

Mapping vernal pools and fens in the Modoc National Forest

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Introduction

Vernal pools are seasonally epistatic wetlands that harbor sensitive biological resources in many parts of California. Their distribution is patchy, and has been so fragmented by agricultural and urban development and mineral extraction (Holland 1998, 2003) that several dozen taxa have been listed under Federal and California endangered species legislation. Many additional taxa are considered sensitive, but have not yet been formally listed. Several of these species are known to occur in Modoc National Forest, but this knowledge is incomplete because the distribution of vernal pools habitats within the Forest has not been systematically determined.

Fens also are wetlands that are habitat for sensitive plants. They are even smaller than vernal pools and in the Modoc National Forest are known only from higher elevations in the Warner Mountain Ranger District.

The purpose of this study was 1) to map systematically the distribution of vernal pool habitats in two Ranger Districts, and 2) to map systematically the distribution of fens in one District using remotely sensed imagery and Geographic Information Systems technology.

Study Area

The vernal pool study area consists of the Devils Garden and Doublehead Ranger Districts, which collectively comprise about half of Modoc County (Figure 1). This remarkably flat area covers nearly 1.4 million acres spread over 53 7.5' US Geological Survey (USGS) topographic quadrangles. Elevations range from about 4000 feet near Tule Lake to 7913 feet atop Mt. Hoffman. Zonal vegetation varies from naturalized annual grassland and sparse juniper woodland at the lower elevations to mixed conifer forest at higher elevations where precipitation is more abundant. The fen study is the 360,000-acre Warner Mountain Ranger District, excluding the South Warner Wilderness. Elevations vary from around 5,000 feet up to nearly 10,000 feet atop Eagle Peak. Zonal vegetation in the Warners varies from sagebrush and juniper at low elevations to mixed conifer and lodgepole pine.

Methods

Forest botanists provided a variety of background materials for this study, including Natural Diversity Data Base records for all vernal pool and fen taxa known from the Forest, soils and habitat type mapping, digital raster graphic (drg) copies of the 7.5' topographic quadrangles, a 10 m digital elevation model, several Landsat images, the NAIP image, and copies of the digital orthophoto quadrangles of the entire Forest. I spent several days reviewing these data before conducting a two-day reconnaissance of the Devils Garden district. During this reconnaissance I visited several known locations of vernal pool taxa with copies of the DOQQs in hand. This site visit provided an opportunity to compare the visual, on-the-ground characteristics of vernal pool habitats

with the digital aerial imagery, and thereby facilitated the identification and delineation of vernal pool habitats in unmapped area.

Lingering snowpack precluded a reconnaissance of fens in the Warners before I began mapping there. I used nine previously documented fen locations and occurrence data for several fen-dwelling sensitive plants as training areas. I also spoke by telephone with several Forest Botanists on other National Forests who have mapped fens from air photos to help refine my search image.

Imagery

Digital Ortho Quarterquads (DOQQs) are a standard digital data product produced by the USGS. Each quarterquad is an orthographically corrected air photo mosaic scanned at one-meter pixel resolution from conventional black and white air photos. Most of the DOQQs in the study area were assembled from photos taken in 1996.

Fens were not visible in the black and white DOQQs, they are just too small to differentiate from surrounding wet meadows. Instead, I used a true-color NAIP image of Modoc County that had been compressed with MrSID technology (“multiple-resolution seamless interleaf display”). This provides much better resolution and true color, but is slow to repaint after zooming or shifting viewed location: you must wait for the entire County to process, even though you may be looking at only a few hundred acres.

Mapping Mechanics

This mapping project was completed without the use of paper maps. Instead, I used Arc9 software to superimpose 1:24,000 scale DRG images of the standard quadrangles onto one-meter pixel DOQQs (for vernal pools) or the NAID image (for fens). It is a simple procedure to turn white background and blue (water) and green (forest canopy) overprint transparent, producing a composite image of the air photo with all the familiar context provided in standard topographic maps (Figures 2 and 3). Working at 1: 9000 scale (750 feet/inch), it was a simple matter to tile across the images, looking for the diagnostic signatures of vernal pool habitat. Because they are so much smaller, I had to map fens at 1: 4,000 scale. When I found mappable habitat, I digitized the polygon boundary directly on-screen. The software allowed me to zoom in or out and to superimpose digital maps of soils, geology, and habitat type over the imagery and DRGs. The use of these additional layers vastly increased confidence in delineating habitat, and made it possible to eliminate potential polygons that resembled vernal pools or fens, but whose topography, geology, or soils were not appropriate. Polygon boundaries generally followed landscape features, typically coinciding with obvious physiographic transitions. Thus, the project was an air photo interpretation exercise, done on-screen instead of on paper.

Polygon Attribution

Obvious disturbances were visible in many of the delineated vernal pool polygons. Most are related to livestock or wildlife management activities, including saddle dams to increase ponding, ditch work to improve drainage, excavation of stock ponds with attendant deposition of spoil, and the construction of nest islands. Often several disturbances were evident in a single wetland. These disturbances were counted and recorded as each polygon was mapped. One wetland, the Antelope Plains, had all of these disturbances evident (Figure 4).

Ground truth

After all mapping had been completed, I returned to the Forest for three days of ground truth. I visited nine mapped vernal pool complexes near Canby (selected for ease of access) and 28 potential fens scattered the length of the Warner Mountains (again, selected for ease of access).

Results

I mapped 660 vernal pool complexes and 132 potential fens (Figure 5). Shapefiles of these are included on a compact disk that accompanies this report. Ground truth results are summarized in the following table.

Parameter	Vernal pools	Fens
Number mapped	660	132
Number visited	9	28
Percent visited	1	21
Number correctly mapped	9	12
Percent correctly mapped	100	43

The ground truth sample for vernal pools is quite small, just over 1%, but the results are reassuring. I attribute this high accuracy to my previous experience mapping vernal pools (nearly 30,000,000 acres), the contrast between vernal pools and surrounding vegetation, and their large size. The ground truth sample for fens is very large (21%) because I had low confidence that I was correctly seeing the habitat: indeed, I got it right just under half of the time. This compares well with results from other Forest Botanists working with fens in the Sierra Nevada. These data suggest that there may be up to about 60 fens in the Warner Mountains (43% of 132).

Many of the vernal pool complexes are quite large, covering thousands of acres. Many are reservoirs; some even have boat ramps for fishing and other flat-water recreation. Others, called “swamps” on local topographic maps, have perennial emergent marshes in their centers. But all of them have large drawdown zones that are inundated during late winter and early spring and are mantled with vernal pool plants during the spring and early summer. I found listed vernal pool plants (*Gratiola heterosepala*, *Orcuttia tenuis*, and *Pogogyne floribunda* in various combinations) at five of the nine complexes visited during early July ground truth. Similar habitats exist in eastern California and western

Nevada as far south as the Silver Peak Range (the next range east of the White Mountains). There is an inverse relation between altitude and these habitats, occurring at higher elevations in more southern latitudes (nearly to 10,000 feet near Bodie and on Silver Peak).

References

Holland, R. F. 1998. Great Valley vernal pool distribution, photorevised 1996. In: *Ecology, Conservation, and Management of Vernal Pool Ecosystems – Proceedings from a 1996 Conference*. Edited by C. W. Witham, E. T. Bauder, W. R. Ferren, Jr., and R. Ornduff. California Native Plant Society, Sacramento. Pp. 71-75.

Holland, R. F. 2003. Distribution of vernal pool habitats in five counties of California's southern Coast Ranges. US Fish and Wildlife Service, Ventura Fish and Wildlife Office. Consultant report. 23 pp.

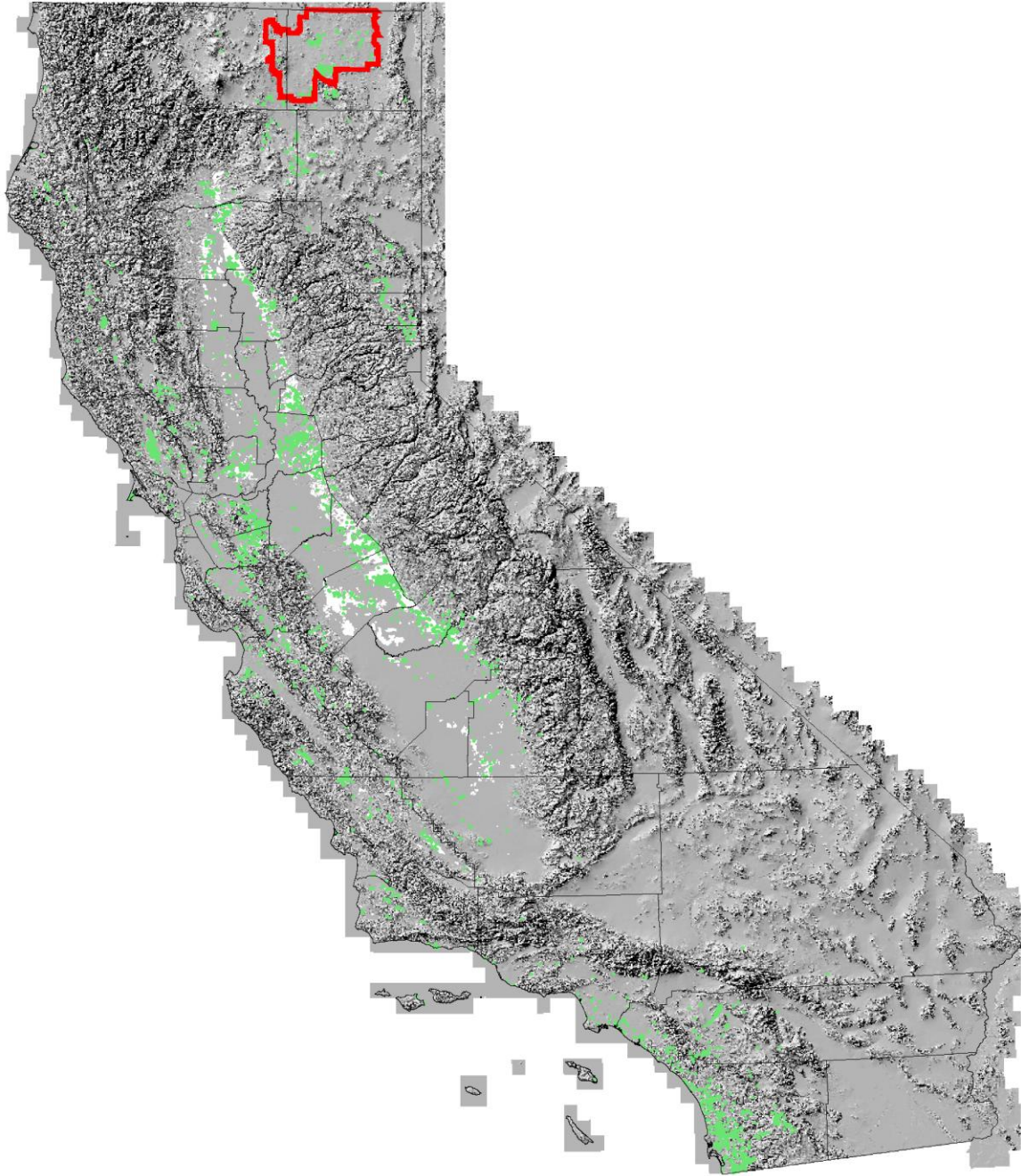


Figure 1. Shaded relief image of California showing county outlines (black), Great Valley and south Coast Range vernal pool distribution (white, from Holland 1998, 2003), vernal pool element occurrences recorded in the California Natural Diversity Data Base (green), and study area boundary (red).

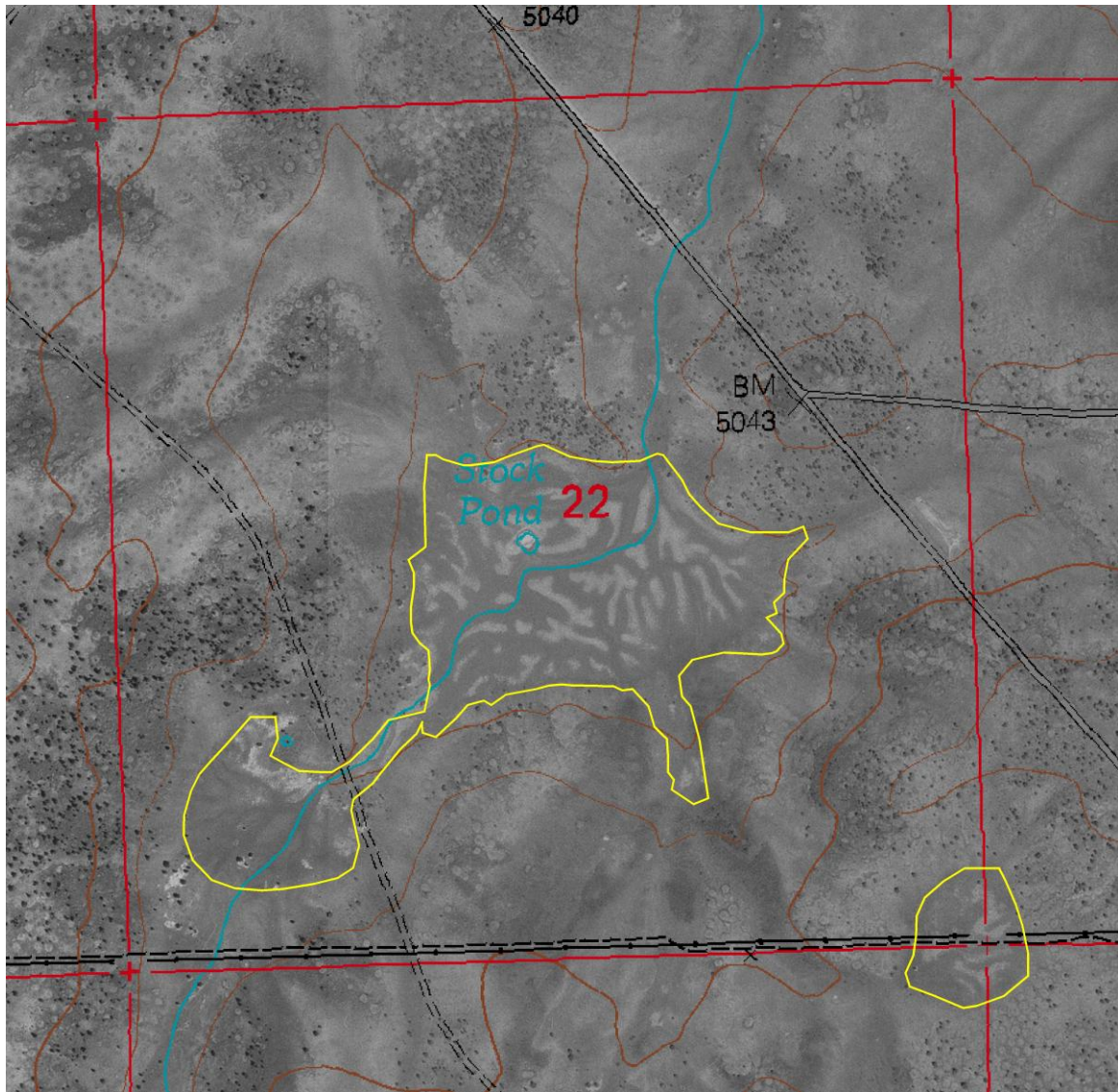


Figure 2. Portion of the Big Sage Flat 7.5' quadrangle superimposed on digital orthophotos, here enlarged to 1:12,000 scale (1000 feet/inch). Yellow lines delimit two mapped vernal pool polygons. The variegated white areas within the polygons are depressions with dense stands of *Pogogyne floribunda*. Intervening darker gray areas are dominated by *Artemisia cana bolanderi*, *Taeniatherum caput-medusae*, and *Epilobium brachycarpum*. The excavated stock pond has spoil piles to the northeast and southwest. Darkest spots on surrounding uplands are individual *Juniperus occidentalis* trees growing amongst *Artemisia arbuscula*. Light gray, round spots in the north west quarter of section 22 are mima mounds about 2 feet tall and 30-50 feet in diameter.

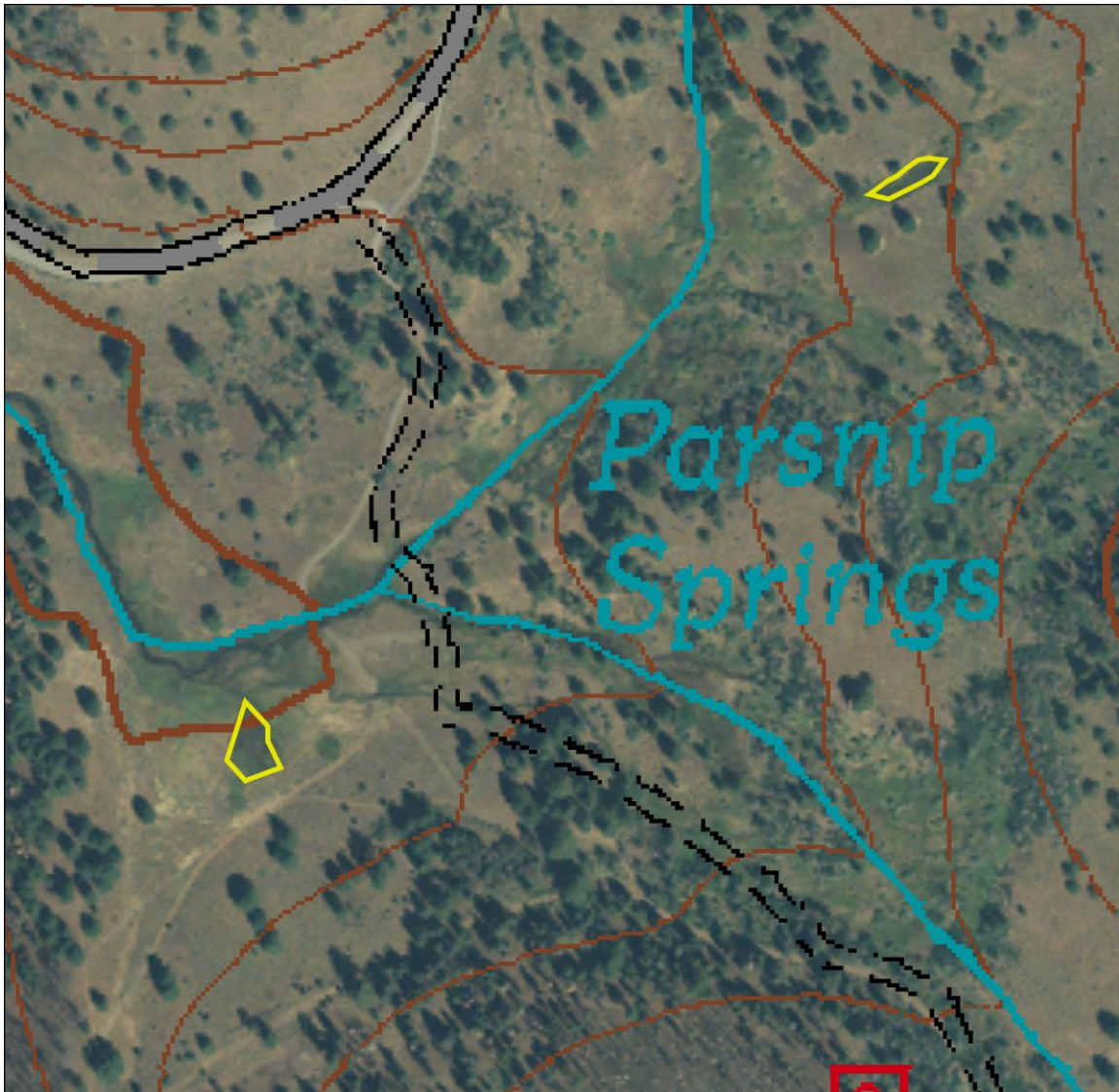


Figure 3. Portion of the Jess Valley 7.5' quadrangle superimposed on the NAIP image, here zoomed in to about 1:4,000 scale. The fen in the lower left was one of the prior-known fens used as a training area. The smaller polygon in the upper right corner was found during ground truth to lack any accumulation of peat.

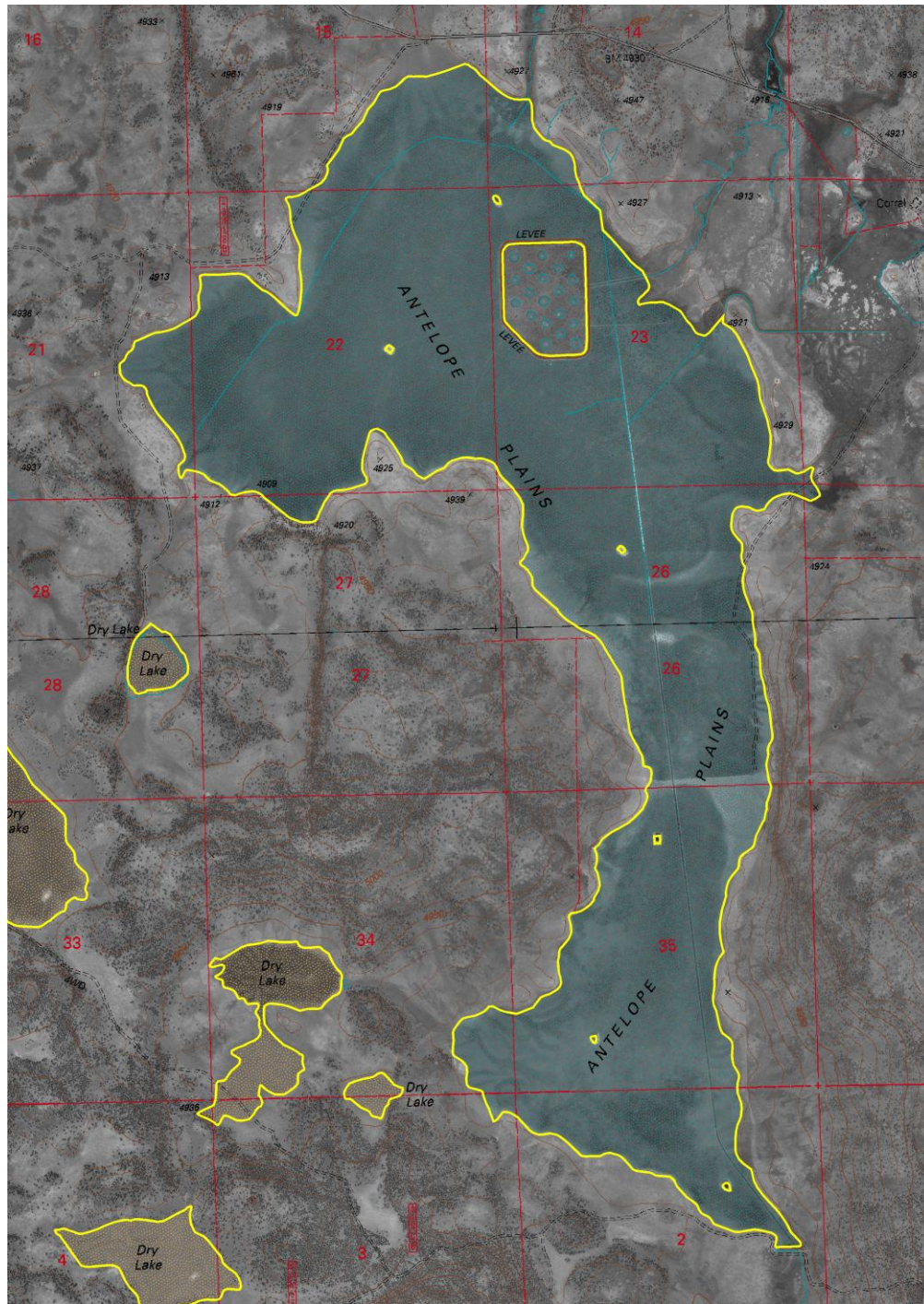


Figure 4. Portion of the Boles Meadows East and Jacks Butte quadrangles showing the Antelope Plains and surrounding environs. This large wetland has a dam, 2 ditches, 6 dugouts with accompanying spoil piles, and 20 nest islands (enclosed within the nearly square leveed area). Dugouts also are visible in the two smaller dry lakes in sections 4 and 33 (light blotches).

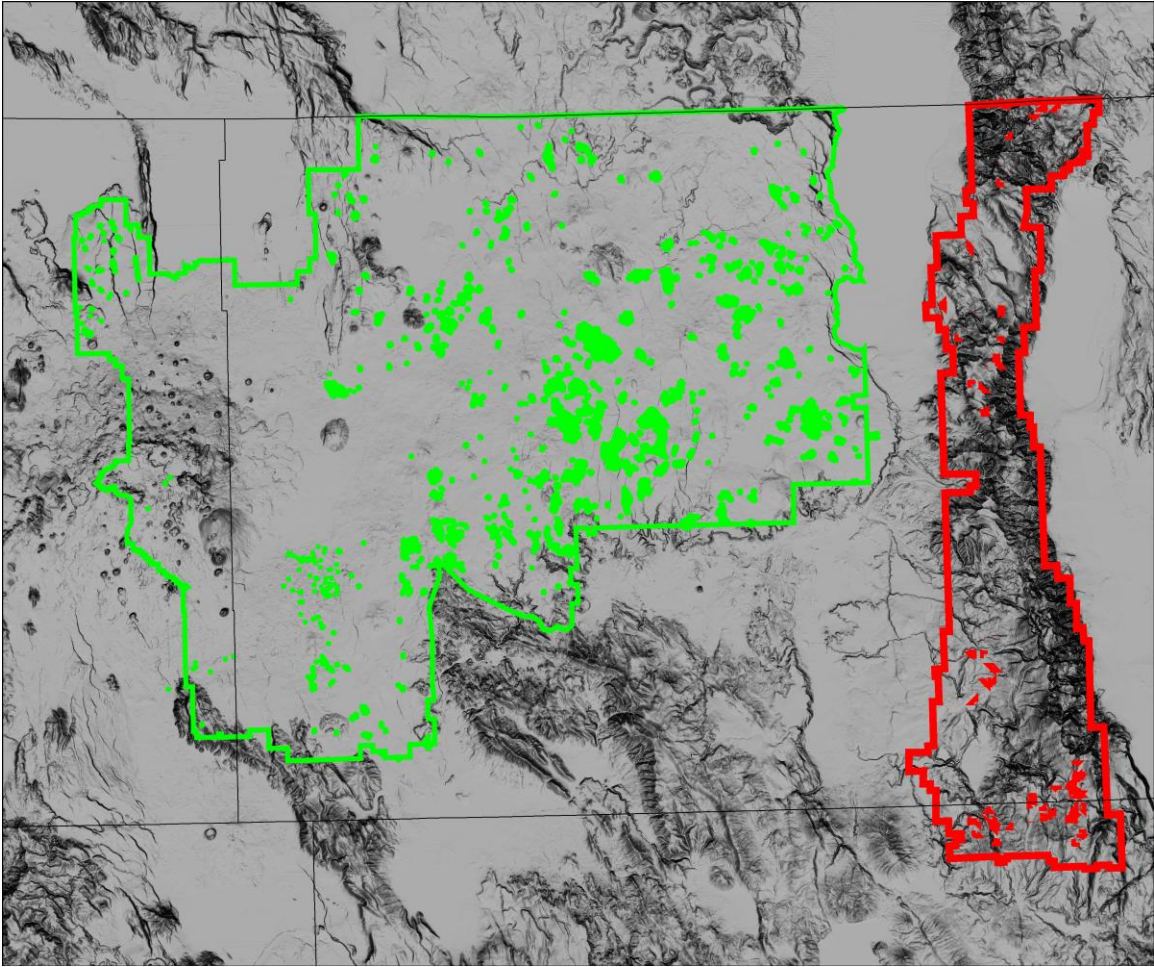


Figure 5. Shaded relief image of northeastern California showing county lines (black), the Warner Mountain Ranger District (red outline) with potential fens (red), and the Devil's Garden and Doublehead ranger districts (green outline) with vernal pool complexes in green.