

Knowlton's Cactus
(Pediocactus knowltonii)

5-Year Review:
Summary and Evaluation



Photo: Robert Sivinski

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

5-YEAR REVIEW
Knowlton's Cactus/*Pediocactus knowltonii*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Regional Office: Southwest Regional Office, Region 2
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1.2 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.). We provided notice of this status review via the Federal Register (72 FR 20134) requesting information on the status of Knowlton's cactus (*Pediocactus knowltonii*). No comments from the public were received. This review was a collaborative effort comprised of biologists from the Service's Region 2 Regional Office, the New Mexico Ecological Services Field Office, and the New Mexico State Forestry Division. Robert Sivinski, Botanist for the New Mexico State Forestry Division, was contracted through a section 6 grant to gather the relevant information and prepare a draft of the review. The final review and recommended classification was prepared by the New Mexico Ecological Services Field Office.

1.3 Background

1.3.1 FR Notice citation announcing initiation of this review:
72 FR 20134; April 23, 2007

1.3.2 Listing history:

Original Listing

FR notice: 44 FR 62244

Date listed: October 29, 1979

Entity listed: Species, *Pediocactus knowltonii*

Classification: Endangered, without critical habitat

1.3.3 Associated rulemakings: None

1.3.4 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.

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

1.3.6 Recovery Plan or Outline

Name of plan or outline: Knowlton Cactus (*Pediocactus knowltonii*) Recovery Plan.

Date issued: March 29, 1985

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 Knowlton's cactus, 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 the most up-to-date information on the species' biology, nor does it address all of the five listing factors that are relevant to the species. When the recovery plan was finalized in 1985, limited data made it impossible to quantify habitat requirements with enough precision to establish further recovery criteria and none were established for downlisting the species.

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No.

The recovery plan lists one main objective: to remove Knowlton's cactus from the list of endangered and threatened species. The benchmark provided is restoring the primary population to 100,000 individuals, which is believed to be a self-sustaining population. The goals of the existing recovery plan are to: 1) protect existing populations from present and future human threats; and 2) ensure the maintenance of vigorous, self-sustaining populations in the species' natural habitat (Service 1985). Although these criteria provide guidance for recovery, they do not offer measurable standards by which recovery progress can be objectively determined or that specifically address current threats.

The recovery plan does contain an implementation table of prioritized actions to recover Knowlton's cactus. Of the 15 actions recommended, 5 have been implemented or are ongoing, including:

- 1) enforcement of existing regulations;
- 2) maintenance of fencing around cacti;

- 3) monitoring of known populations and potential habitats;
- 4) reintroduction of Knowlton's cactus; and
- 5) development of public awareness.

These actions address both recovery goals above, but there is no way to quantify whether either goal has been fulfilled entirely. Even so, recovery goals have not been met based on the continuation of human impacts from occasional, illegal collecting and the lack of success from two attempts to establish additional, viable populations of Knowlton's cactus in presumably suitable habitat.

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:

Knowlton's cactus is a tiny plant. Solitary or clustered stems measure up to 5.5 centimeters (cm) (2.2 inches (in)) tall and 3 cm (1.2 in) in diameter. Flowering peaks in early May and fruits ripen in June and July. The species occurs on rolling, gravelly hills in a pinon-juniper-sagebrush community at about 1,900 meters (m) (6,200-6,300 feet (ft)). This cactus is known only from the type locality in San Juan County, New Mexico. At the time of listing, there was a limited amount of information available on the life history and habitat requirements of Knowlton's cactus. Although the recovery plan identified specific information needs, few studies have been conducted to increase our understanding of the species since the plan was finalized in 1985.

Knowlton's cactus is reproductively unusual for cacti because it initiates its flower primordia in the early autumn months, which over-winter as small buds. Therefore, spring flowering is greatly influenced by the condition of the plant during the previous growing season and the intervening winter months. This plant is not a prolific bloomer, even during years of good precipitation. In an 18-year assessment of reproductive effort, the natural population annually had flowers or fruits on less than 51 percent of adult-size cacti. Flowering during periods of drought was especially suppressed with eight percent or less of adult-size cacti flowering or fruiting. An 18-year average for annual percent of adult-size cacti making reproductive effort is only 30.6 percent. Knowlton's cactus reaches reproductive adult size when exceeding 10 millimeter (mm) (0.39 in) in diameter (Sivinski 2008).

Pollination for Knowlton's cactus has not been studied, but three other rare species of *Pediocactus* in Arizona and Utah are known to be pollinated by many small bee species. All three are self-incompatible and must be cross-pollinated, but are not pollen limited and are successful in fruit production (Tepedino 2002). Knowlton's cactus appears to fit this same pattern. The most common pollinators seen on its flowers are small native bees and most flowers produce seed-filled

fruits (Robert Sivinski, personal observations, 1990 to 2008). Fruit predation by rodents (probably *Peromyscus* sp.) is very severe and few seeds of Knowlton's cactus are left to mature (Sivinski and McDonald 2007).

2.3.1.2 Abundance, population trends (e.g. increasing, decreasing, stable), demographic features (e.g., age structure, sex ratio, family size, birth rate, age at mortality, mortality rate, etc.), or demographic trends:

The natural habitat of Knowlton's cactus is mostly confined to a single population within a 10-hectare (ha) (25-acre (ac)) preserve that was donated by the Public Service Company of New Mexico to The Nature Conservancy (TNC). A few (<50) cacti occur on adjoining Bureau of Land Management (BLM) land within 33 ft (10 m) of the TNC preserve boundary fence. In 1986, 11 permanent monitoring plots were established in the TNC population and 10 of these plots still exist (Sivinski 2008). All 10 plots have been annually monitored for 23 years to estimate population trends and reproductive effort. The Knowlton's cactus population may have been as high as 100,000 plants in 1960, and then reduced by cactus collectors to only 1,000 plants by 1979 (Service 1985).

In 1985, the estimate of the population of Knowlton's cactus on the TNC preserve was about 7,000 cacti (Service 1985). The first attempt to accurately survey this population was conducted in 1992, which estimated about 12,000 cacti (Sivinski and McDonald 2007). Cacti within this population increased through the late 1980s and early 1990s to a peak of about 14,000 individuals in 1994. Since then, the population has been gradually and steadily declining, likely in response to drought. This decline is due to mortality exceeding recruitment. In 2008, the population estimate was about 6,100 cacti (Sivinski 2008). All cactus deaths within the monitoring plots of this population have been attributed to natural causes, mostly rodent predation (Sivinski 2008).

Relatively few new seedlings have become established in the TNC population since 1994; almost all Knowlton's cacti are adult plants. Requirements for germination and seedling establishment have not been studied, although plantings of experimental seeds attempted to establish another population within similar unoccupied habitat BLM and Bureau of Reclamation (BOR) lands south of the TNC population. In 1987, 228 seeds were planted at the BOR site; only three cacti were located at this site in 2006 and no recruitment has ever been observed (Sivinski 2008). In 1994, 2,250 seeds were planted at the BLM site; 97 cacti were located at this site in 2003 (Sivinski and McDonald 2007). Most of the seeds did not germinate and those that did usually failed to survive.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation (e.g., loss of genetic variation, genetic drift, inbreeding, etc.):

The only known, naturally-occupied population of Knowlton's cactus occurs on the TNC preserve. This population is situated on the top and slopes of a single

small hill, less than 10 ha (25 ac) in size. There are about 6,100 cacti in this population currently and the area for gene flow is exceedingly small. Flowers that are pollinated usually produce seed-filled fruits. Aborted flowers are evident in the population, and most commonly associated with very dry conditions (Robert Sivinski, unpublished observations, 1990-2008). Inbreeding may be a detriment to this population, exhibited by a relatively low reproductive effort (flowering) and seedling establishment.

2.3.1.4 Taxonomic classification or changes in nomenclature:

The most recent taxonomic treatment of the genus *Pediocactus* maintains the species rank of *Pediocactus knowltonii* for this taxon (Heil and Porter 2003). Chloroplast DNA sequence analysis provides support that it is a recent developmental mutation from its closest relative, *Pediocactus simpsonii* (Heil and Porter 2003).

2.3.1.5 Spatial distribution, trends in spatial distribution (e.g., increasingly fragmented, increased numbers of corridors, etc.), or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):

Knowlton's cactus occurs within a single natural population in northern San Juan County, New Mexico, very close to the Colorado border (Service 1985). Surveys within potential habitat have failed to locate any additional populations, outside of the few individual cacti at the Reese Canyon Area of Critical Environmental Concern (ACEC) that were likely transplanted (see discussion below). No other populations of this species have ever been located. This cactus is not known to occur in Colorado. Inaccurate reports of the species occurring in Colorado are still common in Federal, State, and conservation organization literature and on their web sites (see references in NatureServe 2008). This faulty information is based on an old fence at the northern edge of the Knowlton's cactus population that was mistakenly thought to be the New Mexico/Colorado border until a new fence was erected along the border in 2007. The northern-most plants in the Knowlton's cactus population are at least 30 m (94 ft) south of the New Mexico/Colorado border (Robert Sivinski, unpublished observation, 2007).

In 1986 and 1987, 150 stem cuttings of Knowlton's cactus were transplanted from the TNC population into an area 5 miles to the south to try and establish a new population on BOR lands (Olwell et al. 1987). The number of cacti at the BOR transplant site gradually declined until an additional 102 cuttings were transplanted in 1995. Although many of these plants survived to flower and produce fruit (Olwell et al. 1990), only two new plants were recruited into this population from 1987-2006. Rodent or rabbit predation in 2006 killed most of the remaining cactus transplants (Sivinski 2008). Mortality consistently exceeded recruitment and only a few of the originally-transplanted cacti were remaining

when the effort was abandoned in 2007 (Sivinski 2008). Subsequently, this transplant effort was deemed a failure (Sivinski 2008).

Another transplant was attempted in 1991 when 149 stem cuttings were planted on BLM land about two miles south of the TNC population. This two ha (five ac) BLM transplant site is within the Reese Canyon ACEC. Only three new plants were recruited into this population by 2008 (Sivinski 2008). This site was also seriously impacted by rodent or rabbit predation in 2006 and 2007 and only 48 of the originally-transplanted cacti remained alive (Sivinski 2008). The abundance of cacti at this site is also gradually declining and its long-term persistence is unlikely (Sivinski 2008).

The Knowlton's Cactus Recovery Plan identifies another small Knowlton's cactus site within the BLM Reese Canyon ACEC, which is in the same vicinity of the transplant site described above (Service 1985; Sivinski and McDonald 2007). The Reese Canyon site is likely a remnant of a 1960s transplant attempt by cactus hobbyists (Service 1985). In 1985, this location had two cacti present (Service 1985). Likewise, no reproduction has ever been documented at this location. Consequently, the Reese Canyon site is not considered to be a viable population and has not been monitored since the 1980s.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem):

Numerous pinon trees (*Pinus edulis*) have grown around the TNC population. Canopy closure has increased in recent years. Some pinon trees were killed by bark beetles (*Ips confusa*) during the 2001-2003 drought, which created a few openings in the canopy (Robert Sivinski, unpublished observations, 1990-2008). The effect of tree density and the increase in canopy closure on Knowlton's cactus has not been studied; however, many cacti are growing as healthy individuals in the tree understory.

The cobble-covered substrates in the habitat of the TNC population are unique in this region. Similar cobble-covered habitats with comparable vegetation cover have been located nearby, but are slightly different in soil texture and possibly other characteristics. Knowlton's cactus transplant attempts at two nearby locations have failed to produce viable new populations (Sivinski 2008).

2.3.2 Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

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

The population of Knowlton's cactus is mostly confined to a 10-ha (25-ac) preserve owned by the TNC, although some cacti occur on adjoining BLM land.

The Public Utilities Company of New Mexico donated the title to the surface rights of the preserve to TNC in 1983; however, TNC does not own mineral rights beneath the land. This region is severely impacted by natural gas development and an active well pad is adjacent to the south fence of the TNC preserve boundary. New Mexico Oil and Gas Conservation rules require a minimum well spacing of 65 ha (160 ac). The Oil and Gas Commission may grant exceptions for lesser spacing; however, it is unknown whether they would grant an exception that would impact a TNC preserve for an endangered cactus. Six energy firms hold mineral rights beneath the TNC lands (Service 1985). Therefore, the potential for natural gas exploration, development, and production in and around the TNC lands exists.

The TNC preserve and adjoining BLM land have been fenced to exclude livestock that might trample the cacti. The location on BLM land where transplants occurred in 1991, although declining in abundance, is also fenced. This two ha (five ac) transplant area is also within the Reese Canyon ACEC and has been withdrawn from mineral entry and surface occupancy, thus limiting the potential for impacts to the species.

2.3.2.2 Overutilization for commercial, recreational, scientific, or educational purposes:

Cacti are desirable plants whose wild populations in the U. S. and Mexico have been subject to illegal collection and trade (Robbins 2003). Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare and recently discovered cactus species and have gone to illegal lengths to obtain certain species for their private collections (Robbins 2003).

The most significant impact to Knowlton's cactus after its discovery in 1958 was unregulated collection by cactus hobbyists and the succulent plant trade. A Knowlton's cactus population estimated at 100,000 in 1960 was reportedly depleted to about 1,000 cacti by 1979 (Service 1985). During the past 20 years, the U.S. cactus trade has experienced some positive changes, including a progressive shift from solely relying on wild specimens of rare species to artificially propagating those species (Robbins 2003). Currently, Knowlton's cactus is grown by commercial vendors that supply the succulent market demand for this very rare and endangered species. Knowlton's cactus seed is readily available on the Internet to cactus hobbyists from commercial growers (\$10/100 seeds). These commercial activities have relieved some, but not all, of the collection pressure on the species (Sivinski and McDonald 2007).

After being listed and protected as an endangered species under the Act, the Knowlton's cactus population on TNC lands began to recover and was less impacted by cactus collectors. Commercial collecting of large quantities of cacti from the field appears to have been reduced because of the difficulty in marketing these plants legally. Nevertheless, evidence of cactus collection in the natural

habitat is often difficult to observe. A blatant example is the 1996 theft of the all the markers and tags from one of the 11 permanent monitoring plots within the TNC preserve. An unknown number of Knowlton's cacti were also illegally collected (Sivinski and McDonald 2007). An investigation was initiated and the Cactus and Succulent Society alerted, but no one was charged with this theft (Sivinski 1996).

Knowlton's cactus collecting will probably continue into the foreseeable future because there is a demand for this species. Most of these thefts will likely involve small numbers of cacti for personal collections, which, although illegal, have not been cumulatively significant over the last 18 years (Robert Sivinski, unpublished observations, 1990-2008).

Positive steps have been taken to inform and educate the public about the Knowlton's cactus. The New Mexico Rare Plants web site was established in 1998 by the New Mexico Rare Plant Technical Council to provide the public with information on rare, threatened, and endangered plant species. Descriptive information and photographs of Knowlton's cactus are prominently displayed on this web site. This effort has helped fulfill the intent to provide information to the public and foster support for the conservation of Knowlton's cactus. A poster of federally threatened and endangered plants of New Mexico, including Knowlton's cactus in the photograph on the cover of this review, was completed and printed in 2006 and is being disseminated to schools, universities, and the general public.

2.3.2.3 Disease or predation:

Knowlton's cactus appears to be relatively free of disease organisms (Robert Sivinski, unpublished observations, 1990-2008). Predation by rabbits or rodents is a significant cause of mortality (Sivinski and McDonald 2007; Sivinski 2008). This type of predation removes all or most of the above-ground part of the plant and is more frequent during periods of drought.

The maturing fruits of Knowlton's cactus are also preyed upon by rodents, presumably deer mice (*Peromyscus* sp.). An attempt to gather seed from the TNC population to plant at a new location failed because almost all the seeds in mature fruits were eaten by rodents as soon as the fruit ripened (Sivinski and McDonald 2007). Seed predation by rodents was almost 100 percent in June of 1993 (Sivinski 1993).

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Knowlton's cactus was listed as endangered without critical habitat in October 1979 (44 FR 62244). The Endangered Species Act is the primary Federal law providing protection for the species. The majority of cacti occur on TNC land; however, the few cacti that occur on BLM land are protected by the Act. Beyond the actual 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, although there is no critical habitat designated for the species. 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 Service has addressed some projects within potential Knowlton's cactus habitat through informal section 7 consultations with the BLM and the Federal Highways Administration.

The National Environmental Policy Act (NEPA) may provide some protection for Knowlton's cactus 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.

As noted above, Knowlton's cactus occurs mostly on TNC property, where there is little Federal oversight. Therefore, it is less likely that provisions of the Act will be invoked. Because there is no prohibition against take of listed plants on private lands, activities without a Federal nexus which might adversely impact the species or its habitat do not require consultation with the Service. Still, we do not anticipate that future project proposals would adversely affect the species, because TNC has dedicated the land for conservation. Moreover, TNC has owned the land since 1983 and no projects have impacted the species.

Federally-listed plants occurring on private lands have very limited protection under the Act unless they are also protected by State laws. Knowlton's cactus 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 Knowlton's cactus was delisted.

All native cacti, including Knowlton's cactus, are on Appendix II of Convention on International Trade of Endangered Species (CITES). Trade of Knowlton's

cactus seeds and plants (import and export) is regulated under CITES, but there are no protections for internal trade or habitat destruction under this convention. While State and Federal laws against cactus collecting can be substantial and effective deterrents, illegal collecting of Knowlton's cactus may regularly occur and likely goes undetected. The TNC population is located in a remote area that is easily accessed by road, but rarely patrolled by law enforcement agents.

The BLM's Farmington District Office has designated the Knowlton's cactus habitat and transplant location within the Reese Canyon an ACEC. This area is fenced and closed to livestock grazing, OHV traffic, mineral entry, and surface occupancy. These protections will likely remain in effect as long as Knowlton's cactus remains listed as a threatened or endangered species.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Climate models project substantial changes in New Mexico's climate over the next 50 to 100 years. Projected climate changes by mid- to late-21st century include: air temperatures warmer by 6-12°F on average, but more in winter, at night, and at high elevations; more episodes of extreme heat, fewer episodes of extreme cold, and a longer frost-free season; more intense storm events and flash floods; and winter precipitation falling more often as rain than as snow (IPCC 2007). Some climate models project that average precipitation will increase, while others predict a decrease (NMCCAG 2005).

Periods of drought in the southwest are common. However, the frequency and duration of droughts may be altered by climate change. Global warming, and associated effects on regional climatic regimes, is not well understood, but weather predictions for the southwestern United States include less overall precipitation and longer periods of drought. Based on broad consensus among 19 climate models, Seager et al. (2007) predict that the southwest will dry in the 21st century and that this drier climate change is already occurring. Increased aridity associated with the current on-going drought and the 1950's drought will become the norm for the American southwest within a timeframe of years to decades if the models are correct. The 2007 Intergovernmental Panel on Climate Change (IPCC) report outlines several scenarios that are virtually certain or very likely to occur in the 21st century. These are: 1) over most land, there will be warmer and fewer cold days and nights, and warmer and more frequent hot days and nights; 2) areas affected by drought will increase; and 3) the frequency of warm spells/heat waves over most land areas will likely increase. The IPCC makes equally sobering predictions for ecosystems; the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects), and other global drivers (IPCC 2007). With medium confidence, IPCC predicts that approximately 20-30 percent of plant and animal species assessed so far are likely to be at an increased risk of extinction if increases in global average temperature exceed 1.5 – 2.5°C (IPCC 2007). Almost certainly this species, along with its habitat, will be

affected in some manner by climate change; the magnitude and extent of the change cannot be quantified at this time.

Demographic trends in the natural Knowlton's cactus population appear to be influenced by climate. Rodent or rabbit predation on adult cacti increases during periods of drought and significant germination events have not been observed since 1994 (Sivinski 2008). The natural population has been in continuous decline for 14 years (Sivinski 2008). In fact, the estimated Knowlton's cactus population in 2008 was 6,100, the lowest number ever recorded, comprising less than half of the 14,000 observed in 1994 (Sivinski 2008). Weather cycles that positively influence germination and establishment of northwestern New Mexico plants are more frequent than 14 years (Sivinski and Knight 2001; Sivinski 2007). This unusually long period of decline in the natural Knowlton's cactus population may be indicating that a climatic threshold for this species has been crossed and future demographic trends will continue to decline.

2.4 Synthesis

Knowlton's cactus was discovered in 1958 and described as a new species in 1961. Knowlton's cactus is a diminutive, single- or multi-stemmed cactus with very short spines and pink flowers. It flowers in late April to early May and may be pollinated by small native bees. Fruits ripen in late June and usually contain 10-12 seeds. In some years, most of the seeds are harvested by rodents before they can drop from mature fruits. Seeds that escape predation, germinate, and survive the dry early summer months take three to four years to become flowering adults. Usually much fewer than half of the adult cacti will flower, even during a favorable rainfall year.

Knowlton's cactus was one of the first cacti listed as an endangered species in 1979. In terms of distribution, this is one of the rarest species of cacti. More than 99 percent of the population occurs within a 10-ha (25-ac) preserve owned by The Nature Conservancy in northern San Juan County, New Mexico. A few (<50) cacti occur on adjoining BLM land.

Several thousand Knowlton's cacti were collected prior to this species being listed as endangered. Fortunately, some of these plants ended up in the greenhouses of commercial growers who have produced seeds and plants for cactus hobbyists and this has reduced the need to take cacti from the natural population. Commercial availability and prohibitions of the Federal and State of New Mexico endangered species statutes have greatly reduced the impacts of cactus collection on Knowlton's cactus. Still, some illegal theft of cacti is likely occurring.

Two transplant projects have been attempted to establish additional populations of Knowlton's cactus within similar habitat. Most of these transplants produced flowers and fruits in their new habitat, but only few new cacti were recruited by natural reproduction from 1987 to 2007. Our inability to establish Knowlton's cactus at other nearby habitats

is an indication that this species may have always been confined to the single suitable habitat it presently occupies and has never had a more widespread historic range.

From 1994 to 2008, a gradual, continuous decline has been documented in the natural population. Few new cacti are being recruited and many adult cacti are being eaten by rabbits or rodents. The years 1996, 2001, and 2002 were severe periods of drought for this region. An increase in rabbit or rodent predation in conjunction with depressed seed production and germination has been observed. It is likely that climate change will affect this species and future demographic trends will continue to decline. Therefore, Knowlton's cactus continues to meet the definition of endangered.

3.0 RESULTS

3.1 Recommended Classification: No change; remain as endangered. This status is advised because the species remains restricted to a single, natural location; population numbers are declining; and the recovery criteria for downlisting, although lacking in measurable, threats-based standards, have not been met.

3.2 New Recovery Priority Number: No change; remain at 2.

3.3 Listing and Reclassification Priority Number: Not applicable.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- The recovery plan for the species needs to be revised to incorporate new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria for down and delisting of the species should be developed which also address all listing factors relevant to the species.
- Legally grown seeds and plants of Knowlton's cactus should continue to be made available in the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti from the TNC population.
- Provide viable Knowlton's cactus seeds to a seed bank operating under the Center for Plant Conservation guidelines.
- Continue the monitoring program, including documenting losses attributed to illegal collectors. Monitor the species' response to changes in seasonal rainfall and temperature patterns.

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I. U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW Knowlton's Cactus (*Pediocactus knowltonii*)

Current Classification: Endangered.

Recommendation resulting from the 5-Year Review:


- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: n/a.

Review Conducted By: Eric Hein, Terrestrial Branch Chief, New Mexico Ecological Services Field Office.

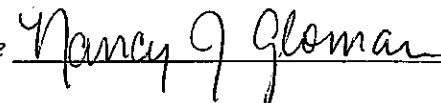
FIELD OFFICE APPROVAL:

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

Approve  Date 1-7-10

REGIONAL OFFICE APPROVAL:

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

Approve  Date 2-4-10