OREGON DEPARTMENT OF AGRICULTURE

NATIVE PLANT CONSERVATION PROGRAM

Status evaluation of *Astragalus tricarinatus* (triple-ribbed milkvetch)

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for
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Introduction

Astragalus tricarinatus (triple-ribbed milkvetch) is a perennial, showy milkvetch with creamy flowers and large distinctive pods (Figures 1-3). This species is included in both commonly used California floras (Munz and Keck 1959, Hickman1993), and a recent revised description, along with an update on the probable location for most herbarium collections, was completed in preparation for development of the West Mohave Desert Habitat Conservation Plan (Sanders 1999). Triple-ribbed milkvetch is restricted to San Bernardino and Riverside Counties, California, with the majority of documented sites occurring in the Morongo Canyon, Mission Creek and Whitewater River areas (Figure 4). Considering the showy nature of this unusual species, and its distribution within a fairly well botanized area, surprisingly little is known about its biology and ecology.

Described by Asa Gray from a specimen collected in 1873 by Charles C. Parish in Whitewater Canyon, A. *tricarinatus* was initially believed to inhabit "gravelly canyons and washes" (Munz and Keck 1959). Many of the pre-2000 collections, including a large population of over 100 plants in the bottom of Big Morongo Canyon, were made on disturbed sandy soils on the floors of washes. These populations, including the one in Big Morongo Canyon, were transient, quickly exhibiting precipitous reductions in numbers, then disappearing. The waif-like behavior of wash populations prompted local botanists to suggest that plants in these sites appeared from seeds washed downstream from populations higher up in the canyons. Larger, more permanent populations were suspected to occur on the rocky exposed slopes and slides above the documented wash sites, and ridges and uplands were eventually proposed as the preferred habitat for *A. tricarinatus* (Sanders 1999, White 2004*a*).

In April 2004, a previously undocumented population of *A. tricarinat*us was discovered on an upland ridge in the Mission Creek watershed (White 2004*a*). Over 300 plants were counted by White and colleagues at a second visit to this site in 2004, making this population the largest one ever reported. Habitat was described as "a small outcrop of unproductive-looking gravelly soil" produced through weathering of "an unusual metamorphic rock".

Figure 1. Healthy plant of *A. tricarinatus* in flower at Wathier Landing. Note the barren substrate on which this plant is growing. (Photo by R. Currin.)

Figure 2. The pods (left and background) of triple-ribbed milkvetch are distinctive, and the three ribs noticeable in cross-section give the species its name. (Photo by K. Amsberry.)

Plants were also located on "a few other, similar outcrops" at that time, but no plants were found during a search of surrounding granites slopes and alluvial fans and washes. White suggested that additional populations of *A. tricarinatus* probably exist in the uplands of the Mission Creek and Morongo Canyon watersheds, and that these populations can be found by searching potential habitat within these areas (White 2004*b*).

Conservation status

- US Fish and Wildlife Service: **Endangered (1998)**
- California Department of Fish and Game: **none**
- California Native Plant Society: **List 1B** (Rare or Endangered in California and elsewhere)

Figure 3. *A. tricarinatus* flowers in March at the Catclaw Flat site. (Photo by R. Currin.)

Survey and site assessments

Mission Creek/Whitewater River. On March 20, 2005, ODA staff, along with The Wildlands Conservancy (TWC) Mission Creek Preserve manager April Sall, and Danny and Claudia Sall revisited the *A. tricarinatus* population discovered by White and colleagues in 2004 in the Mission Creek drainage. This site is located above Mission Creek, near Wathier Landing, east of the Whitewater River. (See Appendices A and B for detailed site location information.) Plants of *A. tricarinatus* in this site were restricted to white or pale gray-blue colored soils above and below an old mining road north of the main trail (Figure 5). Outside of the inhospitable looking gravelly soils extending along this exposed area, plants were not observed. The area between this ridge line and the Whitewater River was searched, but no additional plants were found. Over 300 reproductive plants were counted, with many seedlings also observed (Figure 6). Eighty-six seedlings were counted in an accessible two m^2 plot; with many more suspected to occur in steep inaccessible areas located below the mining road. Large plants appear to be perennial with some plants producing over 100 flowering stems. Although much of the substrate was bare of any vegetation, associated species included *Achnatherum coronatum*, *Erigonum fasciculatum*, *Eriodictyon trichocalyx* and *Yucca schidigera*.

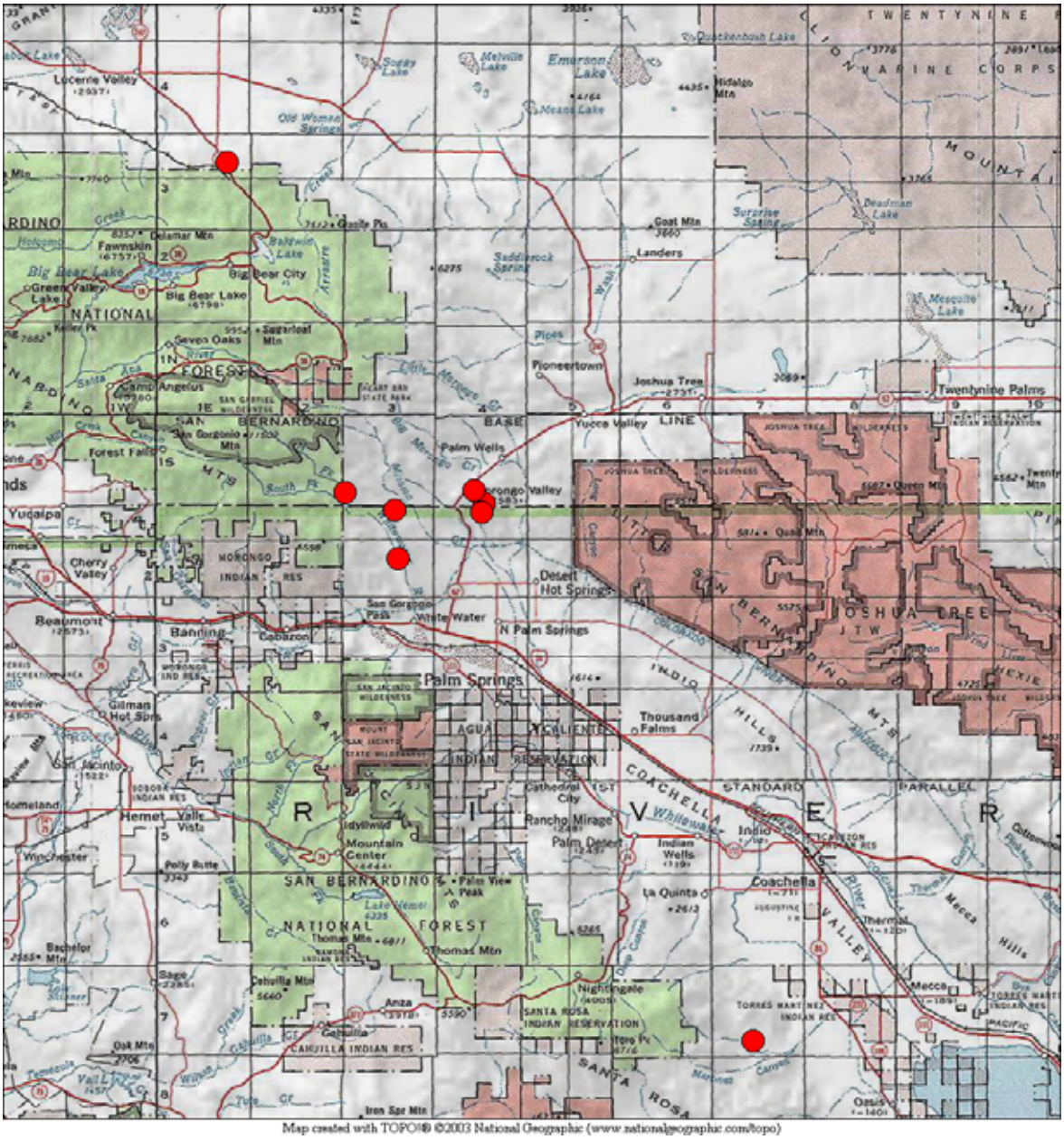

Figure 4. Overview of range of *A tricarinatus*, summarized from location data in CDFG Natural Diversity Database. Location information regarding collections in the Joshua Tree area has not been confirmed and these populations are not included.

Figure 5. Plants of *A. tricarinatus* (circled in foreground) occur in an old roadbed along the ridgetop in the Wathier Landing site. Additional plants were observed on the steep embankments below and above the roadbed, but the population did not extend beyond the end of the exposed soils (arrow). (Photo by S. Meyers.)

Figure 6. Plants of *A. tricarinatus* (circled in foreground) occurred in fairly dense patches throughout the occupied area at Wathier Landing. Seedlings were also prevalent, but are difficult to photograph. (Photo by S. Meyers.)

On our return hike to TWC Mission Creek Preserve headquarters from Wathier Landing, a second population of *A. tricarinatus* was discovered by Danny and Claudia Sall at the east end of Catclaw Flat, about 2½ miles east of Wathier Landing. (Figure 7; see Appendices A and B for detailed site location information). This population was also located on pale-colored decomposed granite substrate on an exposed ridge, and was associated with species similar to those in the Wathier Landing site. Several dozen reproductive plants were initially observed in this site, with many more seedlings. On a second visit to this site in May 2005, the population was estimated to consist of over 100 plants (including seedlings), although an exact count could not be made due to the inaccessibility of some potentially occupied areas.

Figure 7. Large plant of *A. tricarinatus* at the Catclaw Flat site. Note the similarity of soils in this site to substrate at the Wathier Landing site. (Photo by K. Amsberry.)

On both visits to these sites, all accessible areas along the trail were searched, and binoculars were used to scan distant areas. However, the fine textured foliage and pale color of non-reproductive plants make distinguishing small plants from their pale gravelly substrate very difficult (Figure 8). The difficulty in seeing small plants of *A. tricarinatus*, combined with an incomplete knowledge of its preferred habitat, has probably contributed to the large number of unsuccessful searches for new populations of this species. As indicated by previous researchers, it is likely that further, well-focused surveys in the Mission Creek watershed will discover additional populations (Sanders 1999, White 2004*b*).

As plants have also been collected along the access road to the Mission Creek Preserve, this area was also searched. (See Appendix C for areas searched.) No suitable upland habitat along road was observed, indicating that the specimens from this area were collected from transient populations in the washes along Mission Creek that are no longer extant.

Figure 8. Small plants of *A. tricarinatus* blend in with substrate background and are difficult to see, contributing to difficulties in surveying. (Photo by K. Amsberry.)

Big Morongo Canyon. On March 22, 2005, Big Morongo Canyon from the Big Morongo Canyon Preserve south to Indian Avenue was searched for *A. tricarinatus*. One plant was observed on the west side of the canyon just beyond the preserve border but no other plants were seen. (See Appendix A for location.) The single large, reproductive plant consisted of over 100 flowering stems, and was growing on a slide of exposed decomposed granite on the canyon wall. No seedlings were seen near this mature plant, and a thorough searching of the area above this plant did not reveal additional individuals. The remainder of the canyon was also searched, both the wash itself and any promising-looking areas higher up in the canyon. Where accessible, all potentially suitable habitat was closely investigated, and binoculars were used to scan inaccessible areas. As Big Morongo Canyon is the location of several previous collections (USFWS 1998, Consortium of California Herbaria 2007), and appears to have appropriate habitat, further surveys in this area, especially on ridges above the canyon, are likely to reveal additional populations.

Destruction of plants due to pipeline maintenance in Big Morongo Canyon in 1984 and 1995 provided the impetus to list *A. tricarinatus* as endangered (USFWS 1998). Because federal conservation status protects this species from additional destruction in this area, learning the location of any additional extant populations in Big Morongo Canyon will be critical to conservation planning related to future pipeline maintenance in this area.

Other survey sites. As well as in the areas discussed above, *Astragalus tricarinatus* has been collected from several other locations in Riverside and San Bernardino Counties. The CDFG Natural Diversity Database includes a record for a collection by Parish in 1895 from Cushenberry Canyon, but this collection is not included in the on-line Consortium of California Herbaria database, and little information is available about its location. Cushenberry Canyon was visited in 2006, but no habitat for *A. tricarinatus* was observed.

One record for triple-ribbed milkvetch from the Santa Rosa Mountains also exists (Sanders 1999, Consortium of California Herbaria 2007). Because the vicinity of the well-documented Alta Agua location of this 1985 collection has been thoroughly searched without locating additional plants (Sanders 1999), we did not visit this area. However, additional

surveys may yet discover new populations. Whitewater Canyon north of Highway 10 above the town of Whitewater has also been the source of several well-documented collections, and was not visited during our study. Several other potentially anomalous locations (see Sanders 1999) were not visited due to improbability of discovering populations in these areas.

Population viability assessment

The two large populations in the Mission Creek watershed were selected for our population viability data assessment. Ten plants were randomly selected for data collection at Catclaw Flat (May 2005) and 16 at Wathier Landing (March 2005). A series of size parameters were measured on each plant, and selected fertility data were also collected (Figure 9; Table 1). Sixty-two percent of plants at Wathier Landing were in flower only, with 38% beginning to produce fruit during our March 2005 visit, and all plants were in fruit at Catclaw Flat in May 2005. Due to these phenological restrictions, reproductive data collection was limited to measurable parameters on each visit. Follow-up visits in 2006 consisted of plant counts and seedling searches.

Figure 9. ODA staff collect information on plant size and reproduction at the Wathier Landing site. (Photo by S. Meyers.)

Table 1. Summary of reproductive data collected in 2005-2006.

Site visit date	Mean no. flowering stems/ plant	Mean no. flowers/stem	Mean no. pods/stem	Mean no. good seeds/pod	Seed/ovule ratio	Reproductive capacity[1]
3/20/05	17.9 (n=16) WL	31.6 (n=47) WL				
5/5/05	45.6 (n=8) CCF		5.0 (n=64) CCF	12.1 (n=59) CCF	0.57 CCF	2758.8 CCF

[1]Reproductive capacity = (flowering stems/plant) x (number of pods/stem) x (number of seeds/pod), and is an estimate of the number of seeds produced per plant. WL = Wathier Landing; CCF = Catclaw Flat.

Plants were smaller (as measured by mean number of flowering stems per plant) in the Wathier Landing site in March 2005 than they were in May 2005 at Catclaw Flat; this may be due to an inherent disparity in plant size between the two populations, or may be a measure of an increase in plant size due to seasonal growth between the earlier and later sample dates. Plants at Catclaw Flat reproduced well, with an estimated mean of 2758.8 seeds produced per plant. This seed production rate is higher than reported rates for other members of this genus; mean seed production of four Oregon *Astragalus* species ranged from 72 to 450 seeds per plant (Gisler and Meinke 2001*a*). Many hundreds of *A. tricarinatus* seedlings were seen in both sites in 2005 (a "good" rainfall year), and seedlings were again observed in the following year (a dry year). Seedlings were also observed by White and colleagues during their 2004 visit (White 2004*b*), suggesting that reproduction and seedling germination occur in most years.

Plants in both sites were large and healthy in 2005, with an overall mean stem length of 20.9 cm. All reproductively mature plants appeared to be perennial, and 38% had obvious woody bases. Our observations corroborate speculation by previous researchers that plants are short-lived perennials, probably surviving for 3-5 years (Sanders 1999), but long-term monitoring of permanently marked individual plants is needed to determine longevity. Numbers of plants similar to our 2005 counts were observed at both sites during our follow-

up visit in 2006, but again, long term monitoring of plants in permanent monitoring plots is necessary to evaluate population viability.

Pollinators were not observed in either site on any visits. Both sites are extremely windy, especially at the mid-day time period necessitated by the long hike (12 mile round trip) into our remote study sites. As the showy flowers of *A. tricarinatus* are typical of legumes pollinated by native bees and honey bees, visits during early morning, non-windy, hours would probably yield opportunities for pollinator observations.

In a pilot study to determine germination requirements for *A. tricarinatus*, 80% of viable-appearing seeds germinated within 72 hours after scarification and wetting. Seeds are probably scarified naturally through exposure to the elements and/or the action of tumbling gravel during flooding, allowing germination to occur when seeds are moistened. Additional studies evaluating seedling biology and seed longevity will promote understanding of the life history of *A. tricarinatus*, and elucidate the ecology of this mysterious taxon.

Seedlings grew well in the greenhouse environment, and appeared to be more robust when grown in pots inoculated with soil from vigorous cultivated plants of *Astragalus applegatei*, an obligately mycorrhizal species endemic to southeastern Oregon (Figure 10). As growth of rare species of *Astragalus* may depend on relationships with fungal or bacterial associates (Gisler and Meinke 2001*b*), a study focusing on the cultivation of plants in various media, with and without rhizobium and mycorrhizae would provide additional insights into the biotic component of the habitat requirements for this species.

The location of the Wathier Landing population along an old road, combined with observations of plants of *A. tricarinatus* appearing in washes after flooding and other disturbances (CVAG 2007), has prompted suggestions that this species is dependent on disturbance for colonization and population persistence. Evaluating the effect of various kinds of disturbance is a priority for management of the state-listed *Astragalus peckii* in Oregon (Amsberry et al. 2006), and an assessment of the importance of disturbance to *A.*

tricarinatus' persistence and colonization would provide information valuable for this species' habitat management.

Figure 10. Large plants in the row of pots at the back of this array were inoculated with soil surrounding the roots of cultivated healthy plants of *Astragalus applegatei*. Because these *A. applegatei* plants were previously inoculated with native soil containing mycorrhizae and *Rhizobium* (essential for growth of this endemic southeast Oregon species), soil from their roots contains these two symbionts, which are presumably the cause of the increased vigor observed in the inoculated *A. tricarinatus* plants. Small plants (front row) were not inoculated. (Photo by M. Carr.)

Threats and conservation efforts

Threats to *A. tricarinatus* are currently minimal, as most populations occur in fairly remote portions of administratively protected areas. The two currently documented Mission Creek populations occur on land owned by The Wildlands Conservancy, a private foundation committed to managing this area to preserve biodiversity and wilderness values. TWC also currently leases additional land containing habitat for *A. tricarinatus* as a Bureau of Land Management (BLM) grazing allotment – this 40,000 acre allotment is scheduled to be permanently relinquished (no grazing) in the near future (BLM 2007). Should new populations be discovered in Mission Creek in the future, they will probably be within these protected areas or the adjacent San Gorgonio Wilderness Area. However, encroaching development in the lower Mission Creek area threatens the wilderness character of this entire region, and could potentially impact *A. tricarinatus*. The exotic weed infestations and

increased foot and vehicle traffic associated with increasing population density critically threaten many rare plants, even when they occur within administratively protected areas.

Portions of Big Morongo Canyon are protected by inclusion in BLM's Big Morongo Canyon Preserve. Although populations probably also exist outside the Preserve, most potential habitat within this area is managed by BLM for habitat conservation. Additional destruction by pipeline maintenance activities is still a potential concern, making location of extant populations and the development of a specific plan for minimizing potential destruction during these activities a priority.

Additionally, 2026 acres of core habitat for *A. tricarinatus* are included in the Coachella Valley Multiple Species Habitat Conservation Plan (CVAG 2007). Currently in the final stages of development, the Plan provides conservation requirements for areas identified as highest quality habitat for rare species. If adopted as written, the Plan will provide additional protection to populations that are located outside of BLM, TWC and US Forest Service lands, and specify conservation actions for those populations that occur on protected lands.

Summary

- Our observations support suggestions by previous researchers that washes are not the primary habitat for *A. tricarinatus,* and that additional large populations may exist in upland areas.

- Surveys are needed to search for additional populations on the decomposed granite substrate in upland areas preferred by this species.

- The two large populations of *A. tricarinatus* that we visited appear viable, with hundreds of persistent plants and high levels of reproduction.

- Despite a lack of information regarding the distribution, ecology, and biology of this species, the location of most populations in conservation management areas protects *A. tricarinatus* from many of the imminent threats that currently jeopardize the continued existence of other members of the southern California flora.

Recommendations

- Develop a model for locating possible sites using soils survey data, aerial photos and topographical maps. Southern California Arial Mapping Project (SCAMP http://scamp.wr.usgs.gov/scamp/) is currently compiling detailed soils information for this area which will be useful in identifying potential *A. tricarinatus* habitat.

- Complete surveys for additional populations in the Mission Creek and Morongo Canyon areas.

- Relocate the Alta Aqua population in the Santa Rosa Mountains, and survey for additional populations in this area.

- Establish permanent monitoring plots at one or both of the Mission Creek populations. Periodic evaluations of these sites would provide information critical to determining the life history and viability of this species.

- Initiate studies to evaluate germination biology, pollination ecology, edaphic preferences, seed longevity, disturbance ecology and mycorrhizal and/or rhizobium requirements for *A. tricarinatus*. These studies will provide information critical to developing management plans to ensure conservation of this unique and poorly known species.

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We would like to thank Kevin Doran (BLM) and April Sall (TWC) for providing access to study sites and directions to site locations. Thanks also to Danny and Claudia Sall for accompanying us on our trip up Mission Creek, and for discovering the Catclaw Flat population. Stephen Meyers, Liz Martin and Brian Knauss (Oregon State University), Troy Maddux and Rebecca Currin (ODA), and Katie Mitchell (Oregon Flora Project) assisted with field work on this project, and their contributions are greatly appreciated. Cameron Barrows (Center for Natural Lands Management) provided much of the initial information on site location and administrative contacts, and we thank him also. Funding for this project was provided by California Department of Fish and Game (Agreement Number PO485100). Cover photos by Rebecca Currin and Kelly Amsberry.

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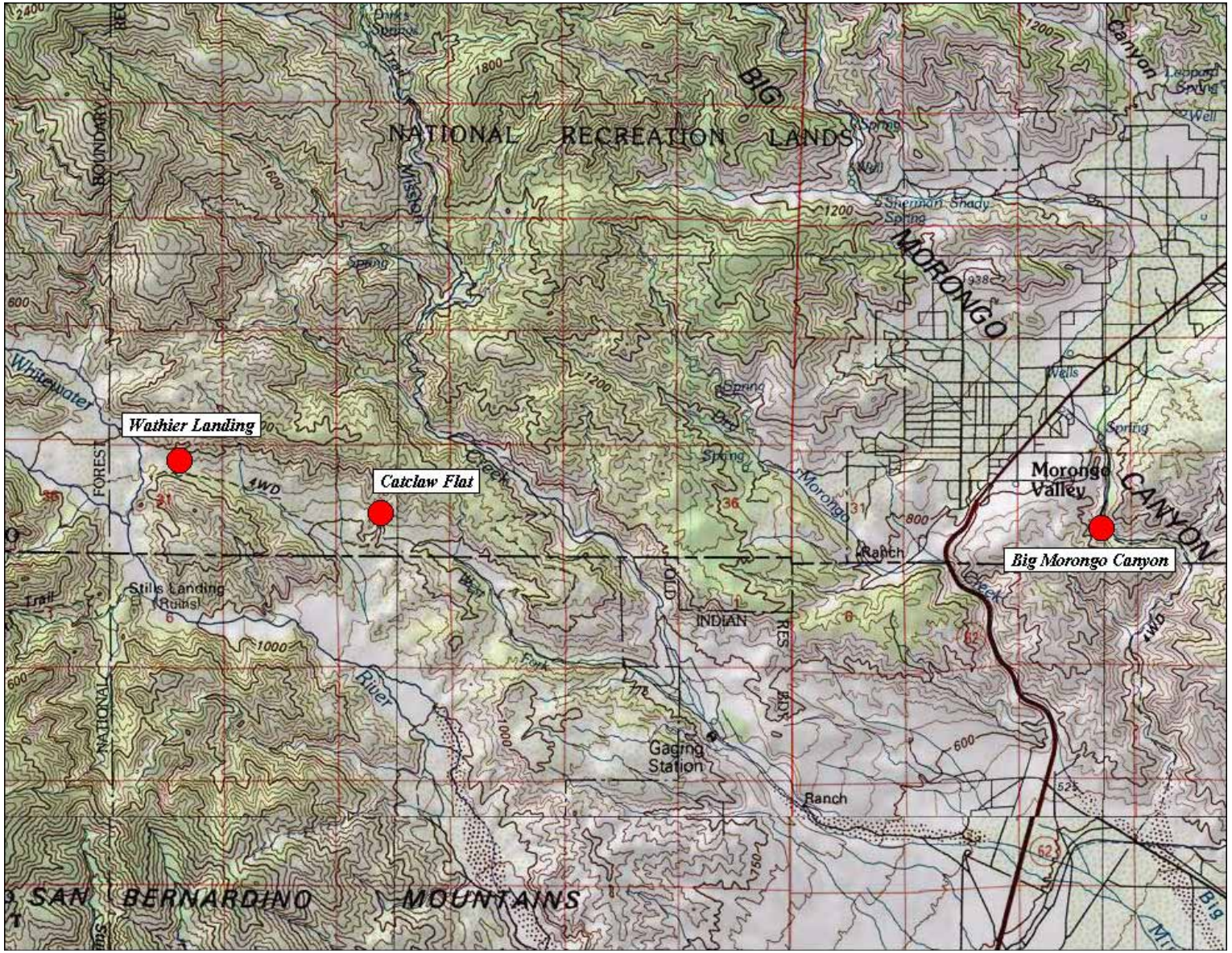
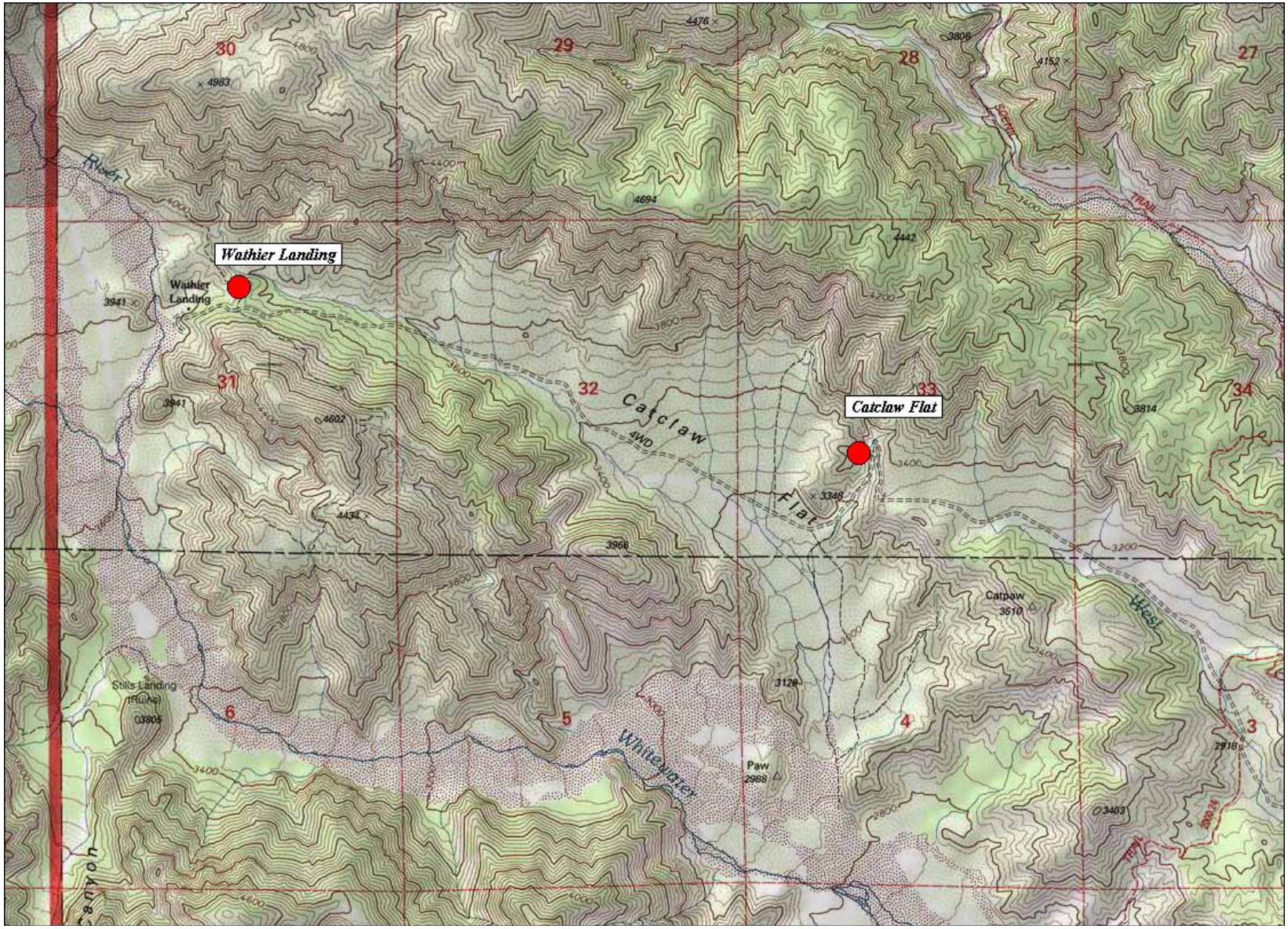
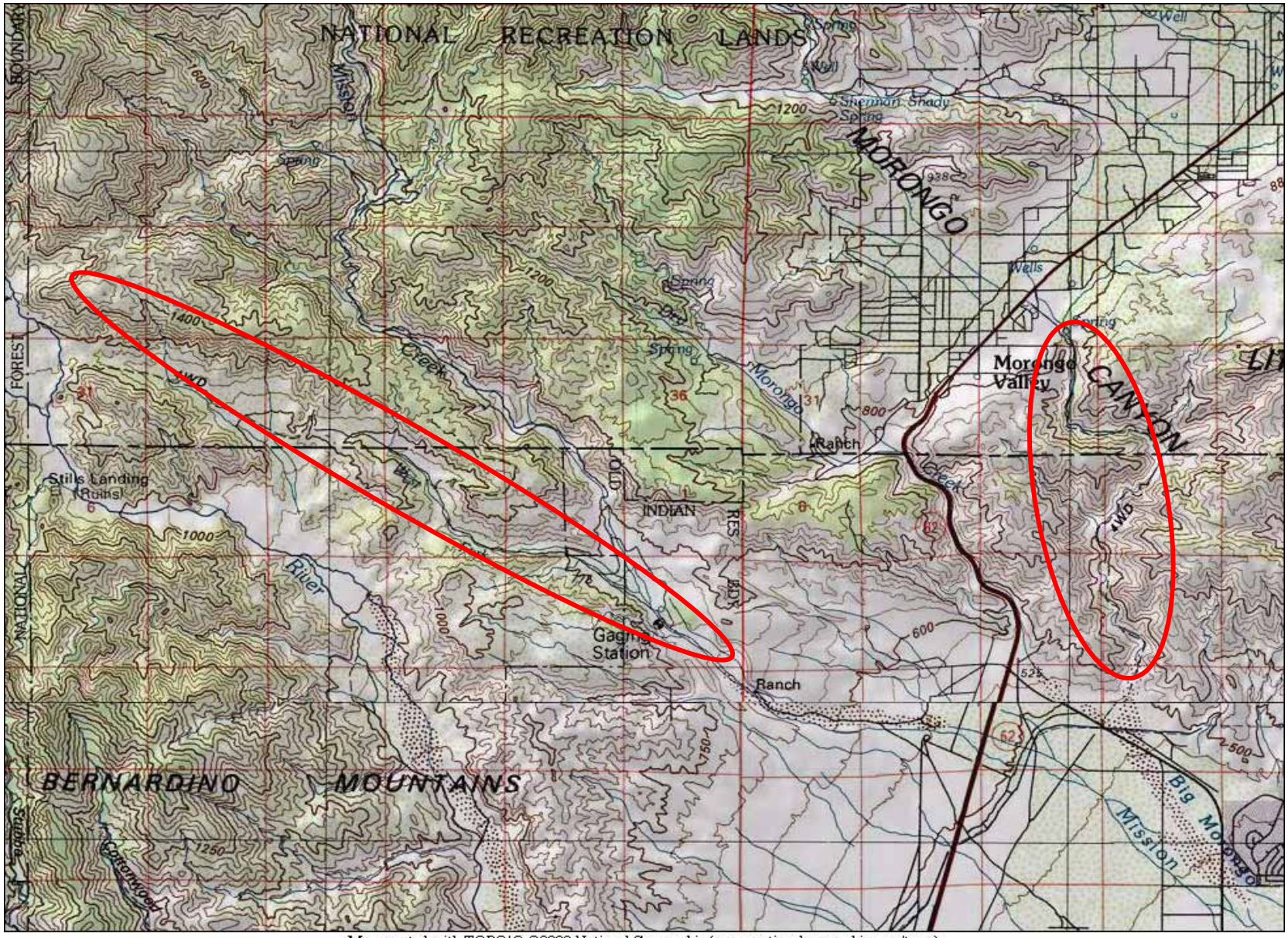
Appendices



Appendix A. Location of the three populations of *Astragalus tricarinatus* visited during our 2005-2006 evaluation. The Catclaw Flat population was discovered during our study.



Appendix B. Location of Wathier Landing (N34º 02.71´ W116º 42.53´) and Catclaw Flat (N34º 02.71´ W116º 42.53´) sites.



Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

Appendix C. Areas searched for *A. tricarinatus* populations in 2005-2006.