Mancos Milkvetch
(*Astragalus humillimus*)

5-Year Review
Summary and Evaluation

Photo: Robert Sivinski

U.S. Fish and Wildlife Service
New Mexico Ecological Services Office
Albuquerque, New Mexico

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5-YEAR REVIEW
Mancos milkvetch/*Astragalus humillimus*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest Regional Office, Region 2
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1.2 Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service or USFWS) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing as endangered or threatened is based on the species' status considering the five threat factors described in section 4(a)(1) of the Act. These same five factors are considered in any subsequent reclassification or delisting decisions. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process including public review and comment.

1.3 Methodology used to complete the review

The U.S. Fish and Wildlife Service (Service) conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act, as amended (Act) (16 U.S.C. 1531 *et seq*.). Public notice for this status review was published in the Federal Register on April 23, 2007 (72 FR 20134), requesting information on the status of *Astragalus humillimus* (Mancos milkvetch). Written comments were received from the Navajo Nation Department of Fish and Wildlife (2009), and a long-term demographic study report was received from the State of New Mexico Forestry Division (2008).

This review was a collaborative effort comprised of biologists from the Service's Region 2 Regional Office and New Mexico Ecological Services Field Office, the Region 6 Western Colorado Field Office, and the State of New Mexico Forestry Division. Several botanical and species experts in Colorado and New Mexico were contacted in spring of 2010 for updated information. Robert Sivinski, Botanist for the State of New Mexico Forestry Division, was contracted through a section 6 grant to gather relevant information and prepare a draft of this review. The final review and recommended classification were prepared by the New Mexico Ecological Services Field Office.

1.4 Background

The purpose of this 5-year review is to ensure that *Astragalus humillimus* has the appropriate level of protection under the Act. The review documents a determination by the Service of whether the status of the species has changed since the time of its listing. The review also provides updated information on the current threats, ongoing conservation efforts, and the priority needs for future conservation actions.

1.4.1 FR Notice citation announcing initiation of this review:

72 FR 20134: April 23, 2007

1.4.2 Listing History:

Original Listing
FR notice: 50 FR 26568
Date listed: June 27, 1985
Entity listed: Species, *Astragalus humillimus*
Classification: Endangered, without critical habitat

1.4.3 Associated rulemakings: None.

1.4.4 Review History: A 5-year review was initiated on November 6, 1991, (56 FR 56882) for all species listed before 1991, but no document was prepared for this species.

1.4.5 Species Recovery Priority Number at start of 5-year review: 2.
The recovery priority number is 2, indicating a high degree of threat, a high recovery potential, and the listed entity is a species.

1.4.6 Recovery Plan or Outline

Name of plan or outline: Mancos Milkvetch (*Astragalus humillimus*) Recovery Plan
Date issued: December 20, 1989
Dates of previous revisions: The recovery plan has not been revised.

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy

The Distinct Population Segment policy does not apply to *Astragalus humillimus* because it is not a vertebrate animal.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan? Yes.
Although there is a final recovery plan, it does not reflect up-to-date information on the species' biology, nor does it address all five listing factors that are relevant to the species. When the recovery plan was finalized in 1989, limited available data made it impossible to quantify habitat requirements with enough precision to establish further recovery criteria. Thus, while criteria for recovery, downlisting, and delisting were established, they are difficult to quantify and have not been met.

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No
The recovery plan lists one main goal which is to remove *Astragalus humillimus* from the Federal list of endangered and threatened species by managing the essential habitat to sustain natural populations in the wild. The delisting criteria within the recovery plan are meant to demonstrate (1) long-term stability of populations and habitat through at least 10 years of monitoring, and (2) continued assurances that threats have been alleviated for all presently known populations, and 75 percent of any plants and habitat has been discovered.

The criteria given for downlisting *A. humillimus* to threatened are summarized below, including known details on their current status.

1) Census and map all known populations.

   Known populations were surveyed and mapped for Navajo Nation, Bureau of Land Management, and State of New Mexico lands during the 1980s; monitoring plots for these three agencies were last surveyed in 2008 (see Section 2.3.1.2). Colorado Natural Heritage Program has census and map data for this species on Ute Mountain Ute tribal lands, but no new information has been collected since the late 1980s.

2) Use this data to develop formal documentation of long-term mineral, oil, gas, and energy development potential in the area.

   Navajo Nation, Bureau of Land Management, and State of New Mexico lands are managed to protect and minimize impacts to federal, state, or agency listed species regarding any mineral or energy development (see #3 below on habitat management plans). Each of these three agencies will determine the need to consult with the Service based on whether the proposed project location

overlaps with known populations previously surveyed and mapped. It is unknown if the Ute Mountain Ute tribe uses their census and map data (last prepared by Colorado Natural Heritage Program in the late 1980s) to manage for the protection of this species if and when mineral or energy development is proposed.

3) Develop a habitat management plan to administer mineral development in the area and to provide for this species' welfare.

   A habitat management plan with conservation recommendations was completed by the Nature Conservancy for Navajo Nation lands in 1992, but enactment of the provisions within the plan is unknown. Navajo Nation classifies this species as Group 2, which is defined as a species or subspecies whose prospects of survival or recruitment is in jeopardy. Bureau of Land Management classifies this plant as a sensitive species (SS) found in the Hogback Area of Critical Environmental Concern (ACEC). State of New Mexico and Ute Mountain Ute lands do not have management plans, even though the State of New Mexico considers this species to be "endangered" and Colorado State classifies this species as "rare."

4) Establish permanent long-term monitoring plots at population sites.

   All systematic plot monitoring ended in 2008 on State of New Mexico and Bureau of Land Management lands; only observational visits continue to be performed. The Navajo Nation established two permanent plots in 1991 located on the Hogback geologic formation; however, only one of these plots was relocated, remapped, and surveyed in 1991. The status of all known populations and known potential habitat on Navajo Nation lands was summarized in a 2009 letter to the Service. We are not aware of any long-term monitoring plots on Ute Mountain Ute tribal lands.

The recovery plan also contains an implementation table of prioritized actions to recover *A. humillimus*. These actions address the stated recovery goal, but cannot be quantified. Of the 13 actions recommended, 3 have been implemented or are ongoing, including:

1) enforcement of existing laws;
2) research into the species ecological requirements; and
3) research regarding seed biology.

Although the downlisting criteria and prioritized actions provide guidance for recovery, they do not offer benchmarks for measuring progress towards recovery or specifically address current threats. Even though the original listing factors remain relevant to this species, climate change (specifically severe drought) and off-road vehicle use are now recognized as additional threats to this species' recovery.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history

Morphology, reproductive biology, and phenology
Astragalus humillimus is a diminutive, tufted perennial growing in clumps up to 30 centimeters (cm) (12 inches [in]) across with a dense crown of persistent spiny leaf stalks; no other mat-forming *Astragalus* species has persistent, subspinescent petioles (Barneby 1964). Stems are up to 1 cm (0.4 in) long and are crowded with leaves up to 4 cm (1.6 in) long (Barneby 1964). Flower branches support 1 to 3 lavender/purplish flowers with a conspicuous lighter-colored spot in the throat of the corolla tube (Service 1989). *Astragalus humillimus* flowers in late April and early May (Service 1989). Root systems proliferate about 7 cm (3 in) below the surface (Service 1989). Larger plants may produce over 100 flowers in a growing season and fruits mature by mid-June (Service 1989). The fruit is egg-shaped and laterally compressed measuring about 4.5 millimeters (mm) (0.2 in) long and 2 mm (0.1 in) in diameter (Barneby 1964), and each produces 4 to 9 seeds (Service 1989). In New Mexico, monitoring results revealed that it takes two growing seasons for seedlings to mature with flowering into the third or fourth year as compared to other species of *Astragalus*, which typically take one growing season to bloom (New Mexico State Forestry Division 2008).

Pollination biology
Astragalus humillimus plants produce viable fruit by outcrossing and self-pollination (Tepedino 2002). Flowers of rare plants, including *A. humillimus*, often require pollination by native bees to produce seeds (Tepedino 2002). Possible pollinators of *A. humillimus* were studied in 1989 by the Bee Biology and Systematics Laboratory for the Navajo Nation; a full list is provided in the Habitat Management Plan for Navajo Nation (House and Engelking 1992). They found the most common visitors were two members of the bee family Megachilidae: *Osmia titusi* and *O. sculleni*. Honey bees and butterflies, including the painted lady butterfly (*Vanessa cardui*), were also noted as potential pollinators (Service 1989). Fruit set is generally good and no pollinator limitations were detected (Tepedino 2002).

Habitat, geology, and plant community
This species occurs on sandstone substrate ledges and mesa tops in cracks or shallow bowl-like depressions (tinajas) that accumulate sandy soils and rainfall (Service 1989; New Mexico State Forestry Division 2008). Populations are found along the Colorado Plateau subdivision of the Great Basin Desert of northwestern New Mexico and southwestern Colorado within pinyon-juniper woodland and desert scrub communities (Dick-Peddie 1993). Potential habitat corresponds to rimrock outcrops of the Point Lookout and Cliffhouse members of the Mesa Verde sandstone series with flat or gently sloping surfaces at an average elevation

of 1,854 meters (m) (5,650 feet [ft]) (Service 1989). This species is confined to large sheets of exfoliating whitish-tan colored sandstone (New Mexico State Forestry Division 2008) alongside *Fraxinus anomala* (single leaf ash), *Brickellia microphyla* var. *scabra* (scabrous bricklebush), *Cercocarpus intricatus* (small leaf mohagany), and *Ipomopsis roseata* (rosy ipomopsis) (Service 1989). Overall cover is very low (less than five percent), and resource competition for all of these species is minimal (Service 1989). At a broader landscape scale, dominant plant associates are *Achnatherum hymenoides* (Indian ricegrass), *Gutierrezia sarothrae* (broom snakeweed), *Yucca angustissima* (narrow leaf yucca), and *Artemisia tridentata* (big sagebrush) (Service 1985).

Fecundity and genetic variability

At the time of listing, a limited amount of information was available about the species' life history and habitat requirements. While the 1989 Recovery Plan identified specific information needs, few studies have been conducted to increase our knowledge. Many Federal permits have been issued for collection and study of this species since the early 1980s, but only a few of these research projects have been completed. One final report involved research on several populations of *Astragalus* from Arizona and New Mexico, including *A. humillimus*, which were assessed for morphological, reproductive, genetic, and ecological differences (Allphin et al. 2005). Results suggest that two endangered taxa, *A. humillimus* and the closely related *A. cremnophylax* var. *cremnophyla*x (sentry milkvetch), appear to have low fecundity (fertility). The authors suggest that environmental fluctuations would not likely be a contributing factor to their small population size; instead, low fecundity and reduced genetic variability is more likely due to inbreeding depression (Allphin et al. 2005). Reduced fitness is commonly found within the *Astragalus* genus where many species persist in small, highly restricted populations and are endemic to particular geologic formations (Karron 1989).

Mycorrhizal associations

The Arboretum at Flagstaff, an ongoing Federal permittee, is conducting studies on *A. humillimus* seed biology and ecological requirements (Service 2010). Seed germination trials from the Arboretum's early work show that this species is difficult to keep in cultivation and is sensitive to over or under-watering; no seeds germinated in the first trial with seeds collected from 1993 (Center for Plant Conservation 2010). Other preliminary results found that soils collected from the Hogback ridge sandstone were low in arbuscular mycorrhizal fungi inoculum potential; these soils were just slightly higher in inoculant capacity than sterile potting soil (Haskins and Murray 2009). Mycorrhizal fungi are found in root tissues and increase the efficacy with which plants harvest soil minerals necessary for plant growth (Graham et al. 2006). Because *Astragalus* species are generally mycorrhizal dependent, this lack of mychorrhizae could be detrimental to the long-term persistence of *A. humillimus* (Haskins and Murray 2009). Another listed species in the same study, the sentry milkvetch (*A. cremnophylax* var. *cremnophylax*), which is genetically related to *A. humillimus* and found in nearby

Grand Canyon National Park, had much higher mychorrhizal inoculant capacity in occupied soils (Haskins and Murray 2009). More studies are underway to better understand the implications of this fungi-soil relationship.

2.3.1.2 Abundance, population trends, demographic features, or demographic trends

Astragalus humillimus is a narrow endemic known only from the Four Corners region of New Mexico, San Juan County, and adjacent Montezuma County, Colorado. Species distribution closely follows a narrow band of Mesozoic (Point Lookout and Cliff House) sandstone along a 10-mile section of the Hogback geologic formation (Service 1989). Prior to 1989, there were a total of 13 known populations with 3 of these located on Ute Mountain Ute tribal lands in Colorado (Service 1989). Since the completion of the recovery plan in 1989, the Colorado populations have not been monitored. New plots were installed for Bureau of Land Management (BLM) and State of New Mexico lands starting in 1990. Only Navajo Nation found their 13 previously known populations, along with one new population, allowing for some long-term comparisons to past population numbers.

SPECIFIC STUDY AREA STATUS AND TRENDS

COLORADO

Ute Mountain Ute: In 1987, there were four populations of *A. humillimus* in Colorado on Ute Mountain Ute tribal lands; surveys were done by employees of the Colorado Natural Heritage Program (Colorado Natural Heritage Program 2010). In 1987, the total estimated sum of individuals from the four populations was 4,421 with total occupied habitat about 43 hectares (ha) (106 acres [ac]); approximately 0.2 ha (0.5 ac) per population (Colorado Natural Heritage Program 2010). Since 1987, access has been restricted, and no new information about these populations has been provided to the Service.

NEW MEXICO

Bureau of Land Management: In 1990, five plots were installed on a rim of sandstone at Slickrock Flats on the northwest BLM boundary with Navajo Nation (New Mexico State Forestry Division 2008). These plots were read annually until 1999, then in 2002 and 2008 with an informal site visit in 2010. Plots were located on specific habitat (a single tinaja or crack segment) over 3.1 ha (7.6 ac). Initially, density (total plant counts), mortality, and recruitment were recorded. However by 1993, it became apparent that single plants were coalescing into single larger masses. Thus, new measurements were developed to determine at a minimum "population vigor" (total plant cover) while still counting new seedling density.

Severe mortality occurred prior to the installation of plots; drought years were 1988 and 1989. On average, there was 60 percent mortality based on dead versus live plant counts. Some tinajas experienced a 100 percent mortality rate possibly due to the nature of these small exposed depressions versus sandstone cracks. Sandstone cracks are deeper and more protected from moisture loss and appeared to have higher adult populations over time (New Mexico State Forestry Division 2008). Starting in 1990, seedling density varied from a high of 71 individuals in 1997 to a low of zero plants in 2002 (Figure 1). No monitoring was done in 2003 which was the second year of a severe and ongoing drought for this region (Western Regional Climate Center 2010). By 2008, only two plots had any seedlings (four seedlings total were found). During the 2010 informal site visit, a stable, possibly increased population of adults was observed based on 2008 plant numbers, but cover estimates and seedling counts were not conducted.

Results of total plant cover in squared centimeters (cm^2) for all five BLM plots combined revealed the highest cover of 2,354 cm^2 during 1993, and the lowest cover value in 2008 (92 cm^2) with the complete loss of plants in two of the plots (Figure 2).

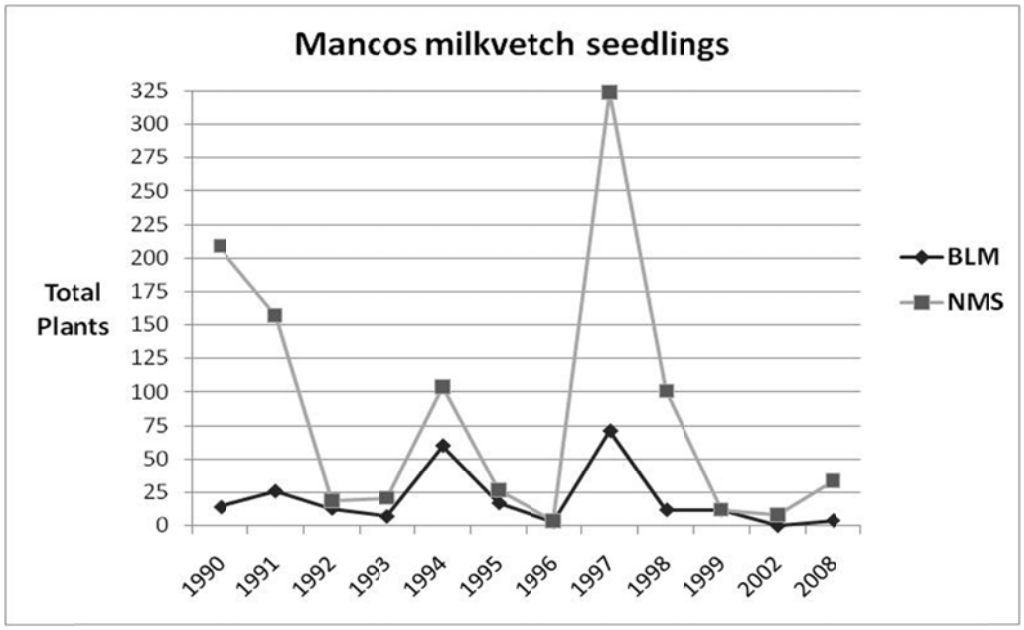

Figure 1. *Astragalus humillimus* seedling density (total seedlings per year) for five plots each on New Mexico State (NMS) and Bureau of Land Management (BLM) lands. Plots were read during June of each year from 1990 to 1999, then 2002 and 2008. Data provided by New Mexico State Forestry (2008) and figure developed by Service (2010).

State of New Mexico: Originally in 1988, a one hectare monitoring plot was placed at the Sleeping Rocks population on State of New Mexico lands. Results from 1988 found 54 percent of the population was in the seedling and juvenile age class indicating a high level of reproduction at that time (New Mexico State Forestry Division 2008). A prolonged drought occurred in late 1988 through

1989. By 1990, all the steel plot posts were missing from this original monitoring plot, so five new plots of variable sizes was installed over 2 ha (5 ac). These plots were surveyed annually from 1990 until 1999, then in 2002 and 2008 with an informal site visit in 2010. Plots were measured in the same manner as described above for BLM.

Results were similar to the BLM plots described above except that seedling density was higher overall. From 1990 to 2008, seedling density varied from a high of 324 individuals in 1997 to a low of four plants in 1996 and eight in 2002 (Figure 1). By 2008, only one plot had any live plants (n=34); in 1997, this plot had a high of 303 plants. During the 2010 informal site visit, a stable population of adults was observed with some recent dead plants based on 2008 plant numbers, but cover estimates and seedling counts were not conducted.

Results of total plant cover in cm^2 for all five State of New Mexico plots combined revealed the highest cover of 4,443 cm^2 during 1993, and the lowest cover value in 1996 (640 cm^2) with the complete loss of plants in one of the plots by 2008 (Figure 2). However, plant cover remained relatively high for two plots averaging 665 cm^2 by 2008. During a 2010 informal site visit, there appeared to be a decrease in overall plants based on 2008 numbers, but cover estimates and seedling counts were not conducted.

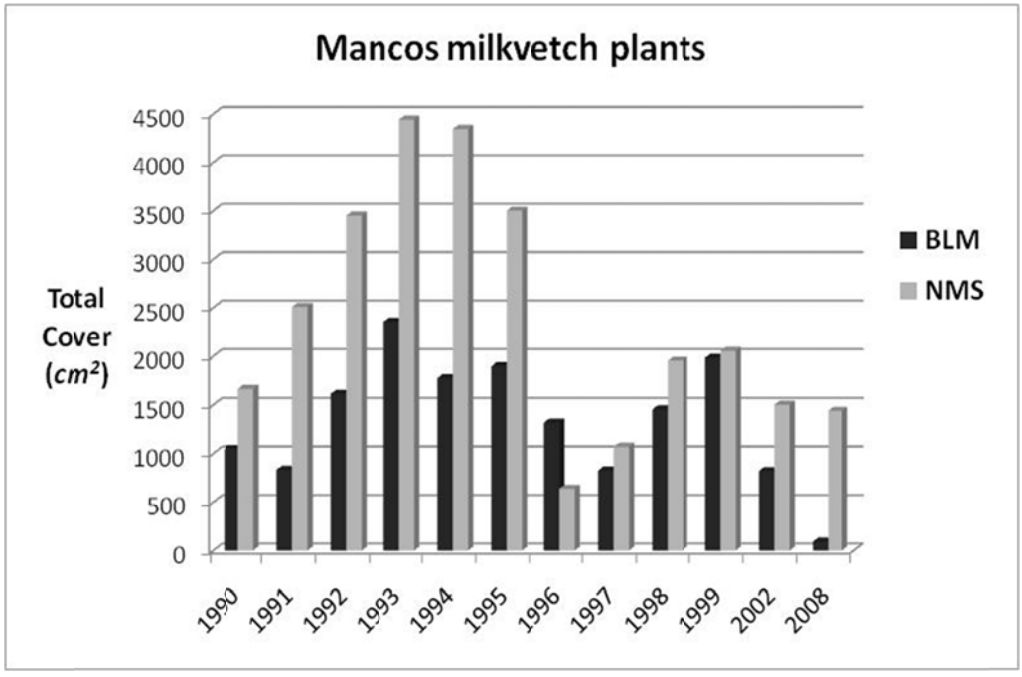

Figure 2. *Astragalus humillimus* total cover (cm^2) for plants found in five plots each on New Mexico State (NMS) and Bureau of Land Management (BLM) lands. Plots were read during June of each year from 1990 to 1999, then 2002 and 2008. Data provided by New Mexico State Forestry (2008) and figure developed by Service (2010).

Navajo Nation: The Navajo Natural Heritage Program has 13 historical population records for *A. humillimus*. In 2007 and 2008, the Program Botanist, Daniela Roth, resurveyed known populations as well as potential habitat in the Hogback and Palmer Mesa areas. When surveys were conducted in 2007 and 2008, 13 populations were found. However, plants at one of these 13 locations appeared to be extirpated, and one population was newly discovered, but contained only a single individual. Total plant counts in known populations clearly indicate a precipitous decline (Table 1).

Table 1. Historical records and recent survey results summarized for *Astragalus humillimus* (Navajo Natural Heritage Program 2008a).

Site	1980s (*approximate*) counts	2007 or 2008 counts	Notes
1	500	35	
2	200	115	All age classes
3	500	28	90% juveniles
4	200	14	
5	4,200	11	
6	1,700-2,000	100	Oil & gas activity
7	++	++	*BLM ACEC
8	50	8	
9	a few	12	
10	-	-	Cannot relocate
11	100s	35	
12	17	7	
13	30	20	
14		1	Newly found.
	TOTAL: ~7,500	**TOTAL: 386**	

*Bureau of Land Management Area of Critical Ecological Concern

++ Monitoring data in New Mexico State Forestry Division 2008 final report.

Historical records indicated that during the 1980s, total known population size was approximately 7,600 individual plants on Navajo Nation lands. By 2008, less than 400 plants were found in 12 populations and only 2 of the 12 populations (17 percent) had more than 50 live plants (Navajo Natural Heritage Program 2008a; Navajo Nation Department of Fish and Wildlife 2009). Other 2008 results found the majority of plants remaining were small to medium in size; dead plants were observed in almost all locations; plants were widely scattered and only a very small fraction of the habitat was occupied; and 82 percent of the plants were ranked as fair to poor based on low plant numbers, plant condition, and landscape context (Navajo Natural Heritage Program 2008a; Navajo Nation Department of Fish and Wildlife 2009).

Other *Astragalus humillimus* surveys: In 2006, presence/absence data was collected for this species along a 25.8 kilometer (km) (16 mile [mi]) right-of-way for the Segment A, Shiprock Substation, Navajo Transmission Project which included a small section of BLM land; no *A. humillimus* were found (Ecosphere Environmental Services 2006).

In 2007, Western Area Power Administration contracted a botanical survey for the existing Lost Canyon-Shiprock and Kayenta-Shiprock Transmission Lines, approximately 45 km (28 mi) across Navajo Nation, New Mexico State, and Bureau of Land Management lands; 71 *A. humillimus* were found (56 live and 15 dead) all on BLM land (Ecosystems Environmental Services 2007).

In 2008, Ecosphere Environmental Services performed *A. humillimus* presence/absence surveys on five oil and gas wells (Navajo #5, Navajo B #2, Navajo C #5, Mesa Gallup Unit #15, and Navajo G #222). All wells are located on Navajo Nation lands along the Point Lookout Sandstone mesa, and only the Navajo B #2 well location and associated pipeline had plants onsite. Two main populations were recorded with a total count of 109 plants (Ecosphere Environmental Services 2008b). As of 2011, BLM stated that most of the wells have been plugged and abandoned, and because the work required a biological monitor on site, the plants should have been protected (Kendall 2011).

There are major individual site differences with regard to *A. humillimus* seedling density and mature plant cover. Despite these differences, it appears that maximum population development and density occur on larger, relatively flat surfaces with numerous cracks and tinajas that accumulate soil and rainfall (New Mexico State Forestry Division 2008). This observation is supported by distinct site differences found between the BLM and State of New Mexico plots. The BLM plots are all within a larger sandstone surface containing many sizable tinajas; whereas, the State of New Mexico plots are smaller sandstone islands with fewer depressions for soil and moisture deposition (New Mexico State Forestry Division 2008).

Astragalus humillimus germination and initial seeding survival appear to be positively related to the death of older plants and subsequent moisture availability (New Mexico State Forestry Division 2008). This availability may be due to increased precipitation events aboveground in conjunction with moisture/nutrient releases belowground from the loss of adult root biomass. Seedling establishment and adult cohort mortality cycles may also be related to shade limitations (foliar canopy is reduced) and space limitations (sites become available for germination). Mortality of older plants (five to seven years of age) appeared to increase during and possibly after drought years, but dry conditions were also often associated with spider mite infestations, which could hasten mortality (New Mexico State Forestry Division 2008).

2.3.1.3 Genetics, genetic variation, or trends in genetic variation

Even though specific genetic studies are needed, inferences can be made from research on several rare *Astragalus* species in Arizona and New Mexico. Results from Allphin et al. (2005) suggest that two endangered taxa, *A. humillimus* and the closely related *A. cremnophylax* var. *cremnophyla*x, appear to have low fecundity (fertility) and environmental fluctuation is not likely a contributing factor to small population size (Allphin et al. 2005). Moreover, one of two populations of *A. cremnophylax* var. *cremnophyla*x (North and South Rim of Grand Canyon, AZ) was found to be genetically depauperate (lacking genetic diversity) indicating a bottleneck caused by historic trampling on the South Rim, and was less related genetically to the North Rim population than other taxa within this species complex (Allphin et al. 2005). These results suggest that inherent low fecundity and potential bottlenecks due to isolation could negatively affect *A. humillimus* populations through loss of genetic variation as reported for the closely related species *A. cremnophylax* var. *cremnophylax.*

2.3.1.4 Taxonomic classification or changes in nomenclature

Taxonomic classification of *A. humillimus* has not changed since the recovery plan was finalized in 1989.

2.3.1.5 Spatial distribution, trends in spatial distribution or historic range

The distributional range of *A. humillimus* has not changed since the recovery plan was finalized in 1989. Although there is suitable habitat within Ute Mountain Ute tribal lands, we are not sure if any new surveys have been done due to lack of communications from the tribe.

2.3.1.6 Habitat or ecosystem conditions

Climate

Astragalus humillimus is a narrow endemic with very specific habitat needs in shallow tinajas, and appears to be sensitive to ecosystem conditions affected by changes in climate, particularly precipitation. The recent drought (2002-2003) spanning southwestern North America was anomalously dry, but is different from the 1950s drought in having unusually high temperatures (higher annual maximum and minimum temperatures as well as higher average summer temperatures) (Breshears et al. 2005). The IPCC (2007) predicts the average annual temperature in the southwest region of the United States could rise by about 2.5 to 3.9 º C (4.5 to 7 º F) during this century. This increasing rate of 0.56 º C (1.0 º F) every 14 years has already been surpassed in Arizona since the 1970s, and New Mexico is just slightly below this rising temperature rate (Lenart et al. 2007).

Hydrologic trends in the Southwest are less clear except when considering snow; less snowpack, and earlier spring melt and runoff in the Intermountain West states is substantiated (Parmesan and Galbraith 2004; Udall and Bates 2007), yet the southwestern states show a long-term trend of increased precipitation since the 1970s (Parmesan and Galbraith 2004; Udall and Bates 2007; Enquist and Gori 2008). New Mexico precipitation changes show more variation than temperature, with about 54 percent of the state trending toward wetter conditions, 41 percent toward drier, and 5 percent with no discernable change between 1991 and 2005 (Enquist and Gori 2008).

Spatial heterogeneity of drought as defined by temperature, and particularly precipitation, is extremely variable in the state of New Mexico (Enquist and Gori 2008). To look at precipitation more locally can reveal site specific trends particular to a narrow endemic such as *A. humillimus*. Average annual precipitation in Shiprock, New Mexico, an area in which *A. humillimus* is known to occur, has been 157 mm (6.2 in) from 1926 to 2000 (Western Regional Climate Center 2010). In 2002, no precipitation was recorded, and by 2004, 33 mm (1.3 in) was recorded which is the third lowest level measured since 1926 (Figure 3). Mean annual precipitation since the drought (2003-2007) was 97 mm (3.8 in), well below the long-term average (Western Regional Climate Center 2010).

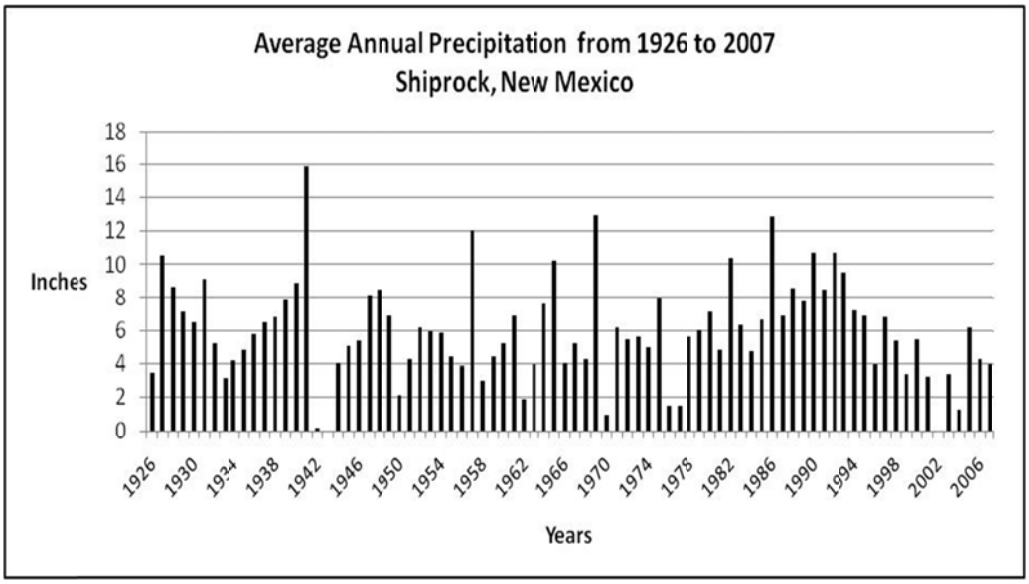

Figure 3. Average annual precipitation totals (inches) from 1931 to 2007. Data retrieved from the Western Regional Climate Center (2010) and figure developed by Service (2010).

At the population level, *A. humillimus* is a spring flowering species (Service 1989). Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and because this plant has a

limited distribution, we would predict a substantial population reduction associated with a long-term warming trend.

At the microsite level, *A. humillimus* is found in small depressions on sandstone substrates where cracks and fissures accumulate sands and form small soil pockets that support root systems that can extend 3 to 8 cm (1.1 to 3.1 in) below the surface (Service 1989, New Mexico State Forestry Division 2008). These distinct sites are affected by the slightest change in precipitation and temperature, and *A. humillimus* appears to respond quickly to the change. Study results indicated that this plant fared better in habitats consisting of deep cracks in the bedrock where depth provides shade and lower temperatures, increasing the amount and length of time when moisture is available to plants, particularly during drought years (New Mexico State Forestry Division 2008).

Increases in herbivorous insects, both native and nonnative, are also predicted with changes in climate, and will adversely affect many species (Enquist and Gori 2008). This herbivory was documented since the 1980s for *A. humillimus* during many of the drier years. During the drought of 2002 and 2003, an infestation of spider mites entirely covering many mature plant clumps often contributing to mortality of already stressed plants (Service 1989, Sivinski and Knight 2001, New Mexico State Forestry Division 2008). Spider mites feed on the leaf surface and these injured leaves are shed more quickly, and eventually the whole plant may die. Even a minor spider mite infestation can have a significant impact on a plant's health.

Since the documented decline of *A. humillimus* is concurrent with drier years and the severe drought of the early 2000s, we would expect that if a change in climate led to increased severity or frequency of drought, it would have a negative impact on the species. Narrow endemics, like *A. humillimus*, often have very specific habitat requirements. Because plants are unable to move, a change in climate that causes mortality that exceeds reproduction and recruitment, could lead to the extirpation of *A. humillimus*. We believe the 2008 low population numbers are likely caused by cumulative losses since the 1980s due to several notable drought periods for this region. Continued long-term effects on their population numbers may not be entirely evident until drought conditions cease to exist. Some recovery, particularly for new seedlings, has occurred but appears to be triggered by both adult plant mortality and increased moisture events.

2.3.2 Five-Factor Analysis

2.3.2.1 Present or threatened destruction, modification, or curtailment of its habitat or range – Factor A:

Major threats to *A. humillimus* continue to be from surface disturbance activities associated with energy exploration and development, and transmission line construction and maintenance (Service 1989; House and Engelking 1992; Bureau

of Land Management 2007; Navajo Nation Natural Heritage Program 2007, 2008a, and 2008b; Navajo Nation Department of Fish and Wildlife 2009). Threats to habitat or range summarized below include:

(1) energy exploration and development;
(2) transmission lines; and
(3) off-road vehicles.

Energy Exploration and Development: The majority of known occupied and potential *A. humillimus* habitat is located on the Navajo Nation lands. Most of this habitat is located on Palmer Mesa and the Hogback areas covering approximately 16,187 ha (40,000 ac) on Navajo Nation lands. These areas contain active and plugged oil and gas wells, including numerous roads associated with these activities. Navajo Nation and BLM lands contain significant deposits of oil and natural gas, and the development of these energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). Nearly all known and potential *A. humillimus* habitat may be affected by natural gas or oil exploration and development. Most damage occurs after vehicles and heavy equipment drive over and crush individual plants as well as break apart sandstone areas that contain tinajas, which are required for *A. humillimus* seedling establishment (Navajo Nation Department of Fish and Wildlife 2009).

Since listing, several reports documented negative effects to *A. humillimus* populations. In 2007, the Navajo B Well #2 well plug and abandonment operation either crushed (11 plants) or killed (6 plants) all of the plant population within the disturbed area on west Palmer Mesa; damage was caused by industry vehicles driving off the designated well pad and existing road (Navajo Natural Heritage Program 2007; Bureau of Land Management 2007). The vehicles and heavy equipment also fractured sandstone, compacted soils, and created a new spur road that bisected part of this *A. humillimus* population (Navajo Natural Heritage Program 2007). In addition to this disturbance, but unrelated to the well activities, a pipe and electrical line were found nearby above ground with no history of installation; one plant appeared to have died from the line with eight live plants remained next to or under the line (Bureau of Land Management 2007).

In 2008, a separate incident occurred in the same general vicinity of Navajo B Well #2 where heavy equipment drove over several *A. humillimus* plants (they survived), but the surrounding habitat was extensively damaged (Navajo Natural Heritage Program 2008b). Several days later, two backhoes were found parked two miles away still encrusted in heavy mud. The impacts started nearby the well site, but also occurred alongside several access roads and involved tracks to other well sites within a two-mile radius. Significant scraping of the soil surface occurred, and the construction of an earthen berm and trenching for a pipeline was also recorded by Navajo Nation and BLM law enforcement (Navajo Natural Heritage Program 2008b). Due to the wet conditions at the time, severe backhoe

damage occurred over two miles of sandstone and tinaja habitat essential to *A. humillimus* populations (Navajo Natural Heritage Program 2008b).

As of 2011, BLM has no new oil and gas development in the Hogback ACEC since 2008, only maintenance for existing wells (Kendall 2011). Presently, there are 7-8 active oil wells (one gas well) in the entire ACEC with over 30 plugged and abandoned wells, thus oil and gas development is nonexistent at this time (Kendall 2011).

The Desert Rock Energy Project (DREP) has been proposed by the Bureau of Indian Affairs (BIA) and is within the range of this species. The biological assessment for the project found that *A. humillimus* will be exposed to and adversely impacted by the deposition of contaminants from two other existing power plants as well as DREP (Ecosphere Environmental Services 2008a). The significance of these impacts to *A. humillimus* is unknown at this time because the DREP consultation has not been completed.

Astragalus humillimus populations and their habitat have been negatively impacted by crushing from vehicles and equipment, direct removal and destruction from energy-related activities, and indirect effects of unauthorized traffic using roads constructed by oil and gas companies. Oil and gas well construction has resulted in a variety of unauthorized roads, multiple pipelines, and small but enduring piles of waste, all of which further degrade *A. humillimus* habitat over the larger landscape. Also, some habitat damage has been reported by Navajo Nation from vandalism associated with theft of copper cables running between oil wells (Navajo Natural Heritage Program 2008b). Thus, we believe oil and gas development remains a severe threat to the species and will likely increase in the foreseeable future.

Transmission Lines: Transmission lines have likely impacted *A. humillimus* populations because potential habitat and recently surveyed plants have been found along several major transmission line corridors (Ecosphere Environmental Services 2007). A large population of approximately 1,000 plants was bisected by two major transmission lines, the Glen Canyon-Shiprock and the Curecanti-Shiprock transmission lines, which were constructed in 1962 and 1963 prior to the National Environmental Policy Act taking effect (50 FR 26570). Immediate impacts were complete scraping of topsoil and vegetation directly underneath the power line, thus it is unknown how many plants may have been destroyed. Since that time, any plants underneath and nearby the power line have been driven over by either maintenance vehicles or off-road recreation vehicles. At the time of listing in 1985, no repopulation had occurred, but the most recent survey done by Western Area Power Administration found 71 plants over approximately 45 km (28 mi) of Navajo Nation, State of New Mexico, and BLM lands; total area surveyed was 138 ha (342 ac) (Ecosphere Environmental Services 2007).

The 1992 Habitat Management Plan (HMP) for *A. humillimus* describes the extensive transportation system within and surrounding Navajo Nation lands. This system, consisting of roads and corridors, is being developed by BIA, Navajo Nation, private corporations, and individuals, with little coordination between these entities on the protection of rare and endangered species' habitat (House and Engelking 1992). The HMP also mentions the increased demand for utilities, which has led to disturbance of *A. humillimus* habitat. For example, in the early 1980s a powerline and tower were constructed within the Hogback population of *A. humillimu*s destroying the northern part of this population (Service 1989). Similarly, the southern part of this population was also extirpated during the same period from a rock quarry operation (Service 1989). No new plants have ever been found in this area (Navajo Natural Heritage Program 2008a).

Impacts are generally associated with maintaining transmission line roads and the associated vehicles that crush plants. Conservation measures recommended in the recovery plan (Service 1989) and the HMP for Navajo Nation lands (House and Engelking 1992), such as avoidance and transplanting, could minimize impacts within the construction footprint of these types of projects. We do not know if these conservation measures were enacted on past projects, and whether they are being implemented currently. Thus, we believe that the ongoing impacts associated with transmission lines could be severe if they involve *A. humillimus* habitat, but could be easily mitigated by implementing recommended conservations measures along these proposed corridors.

Off-Highway Vehicles: Off-highway vehicles (OHVs) were not a threat until recently, but their impacts are now being considered. The recreational use of OHVs has increased dramatically since the plant was listed. This increase is most likely due to the recent expansion of oil and gas extraction and the resultant population growth within San Juan County. From 1980 to 2006, the human population of San Juan county increased by 55 percent (http://wrdc.usu.edu/htm/publications/). OHV-related damage to *A. humillimus* and its habitat has increased, especially around oil and gas well pads and transmission line corridor roads (Service 1989; House and Engelking 1992; Bureau of Land Management 2007; Navajo Nation Natural Heritage Program 2007, 2008, and 2008b; Navajo Nation Department of Fish and Wildlife 2009).

Unauthorized roads, trails, and recreational OHV use on sandstone cliffs and outcrops have been observed on and near known populations of *A. humillimus* (Bureau of Land Management 2006). For example, surveys undertaken in 2006 on BLM plots found scattered glass and OHV tire marks where 24 plants were found alive and 11 dead; cause of mortality was unknown, but this site is a popular recreational parking area with unrestricted access (Bureau of Land Management 2006). Not only did several plants appear damaged from being crushed, but their micro-habitat (small depressions or tinajas) has been fractured leaving a dearth of required habitat for future seedling establishment. Although

most OHV activity is restricted to the southern part of the ACEC (outside of known milkvetch habitat), the potential for impacts still exists (Kendall 2011). Lack of law enforcement continues to be problematic for both BLM and Navajo Nation. We believe that use of OHVs is presently a moderate threat to this species and will likely increase in the foreseeable future.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes – Factor B:

Overutilization for commercial, recreational, scientific, or educational purposes has not been documented for *A. humillimus*. The species has no known commercial use and illegal collection does not appear to be a threat currently or in the foreseeable future.

2.3.2.3 Disease or predation – Factor C:

No diseases have been observed on this species. Herbivory by wildlife and livestock has not been reported although no formal studies have been conducted. Livestock grazing is not considered a current threat, or a threat for the foreseeable future. Some insect herbivory by seed weevils and *Lepidoptera* larvae has been reported (NatureServe 2010), but appears to occur at insignificant levels during favorable rainfall years (New Mexico State Forestry Division 2008). Spider mite infestations have been recorded and appear to kill plants particularly during drought periods when the plant is already stressed (Siviniski and Knight 2001). The mites pierce the epidermis to ingest the sap which results in leaf discoloration and death, weakening the plant even further and causing mortality (Sivinski and Knight 2001). Insect infestations appear to be relatively rare, but could increase if drought continues into the foreseeable future. Thus, insect predation is considered a minor threat at this time.

2.3.2.4 Inadequacy of existing regulatory mechanisms – Factor D:

Astragalus humillimus was listed as threatened without critical habitat in June 1985 (50 FR 26568). The Act is the primary Federal law providing protection for the species. Beyond the listing of the species, these protections are afforded particularly through sections 7 and 9 of the Act. Section 7 of the Act requires Federal agencies to ensure that any action authorized, funded, or implemented by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat, if critical habitat has been designated. Section 7 also encourages Federal agencies to use their authorities to carry out programs for the conservation of listed species. Section 9 of the Act prohibits the removal, damage, or destruction of listed plants on Federal lands and on other areas in knowing violation of any State law or regulation or State criminal trespass law.

The National Environmental Policy Act (NEPA) may provide some protection for *A. humillimus* for projects with a Federal nexus (i.e., funding, authorization, or

permitting). NEPA requires that the planning process for Federal actions be analyzed to ensure that effects on the environment are considered. The NEPA process is intended to help public officials make better decisions based on an understanding of the environmental consequences of their actions and to take actions to protect, restore, and enhance the environment (40 CFR 1500.1). Carrying out the NEPA process ensures that agency decision makers have information about the environmental effects of Federal actions and information on a range of alternatives that will accomplish the project purpose and need.

Federally listed plants occurring on private lands have very limited protection under the Act unless they are also protected by State laws. *Astragalus humillimus* is listed as endangered by the State of New Mexico under the New Mexico Endangered Plant Species Act, Section 75-6-1 NMSA 1978, which protects it from unauthorized collection, transport, and sale, but provides no protection from land use impacts. There are no regulatory protections for federally listed threatened and endangered plant species from surface disturbing land uses on private or state owned lands in New Mexico, unless they are authorized, funded, or carried out by a Federal agency and subject to section 7 consultation of the Act. Prohibitions for this species under State law would not be sufficient for its conservation if *A. humillimus* was delisted.

The Lacey Act, as amended in 1981, prevents the import, export, sale, acquisition, purchase, or interstate or foreign commerce of any plant and/or animal taken, possessed, or sold in violation of any law, treaty, or regulation of the United States, any Indian tribal law, or any regulation of any State. If transported or exchanged for currency, the plant could be protected under the Lacey Act.

Bureau of Land Management Manual 6840 establishes Special Status Species (SSS) policy for plant and animal species and the habitat on which they depend (Bureau of Land Management 2008). This SSS policy refers not only to species protected under the Act, but also to those designated by the BLM State Director as Sensitive. The BLM maintains *A. humillimus* as a SSS. The intent of the sensitive species designation is to ensure actions on BLM administered lands consider the welfare of these species and do not contribute to the need to list any SSS under the provisions of the Act. As written, the BLM management prescriptions allow several avenues of protection for this plant including, but not limited to, managing existing oil and gas leases under Controlled Surface Use constraint and discretionary closure on new leases. These protective measures should be sufficient to the conservation of this species, yet negative impacts continue to occur particularly on Navajo Nation lands with lease oversight by BLM. At this time, BLM's SSS policy has not been sufficient for the conservation of this species.

The Hogback Area of Critical Environmental Concern (ACEC), located on BLM administered lands, was established after *A. humillimus* was listed in 1987. This ACEC designation is intended to ensure that proposed projects in this area receive

the highest environmental scrutiny before being implemented. Projects are not prevented from occurring in the ACEC, but recommendations may be made to modify them to protect certain critical resources including *A. humillimus* habitat. Despite these additional protections for listed species, recreational OHV use and energy maintenance activities continue to have the potential to impact known populations throughout the Hogback ACEC, thus this BLM designation has not been sufficient in the conservation of this species.

Navajo Tribal Code 17 Section 500(8) defines and protects species in three Groups based on a species' conservation status. Group 1 pertains to species or subspecies that are no longer found on the Navajo Nation. Group 2 applies to species or subspecies whose prospects of survival or recruitment are in jeopardy, and Group 3 incorporates species or subspecies whose prospects of survival or recruitment are in jeopardy in the foreseeable future. *Astragalus humillimus* is listed as a Group 2 Endangered species on the Navajo Nation lands, which means that the species prospects of survival or recruitment are or are likely to be in jeopardy. Tribal laws protect species in Group 2. Title 17 § 507 of the Navajo Tribal Code makes it unlawful for any person to "take, possess, transport, export, process, sell or offer for sale or ship any species or subspecies" on the Navajo Endangered Species List. Despite these regulatory mechanisms, continued habitat destruction through oil and gas development has occurred, and none of the recovery actions identified in the 1985 recovery plan have been initiated on Navajo Nation lands (Navajo Nation Department of Fish and Wildlife 2009).

Existing regulatory mechanisms, secured through the Act, have reduced some threats on Federal lands. In the absence of the Act's protective regulatory mechanism, we believe the situation would be considerably worse. After considering the regulations other than the Act designed to protect this plant, and due to continued negative impacts to this species, we believe other Federal, Tribal, and State legal protections provided for this species have not been sufficient for its conservation in the foreseeable future.

2.3.2.5 Other natural or manmade factors affecting its continued existence – Factor E:

Pesticide Use: Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of *A. humillimus* or their host plants (Service 1989). Herbicides are commonly used for noxious weed control, but no documentation has been provided on whether any *A. humillimus* populations have been directly or indirectly affected. In the Navajo Nation Habitat Management Plan for *A. humillimus* from 1992, agricultural use of pesticides is mentioned in regard to the Navajo Indian Irrigation Project and local Navajo farmers along the San Juan River (House and Engelking 1992).

Pesticides, particularly insecticides, are linked to bee declines (Kearns et al. 1998, Kremen et al. 2002, National Academy of Sciences 2007), with the abundance

and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008, Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (*Apis mellifera*) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the pollinator community than just a targeted area (Kevan 1975, Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007, Tuell and Isaacs 2010).

Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests in Farmington, New Mexico. Most of the *A. humillimus* populations are miles away, but could be affected by drift if aerial spraying were to occur on Navajo Nation lands, particularly the Navajo Indian Irrigation Project or local Navajo farmers (House and Engelking 1992). There is no information on pesticide use and subsequent monitoring on Navajo lands and local farmers are not monitored. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of *A. humillimus*. Thus, we do not consider pesticides to be a threat to this species currently or in the foreseeable future.

Natural Processes: Natural processes such as erosion could account for some mortality, yet they also are responsible for soil deposition in the bedrock depressions that are essential habitat for this species. Since this species is restricted to small and widely dispersed segments of sandstone, the resulting populations are disjunct and scattered. This fragmented distribution impedes gene flow among subpopulations. Without the maintenance of genetic diversity to buffer against stochastic events, the species becomes increasingly vulnerable to external threats. Genetic limitations (low fecundity) and ecological isolation (disjunct and small populations) increase the risk of extinction when considering additional pressure from human impacts as well as stochastic events such as severe drought.

Climate Change: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 º C (1.3 º F) during the 20th century (IPCC 2007) and, since 1960, the annual average temperature across the United States has increased by more than 2° F (1.1°C) (Global Climate Change Impacts in the United States [GCCIUS] 2009). The IPCC (2007) projects

that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. The IPCC projects there will be an increase in the frequency of extreme weather events that are temporally and spatially more variable as a result of climate change (IPCC 2007).

The most recent drought (2002-2003) spanning southwestern North America, prior to the current drought (winter 2010-summer 2011), was anomalously dry with unusually high temperatures (Breshears et al. 2005). In Shiprock, NM, within *A. humillimus* habitat, no precipitation was recorded in 2002, whereas in 2004 only 33 mm (1.3 in) was recorded, the third lowest level measured since 1926 (Western Regional Climate Center 2010). Mean annual precipitation since the drought (2003-2007) has been 97 mm (3.8 in), well below the long-term average (Western Regional Climate Center 2010; see Figure 3).

Climate change also involves an increase in atmospheric carbon dioxide which is commonly associated with increased temperatures and the greenhouse gas effect. Since 2000, the observed emissions of greenhouse gases, which are a key influence on climate change, have been occurring at the mid- to higher levels of the various emissions scenarios developed in the late 1990s and used by the IPPC for making projections (e.g., Raupach et al. 2007, Pielke et al. 2008, Manning et al. 2010). This increased carbon dioxide directly affects plant photosynthesis (Huxman and Scott 2007). At the plant level, adapting to drought involves the ability to balance carbon sequestration (the uptake and storage of carbon), carbon respiration (efflux back into the atmosphere), and maintain sustainable evapotranspiration rates (Huxman and Scott 2007). Adaptation would also require a plant to change its phenology (timing of life cycle events) to coincide successfully with extreme shifts in temperature, precipitation, and soil moisture (Walther et al. 2002) which are all part of the evapotranspiration equation. The potential for rapid climate change, which is predicted for the future, could pose significant challenges for plants because they may not be able to adjust their phenology or photosynthetic mechanisms quickly enough.

At the population level, *A. humillimus* is a spring flowering species (Service 1989). Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). A reduction in soil moisture and earlier soil moisture stress to the plant could decrease flowering and reproduction of the species. Because *A. humillimus* has a limited distribution, we would predict a substantial population reduction with a long-term warming trend.

Astragalus humillimus is likely to have experienced and rebounded from periods of drought in the past. If climate change materializes with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Narrow endemics, like *A. humillimus*, often have very specific habitat requirements. This species has affinity for depressions in the sandstone,

suggesting that water is critical for its germination and development, thus climate change could affect its continued existence. We believe the 2008 low population numbers are likely caused by cumulative losses since the 1980s due to several notable drought periods for this region, thus we believe that climate change is a severe threat to this species in the foreseeable future.

2.4 Synthesis

Prior to anthropogenic threats and anomalous climate extremes, *A. humillimus* populations likely adapted to more cyclic disturbance regimes with high mortality balanced by successful regeneration and reproduction. Preliminary observations suggest that adult mortality is necessary for new seedling establishment, so there is a relatively short-term mortality cycle required for continued population establishment. However, cumulative mortality due to more frequent and extreme droughts from the 1980s to present may be affecting the baseline population size and the continued genetic integrity of this species. Although some recovery is evident, population numbers have not returned to the earliest field estimations (approximately 10,000 on Navajo Nation lands as of 1989), and decreased dramatically after the 2002-2003 drought (less than 400 on Navajo Nation lands as of 2008). The overall population trend appears to be declining in New Mexico; population size and status is unknown for Colorado.

Since the development of the recovery plan in 1989, threats have increased rangewide. Populations have been directly impacted by human caused disturbance which not only has killed plants, but also has destroyed the unique micro-habitat required for new seedling establishment. Although some level of regulatory protection exists for all known populations, these protective measures have not been applied sufficiently to adequately protect the species. It appears that most of the negative impacts to this species occurred due to lack of on-the-ground enforcement of mitigation and conservation measures before, during, and after implementation of energy and transmission line projects.

Although the recovery criteria have not been entirely met nor do we anticipate that they will be met in the foreseeable future, progress has been made by the ongoing census and mapping of known populations (Recovery Criterion 1); development of a draft habitat management plan by Navajo Nation (Recovery Criterion 3); and installation of long-term monitoring plots that were last read in 2008 (Recovery Criterion 4). As damage to plants may occur unintentionally, the construction of protective fencing around known populations to prevent inadvertent destruction of plants could protect the remaining individuals. Active, standardized surveying and monitoring to record the species' status, and tracking of seed collection, germination, and survival would assist with the understanding and conservation of this plant. With the implementation and enforcement of conservation measures recommended in the draft habitat management plan for Navajo Nation, and as specified for the Hogback ACEC on BLM land, recovery of this plant would be further supported.

Upon reviewing the combined significance of current threats, we recommend that the federally endangered status of *A. humillimus* remain unchanged at this time. We also recommend that the plant be closely monitored for future population trends, new population discoveries, and the level of cumulative threats. We note that serious threats continue such as: (1) energy exploration, development, and maintenance activities; (2) transmission line installation and maintenance; (3) increased off-road vehicle use; (4) inadequacy of implementing existing regulatory mechanisms; (5) increased understanding of this species' genetic limitations within the context of ecological isolation and restricted distribution; and (6) predicted increase in frequency and severity of drought. For these reasons, this species continues to have a tenuous existence.

3.0 RESULTS

3.1 Recommended Classification: No change; remain as endangered.

____ Downlist to Threatened
____ Uplist to Endangered
____ **Delist**
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
__X_ No change is needed

3.2 New Recovery Priority Number: 5C

Brief Rationale: We recommend the recovery priority number be changed from 2 (high degree of threat and high recovery potential) to a 5C (high degree of threat and low recovery potential with some conflict). This change is justified based on recent genetic research that indicates this species has low fecundity, which would increase the potential for a genetic bottleneck in conjunction with its isolated and restricted distribution, and limited micro-habitat. As well, there has been no long-term propagation success despite numerous attempts. Our review also indicates that human-caused threats such as energy development, transmission lines, and OHV use are more numerous at present than at the time of the listing and are more immediate. In combination, these factors indicate a low recovery potential is more appropriate for this plant at this time, and support the change from a high to a low recovery potential.

3.3 Listing and Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- Revise recovery plan to incorporate new information on biology, ecology, threats, and conservation recommendations.

- Recommend Federal plant permittees report on number of seeds collected over time and status of attempts to germinate (success/failures). Because native seed bank viability and longevity in the field is unknown, knowing how many cumulative seeds are being taken from this rare species could be important to its future regenerative capacity in the field, particularly during drought periods.

- Provide viable *A. humillimus* seeds to a seed bank operating under the Center for Plant Conservation guidelines.

- Continue research on species biology, ecology, reclamation, and transplantation.

- Develop standardized survey and monitoring protocols for this species to be conducted annually by experienced personnel.

- Develop a mitigation banking requirement (a system whereby proponents of projects that may cause harm to *A. humillimus* or its habitat pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects).

- Develop an *A. humillimus* multi-agency working group to share and disseminate information regarding this listed species by promoting education, protection, and recovery actions.

- Work with the BLM Farmington Field Office to develop and implement consistent conservation measures in the Resource Management Plan revision that will avoid and minimize impacts to *A. humillimus* and its habitat from livestock trampling, ORV activities, and energy development. Include protection for all occupied and suitable habitat in the conservation measures.

- Work with the Ute Mountain Ute tribe to encourage and support surveys, monitoring and conservation measures for *A. humillimus* on their land, and development of their management plan to include this species.

5.0 REFERENCES

Allphin, L, N. Brian and T. Matheson. 2005. Reproductive success and genetic divergence among varieties *of* the rare and endangered *Astragalus cremnophylax* (Fabaceae) from Arizona, USA. Conservation Genetics 6:803-821.

Breshears, D., N. Cobb, P. Rich, K. Price, C. Allen, R. Balice, W. Romme, J. Kastens, M. Floyd, J. Belnap, J. Anderson, O. Myers, and C. Meyer. 2005. Regional vegetation die-off in response to global-change-type drought. Proceedings National Academy of Sciences 102(42):15144-48.

Bureau of Land Management. 2003. Farmington district resource management plan with record of decision. December 2003. Farmington Field Office, Farmington, New Mexico.

Bureau of Land Management. 2006. Final report - BLM CPC oil shale seed collections, 2006. Submitted to BLM by the Arboretum at Flagstaff, Arizona.

Bureau of Land Management. 2007. Biological examination report of the Navajo B well #2 on the Navajo Nation. Lease #: 14-20-603-583. API well #: 30-045-20622. Field and Pool: Horseshoe Gallup. BLM-Farmington Field Office, Farmington, New Mexico.

Bureau of Land Management. 2008. Bureau of Land Management Manual – 6840 Special Status Species Management. Rel. 6-125, 12/12/2008.

Cayan, D., S. Kammerdiener, M. Dettinger, J. Caprio, and D. Peterson. 2001. Changes in the onset of spring in the western United States. Bulletin of American Meteorological Society 82:399-415.

Center for Plant Conservation. 2010. Plant profile for *Astragalus humillimus*. Accessed 4/28/2010. Available at: http://centerforplantconservation.org.

Colorado Natural Heritage Program. 2010. Element state rank report for *Astragalus humillimus*. Retrieved 4/28/2010. Colorado State University, Fort Collins, Colorado.

Desneaux, N., A. Decourtye, and J.M. Delpuech. 2007. The sublethal effects of pesticides on beneficial arthropods. Annual Review of Entomology 52:81-106.

Dick-Peddie, W. 1993. New Mexico Vegetation. University of New Mexico Press, Albuquerque, New Mexico.

Ecosphere Environmental Services. 2006. Presence/absence summary report – Mesa Verde cactus (*Sclerocactus mesae-verde)*, Mancos milkvetch (*Astragalus humillimus*), and listed noxious weeds along segment A of the proposed Navajo Ttransmission Line. Prepared for Environmental Planning Group, Tucson, Arizona.

Ecosphere Environmental Services. 2007. Draft Lost Canyon-Shiprock and Kayenta-Shiprock Transmission Lines botanical resources survey on Navajo Nation lands in San Juan County, New Mexico. Prepared for Western Area Power Administration, Rocky Mountain Customer Service Region.

Ecosphere Environmental Services. 2008a. Biological assessment for the proposed Desert Rock Power Plant. Prepared for Bureau of Indian Affairs, Gallup, New Mexico.

Ecosphere Environmental Services. 2008b. Survey results for Mancos milkvetch for the Hart Oil and Gas natural gas well plug and abandonment project. Prepared for Steven Mason, Petroleum Engineer, Bureau of Land Management, Farmington Field Office, Farmington, New Mexico.

Easterling, D. 2002. Recent changes in frost free days and the frost-free season in the United States. Bulletin of American Meteorological Society 83:1327-1332.

Energy, Minerals and Natural Resources Department. 2008. 2008 Annual report. New Mexico Energy, Minerals, and Natural Resources Department, Santa Fe, New Mexico.

Enquist, C. and D. Gori. 2008. A climate change vulnerability assessment for biodiversity in New Mexico, Part I: Implication of recent climate change on conservation priorities in New Mexico. The Nature Conservancy and Wildlife Conservation Society. http://nmconservation.org/dl/NMClimateChange_report1_527.pdf

Global Climate Change Impacts in the United States. 2009. T. R. Karl, J.R. Melillo, and T.C. Peterson (eds). Cambridge University Press, 189 pp.

Graham, L.E., J.M. Graham, and L.W. Wilcox. 2006. Plant Biology, 2nd Edition. Pearson Prentice Hall, Upper Saddle River, New Jersey.

Haskins, K. and S. Murray. 2009. Ecological study and comparison of two rare *Astragalus* species – final report. The Arboretum at Flagstaff, Arizona.

House, D. and L. Engelking. 1992. Habitat management plan for *Astragalus humillimus* (Mancos milkvetch). The Nature Conservancy, Western Regional Tribal Lands Program (San Juan Pueblo, NM) and Western Regional Heritage Task Force (Boulder, CO).

Huxman, T. and R. Scott. 2007. Climate change, vegetation dynamics, and the landscape water balance. Southwest Hydrology, January/February 2007:28-29, 37.

IPCC (Intergovernmental Panel on Climate Change). 2007. Summary for policymakers. In: Climate change 2007: the physical science basis. Contribution of working group one to the fourth assessment report of the intergovernmental panel on climate change (Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H. L. Miller, eds.) Cambridge University Press, New York, New York. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg1_report_the_physical_science_basis.htm

Johansen, C.A. 1977. Pesticides and pollinators. Annual Review of Entomology 22:177-192.

Karron, J.D. 1989. Breeding systems and levels of inbreeding depression geographically restricted and widespread species of *Astragalus* (Fabaceae). American Journal of Botany 76:331-340.

Kearns, C.A., D.W. Inouye, and N.M. Waser. 1998. Endangered mutualisms: the conservation of plant-pollinator interactions. Annual Review of Ecology and Systematics 29:83-112.

Kendall, J. 2011. Email correspondence on the status of Mancos milkvetch and oil and gas development within the Hogback Area of Critical Environmental Concern (ACEC). Bureau of Land Management, Farmington, New Mexico.

Kevan, P.G. 1975. Forest application of the insecticide fenitrothion and its effect on wild bee pollinators (Hymenoptera: Apoindea) of lowbush blueberries (*Vaccinium* spp.) in southern New Brunswick, Canada. Biological Conservation 7:301-309.

Kevan, P.G., E.A. Clark, and V.G. Thomas. 1990. Insect pollinators and sustainable agriculture. American Journal of Alternative Agriculture 5:12-22.

Kremen, C., N.M. Willimans, and R.W. Thorp. 2002. Crop pollination from wild bees at risk from agricultural intensification. Proceedings from the National Academy of Sciences 99:16812-16816.

Lenart, M., G. Garfin, B. Colby, T. Swetnam, B.J. Morehouse, S. Doster, and H. Hartmann. 2007. Global warming in the southwest: projections, observations, and impacts. Climate Assessment for the Southwest, University of Arizona. http://www.climas.arizona.edu/files/climas/GWSouthwest.pdf.

Manning, M.R., J. Edmonds, S. Emori, A. Grubler, K. Hibbard, F. Joos, M. Kainuma, R.F. Keeling, T. Kram, A.C. Manning, M. Meinshausen, R. Moss, N. Nakicenovic, K. Riahi, S.K. Rose, S. Smith, R. Swart, & D.P. van Vuuren. 2010. Misrepresentation of the IPCC CO_2 emission scenarios. Nature Geoscience 3:376-377.

Mineau, P., K.M. Harding, M. Whiteside, M.R. Fletcher, D. Garthwaite, and L.D. Knopper. 2008. Using reports of bee mortality in the field to calibrate laboratory-derived pesticide risk indices. Environmental Entomology 37:546-554.

National Academy of Sciences. 2007. Status of pollinators in North America. The National Academies Press, Washington, D.C.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe. Arlington, VA. Available at: http://www.natureserve.org/explorer/.

Navajo Nation Department of Fish and Wildlife. 2009. Letter summarizing status regarding the 5-year review of Mancos Milkvetch (*Astragalus humillimus*). May 13, 2009. Navajo Nation, Window Rock, Arizona.

Navajo Natural Heritage Program. 2007. Memorandum: Disturbance of *Astragalus humillimus* EOR #6 by plugging and abandonment operations on Palmer Mesa. May 14, 2007.

Navajo Natural Heritage Program. 2008a. Mancos milkvetch (*Astragalus humillimus*) Trend/Status Assessment. Daniela Roth, author. Navajo Natural Heritage Program, Window Rock, Arizona.

Navajo Natural Heritage Program. 2008b. Field report regarding damage and ground work conducted on Palmer Mesa by Hart Oil and Gas Inc., Lease no. 14-20-603-584 at site of known Mancos milkvetch (*Astragalus humillimus*) populations. April 8, 2008.

New Mexico State Forestry Division (State of New Mexico). 2008. Population studies of Mancos milkvetch (*Astragalus humillimus*: Fabaceae) in San Juan County, New Mexico from 1988 to 2008. R. Sivinski, author. New Mexico Energy, Minerals, and Natural Resources Department, Santa Fe, New Mexico.

Parmesan, C. and H. Galbraith. 2004. Observed impacts of global climate change in the U.S. Pew Center on Global Climate Change, Arlington, VA. Prepared for the Pew Center on Global Climate Change, November 2004.

Parmesan, C. 2007. Influences of species, latitudes and methodologies on estimates of phenological response to global warming. Global Change Biology 13:1860-1872.

Pielke Jr., R., T. Wigley, and C. Green. 2008. Dangerous assumptions. Nature 452:531-532.

Raupach, M.R., G. Marland, P. Ciais, C. Le Quéré, J.G. Canadell, G. Klepper, and C.B. Field. 2007. Global and regional drivers of accelerating CO_2 emissions. Proceedings of the National Academy of Sciences. cgi/doi/10.1073/pnas.0700609104

Sivinski, R.C. and P.C. Knight. 2001. Population characteristics of Mancos milkvetch (*Astragalus humillimus*: Fabaceae) in San Juan County, New Mexico. New Mexico Naturalist Notes 3(1):51-61.

Tepedino, V.J. 2002. The reproductive biology of rare rangeland plants and their vulnerability to insecticides. In: Cunningham, G.L., Sampson, M.W., tech. cords. 1996. Grasshopper integrated pest management user handbook. Tech. Bull. 1809. Washington, DC: US Department of Agriculture, Animal and Plant Health Inspection Service. Available at: http://www.sidney.ars.usda.gov/grasshopper/Handbook/III/iii_5.htm.

Tuell, J.K. and R. Isaacs. 2010. Community and species-specific responses of wild bees to insect pest control programs applied to a pollinator-dependent crop. Journal of Economic Entomology 103(3):668-675.

Udall, B. and G. Bates. 2007. Climatic and hydrologic trends in the Western U.S.: A review of recent peer-reviewed research. Intermountain West Climate Summary 3(1): 2-8.

U.S. Fish and Wildlife Service. 1985. Endangered and threatened wildlife and plants; final rule to determine *Astragalus humillimus* to be endangered. Federal Register. 50 (124):26568-26572.

U.S. Fish and Wildlife Service. 1989. Mancos milkvetch (*Astragalus humillimus*) recovery plan. P. Knight and D. House, authors. New Mexico Ecological Services Field Office, Albuquerque, New Mexico.

U.S. Fish and Wildlife Service. 2010. Project Title: Ecological study and comparison of two rare *Astragalus* species. Permit # TE009792-2 and TE226653-0. The Arboretum at Flagstaff, Arizona.

Walther, G., E. Post, P. Convey, A. Menzel, C. Parmesan, T. Beebee, J. Fromentin, O. Hoegh-Guldberg, and F. Bairlein. 2002. Ecological responses to recent climate change. Nature 416:389-395.

Western Regional Climate Center. 2010. Historical climate information, Western U.S. climate historical summaries. New Mexico; Shiprock; Monthly Total Precipitation. http://www.wrcc.dri.edu.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Mancos Milkvetch (*Astragalus humillimus)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: N/A

Review Conducted By: Laura Hudson, Vegetation Ecologist, New Mexico Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 8/1/11

REGIONAL OFFICE APPROVAL:

Lead Assistant Regional Director, Ecological Services, U.S. Fish and Wildlife Service, Region 2

Approve _____ Date 8/17/2011

Cooperating Assistant Regional Director, U.S. Fish and Wildlife Service, Region 6

Concur X Do Not Concur _____

Signature _____ Date 8/16/11