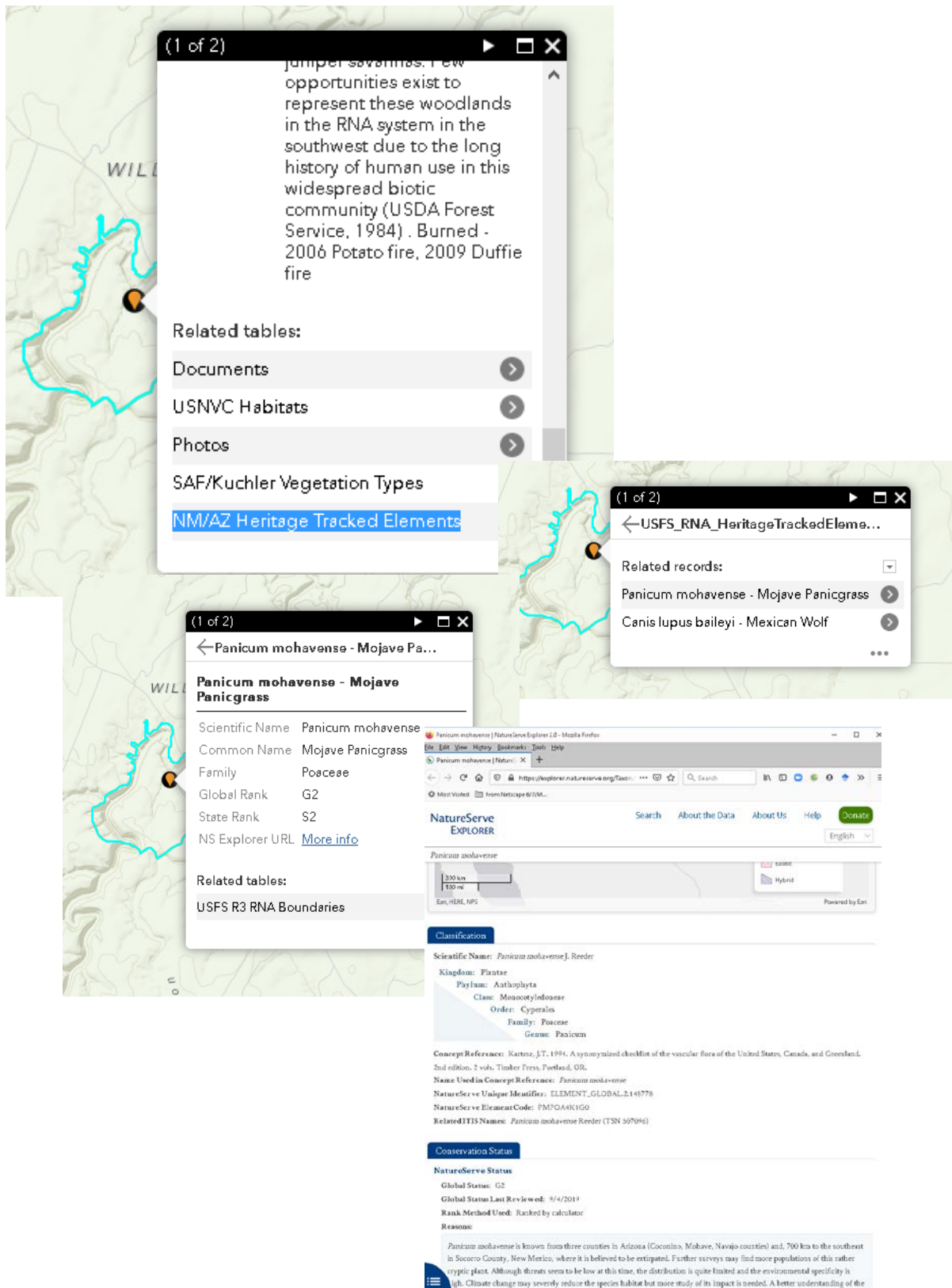


Figure 8. The “NM/AZ Heritage Tracked Elements” table provides a list of sensitive species in an RNA from Natural Heritage databases. “More info” provides a link to the global descriptions for the species from the NatureServe Explorer website.

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