

RECOVERY PLAN AMENDMENTS FOR 20 SOUTHWEST SPECIES

The U.S. Fish and Wildlife Service has identified best available information that indicates the need to amend recovery criteria for the below species. Each amendment is recognized as an addendum that supplements the existing recovery plan.

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| <p>Brady Pincushion Cactus (<i>Pediocactus bradyi</i>) Recovery Plan Original Recovery Plan Approved: March 28, 1985 Page(s) Superseded: 19-34</p> |
| <p>Endangered Karst Invertebrates (Travis and Williamson Counties, Texas) Recovery Plan Original Recovery Plan Approved: August 25, 1994 Page(s) Superseded: 86-88 Species Included: Bee Creek Cave harvestman (<i>Texella reddelli</i>) Bone Cave harvestman (<i>Texella reyesi</i>) Coffin Cave mold beetle (<i>Batrisodes texanus</i>) Kretschmarr Cave mold beetle (<i>Texamaurops reddelli</i>) Tooth Cave spider (<i>Tayshaneta=Neoleptoneta myopica</i>) Tooth Cave ground beetle (<i>Rhadine persephone</i>) Tooth Cave pseudoscorpion (<i>Tartarocreagris texana</i>)</p> |
| <p>Holy Ghost Ipomopsis (<i>Ipomopsis sancti-spiritus</i>) Recovery Plan Original Recovery Plan Approved: September 26, 2002 Page(s) Superseded: 18-21</p> |
| <p>Knowlton Cactus (<i>Pediocactus knowltonii</i>) Recovery Plan Original Recovery Plan Approved: March 29, 1985 Page(s) Superseded: 16</p> |
| <p>Kuenzler Hedgehog Cactus (<i>Echinocerus fendleri</i> var. <i>kuenzleri</i>) Recovery Plan Original Recovery Plan Approved: March 28, 1985 Page(s) Superseded: 13</p> |
| <p>Sacramento Prickly Poppy (<i>Argemone pleicantha</i> ssp. <i>pinnatisecta</i>) Recovery Plan Original Recovery Plan Approved: August 31, 1994 Page(s) Superseded: 16-17</p> |
| <p>Siler Pincushion Cactus (<i>Pediocactus sileri</i>) Recovery Plan Original Recovery Plan Approved: April 14, 1986 Page(s) Superseded: 19-41</p> |
| <p>Sneed and Lee Pincushion Cacti Recovery Plan Original Recovery Plan Approved: March 21, 1986 Page(s) Superseded: 19 Species Included: Sneed pincushion cactus (<i>Coryphantha sneedii</i> var. <i>sneedii</i>) Lee pincushion cactus (<i>Coryphantha sneedii</i> var. <i>leei</i>)</p> |
| <p>Socorro Isopod (<i>Thermosphaeroma thermophilum</i>) Recovery Plan Original Recovery Plan Approved: February 16, 1982 Page(s) Superseded: 6-7, 10-11, 13</p> |

Star Cactus (*Astrophytum asterias*) Recovery Plan

Original Recovery Plan Approved: August 26, 2003

Page(s) Superseded: 11-14

Tobusch Fishhook Cactus (*Ancistrocactus tobuschii*) Recovery Plan

Original Recovery Plan Approved: March 18, 1987

Page(s) Superseded: iii, 14-15

Zapata Bladderpod (*Lesquerella thamnophila*) Recovery Plan

Original Recovery Plan Approved: July 14, 2004

Page(s) Superseded: 9-11

Zuni Fleabane (*Erigeron rhizomatus*) Recovery Plan

Original Recovery Plan Approved: September 30, 1988

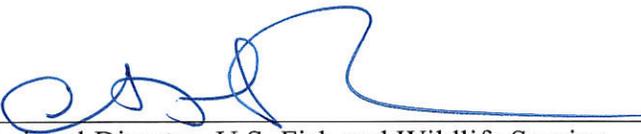
Page(s) Superseded: 14

For

**U.S. Fish and Wildlife Service
Southwest Region
Albuquerque, New Mexico**

August 2019

Approved:



Regional Director, U.S. Fish and Wildlife Service

Date:

8/28/19

Recovery Plan for *Pediocactus knowltonii* (Knowlton's cactus)

Original Approved: March 29, 1985

Original Prepared by: Kenneth D. Heil (San Juan Community College, Farmington, NM)

AMENDMENT 1

We have identified best available information that indicates the need to amend recovery criteria for this species since the Knowlton's Cactus (*Pediocactus knowltonii*) Recovery Plan (Recovery Plan) was completed. In this proposed modification, we synthesize the adequacy of the existing recovery criteria, show amended recovery criteria, and the rationale supporting the proposed recovery plan modification. The proposed modification is included as an appendix that supplements the existing Knowlton's Cactus (*Pediocactus knowltonii*) Recovery Plan (Recovery Plan), superseding only page 16 (U.S. Fish and Wildlife Service (Service) 1985: 16).

**For
U.S. Fish and Wildlife Service
Southwest Region
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BACKGROUND INFORMATION

Recovery plans should be consulted frequently, used to initiate recovery activities, and updated as needed. A review of the recovery plan and its implementation may show that the plan is out of date or its usefulness is limited, and therefore warrants modification. Keeping recovery plans current ensures that the species benefits through timely, partner-coordinated implementation based on the best available information. The need for, and extent of, plan modifications will vary considerably among plans. Maintaining a useful and current recovery plan depends on the scope and complexity of the initial plan, the structure of the document, and the involvement of stakeholders.

An amendment involves a substantial rewrite of a portion of a recovery plan that changes any of the statutory elements. The need for an amendment may be triggered when, among other possibilities: 1) the current recovery plan is out of compliance with regard to statutory requirements; 2) new information has been identified, such as population-level threats to the species or previously unknown life history traits, that necessitates new or refined recovery actions or criteria; or 3) the current recovery plan is not achieving its objectives. The amendment replaces only that specific portion of the recovery plan, supplementing the existing recovery plan, but not completely replacing it. An amendment may be most appropriate if significant plan improvements are needed, but resources are too scarce to accomplish a full recovery plan revision in a short time.

Although it would be inappropriate for an amendment to include changes in the recovery program that contradict the approved recovery plan, it could incorporate study findings that enhance the scientific basis of the plan, or that reduce uncertainties as to the life history, threats,

or species' response to management. An amendment could serve a critical function while awaiting a revised recovery plan by: 1) refining or prioritizing recovery actions that need to be emphasized, 2) refining recovery criteria, or 3) adding a species to a multispecies or ecosystem plan. An amendment can, therefore, efficiently balance resources spent on modifying a plan against those spent on managing implementation of ongoing recovery actions.

METHODOLOGY USED TO COMPLETE THE RECOVERY PLAN AMENDMENT

The recovery criteria were developed and reviewed by species experts that included biologists and botanists from the Bureau of Land Management (BLM), New Mexico Energy, Minerals and Natural Resources Department (NMEMNRD), The Nature Conservancy (TNC), and the Service. The development process was informed by the best available science regarding species biology and current threats. The recovery criteria were designed to be objective and quantifiable, in order to meet the conditions needed to ensure species viability through sustainment of populations in the wild that demonstrate resiliency, redundancy, and representation (Wolf et al. 2015: entire).

ADEQUACY OF RECOVERY CRITERIA

Section 4(f)(1)(B)(ii) of the Endangered Species Act (Act) requires that each recovery plan shall incorporate, to the maximum extent practicable, "objective, measurable criteria which, when met, would result in a determination...that the species be removed from the list." Legal challenges to recovery plans (see *Fund for Animals v. Babbitt*, 903 F. Supp. 96 (D.D.C. 1995)) and a Government Accountability Audit (GAO 2006: 2) also have affirmed the need to frame recovery criteria in terms of threats assessed under the five delisting factors.

Recovery Criteria

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 five delisting factors that are relevant to the species. When the Recovery Plan was finalized in 1985, limited data made it difficult to quantify habitat requirements with enough precision to establish detailed and measureable recovery criteria (Service 1985: entire).

Synthesis

In 2010, we completed a 5-year review that recommended Knowlton's cactus remain classified as endangered due its limited number of populations and declining population numbers (Service 2010: 13). Currently, there are two known populations of Knowlton's cactus. The largest population occurs at the Sabo Preserve (type locality) on private land owned and managed by TNC. A small portion (fewer than 50 individuals) of the Sabo Preserve population occurs on adjacent BLM land. There has been standardized monitoring of the Sabo Preserve site since 1985. This data shows a declining trend in abundance from 1994 to 2016 (Roth 2016: 7). The other Knowlton's cactus population is located at a transplant site in the BLM Reece Canyon Area of Critical Environmental Concern (ACEC). It supports only a small number of individuals (approximately 145 as of 2016), and has shown a declining trend in abundance of transplant individuals and a stable number of seed derived individuals (Roth 2016: 13, 21). Total abundance estimates for both populations are shown in Table 1.

Table 1. Knowlton’s cactus abundance estimates.

| | 1979 | 1985 | 1992 | 1994/1995 | 2008 | 2015 | 2016 |
|--|----------------------|----------------------|-------------------------------------|--------------------|-----------------------|-------------------|-----------------|
| TNC Sabo Preserve (Type Locality) | 1,000 (Service 1985) | 7,000 (Service 1985) | 12,000 (Sivinski and McDonald 2007) | 14,000 (Roth 2016) | 6,100 (Sivinski 2008) | 3,500 (Roth 2015) | No Data |
| BLM Reese Canyon ACEC | No Data | No Data | 137 (Sivinski 2008) | 69 (Sivinski 1995) | 157 (Sivinski 2008) | 25 (Roth 2015) | 145 (Roth 2016) |

Current Threat Status

The largest population of Knowlton’s cactus is located on private property owned and managed by TNC. Surface disturbance is restricted by TNC ownership, but mineral rights are owned by other interests that could disturb the property for mineral extraction. Energy development (oil and gas) is also prevalent in the immediate area. A suite of indirect effects from energy development (e.g., habitat loss or fragmentation, dust, effects to pollinators) may present challenges to the long-term persistence of this population (Service 2013: 16–17). Collection is still a threat; however, it is difficult to estimate the extent of the threat at this time (Roth 2016: 27). Lastly, low rates of reproduction and recruitment within both populations are correlated with long-term drought conditions (Roth 2016: 27) that may be exacerbated by predicted warmer temperatures and lower rainfall in the foreseeable future.

AMENDED RECOVERY CRITERIA

Recovery criteria serve as objective, measurable guidelines to assist in determining when an endangered species has recovered to the point that it may be downlisted to threatened, or no longer meets the definition of an endangered or threatened species and may be delisted. Delisting is the removal of a species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Downlisting is the reclassification of a species from endangered to threatened. The term “endangered species” means any species (species, subspecies, or Distinct Population Segment), which is in danger of extinction throughout all or a significant portion of its range. The term “threatened species” means any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

We establish delisting criteria for Knowlton’s cactus as follows:

Delisting Recovery Criteria

Current recovery criteria

Because there is inadequate biological data for Knowlton’s cactus and because there is only one viable population, downlisting and delisting criteria cannot be established at this time (Service 1985: iii).

Amended recovery criteria

Knowlton's cactus will be considered for delisting when:

1. Long-term monitoring of the Sabo Preserve Population demonstrates a stable or increasing trend in population abundance (including evidence of a stable demographic structure) over a 20-year survey period.

Justification: A stable or increasing trend demonstrates that all threats are ameliorated. In order to provide enough data for a rigorous statistical analysis, a minimum period of 20 years will be required to determine demographic trends. A 20-year survey period is a time period that allows for variability in ecological factors (i.e., several drought cycles).

2. Long-term monitoring demonstrates that the annual total estimated population size range-wide is maintained at greater than 7,500 individuals during a 20-year survey period.

Justification: A minimum of 7,500 individuals is the median of the known range of surveyed individuals at the Sabo Preserve (see Table 1 above), and is above a minimum total of 5,000 individuals which emerged as a conservation metric across taxa (Traill et al. 2007: 164). A minimum of 7,500 individuals will allow for the maintenance of genetic diversity (representation), and provides evidence of a resilient population.

3. Long-term monitoring demonstrates that a minimum of two local transplant populations are occupied at least 75 percent of a 20-year survey period (15 years).

Justification: Because of the low number (two) of existing populations, additional populations need to be established to increase redundancy to guard against extinction from catastrophic events. Establishing additional populations is intended to address the threats related to climate change. Currently, there is only one population outside of Sabo Preserve; one additional population will need to be established nearby to provide additional redundancy. Recognizing that stochastic events and long-term drought may present disproportionate challenges to these small populations, both populations need to be occupied a minimum of 75 percent (15 years) of a 20-year survey period.

4. A minimum of one new climate refugia population will be established outside the current range of the species and be maintained occupied at least 75 percent of a 20-year survey period (15 years). Alternatively, a robust seed banking program could be established, thus providing the potential for species resiliency over evolutionary time.

Justification: The effects of climate change (warmer temperatures and less precipitation) are a major threat to this species. A climate refugia population needs to be established outside the current range and wholly separate geographically. The location will be determined by modeling habitat requirements and predicted climatic conditions into the foreseeable future (Keppel et al. 2012: entire). Alternatively the

establishment of a seed banking program that would protect the species in perpetuity, and would provide the ability of a transplant program in the future, would provide a measure of species' resiliency in the face of climate change.

5. Adequate regulatory mechanisms need to be in place to ensure the long-term ecological integrity of the Sabo Preserve.

Justification: The Sabo Preserve needs protection in perpetuity from surface disturbing activities. Additional protections, such as a development buffer for new surface disturbing activities (e.g., energy development and road, pipeline, and transmission line right-of-ways) should be in place around the Sabo Preserve to protect it from indirect effects. Because of its isolated nature and lack of an on-site manager, the Sabo Preserve is susceptible to illegal collection. Better surveillance of the property is needed to minimize the risk of collection. Other populations once established should have the same protective measures.

6. A Service approved post-delisting monitoring plan will be implemented.

Justification: A post-delisting monitoring plan is necessary to ensure the ongoing conservation of the species and the continuing effectiveness of management actions.

Rationale for Recovery Criteria

All classification decisions consider the following five factors: 1) is there a present or threatened destruction, modification, or curtailment of the species' habitat or range; 2) is the species subject to overutilization for commercial, recreational scientific or educational purposes; 3) is disease or predation a factor; 4) are there inadequate existing regulatory mechanisms in place outside the Act (taking into account the efforts by states and other organizations to protect the species or habitat); and 5) are other natural or manmade factors affecting its continued existence. When delisting or downlisting a species, we first propose the action in the *Federal Register* and seek public comment and peer review. Our final decision is announced in the *Federal Register*.

The amended criteria addresses all threats to the species. All addressable threats that do not cause the populations to decline would be negligible. If the populations are decreasing, the species would not warrant to be delisted. There will be threats, such as drought and herbivory, that will continue to exist in a natural environment. In addition to minimizing and ameliorating the threats identified above, the recovery criteria for Knowlton's cactus address the conservation principles of the 3-Rs: representation, resiliency, and redundancy (Wolf et al. 2015: 204).

Resiliency ensures that populations are sufficiently large to withstand stochastic events, and the identified threats have been ameliorated. A stable or increasing population trend indicates that annual mortality is compensated by recruitment events, evidence of resilient populations. A minimum of 7,500 individuals will allow for the maintenance of genetic diversity (representation), and provides evidence of a resilient population. A seed banking program that would protect the species in perpetuity, and provide the ability of a transplant program in the future would provide measure of species' resiliency in the face of climate change.

Redundancy provides for security against extinction from catastrophic events that could impact a single population by ensuring that one or more additional populations persist. There is no evidence that this species was ever widespread, and survey efforts over the last several decades in New Mexico and Colorado has found no additional populations (Roth 2016: 2). Multiple small populations are believed to have existed near Sabo Preserve. Additional populations in the local area need to be established through transplanting to increase redundancy.

Representation involves conserving the breadth of the genetic makeup of the species to maintain its adaptive capabilities. If both existing populations and newly established populations are located in a limited area, long-term drought and variation in precipitation patterns could pose a significant challenge to species recovery. In order to ameliorate this risk, a minimum of one climate refugia population will need to be established outside of the current range, wholly separate geographically. This population should be established at a site where the threat of long-term drought will be diminished significantly but where the ecological envelope and site specific habitat characteristics of the current populations can be replicated. Expert elicitation and modeling efforts should provide a reasonable degree of certainty in order to maximize the resiliency of this population (Keppel et al. 2012: entire). By establishing a climate refugia population, redundancy be bolstered, along with representation as the population will most likely be located in a different ecological setting and regional landscape.

ADDITIONAL SITE SPECIFIC RECOVERY ACTIONS

Not Applicable

COSTS, TIMING, PRIORITY OF ADDITIONAL RECOVERY ACTIONS

Not Applicable

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APPENDIX A – SUMMARY OF PUBLIC, PARTNER, AND PEER REVIEW COMMENTS RECEIVED

Summary of Public Comments

The Service published a notice of availability in the *Federal Register* on January 31, 2019 (84 FR 790-795) to announce that the amendment for the Knowlton's Cactus (*Pediocactus knowltonii*) Recovery Plan (Recovery Plan) was available for public review, and to solicit comments by the scientific community, State and Federal agencies, Tribal governments, and other interested parties on the general information base, assumptions, and conclusions presented in the draft amendment. An electronic version of the draft Recovery Plan amendment was also posted on the Service's Species Profile website (<https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=1590>).

We also developed and implemented an outreach plan that included (1) publishing a news release on our national webpage (<https://www.fws.gov/news/>) on January 30, 2019, (2) sending specific notifications to Congressional contacts in Districts (include appropriate Districts, consult the corresponding Outreach Plan or contact your Regional Public Affairs Officer for more information), and (3) sending specific notifications to key stakeholders in conservation and recovery efforts. These outreach efforts were conducted in advance of the *Federal Register* publication to ensure that we provided adequate notification to all potentially interested audiences of the opportunity to review and comment on the draft amendment.

The Service received four responses to the request for public comment. These included comments from individual citizens, the Center for Biological Diversity, and the Energy and Wildlife Action Coalition.

Public comments ranged from providing minor editorial suggestions to specific recommendations on the amendment content. We have considered all substantive comments; we thank the reviewers for these comments and to the extent appropriate, we have incorporated the applicable information or suggested changes into the final Recovery Plan amendment. In general, these comments did not lead to significant changes in the draft amendment. Below, we provide a summary of public comments received; however, some of the comments that we incorporated as changes into the Recovery Plan amendment did not warrant an explicit response and, thus, are not presented here.

Comment (1): Concern that, “criteria are being added in the absence of any scientific peer review and that this will lead to a failure on the Service’s part to follow the best-available science.”

Response: Peer review was conducted following the publication of the Notice of Availability, and in accordance with the requirements of the Endangered Species Act (Act). Below, we provide a detailed summary of peer review comments and responses, where appropriate.

Comment (2): Concern that, “the decision to update recovery criteria for these 42 species as a group is indicative of the Service moving away from utilizing recovery teams and outside scientific expertise.”

Response: Section 4 of the Act provides the Service with the authority and discretion to appoint recovery teams for the purpose of developing and implementing recovery plans. The current effort to update recovery plans with quantitative recovery criteria for what constitutes a recovered species is not indicative of the future need for, and does not preclude the future utilization of, recovery teams to complete recovery planning needs for listed species.

Comment (3): New and significant information has been developed in the years since the existing Recovery Plan was adopted. Updating this plan can serve to better inform the Service, the regulated community, and Federal, State, and local resource agencies.

Response: A recovery plan should be a living document, reflecting meaningful change when new substantive information becomes available. Keeping a recovery plan current increases its usefulness in recovering a species by ensuring that the species benefits through timely, partner-coordinated implementation based on the best available information.

Comment (4): The Service should consider whether the updated recovery criteria would be less burdensome on Federal agencies and the regulated community than the existing criteria.

Response: Recovery plans are guidance documents that outline how best to help listed species achieve recovery, but they are not regulatory documents. Recovery plans are intended to establish goals for long-term conservation of listed species and define criteria that are designed to indicate when the threats facing a species have been removed or reduced to such an extent that the species may no longer need the protections of the Act.

Recovery criteria are achieved through the funding and implementation of recovery actions by both the Service and our partners. In addition to the existing recovery actions included in each of these recovery plans, the amendments address the need for any new, site-specific recovery actions triggered by the modification of recovery criteria, along with the costs, timing, and priority of any such additional actions. Because recovery plans are not regulatory documents, identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in a recovery plan should be construed as a commitment or requirement that any Federal agency obligate or provide funds.

Comment (5): The Service should consider whether the recovery criteria are achievable, because including unattainable recovery criteria could render such plans meaningless, or impede other processes under the Act.

Response: The National Marine Fisheries Service and U.S. Fish and Wildlife Service Interim Endangered and Threatened Species Recovery Plan Guidance (2010) emphasizes the development of recovery criteria that are specific, measurable, achievable, realistic, and time-referenced (SMART). The achievable component of SMART criteria implies that the authority, funding, and staffing needed to meet recovery criteria are feasible, even if not always likely. In developing recovery criteria specifically, we attempt to establish criteria that are both scientifically defensible and achievable to the greatest extent possible. At times, however, the feasibility of achieving certain criteria can be, or appear to be, constrained by the particular, difficult circumstances that face a species. Even in such cases, criteria serve to guide recovery

actions and priorities for the species. Furthermore, as recovery progresses, periodic reevaluation of the species status through the 5-year review process may reveal that the barriers to achieving certain criteria have been removed or that circumstances or our understanding of the species have evolved. In that event, the Service can revise recovery criteria to ensure that they reflect the strategy most likely to succeed in the goal of recovery.

Comment (6): The Service should consider conservation efforts that have been put into place for the listed species since the previous iteration of the recovery plan, especially where the Service has supported conservation efforts, in formulating recovery criteria that will be established or amended by the revised draft plan.

Response: While section 4 of the Act directs the Service to specifically develop and implement recovery plans, several other sections of the Act and associated programs and activities also provide important opportunities to promote recovery. Information from these programs and activities about the biological needs of the species can inform recovery planning (including the formulation or revision of recovery criteria) and implementation. These conservation efforts have been considered during the development of this and other recovery plans.

Comment (7): The Service should determine whether ongoing species conservation efforts beneficially address one or more of the listing factors set forth in the Act implementing regulations addressing species listings and designation of critical habitat.

Response: All Service decisions that affect the listed status or critical habitat designation of a particular species, including our 5-year review of each listed species, are made by analyzing the five factors described in section 4 of the Act. Such an analysis necessarily includes an assessment of any conservation efforts or other actions that may mitigate or reduce impacts on the species. While our objective with this particular effort was to establish objective, measurable criteria for delisting, conservation actions play a crucial role in determining if and when those criteria have been satisfied.

Comment (8): The Service should be mindful of the impacts that recovery plan criteria can have on the section 7 process of the Act for the regulated community, because the Service and other Federal resource agencies sometimes request that recovery criteria be addressed in biological assessments and other planning processes under the Act addressing listed species.

Response: Recovery plans can both inform, and be informed by section 7 processes of the Act. When revising a recovery plan, existing section 7 consultations may provide helpful information on: recent threats and mechanisms to avoid, minimize, or compensate for impacts associated with those threats; a summarized status of the species; and indication of who important partners may be. Section 7 consultations can inform the need for revised recovery actions, recovery implementation schedule activities, recovery criteria, or species status assessments to provide more comprehensive recovery planning while the species remains listed.

Comment (9): The Service should include the full panoply of current information available for the species in all revised draft recovery plans.

Response: Our recovery planning guidance recommends that recovery planning be supported by compilation of available information that supports the best possible scientific understanding of the species. Although it is not necessary to exhaustively include all current information within the text of the recovery plan, to the extent that this information is specifically relevant and useful to recovery, the recovery plan may summarize such material or incorporate it by reference. Supporting biological information may also be included within a species status assessment or biological report separate from the recovery plan document itself.

Comment (10): The Service should consider whether the existing recovery plan should be revised or replaced in its entirety rather than amended in part.

Response: Under guidance established in 2010, partial revisions allow the Service to efficiently and effectively update recovery plans with the latest science and information when a recovery plan may not warrant the time or resources required to undertake a full revision of the plan. To further gauge whether we had assembled, considered, and incorporated the best available scientific and commercial information into this recovery plan revision, we solicited submission of any information, during the public comment period, that would enhance the necessary understanding of the species' biology and threats, and recovery needs and related implementation issues or concerns. We believe the recovery plan amendment, which targets updating recovery criteria, is appropriate for the species. However, we will also continue to evaluate the accuracy and usefulness of the existing recovery plan with respect to current information and status of conservation actions, and may pursue a full revision of the plan in the future, if appropriate.

Comment (11): One commenter was concerned about the use of a definitive numerical threshold for recovery in the absence of a published and current population viability analyses (PVA). The commenter was concerned that de-listing may be pre-mature upon reaching the numeric criteria alone.

Response: The numeric criteria are only one component of the biologically based recovery criteria. The numeric criteria (n=7,500) are designed to provide a minimum population size, where genetic mutation may exceed genetic drift/fixation rates. The combination of numeric goals, stable/increasing trends (including stable demographic structure), and occupancy metrics across the range of the species should provide the necessary biological platform for species recovery. Additionally as recovery criteria are reached, "delisting" is not automatically triggered. A listing decision would follow a petition where the recovery criteria simply provide a measure against which recovery can be analyzed.

Comment (12): The concept of climate refugia is hypothetical and unproven for recovery of endangered plants, so the proposed recovery criterion could be an experimental action but no data shows that refugia could be realistic for establishing this cactus outside of its current range.

Response: Though experimental, creating climate refugia is an emerging strategy in conservation biology. With only two extant populations, this strategy is simply an effort to increase the redundancy, resiliency, and representation of the species. Other strategies (seed banking, etc.) were added as an alternative strategy in the amended recovery criteria.

Summary of Peer and Partner Review Comments

In accordance with the requirements of the Act, we solicited independent peer review of the draft amendment from the Bureau of Land Management, the National Park Service, and the New Mexico Division of Forestry. Peer review was conducted concurrent with the *Federal Register* publication. Criteria used for selecting peer reviewers included their demonstrated expertise and specialized knowledge related to Knowltons' cactus, botany, and the Colorado Plateau. (The qualifications of the peer reviewers are in the decision file and the administrative record for this Recovery Plan amendment).

In total, we solicited review and comment from 3 peer reviewers (which includes two partner agencies). We received comments from 3 peer reviewers. Peer reviewers that responded included representatives from the Bureau of Land Management (Federal Agency), the National Park Service (Federal Agency), and the New Mexico Division of Forestry (State Agency). Several reviewers provided additional specific information, including citations; we thank the reviewers for these data and we have added the information where appropriate.

We considered all substantive comments, and to the extent appropriate, we incorporated the applicable information or suggested changes into the final Recovery Plan amendment. Below, we provide a summary of specific comments received from peer and partner reviewers with our responses; however, we addressed many of the reviewers' specific critiques and incorporated their suggestions as changes to the final amendment. Such comments did not warrant an explicit response, and as such, are not addressed here. We appreciate the input from all commenters, which helped us to consider and incorporate the best available scientific and commercial information during development and approval of the final Recovery Plan amendment.

Peer Review Comment (1): One commenter raised concerns with using a stochastic patch occupancy model (SPOM). The commenter noted that the multiple agencies with land ownership have the means to inform this type of model. These models are more often used with animals and are less practiced with plants. The commenter provided articles that highlight issues with these types of models (Menges 2000, Zeigler et al. 2013, Wolf et al 2015). "It has long been recognized that studies of patch occupancy are often prone to data quality issues, most notably imperfect detection and missing data (Moilanen 2002, MacKenzie and Royle 2005, Traill et al 2007)."

Response: The amended criteria do not necessitate or describe a SPOM *per se*. The patch occupancy metric is designed to focus management at the subpopulation/Element Occurrence (EO) level instead of a singular focus on the Sabo Reserve site. Additionally, focusing management at the sub-population level ensures redundancy across the species range.

Peer Review Comment (2): One commenter suggested that the proposed amendment uses arbitrary numbers (700 or 5,000) for recovery. The commenter suggested there are other ways to quantitatively determine recovery. The commenter questioned the Service's reliance on Traill et al. 2007 because it is not widely recognized across the botanical community. The commenter provided another review that discusses the shortcomings of the Traill et al study: *A general target for MVPs: unsupported and unnecessary*, Flather et al 2011.

Response: The numeric criteria are only one component of the biologically based recovery criteria. The numeric criteria (n=7,500) is designed to provide a minimum population size, where genetic mutation may exceed genetic drift/fixation rates. The combination of numeric goals, stable/increasing trends, and occupancy metrics across the range of the species should provide the necessary biological platform for species recovery. Additionally, Traill et al. (2007), has not been uniformly rejected by the conservation community at large.

Peer Review Comment (3): The commenter states that the term "abundance" has been globally misused and recommends replacing this term with "stable demographic structure." The commenter states that abundance is an unreliable (and expensive) indicator of resiliency, referencing. For a comparison of, and recommendations about these monitoring indicators, the commenter references the following citation: Development of Protocols to Inventory or Monitor Wildlife, Fish or Rare Plants (USDA/USFS, June 2006, pg. 3-5, 3-6).

Response: The numeric criteria (abundance) is necessary as it serves as a surrogate for the maintenance of genetic diversity and as a buffer against demographic and ecological stochasticity (providing population and species level resiliency). The Service recognizes the importance of a "stable demographic structure" which is a necessary component of a "stable and increasing trend", i.e. annual recruitment exceeds annual mortality. Based on this comment, the criteria have been amended to include a specific reference to a "stable demographic trend".

Peer Review Comment (4): Demographic trends can be hard to quantify and are easily influenced by a few particularly bad years at the beginning of the monitoring period or a few particularly good ones at the end. The commenter states that the Service should consider a longer period to truly indicate a stable population.

Response: Twenty years is described as the "minimum period", and any trend analysis submitted as part of a potential delisting petition will be subject to a rigorous examination. Increasing the survey period will strengthen any analysis, however we considered a 20 year period to be scientifically meaningful as it allows for variability in ecological factors (i.e., several drought cycles), and it is a realistic time frame from a management perspective.

Peer Review Comment (5): The commenter is concerned that the numerical recovery criteria (n=7,500) is too low.

Response: The numeric criteria are only one component of the biologically based recovery criteria. The numeric criteria (n=7,500) is designed to provide a minimum population size, where genetic mutation may exceed genetic drift/fixation rates. The combination of numeric goals, stable/increasing trends (including a stable demographic structure), and occupancy metrics across the range of the species should provide the necessary biological platform for species recovery.

Peer Review Comment (6): The commenter is concerned with the 75% occupancy rate for the two local transplant populations.

Response: The occupancy rate of two local transplant populations will be adjusted from 75% of a 20-year survey period to a 100% occupancy rate over the 20-year survey period. Though there were two methods (seed plots and cuttings) employed at different times in creating the current local extant “transplant” population, for our purposes this site functions as one local population. So a minimum of one more population would need established (as there is only one extant local transplant population). This does not preclude the establishment of a suite of new transplant populations within suitable habitat in Northern New Mexico and potentially Southern Colorado. With the relatively small size of the extant transplant population, and the potential small relative small size of future transplant populations (in relation to the Sabo Preserver population), requiring stable or increasing trends and numeric goals is not a conservation priority. Maintaining the extant transplant population and creating and maintaining a minimum of one more transplant population provides a measure of redundancy for the species.

Peer Review Comment (7): The commenter is concerned with the feasibility of establishing successful climate refugia, and questions the prudence of establishing wholly disjunct populations outside of the know species range.

Response: Though experimental, creating climate refugia is an emerging strategy in conservation biology. With only two extant populations, this strategy is simply an effort to increase the redundancy, resiliency, and representation of the species. Alternatively, the establishment of a seed banking program that would protect the species in perpetuity, and would provide the ability of a transplant program in the future would provide a measure of species’ resiliency in the face of climate change (seed banking is described in the final recovery criteria).

Peer Review Comment (8): The commenter would like to make the creation of an adaptive management plan to be described as a specific recovery criteria. The commenter is concerned that there is no room on the landscape around the focal population for the creation of a meaningful disturbance buffer (a buffer serves as an example of a protective regulatory mechanism in the recovery criteria).

Response: In order to reach and maintain the recovery criteria presented, the creation and implementation of management plans is encouraged. The use of a buffer for new energy development is presented in the recovery criteria as a potential example of a regulatory mechanism designed to provide protection to the species.

Peer Review Comment (9): The commenter recommends at least 10 years of monitoring following delisting, including acceptable decline thresholds and management and regulatory actions required should populations fall below a certain threshold established by the recovery team.

Response: The number of years of required monitoring by the Service will be determined within any subsequent delisting decision in the Federal Register. At a minimum, the Service must monitor a delisted species for 5 years, but additional monitoring could be determined if appropriate. Additional monitoring may be conducted by agency personnel.