

Nichol Turk's Head Cactus
(Echinocactus horzonthalonius var. nicholii)

5-Year Review:
Summary and Evaluation



Photos by Kathy Robertson, USFWS

U.S. Fish and Wildlife Service
Arizona Ecological Services Field Office
Phoenix, Arizona

5-YEAR REVIEW

Nichol Turk's head cactus (*Echinocactus horizonthalonius* var. *nicholii*)

1.0 GENERAL INFORMATION

1.1 Reviewers:

Lead Regional or Headquarters Office: Region 2, Southwest
Contact: Wendy Brown, Recovery Coordinator, 505/248-6664.

Lead Field Office: Arizona Ecological Services Tucson Sub-Office
Contact: Mima Falk, Plant Ecologist, Tucson, Arizona, 520/670-6150 x225.

Cooperating Field Office(s): None.

1.2 Methodology used to complete the review:

This review was conducted through public notification and a comprehensive review of all documents pertaining to the Nichol Turk's head cactus (NTHC) on file at the Arizona Ecological Services Field Office (AESFO). The Federal Register notice announcing this review and inviting public input was published on April 23, 2007 (72 FR 20134). No comments were received. Interviews with individuals familiar with NTHC were conducted by the AESFO as needed to clarify or obtain specific information. Additional sources of information included the Nichols Turk's Head Cactus Recovery Plan (1986), section 7 consultations, telephone conversation records, letters from researchers providing anecdotal field observations, unpublished field surveys, monitoring reports, peer reviewed publications, reports of research projects, and various documents published by the Bureau of Land Management (BLM).

1.3 Background:

1.3.1 FR Notice citation announcing initiation of this review: 72 FR 20134

1.3.2 Listing history

Original Listing

FR notice: 44 FR 61927

Date listed: October 26, 1979

Entity listed: Variety; in U.S.A. (Arizona) and Mexico (Sonora)

Classification: Endangered

1.3.3 Associated rulemakings: None.

1.3.4 Review History:

A 5-year review was initiated on July 22, 1985 (50 FR 29901) for all species listed before 1976 and in 1979-1980; a notice of completion with no change in status was published on July 7, 1987 (52 FR 25522). Another 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 NTHC recovery priority number is 3, meaning that the level of threat is high, the recovery potential is high, and the listed entity is a subspecies (variety).

1.3.6 Recovery Plan or Outline

Name of plan or outline: Nichol Turk's Head Cactus (*Echinocactus horizonthalonius* Lemaire, var. *nicholii* L. Benson) Recovery Plan

Date issued: April 14, 1986

Dates of previous revisions, if applicable: Not applicable.

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?

Yes
 No

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan?

Yes
 No

2.2.1.1. Does the recovery plan contain objective, measurable criteria?

Yes
 No

The NTHC Recovery Plan includes one objective, measurable criterion to downlist the subspecies from endangered to threatened. When the recovery plan was finalized in 1986, there were limited data available to quantify the total population abundance or other biological and ecological requirements on the subspecies; therefore criteria for delisting the subspecies were not established.

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat?

Yes
 No

The downlisting criterion was developed at the time the NTHC Recovery Plan was written in 1986 and does not reflect any new information that has become available since that date. In addition, new threats that are relevant to the species and its habitat have been identified and should be incorporated and addressed in a revised recovery plan.

2.2.3 List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information:

The recovery criterion for changing the status of NTHC from endangered to threatened is the permanent protection of 75 percent of its known habitat. Once achieved, this amount would be reevaluated for adequacy or when the data indicate that the criterion can be revised. The criterion for removing the cactus from the list of endangered species was not established. It is only after a complete population census or other studies are conducted to collect quantified data that a measurable delisting criterion can be established.

The amount of habitat is not known for this subspecies; therefore, we have no way of measuring when we reach the 75 percent level. The subspecies occurs among four discrete populations. Three populations are located in Arizona on land administered by the Bureau of Land Management (BLM), Arizona State Trust, the Tohono O'odham Nation (Nation), and private lands, and one population in Sonora, Mexico on private lands (Figure 1). At present, permanent habitat protection of 2,368 acres has been accomplished at one site where the cactus occurs on BLM land in the Waterman Mountains; however, surveys to determine the population size at this site have not been completed. The status of the cactus in the three other populations is unknown, as distribution surveys at these sites have not been completed. Two populations occur on the Nation where their habitat is partially protected because access to the land is restricted to tribal members. The fourth population in the Sierra del Viejo Mountains (also referred to as Sierra El Viejo) is protected from public access (Starr et al. 2008; M. Baker, pers. comm. 2009), due to private ownership of the land. However, the ranch offers trophy hunting of bighorn sheep which likely occurs in occupied habitat; impacts to the cactus from this activity are unknown.

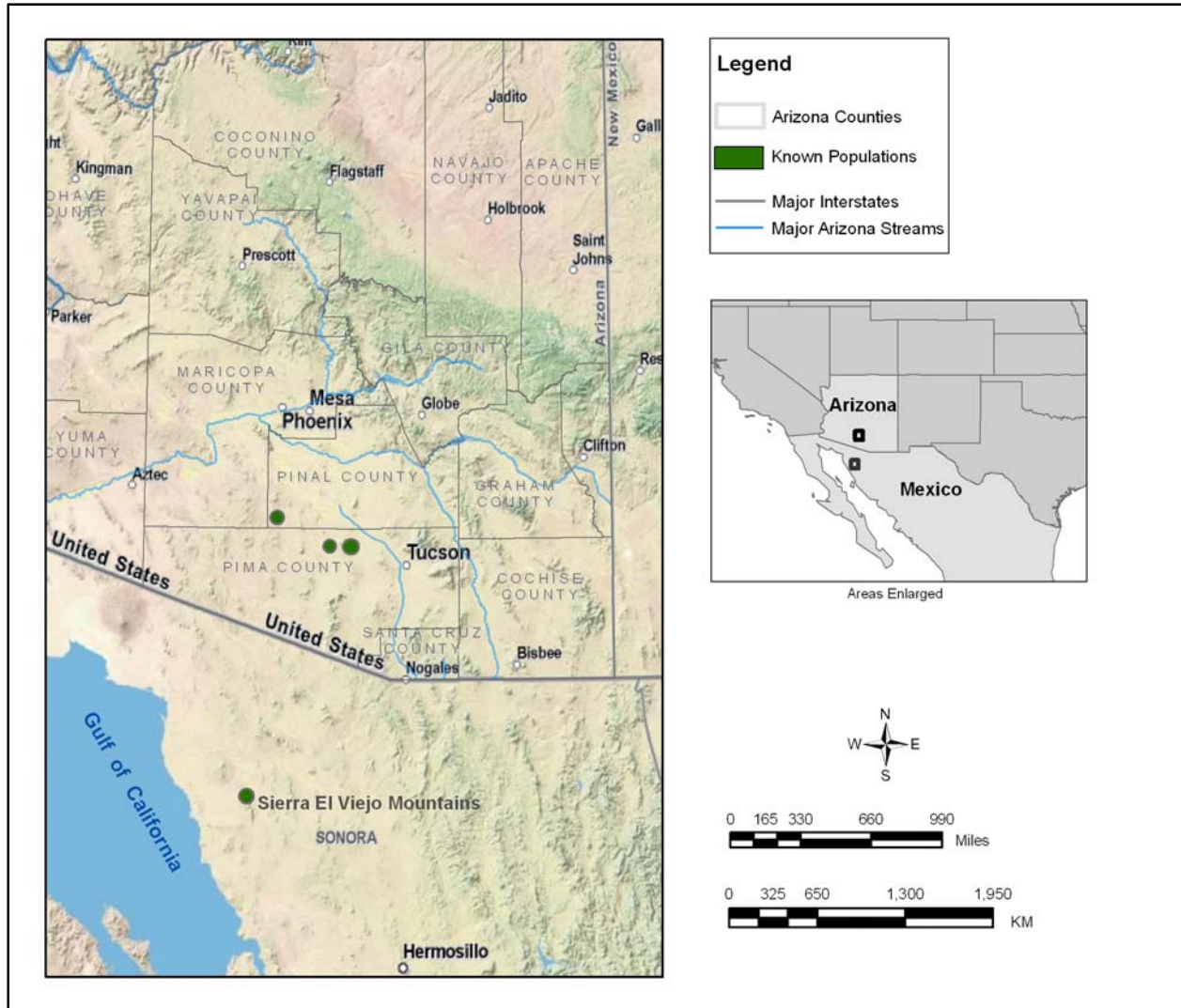


Figure 1. General distribution of Nichol Turk's head cactus in Pima and Pinal Counties, Arizona, and in the Sierra del Viejo Mountains in Sonora, Mexico.

Actions taken to meet the recovery criterion on Federal land continue to be implemented by the BLM and their partners. Below is a summary of the recovery steps that are outlined in the NTHC Recovery Plan and significant accomplishments:

- 1) *Maintain, protect, and enhance natural populations* - Through the implementation of management policies that were assigned to the BLM in the NTHC Recovery Plan (U.S. Fish and Wildlife Service [USFWS] 1986), the agency approved a Habitat Management Plan (HMP) to protect NTHC on BLM-administered land in the Waterman Mountains, Pima County, Arizona (BLM 1986). Within the HMP area, the cactus is found across 2,368 acres (958.30 hectares) of BLM land, interspersed within 590 acres (238.77 hectares) of Arizona State Trust land and 540 acres (218.53 hectares) of

Limestone quarrying, construction of a landing strip and mill site, and recreational off-road vehicle use had destroyed over 350 NTHC and over 200 acres of its habitat in the HMP area (BLM 1986). Prescribed management actions to alleviate these threats included: 1) implement a mineral withdrawal for up to 2,368 acres or on acres not already covered with existing mining claims; 2) conduct a land survey to identify the boundaries between patented and BLM land; 3) establish cooperative conservation agreements with the mining claimants in the Waterman Peak area to minimize surface disturbance; 4) provide aerial surveillance to document habitat disturbances; 5) develop an off-road vehicle designation plan; 6) acquire 590 acres of State Trust land; 7) acquire 540 acres of patented land; 8) conduct an intensive search on BLM land for additional populations; 9) monitor existing populations on Federal land for at least 10 years; and 10) request modifications to the approved mining Plan of Operations. As of 2009, actions 1, 2, 3, 8, and 9 have been completed.

In 1988, the HMP area became designated as the Waterman Mountains Area of Critical Environmental Concern (ACEC) to give priority to NTHC habitat protection during the land-use planning process (BLM 1988). In order to curtail future habitat fragmentation and degradation, the BLM restricted vehicle travel to designated roads and trails (BLM 2001), prohibited surface occupancy for oil and gas development, and limited rights-of-way and/or easements to existing roads (BLM 1988). In 1996, Public Land Order 7197 (61 FR 26528) withdrew all Federal lands in the ACEC from settlement, sale, location, or entry for 50 years effective May 28, 1996. In 2000, Presidential Proclamation 7320 established Ironwood Forest National Monument (IFNM), which includes the entire ACEC and additional Federal, State Trust, and private lands outside of the Nation in Pima and Pinal Counties (Figure 2; 65 FR 37259). The BLM is entrusted with the management of IFNM, in which the lands continue to be managed for multiple uses except when those uses (recreation, mineral, and range) are detrimental to the protection and preservation of cultural, biological, geographical, or other resources values. Thus, management policies on Federal land include a mineral withdrawal, except for land with valid existing rights; and off-road vehicle use prohibitions for all motorized and mechanized vehicles in IFNM, except for emergency and authorized administration purposes.

Surveys and monitoring of populations has occurred sporadically from 1981 to 2006 by the BLM, consultants, volunteers, and other individuals (Kendall 1998; Bainbridge and Wiens 1991; Schmalzel and Francisco 2000; AGFD 2008). Survey efforts were inconsistent among surveyors such that standardized survey protocols were not used and the entire available habitat was not surveyed during each survey, making it impossible to determine the population size in the Waterman Mountains or on the Nation.

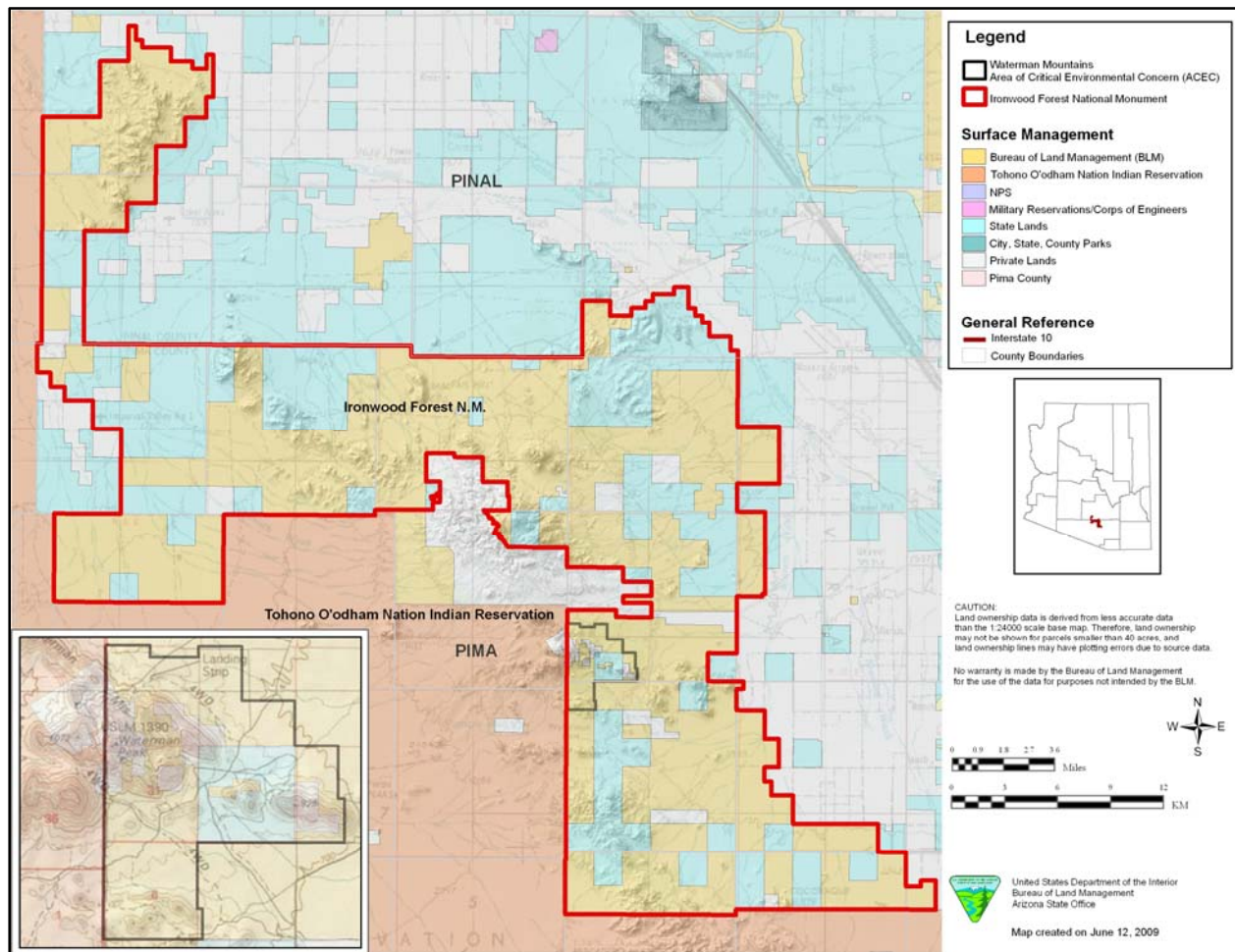


Figure 2. Map of surface ownership for the Waterman Mountains Area of Critical Environmental Concern (ACEC) located within Ironwood Forest National Monument in Pima County, Arizona.

The BLM staff initiated long-term monitoring in 1981 and 1982 by establishing two transects within a dense patch of NTHC. In 1983, BLM staff mapped and labeled approximately 1,179 cacti on the north side of the Waterman Mountains next to a privately-owned airstrip and established two study plots on the north and south side of the Waterman Mountains in 1987 and 1988. No monitoring data were collected for these plots. In 1991, researchers from the BLM, the Arizona Nature Conservancy, and the Arizona Sonora-Desert Museum conducted an intensive search for NTHC in the ACEC (Bainbridge and Wiens 1991). Individuals or groups of cacti were counted and their locations recorded using a global positioning system (GPS). The mapped locations were to be incorporated into a distribution map, but this was never completed.

Legal protection for the NTHC remains unchanged since its listing in 1979. Habitat protection has been permanently secured for populations on Federal land. In 2009, IFNM was added to the National Landscape Conservation

System, which was codified under the Omnibus Public Land Management Act of 2009 (H.R. 146). In effect, the Federal lands encompassed within IFNM are managed primarily for conservation, protection, and preservation purposes.

- 2) *Study populations in their natural habitat at existing sites* - In 1997 and 1998, funding from a USFWS grant was awarded to Robert Schmalzel and Jefford Francisco for a two-year demographic study. The authors planned to 1) determine the distribution of NTHC on the Nation and in the Waterman Mountains, 2) establish permanent plots for monitoring, 3) conduct a census of older BLM transects and plots, 4) determine a population-age structure for all cacti under their study, 5) investigate growth rates, and 6) investigate mortality rates (Schmalzel and Francisco 2000). Based on their report, actions 2, 3, 4, and 5 have been completed.

In 2004, the BLM entered into a research agreement with McIntosh et al. (2007), who are affiliated with University of Arizona, to conduct long-term monitoring on four study plots. The authors had previously been studying a dense patch of NTHC growing on the south-central slopes of the Waterman Mountains since 1995 and were recording annual size measurements for a long-term population study. The authors extended their agreement in 2009 for an additional five years. A morphological study is also currently being conducted with the preliminary results discussed in this review (Baker 2007, 2009). The recovery plan lists additional ecological (e.g. soil and hydrology) and population studies (demographics, life history, and biotic factors) that have not been completed but are necessary to obtain quantified data to establish a measureable criterion for delisting.

Since the recovery plan was published, searches for additional populations have located a fourth population on Koht Kohl Hills on the Nation, but the size and distribution of this population has not been completely delineated (Schmalzel and Francisco 2000). Scattered individuals have also been recorded on private lands outside of the IFNM boundary and within the vicinity of the Silver Bell Mountain (Kendall 1998; AGFD 2008). These individuals were last visited in 1998 by W. T. Kendall, and we do not know the present status of these cacti. No cooperative agreements have been established for cacti occurring on private lands.

- 3) *Develop a comprehensive trade management plan for all cacti to curtail overcollecting* - To our knowledge, a comprehensive trade management plan for this variety has not been completed.
- 4) *Develop public awareness, appreciation, and support for the preservation of the NTHC* - There has been one formal event designed to raise public awareness for the cactus. A joint effort to control buffelgrass (*Pennisetum ciliare*), a non-native perennial, and to mitigate against fire danger in IFNM was made between the BLM, volunteers from the Sierra Club, and the

Arizona-Sonora Desert Museum (Thornton 2007). Besides this event, public appreciation and awareness has been elevated to a certain degree by the establishment of IFNM. Websites hosting information on IFNM generally describe the presence of NTHC, highlighting its endangered status and its need for protection as one of the reasons for the creation of the Monument.

In summary, additional information has been gathered on the subspecies and its habitat since the downlisting recovery criterion was established in the 1986 NTHC Recovery Plan (USFWS 1986). Recovery criteria should be developed and updated to reflect this information, and threats should be addressed relative to the five-factor analysis.

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:

The NTHC is a small, blue-green to gray-green, barrel cactus that is globose, becoming more columnar as it grows. Large individuals range in height from 41 to 51 cm (16 to 20 inches) tall and range in diameter from 13 to 20 cm (5 to 8 inches) wide. Individuals are single-stemmed with 8 ribs that spiral around the base to the apex. Each areole has three central spines, one black that curves downwards and two red or basally gray that curve upwards, and 5 radial spines that tend to be black or partially gray.

Flowering occurs during mid-April to July, with 90 percent of blooms occurring in June (USFWS 1986). Bright pink to red flowers bloom near the apex of the stem, which open midday and close at night and may open again for one to three days following significant rainfall. The NTHC may be opportunistic in its flowering by producing flowers in late summer and early fall in response to rainfall (Powell and Weedin 2004). Flowers are 4 to 7 cm (1.5 to 2.7 inches) in diameter when fully opened (Chamberland 1995; Turner et al. 1995). One to five bright pink fruits are produced in May and June (Benson 1982) and are covered with woolly, white hairs at the apex of the stem, becoming dry with maturity. Fruits are indehiscent and will drop half to two-thirds of their seeds on the ground while the remaining seeds are held within the woolly covered apical pit until they are ejected the following year by flower emergence (USFWS 1986; Powell and Weedin 2004). Seedlings often establish around the base of the “mother” plant and can give the appearance of small clumps.

The NTHC is self-incompatible, requiring pollen from another plant for pollination. Examinations of growth rates found that on average, individuals grow 0.29 cm (0.11 inches) in height and 0.18 cm (0.07 inches) in width per year (McIntosh et al. 2007). Preliminary studies examining population age-structure suggest that an immature cactus takes 11 to 13 years to reach a diameter of 2 cm (0.78 inches) and individual lifespan is estimated between 35 and 95 years

(USFWS 1986; Schmalzel and Francisco 2000). The Schmalzel and Francisco (2000) study found that individuals reach maturity (i.e. bloom for the first time) at 2 cm (0.78 inches) tall and 8 cm (3.2 inches) wide. Young plants produce an average of one flower per year, but with increasing age can produce up to four flowers per year (USFWS 1986; Schmalzel and Francisco 2000). Limited observations suggest fruits ripen approximately 60 to 65 days after pollination but this varies depending on the temperature and available moisture (Schmalzel and Francisco 2000). Each fruit generally contain less than 100 seeds (K. Rice, pers. comm. 2008) that range in size from 3 to 3.5 mm (0.12 to 0.13 inches) long to 1.5 mm (0.06 inches) thick (Bowers and Pierson 2001).

Seedling establishment and recruitment of the cactus is not fully understood. Germination experiments in the 1990s conducted on seeds harvested from NTHC in the field and from cacti in cultivation had a less than 30 percent success rate over a 10-year period due to a limited understanding about the cactus' ecology, soil and water requirements, temperature, and sunlight needs at the time (Ecker 1991; Pritchett-Kozak and Ecker 1992, Pritchett-Kozak 1993). With improved knowledge, the Desert Botanical Garden has been able to germinate seeds stored in a controlled environment into developing plants. Because the cactus inhabits an environment with limited precipitation, germination of 90 percent of seeds may be achieved by allowing the seeds to remain dormant for a period of 5 to 10 years under high soil temperature (i.e. soil temperatures of 160° F). Thus, seeds are incorporated into a soil seed bank until favorable conditions for germination are present (Ecker 1991; Rojas-Aréchiga and Vázquez-Yanes 2000; Godinez-Alvarez et al. 2003; notes from S. Brack, Mesa Garden, courtesy of Desert Botanical Garden files).

The preservation of NTHC has been made possible through conservation efforts by the staff at the Desert Botanical Garden. The Desert Botanical Garden currently has approximately 160 individual plants in cultivation that were salvaged during mining operations in the Waterman Mountains area. Many of these plants appear to be thriving with regular watering, despite growing on granite rather than limestone soil (K. Rice, pers. comm. 2008). In addition, 400 NTHC seeds are stored at the National Seed Storage Lab in Fort Collins, Colorado, with an additional 200 seeds held in the Desert Botanical Garden's own seed bank to further ensure their survival (K. Rice, pers. comm. 2008).

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 NTHC occurs in four disjunct populations: the Waterman Mountains and Koht Kohl Hills in Pima County, Arizona; the Vekol Mountains including those near the vicinity of the Vekol Mine in Pinal County, Arizona; and a population in the Sierra del Viejo Mountains in Sonora, Mexico (Figure 1). When the cactus was listed in 1979, the total population size, based on individuals in the Waterman and Vekol Mountains, was estimated to be less than 500. In the NTHC Recovery

Plan, the total population was estimated to be near 10,000 individuals (USFWS 1986). However, no data are available to substantiate the recovery plan's estimate; therefore, we have low confidence in this number.

Between 1981 and 2006, counts of individual cacti were reported by the BLM, consultants, and other individuals conducting surveys or searches for the cacti in the Waterman Mountains and on the Nation. A preliminary count based on a compilation of the survey results in Arizona indicate there may be less than 2,000 individuals in the Waterman Mountains area and less than 1,000 on the Nation (Bainbridge and Wiens 1991; Kendall 1998; Schmalzel and Francisco 2000). No estimate exists for the Mexican population. A summary of survey results are described below.

Two informal surveys for the cactus have been conducted on the Nation. Gass (1987) counted 413 live plants and 57 dead while walking along a perimeter road near the Vekol Mine. He approximated less than 1,000 plants within the entire Vekol Mountain area. The Schmalzel and Francisco study located approximately 623 plants growing near the Vekol Mountain and on Koht Kohl Hill while searching limestone outcrops for the cactus. The authors documented additional NTHC in other areas when they were investigating flowering among individuals but did not provide specific site details making it confusing to tell whether these cacti were counted in their survey. Bainbridge and Wiens (1991) counted approximately 562 individuals growing within a quarter-mile (0.40 km) buffer between the boundary of the Waterman Mountain ACEC and the Nation while conducting a distribution study for NTHC in the ACEC.

Most of the efforts to document the cactus have occurred in the Waterman Mountains, Arizona. The BLM established two line-transects in 1981 and 1982 for 83 cacti on the south-central slopes of Waterman Mountains. Size measurements of cacti were recorded but the data have not been analyzed. In 1983, the BLM mapped and labeled approximately 1,179 cacti among three patches near an abandoned landing strip on private land, but no growth data were collected (USFWS 1986). In 1987 and 1988, BLM established two study plots on the north and south side of Waterman Mountains with approximately 245 cacti, but no data were collected for these either. The Bainbridge and Wiens (1991) study located approximately 1,273 individuals on Federal, State Trust, and private land during a search for the cactus in the ACEC. They recorded the locations of individuals and large patches using a geographical positioning system (GPS). The distribution of the cactus relative to land ownership was not a part of their study. Their search identified 11 additional sites occupied by the cacti, but technical problems with the GPS satellite system prevented their coordinates from being recorded. Moreover, a final distribution map from this study was planned but never completed. William Kendall (1988), Arizona Native Plant Law Enforcement, visited nine sites in the ACEC and observed approximately 368 live and 89 dead cacti comprised of adults and immature plants. He documented additional cacti located on both sides of Avra Valley road and within a Pima County right-of-way; however, he did not record the number of cacti seen. Some

of the areas visited by Mr. Kendall appear to correlate with those included in the Bainbridge and Wien inventory, but neither surveyor provided sufficient location information to verify this.

The largest and most dense patch of NTHC exists on the south-central slopes of the Waterman Mountains. While no information is available on the total number of cacti located here, preliminary counts indicate there are approximately 175 to 298 individuals (Schmalzel and Francisco 2000; McIntosh et al. 2007) with the relative abundance described as “several hundred” individuals occurring over several acres (Dimmit and Van Devender 2003). A portion of those cacti have been monitored over the last 10 years. McIntosh et al. (2007) have been collecting size measurements and plant condition from 1995 to 2006 on 134 cacti distributed among four study plots (Figure 3). During this period, their results show a steady decline of the cacti among all plots pooled with a 20 percent mortality rate. An analysis of plant conditions show that 39 percent of the cacti had signs of desiccation and discoloration, 37 percent had signs of necrosis (i.e. tissue death), and 14 percent were damaged by small mammals. Reasons for the decline were assumed to be correlated with the prolonged drought impacting the southwest and likely contributing to increased herbivore predation (M. McIntosh, pers. comm. 2008). Data collected from 2003 to 2008 continue to show a decline among the plots with 60 percent mortality (77 out of 129 cacti) since 1995, and 5 plants are missing (Figure 4). Thus, although this study focuses on one site, the conditions of this dense patch suggest concern for the rest of the Arizona population may be warranted.

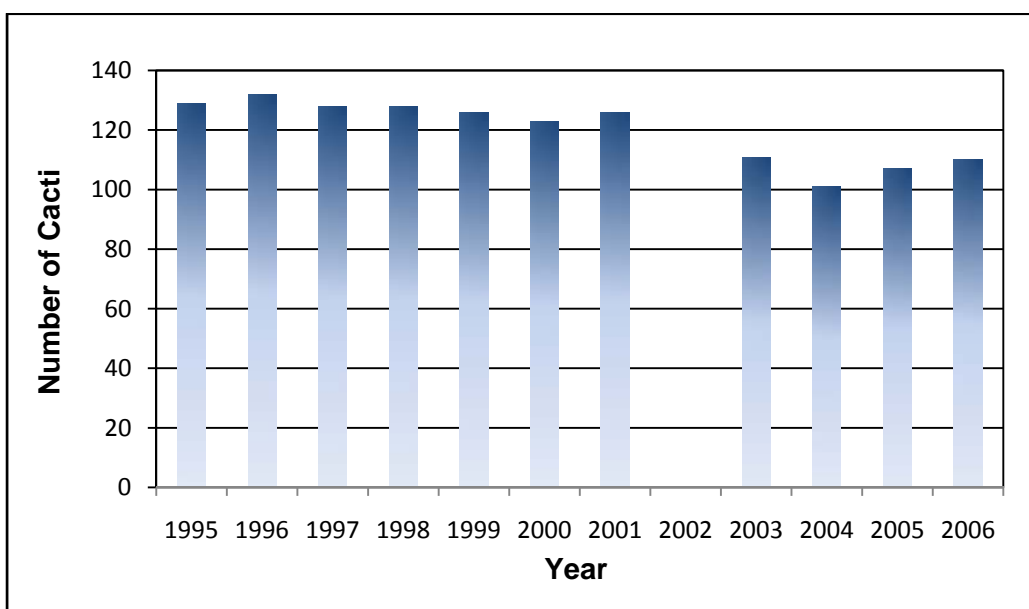


Figure 3. Population trend for Nichol Turk’s head cactus ($n = 134$) among four study plots located south of Waterman Peak in the Waterman Mountains, Arizona, from 1995 to 2006. No census occurred in 2002 (McIntosh et al. 2007).

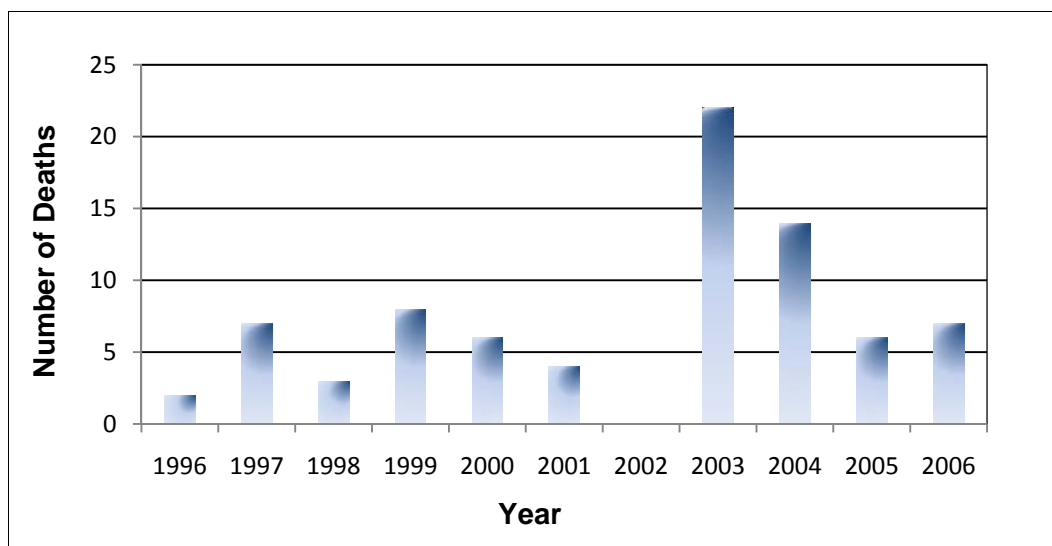


Figure 4. Number of mortalities recorded for Nichol Turk's head cactus ($n = 79$) from four study plots located south of Waterman Peak on the Waterman Mountains, Arizona, from 1995 to 2006. No census occurred in 2002 (McIntosh et al. 2007).

A study conducted by Schmalzel and Francisco (2000) examined population age-structure of 1,150 cacti that were distributed among 11 study plots. Their methods to determine age included relocating and surveying the two study plots BLM established in the 1980s. The authors collected height and diameter information from those cacti and used the data to calculate an overall growth rate that would be used to estimate the age for each individual. Their published results show two different age analyses for each of their plots and these do not correlate with each other. Also, Schmalzel and Francisco (2000) do not relate their age-class classification to a meaningful value such as correlating "age" of an individual to its growth rates in order to understand the relationship between age and size of the cactus at maturity. Lastly, Schmalzel and Francisco (2000) included size measurement data recorded by the BLM when the agency established transects and study plots. Because we do not have a copy or any records of the original BLM data, we cannot be certain about the accuracy of these data. For these reasons, we do not find the information useful in determining the age of NTHC.

No available information exists for the population in the Sierra del Viejo Mountains in Sonora, Mexico. The cactus was first documented there based on a verbal record given by Tony Burgess of the University of Arizona, who found the cactus on the north end of the mountain range on February 19, 1980, but did not collect a specimen (Schmalzel and Francisco 2000). The location of where Burgess observed the cactus is unknown. A second survey was made to relocate individuals in 1981 and 1982 by George Yatskievych and Pierre Fischer. They documented the cactus occurring on the north end of the mountain range and collected a single dead juvenile plant as a herbarium specimen for the University of Arizona in 1982 (Yatskievych and Fischer 1984). Subsequent attempts to

revisit the area where NTHC was found have been unsuccessful due to the investigators being denied permission to access the land by the landowner (Schamalzel and Francisco 2000; Baker 2009). Searches for the cactus on the southern and middle portions of Sierra del Viejo Mountains did not locate any individuals (M. Baker, pers. comm. 2009). Mr. Yatskievych described the cactus as uncommon on ridgetops, suggesting that the population is likely small compared to those in Arizona.

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

We found no information available for this cactus pertaining to genetics, genetic variation, or trends in genetic variation.

2.3.1.4 Taxonomic classification or changes in nomenclature:

The taxonomic classification remains unchanged since the NTHC Recovery Plan was published in 1986. There are no changes in nomenclature. Several naming standards exist for *Echinocactus horzonthalonius* var. *nicholii*. The standard that we chose to use in this review is consistent with the nomenclature used by the Arizona Rare Plant Field Guide (Arizona Rare Plant Committee 2001).

Several biologists questioned the taxonomic validity of variety *nicholii* suggesting that it is not distinct from the common variety *horzonthalonius* (common name is Turk's head or Devil's head cactus) that grows in the Chihuahuan Desert (Chamberland 1995; J. Anderson, pers. comm. 2008; T. Van Devender, pers. comm. 2008). Within populations of the variety *horzonthalonius*, individuals exhibit a wide array of morphological variation. Some experts believe that the amount of variation makes variety *nicholii* appear different from variety *horzonthalonius*, but that there are not enough differences to support its status as a separate variety (Powell and Weedin 2004; M. Chamberland, pers. comm. 2008; M. Baker, pers. comm. 2008). Chamberland (1995) evaluated the differences between the varieties by comparing measured key characters (i.e. plant height, diameter, and seed size) from salvaged plants of variety *nicholii* against herbarium specimens of variety *horzonthalonius* and did not find enough sizeable differences to warrant the classification of *nicholii* (M. Chamberland, pers. comm. 2008).

Baker (2007, 2009) is conducting a multivariate analysis to compare the degree of morphological variation of stem characters within populations of variety *nicholii* to populations within *E. horzonthalonius* throughout its known range to determine if these characters are significantly different to the full suite of characters Benson (1969, 1982; Table 1) used to originally describe the variety. Preliminary results suggest that there are sufficient morphological differences between the two varieties to support the current taxonomic classification. Further, Baker's results suggest that there are three distinct varieties within the species *E. horzonthalonius*: variety *nicholii* in the Sonoran Desert population, variety

horizonthalonius in the Chihuahuan Desert, and an unnamed variety in San Luis Potosí, Mexico. However, more populations need to be measured in order for the results to be conclusive (M. Baker, pers. comm. 2009).

Characters	<i>var. horizonthalonius</i>	<i>var. nicholii</i>
Stem form	Depressed-globose to broadly ovoid	Depressed-globose to broadly ovoid, becoming columnar with age
Stem size	Usually 10-15 cm tall (4-6 inches, rarely 12 inches)	Usually 40-50 cm tall (15-19 inches), 12.5-15 cm (4.9-5.9 inches)
Stem width	10-15 cm (4-6 inches)	12-20 cm (5-8 inches)
Spines	Gray, usually pale gray covering red and yellow	Nearly black or dark gray, some under layers of red
Central spines	3 to 5:1 curving downward or nearly straight, 2 curving upward usually short and straight	3:1 black and curving strongly downward and much shorter than the others, 2 red or basally pale gray and curving upward
Radial spines	5 to 7 per areole	5 per areole
Seeds	Broader than long; 2 mm long (1/12 to 1/7 inches), 3 mm wide (1/12 to 1/8 inches)	Longer than broad; 3-3.5 mm long (1/8 to 1/7 inches), 2 mm wide (0.50 inches)
Hilum	Appearing "lateral" to basal, 0.5 mm diameter (0.02 inches)	"Sub-basal" ± 1 mm diameter (0.04 inches)
Altitude	900-1650 m (3,000-5,500 feet)	900-1,050 m (3,000-3,500 feet)
Floristic association	Chihuahuan Desert	Sonoran Desert

Table 1. Distinctive characters which distinguish the two varieties of *Echinocactus horizonthalonius*, as described by Benson (1982).

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.):

The NTHC is endemic to the Sonoran Desert and occurs in isolated mountain ranges that extend from south-central Arizona in Pima and Pinal Counties to a disjunct location in Sonora, Mexico. When the cactus was listed in 1979, its entire range was estimated to be approximately 20 square kilometers (4,942 acres) based on its known range in Arizona (44 FR 61927).

A biological survey of IFNM found that of nine topographical locations inventoried, NTHC occurs only in the Waterman Mountains and almost exclusively on Horquilla limestone substrate (Dimmitt and Van Devender 2003). The cactus is thought to occur on the Silver Bell Mountains, but attempts to relocate individuals there have not been successful (M. Reimer, pers. comm. 2008). Occurrence records exist for this site (AGFD 2008), but may actually be in error (Dimmitt and Van Devender 2003). Apparently the Silver Bell reference originates from secondhand information obtained in 1951 during a time when the

Waterman Mountains were included as being a part of the Silver Bell Mountain range. In 1990, an independent survey for the cactus was conducted on the northwest portion of the Silver Bell Mountains on private property owned by ASARCO, Inc. Searches for the cactus concentrated on areas where Paleozoic limestone outcrops existed, but no individuals were found (Schmalzel and Francisco 2000). Recent searches of the area did not identify significant limestone outcrops, suggesting that a population in the Silver Bell Mountains may be unlikely (Dimmit and Van Devender 2003). This assumption needs to be verified with on-the-ground surveys. Another population was believed to be located on Twin Peaks, east of IFNM near Marana, but this site was later destroyed by limestone quarrying. The area was surveyed in the early 1960s and in the mid-1980s without success. Photographs taken of Twin Peaks in 1916 and 1962 showed Horquilla limestone formation existing near the peak; however, active limestone quarrying in the 1980s removed the entire peak and the limestone. A report of seeing NTHC on its slopes in 1999 prompted a third survey of the area, but no cacti were located (Schmalzel and Francisco 2000).

The spatial distribution of individuals among and within populations has not been studied. General observations describe the Waterman Mountains population as sporadic. Dimmit and Van Devender (2003) identified three large discontinuous patches where the cacti was concentrated: a large patch of “several hundred” occurs along an inclined terrace on patent land near Waterman Peak, a second large patch grows along a bajada and onto the slopes of the Waterman Mountains, and the third extends along a bajada near an abandoned airstrip. Outside of these areas, individuals are randomly scattered or completely absent. Bainbridge and Wiens (1991) found the population density in the ACEC to be one individual per acre (0.50 individual per hectare). Within the densest patch, McIntosh et al. (2007) estimated densities of 0.05 to 0.29 plants per square meter (0.54 to 3.12 plants per square foot) while Schmalzel and Francisco (2000) estimated 0.72 to 0.94 plants per square meter (7.75 to 10.11 plants per square foot). No density information is available for cacti on the Nation.

The historical range of the NTHC is unknown. The distribution of the common variety, *E. horizonthalonius* occurs in the Chihuahuan Desert from Texas to New Mexico and extends south to San Luis Potosí, Mexico. *Echinocactus horizonthalonius* was first discovered in the Sonoran Desert in 1918 when Forrest Shreve collected an individual in Pima County, Arizona. Another early record documented *E. horizonthalonius* near the Silver Bell Mine, Pima County, in 1935. Anderson and Van Devender (1991) identified seeds of *E. horizonthalonius* in a woodland assemblage in the Waterman Mountains that was radiocarbon dated from 22,380 B.P., providing evidence that the species has existed in this area over a substantial period of time. However, colonization at the subspecies level remains uncertain and we are not aware of any records documenting *E. horizonthalonius* in the areas between New Mexico and the Waterman Mountains. Thus, in 1969 the Arizona plants were described by Benson as variety *nicholii* after A. A. Nichols, who studied populations of *E. horizonthalonius* in the 1930s and considered the plants in Arizona to be larger and darker than those in Texas

(Benson 1969, 1982). Therefore, speculation exists that the common variety *horizonthalonius* may historically have had a range extension from Texas into Arizona and became fragmented during the Pleistocene. Population fragmentation occurring in southern Arizona may have caused individuals within variety *horizonthalonius* to diverge into a unique variety in Pima County (Turner et al. 1995; Scarborough 2003). However, because there are insufficient data to conclusively confirm this assertion, additional taxonomic and genetic investigations are needed.

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

The amount, distribution, and suitability of NTHC habitat have not been delineated. The NTHC Recovery Plan estimated that potential amount of available habitat to be 5,000 acres in the Waterman Mountains and 5,700 acres on the Nation (USFWS 1986). The NTHC occurs within the Upland Division of Sonoran Desert scrub on 732 to 1,219 meters (2,400 to 4,000 feet) elevation on zero to 30 percent slopes with a north, west, and south-facing exposure (USFWS 1986). The cactus is found on limestone substrates along dissected alluvial fans, inclined terraces and saddles, bajadas, and debris flows. The cactus grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or shouldered next to rocks on steep slopes and within limestone outcrops. Dominant plant species associated with NTHC include: creosote bush (*Larrea tridentata*), foothill palo verde (*Parkinsonia microphylla*), triangleleaf bursage (*Ambrosia deltoidea*), white ratany (*Krameria grayi*), brittlebush (*Encelia farinosa*), prickly pear cactus (*Opuntia* sp.), saguaro (*Carnegiea gigantea*), ocotillo (*Fouquieria splendens*), and buckhorn cholla (*Cylindropuntia acanthocarpa*) (BLM 1986; USFWS 1986).

The NTHC has been found to grow almost exclusively on Pennsylvania-aged Horquilla limestone. Schmalzel and Francisco (2000) found NTHC occurring on Horquilla and Earp Formations, and sporadically on small sandstone or quartzite outcrops of Paleozoic and Cretaceous age. Additional surveys also identified NTHC to occur only in the Waterman Mountains and on Horquilla limestone substrate (Dimmit and Van Devender 2003; Scarborough 2003). Horquilla limestone has a high concentration of carbonates and erodes easily on gentle slopes (Osterkamp 2008). In the Vekol Mountains, the cactus is observed growing on Lozier and Tencee soil series (USFWS 1986). Schmalzel and Francisco (2000) observed that among different substrates (e.g. soils comprised of Martin, Escabrosa, Concha, and Rainvalley Formations) soils comprised of Horquilla limestone appeared to support higher densities (0.20 to 0.94 plants per square meters or 2.15 to 10.11 plants per square foot) of NTHC relative to other soil types.

The Waterman Mountains lie south of the town of Silver Bell and 40 kilometers (24.85 miles) west-northwest of Tucson. The range is a northwest-southeast ridge that is approximately seven km (4.35 miles) long and four km (2.49 miles) wide

with elevation ranging from 730 m to 1180 m (2,395 feet to 3,871 feet). Geologically, the Waterman Mountains are comprised of an isolated block of Paleozoic Concha limestone (Anderson and Van Devender 1991). The climate conditions of southern Arizona are subtropical and semi-arid. Precipitation is bi-seasonal with annual average precipitation of 30 cm (12 inches); it rains predominately in the winter and summer months. The months of April, May, and June are often the driest and can be a time of moisture stress for native desert plants. Temperatures frequently exceed 100° F (37.7° C) in the summer and occasionally drop below freezing during the winter season (NOAA 2008).

In Mexico, the Sierra del Viejo Mountains are an isolated mountain range with steep limestone ridges near Carborca, Sonora. The climate is semi-arid, with bi-seasonal rains that support a high diversity of wildlife species in the region. The lands are considered to be high priority conservation areas by the Mexican government, but there is no official protection afforded to the cactus (Diario Oficial de la Federación 2002). There are three different land owners who have claim to the northern, middle, and southern portions of the range, but the entire range is managed by a non-profit organization called the Organizacion Vida Silvestre, A.C. (OVIS), which is based in Monterrey, Mexico. In 1982, a single NTHC was located on the north end of the Sierra del Viejo Mountains along a ridge above a canyon mouth at approximately 2400 feet (731 m) in elevation, northwest of the town of Mina Santa Cruz. The cactus was described as rare on flat, open ridgetops with coarse rocky limestone substrate. Associated plants in the vicinity of the cactus were *Mammillaria*, *Dasyilirion*, *Jatropha*, and *Fouquieria*.

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 threats to the NTHC habitat that were outlined in the 1986 recovery plan have changed significantly. Activities associated with mineral operations and recreational off-road vehicle use from increased urbanization were documented as causing the loss of over 200 acres of habitat, as well as erosion along roadways impacting both the cactus and its habitat. Past legislation that withdrew land in the ACEC from mining operations and the designation of IFNM, which included management actions designed to reduce and eliminate threats to NTHC habitat, have helped to alleviate or minimize the threat of mining and recreational off-road vehicle use on BLM land. However, Federal legislation does not apply to non-Federal lands where destruction is still occurring. New threats to NTHC habitat have also been identified.

In IFNM, there are 225 valid existing mining claims, with about 48 claims located in the ACEC in occupied NTHC habitat (Schmalzel and Francisco 2000; BLM 2007). Most of the claims in the ACEC are owned by the Phoenix Cement

Company on behalf of the Salt River Pima-Maricopa Indian Community. The company is not currently engaging in active operations and is willing to engage in a land exchange of their parcels in the Waterman Mountains with the BLM (R. Smith, P. Kuehner, and B. Dyer, pers. comm. 2009). Outside of IFNM, Pioneer Sand and Gravel operates a quarry in the Silver Bell Mountains where NTHC has been documented. The company arranged the salvage of 23 NTHC in 2006 after an expansion of their operations (M. Reimer, pers. comm. 2008). Currently, the company is active, producing rock and stone pavers for residential and commercial development, but they are not expanding operations into areas where additional salvage may be warranted (S. Anderson, pers. comm. 2008). Depending on the real estate market, this could change in the future. The NTHC is believed to be growing on property owned by ASARCO, Inc., a mining, smelting, and refining company, but the presence of the cactus needs to be verified. The Nation has approximately 143 valid existing claims, six of which are associated with the Vekol Mine. These claims cover approximately 120 acres (48.56 hectares) and are located southeast of a NTHC population (Schmalzel and Francisco 2000). In 2005, three NTHC were destroyed by a non-tribal member who widened an access road leading to his mining claim without authorization (K. Howe, pers. comm. 2008). The person was indicted on 21 counts and the case is currently being investigated.

A more recent and prominent threat to the cactus and its habitat is related to habitat disturbance from illegal immigrants, drug smuggling, and associated law enforcement activities. In the IFNM, substantial evidence of illegal activity includes damage to existing fences, a large amount of discarded personal belongings and trash, and hundreds of vehicles that have been abandoned, staged, or traveled off-road creating new tracks (BLM 2006). Many NTHC grow along the sides of roads and can be easily destroyed or damaged from vehicles or foot traffic. Smugglers have hidden vehicles off-road for undocumented immigrants to use for transportation to Phoenix and other areas. Tire tracks have been observed near or next to cactus (K. Robertson, pers. observation, 2008) and there has been damage to rebar used to mark a long-term monitoring plot (USFWS consultation 22410-2004-I-0409). In one year, approximately 150 abandoned vehicles associated with this activity were towed from IFNM (D. Tersey, pers. comm. 2008). As a deterrent, the BLM constructed a four-strand wildlife fence along the north side of Waterman Mountain Road on BLM land to restrict off-road vehicle use. The fence was subsequently cut by suspected illegal activity in 2006 requiring 253 feet of the fence repaired (BLM 2006). So far, the fence has reduced the number of vehicles stashed off-road on BLM land. There is no deterrent against this activity where the Waterman Mountain Road is on State Trust land and individual cacti may be adversely impacted. In addition, drug smuggling continues in the area as individuals have found ways to drive vehicles over the pedestrian border fence and into IFNM, potentially impacting NTHC and its habitat.

Another significant threat to NTHC habitat is the spread of invasive species within IFNM such as buffelgrass (*Pennisetum ciliare*). Buffelgrass out-competes

native vegetation for resources and its dry leaves can carry hot wildfires across the desert floor becoming a significant threat as a fire hazard. Patches of buffelgrass have invaded a large NTHC patch near the abandoned landing strip and mill site. In these areas or in areas where the spread of buffelgrass has a high potential to affect the cactus, manual control efforts are used, primarily during the time the cactus is dormant (USFWS consultation 22410- 2007-I-0339). Manual control efforts occur frequently to eradicate small populations or individuals from spreading into sensitive areas. But, hand removal will not keep pace with buffelgrass' ability to rapidly invade native habitat (USFWS consultation 22410-2007-I-0339). Two other invasive species in IFNM are Sahara mustard (*Brassica tournefortii*) and Bermuda grass (*Cynodon dactylon*) that also present fire hazard risks to NTHC and its habitat (Dimmit and Van Devender 2003).

Threats to NTHC habitat in the Sierra del Viejo Mountains have not been documented. The north end of the mountain range is privately owned and supports trophy hunting for bighorn sheep. Impacts associated with hunting on available habitat are unknown. Until surveys in this area are conducted, we will not know the status of the cactus, the condition of its habitat, nor potential threats to both of these.

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

Cactus collection for profit and seed collection by commercial nurseries may still pose a potential threat to NTHC (K. Rice, pers. comm. 2008; P. Jenkins, pers. comm. 2008). Illegally collected NTHC have been observed in landscaped areas in the Silver Bell Mountains and in gardens of mining companies (USFWS 1986). Arizona Native Plant Law enforcement records document the illegal collection of approximately 24 cacti from monitored plots in the Waterman Mountains during 1988 to 1998 (Kendall 1998). Eleven of these cacti were illegally collected in association with the export of Turk's head cacti, variety *horizonthalonius*, for commercial purposes. Arizona Native Plant Law enforcement records also noted an increase in the theft of NTHC from May 1996 to May 1998 in which these thefts appeared to be occurring with importations of Turk's head cacti that were reportedly field collected in Texas, then sold to nurseries in Arizona, who exported the cacti to other states. Between 1998 and 2000, there were no reported cases of Arizona native plant violations for NTHC (M. Reimer, pers. comm. 2008). However, the populations are not monitored regularly to determine if theft is occurring and to what degree. No other forms of collection (i.e. scientific or educational) are perceived as potential threats.

2.3.2.3 Disease or predation:

There is no evidence to suggest that disease is a significant threat to the cactus. However, depredation by herbivores has been identified as a new threat. Specifically, desert bighorn sheep, javelinas, and rabbits may depend on the cactus for available moisture during drought conditions (Schmalzel and Francisco

2000; McIntosh et al. 2007; K. Rice, pers. comm. 2008). Impacts to the cactus have been documented. McIntosh et al. (2007) estimated up to 18 percent (24 of 134 plants) were impacted by depredation and documented several “open” carcasses in which the plant was chewed, torn apart, or completely consumed. On the Nation, Gass (1987) reported that six plants near Vekol Mine appeared to have been eaten by rabbits from the amount of rabbit droppings at the base of the cacti, and Schmalzel and Francisco (2000) suspected that 24 percent (107) of 445 plants in their study area were eaten or impacted by javelina. In 1999, fencing was erected around a population of NTHC on the Nation to protect the cacti from herbivore depredation (Jakle and Humphrey 2002). As a follow-up to the project, tribal biologists were collecting information on environmental conditions, such as drought, that may lead wildlife to consume the cactus, but we do not have information on whether this is still on-going or has been completed. Depredation by herbivores will likely increase as the region continues to be in a prolonged drought (NCDC 2009) and may contribute to a population decline.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

There have been a few changes with regard to existing regulatory mechanisms related to the NTHC that were outlined in the listing document and the recovery plan (44 FR 61927; USFWS 1986). The cactus is listed as an Appendix II species of the Convention on International Trade in Endangered Species (CITES) and protected against overutilization by collection and trade through enforcement of the Lacey Act on non-tribal lands. The cactus is protected under the Arizona Native Plant Law as a highly safeguarded plant, which makes it unlawful for any person to destroy, dig up, cut, collect, mutilate, harvest or take, and place into possession any of these plants on non-Federal lands (Arizona Revised Statutes 2009). However, the Arizona Native Plant Law does not prohibit landowners from removing or destroying protected plants on their property, but they are required to notify the Arizona Department of Agriculture 20 to 60 days prior to destruction of a protected native plant. Additionally, the Arizona Native Plant Law does not afford protection to NTHC habitat and there is no protection for the cacti on State Trust lands. Although, the Arizona State Lands Departments requires a recreational permit before anyone is authorized to access State Trust lands (ASLD 2008), but this is rarely enforced.

The habitat for the population in the Sierra del Viejo Mountains is considered a high priority conservation area by the Mexican Federal government. The lands are privately owned and restricted from public access except by permission from the landowner. There is no official protection afforded the cactus in Mexico as defined in the Norma Oficial Mexicana NOM-059-SEMARNAT-2001 (Diario Oficial de la Federación 2002).

Legal mechanisms to protect the cactus on the Nation are described within the Tohono O'odham Code (Tohono O'odham Legislative Branch 2006). Title 15 makes it a misdemeanor to remove any species of cactus from tribal lands without authorization (Tohono O'odham Legislative Branch 2006). The Nation also

restricts access to their land for non-members unless access has been authorized by a Federal statute or administrative regulation allowing the non-member to be present on tribal land, or when the non-member has consent to be present on tribal lands by the landowner, or for access to a state highway within the exterior boundaries of the Tohono O'odham Nation (Title 2, Chapter 4; Tohono O'odham Legislative Branch 2006). Signs are posted at the Nation's boundaries to ensure public knowledge that upon entering tribal land persons are subjected to tribal laws. Thus, if a non-member commits an offense prohibited by the Code, it is the responsibility of the Nation to initiate contact with the appropriate law enforcement agency (e.g. Federal or state) having jurisdiction over the offense. Subsequently, the law enforcement agency may or may not choose to investigate.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

An ongoing drought has been occurring within the range of NTHC since the late 1990s. Periods of drought in the southwest region of the United States are not uncommon. But, the frequency and duration of droughts may be altered by climate change. Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 states (IPCC 2007), with warming in southwestern states greatest in the summer (IPCC 2007). The IPCC (2007) also predicts hot extremes, heat waves, and heavy precipitation will increase in frequency. There is also high confidence that many semi-arid areas, like the western United States, will suffer a decrease in water resources due to climate change (IPCC 2007) as a result of less annual mean precipitation and reduced length of snow season and depth (IPCC 2007). Seager et al. (2007) predict, based on broad consensus among 19 climate models, that the southwestern United States will dry in the 21st century and that this drier climate change is already occurring. Milly et al. (2005) project a 10 to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. Therefore, while it appears reasonable to assume that the NTHC may be affected, we lack sufficient certainty to know how climate change specifically will affect this cactus.

Observations of NTHC within the Waterman Mountains show obvious signs of desiccation, discoloration, and stem shrinkage suggestive of below-normal levels of precipitation. The drought is believed to be contributing to increased mortality observed on monitoring plots in addition to above-normal temperatures. A return to normal climatic conditions could reduce impacts of this threat. Almost certainly the NTHC, along with its habitat, will be affected in some manner by climate change; and these impacts may be worsened by on-going and projected drought.

2.4 Synthesis

The NTHC (*Echinocactus horizonthalonius* var. *nicholii*) is a small, long-lived, and slow growing barrel cactus that is endemic to the Sonoran Desert. The cactus occurs in four discrete populations within a narrow range on isolated mountain ranges, and grows

almost entirely on Horquilla limestone. Preliminary studies show that NTHC is a distinct variety from the more common variety *Echinocactus horizonthalonius* found in the Chihuahuan Desert. Since being listed as endangered in 1979, there are still large gaps in our knowledge of the cactus that limits our understanding of the biology and ecology of this variety. Very few studies have been conducted on the NTHC, and there are limited quantified data available to describe the population in regard to its spatial distribution, population trend, age-structure, growth and mortality rates, phenology, dispersal, habitat availability and condition, and genetics.

The NTHC Recovery Plan estimated a total population of 10,000 individuals within the known range, but there are no data to support this estimate. A complete inventory at any of the sites has not been accomplished, although this may be difficult to do given that the cactus' small size, its ability to blend with its environment, and its relatively low density. Despite numerous surveys in the Waterman Mountains, there are insufficient data to accurately determine the current population size. Based on available data, it appears that the majority of the total population occurs in the Waterman Mountain ACEC. However, we recognize that more surveys have been conducted in this area and that additional searches are needed on the Nation and on private lands outside of the IFNM. Where the cactus occurs across Federal, State Trust, and private lands has not been delineated. Although permanent habitat protection has been achieved for the cactus on Federal land, we do not know the number of NTHC that are benefitting from this protection. Between 1987 and 1998, two attempts have been made to survey the populations on the Nation but these were not comprehensive searches. We also do not have any information about the NTHC population in Mexico. Since the cactus was discovered there in 1982, two attempts have been made to survey the area for additional individuals but these have been unsuccessful. Although the habitat for the NTHC in Mexico is protected, activities occurring on the land are not fully understood whereby threats to the cactus are unknown. Surveys are needed to document the existing population size and present status of the cacti at this site.

While a large portion of NTHC habitat on Federal land has been protected, the cactus continues to face habitat degradation by off-road vehicle use from activities associated with undocumented immigrants, and an increasing fire risk from buffelgrass invasion. On the Nation and on private lands outside of IFNM, the cactus and its habitat continue to be impacted by activities associated with mining. We also recognize that the cactus faces an uncertain future given the predictions of continued drought. A long-term monitoring plot has shown that out of 134 cacti, 60 percent of the individuals have died over a 10-year period which may be indicative of the conditions in the other populations. The decline of cacti correlates to the prolonged drought occurring in Arizona which appears to be exacerbated by small mammals eating the cactus, possibly to obtain water.

In summary, there is still a lot that we do not know about this cactus. We do not have sufficient data to accurately quantify the current status of NTHC populations or to determine the amount of habitat that is occupied by the species to meet the recovery downlisting criterion. New threats to the cactus have been identified that were not discussed in the recovery plan. While existing threats to the cactus are on-going, we are unable to accurately or completely quantify any of the threats and their effects to the

populations. A commitment is needed to survey, census, conduct regular long-term monitoring, and fulfill gaps in knowledge with necessary studies to ensure the conservation of the species. Therefore, we recommend that the Nichol Turk's head cactus remain classified as endangered.

3.0 RESULTS

3.1 Recommended Classification:

- Downlist to Threatened**
 Uplist to Endangered
 Delist (*Indicate reasons for delisting per 50 CFR 424.11*):
 Extinction
 Recovery
 Original data for classification in error
 No change is needed

3.2 New Recovery Priority Number: We recommend that the Recovery Priority Number remain a 3; this means a high degree of threat, high recovery potential, and the listed entity is a subspecies.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

- The 1986 NTHC Recovery Plan should be revised to incorporate new information that has been gathered since it was finalized. The recovery criteria should be revised to address newly identified threats to the subspecies. Criteria for delisting should be established. Threats should be discussed relative to the five-factor analysis regarding their impact to the subspecies and its habitat.
- Establish a systematic monitoring protocol to more effectively evaluate the status of the subspecies across its known range. Expand the area being monitored to include a larger sample size that is more representative of the Waterman Mountains population. Monitoring should be designed to establish long-term population trends and investigate effects of climate change.
- Studies should be conducted to obtain the quantified data in order to support the recovery criteria using the best scientific and commercial data available. Studies should focus on: ecological factors that influence distribution, density-dependence issues, resource requirements for survival, seedling establishment and dispersal, pollination, demographic trends, population biology, and the amount and condition of suitable habitat.
- Evaluate the genetics of this subspecies to better understand its evolutionary history and relationship to *E. horizonthalonius*, and to assess genetic variation within and between the populations. This information would provide a better understanding of its historical range and taxonomic classification.

- Establish a cooperative partnership with OVIS and develop a conservation agreement to survey and (if found) study the cactus in the Sierra del Viejo Mountains in Sonora, Mexico.
- The USFWS should coordinate cooperative agreements with the Tohono O’odham Nation and ensure that partnerships continue to help protect and conserve the cactus on Tribal land.
- The USFWS should coordinate and establish cooperative partnerships with private landowners to implement conservation of the cactus on their land.

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Experts contacted that provided information used in the status review:

John Anderson, Botanist, Bureau of Land Management, Arizona State Office
 Scott Anderson, Manager, Pioneer Sand and Gravel
 Marc Baker, Ph.D, Southwest Botanical Research
 Michael Chamberland, Director of Horticulture, Tucson Botanical Garden
 Ted Cordery, Bureau of Land Management, Arizona State Office
 Mark Dimmit, Ph.D., Director of Natural History, Arizona-Sonora Desert Museum
 Bruce Dyer, Vice President of Aggregates, Phoenix Cement Company
 Law Enforcement Official, Buenos Aires National Wildlife Refuge
 Karen Howe, Ecologist, Tohono O'odham Nation, Natural Resources Department
 Philip D. Jenkins, Curatorial Specialist, Herbarium, University of Arizona
 Pete Kuehner, Senior Vice President & CEO, Phoenix, Cement Company
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 George Montgomery, Curator, Arizona-Sonora Desert Museum
 Michael Reimer, Investigator, Office of Special Investigations, Arizona Department of Agriculture
 Kathy Rice, Former Curator of the rare and endangered plants program, Desert Botanical Garden
 Sabra Schwartz, Heritage Data Management System (HDMS) Program Supervisor, Arizona Game and Fish Department
 Roger Smith, Jr., President & CEO, Phoenix Cement Company
 Darrell Tersey, Natural Resource Specialist, Bureau of Land Management
 Thomas Van Devender, Ph.D., Senior Research Scientist, Sky Island Alliance

Individuals or Organizations contacted: Ondreas Barber, Salt River-Pima Maricopa Indian Community

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Nichol's Turk's Head cactus
(*Echinocactus horizonthalonius* var. *nicholii*)

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:

Review Conducted By: Kathy Robertson, Arizona Ecological Services Field Office, Phoenix, Arizona, 602/242-0210 ext 232.

FIELD OFFICE APPROVAL:

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

Approve *Delmer T. Bills* Date *6/29/09*

REGIONAL OFFICE APPROVAL:

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

Approve *Nancy J. Goman* Date *7/27/09*