Todsen's Pennyroyal
(*Hedeoma todsenii*)

5-Year Review:
Summary and Evaluation

Photo: Bob Sivinski

U.S. Fish and Wildlife Service
Region 2
Ecological Services Field Office
Albuquerque, New Mexico

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5-YEAR REVIEW
Todsen's pennyroyal/*Hedeoma todsenii*

1.0 GENERAL INFORMATION

1.1 Reviewers

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

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

1.3 Methodology used to complete the review

The USFWS conducts status reviews of species on the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) as required by section 4(c)(2)(A) of the Endangered Species Act, as amended (Act) (16 U.S.C. 1531 et seq.). We provided notice of this status review via the Federal Register (72 FR 20134) requesting information on the status of Todsen's pennyroyal (*Hedeoma todsenii*). This review was a collaborative effort comprised of biologists from the New Mexico State Forestry Division, the New Mexico Ecological Services Field Office, and the USFWS's Region 2 Regional Office. Robert Sivinski, Botanist for the New Mexico State Forestry Division, was contracted through a Section 6 grant to gather the relevant information and prepare a draft of the review. The final review and recommended classification was prepared by the New Mexico Ecological Services Field Office.

1.4 Background

Hedeoma todsenii is a regionally endemic mint that occurs in the San Andres Mountains of Sierra County, and the Sacramento Mountains in Otero County in south-central New Mexico. It is an edaphic specialist that grows on steep, north-facing slopes within piñon-juniper habitat in gypseous, sandy loam soils, often with loose limestone gravel. The plant has been recorded only on federally-owned land, including areas administered by the U.S. Department of Defense (DOD) at White Sands Missile Range (WSMR); by the U.S. Forest Service (USFS) in the Lincoln National Forest (LNF); and by the Bureau of Land Management (BLM) out of the Las Cruces District Office. The species was originally listed due to threats from its extremely restricted range and small population size, when only two colonies were known to exist on WSMR (46 FR 5730). Threats from human activities, as given in the 2001 revision of the Recovery Plan, included soil erosion, illegal grazing, minerals exploration, changes in land use management, and military activities. These human-induced threats have been managed by each of the land agencies to varying degrees, but are controlled either by management or topography in the range of the plant. Natural threats to *H. todsenii* listed in the 2001 Recovery Plan, which continue to affect the species today, include wildfire, low sexual reproduction, limited dispersal ability, and limited suitable habitat. In terms of current impact to *H. todsenii*, the natural threats, with the addition of climate change, have the capacity to exceed human activities in impacting the plant into the future.

1.4.1 FR Notice citation announcing initiation of this review:

71 FR 20714-20716; April 21, 2006

1.4.2 Listing history:

Original Listing
FR notice: 46 FR 5730-5733
Date listed: January 19, 1981
Entity listed: Species, *Hedeoma todsenii*
Classification: Endangered, with critical habitat

1.4.3 Associated rulemakings: Critical Habitat, 1981.
Two parcels of approximately 1 square kilometer (km^2) (0.39 square miles [mi^2]) each in Sierra County, New Mexico, San Andres Mountains, Rhodes Canyon on White Sands Missile Range; UTM Zone 13 between 76 and 77,000 meters (m) N and 39 and 40,000 m E; and between 74 and 75,000 m N and 40 and 41,000 m E (46 FR 5730-5733; January 19, 1981).

1.4.4 Review History: A 5-year review was initiated on November 6, 1991 (56 FR 56882), for all species listed before 1991, but no document was prepared for this species. In 2001, Sivinski completed a Section 6 progress report on Todsen's pennyroyal (*Hedeoma todsenii*): 2000-2001 (Sivinski 2001).

1.4.5 Species' Recovery Priority Number at start of 5-year review: 8.
A Recovery Priority Number of 8 indicates a full species with a moderate degree of threat and a high recovery potential.

1.4.6 Recovery Plan or Outline

Name of plan or outline: Todsen's Pennyroyal (*Hedeoma todsenii*) Recovery Plan
Date issued: March, 1985
Dates of previous revisions, if applicable: August, 2001

2.0 REVIEW ANALYSIS

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

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

2.2 Recovery Criteria

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

2.2.1.1 Does the recovery plan contain objective, measurable criteria? No.
The objective of the recovery plan is to downlist the species with a final goal of delisting (USFWS 2001). The benchmark provided is to protect and manage *Hedeoma todsenii* so it will sustain itself indefinitely in its natural habitat. Although the criteria provide guidance for recovery, they do not offer measurable standards by which recovery progress can be objectively determined or that specifically address current threats.

The recovery plan does contain an implementation table of prioritized tasks to recover *H. todsenii*. Of the 17 tasks recommended, 11 have been implemented or are ongoing, including:

(1) Ensure compliance with laws and regulations;
(2) Develop and implement management plans to prevent detrimental land use impacts;
(3) Protect populations from disturbance;
(4) Initiate long-term monitoring;
(5) Study genetic structure of all populations;
(6) Study germination requirements;
(7) Protect new populations;
(8) Ensure appropriate personnel are aware of *H. todsenii*;
(9) Study geology and soils;
(10) Use research results to determine if populations can sustain themselves;
(11) Search for more populations.

Remaining tasks to be completed include:

(1) Study all aspects of reproductive biology;
(2) Determine growth requirements;
(3) Remove any trespass livestock;
(4) Assess erosion and take corrective action;
(5) Study fire effects; and
(6) Establish a working group for agency and public coordination.

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? No.
The recovery criteria were composed before updated population localities were known and do not include demographic, quantifiable information by which recovery can be measured throughout the range of the species and assured over time.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? No.
The recovery criteria are very general and do not specifically address the threats of low genetic diversity and poor dispersal, mentioned in the 2001 Recovery Plan, and the more recently noted threats of piñon-juniper encroachment and climate change. The threat of disease, mentioned in the Recovery Plan, has not yet manifested as an actual threat.

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 Plan contains both downlisting and delisting criteria.

Downlisting criteria: The following criteria are given as actions to accomplish in order to downlist from endangered to threatened status:

(1) Plans are developed and implemented to permanently protect occupied *Hedeoma todsenii* habitat from human degradation or destruction (Listing Factors A and D);
(2) The responsible land management agencies verify through monitoring that protective management is successful (Listing Factors A and D).

Delisting criteria: Removal of *H. todsenii* from the list of threatened and endangered species will occur when the species can sustain itself indefinitely at present or higher population levels and the following actions have been accomplished as delisting criteria:

(1) Research identifies the factors responsible for the low sexual reproduction and restricted distribution of *H. todsenii* (Listing Factors A and E);

(2) Measures are taken to correct any factors within management control (Listing Factors A, D, and E);
(3) Monitoring and further research demonstrate *H. todsenii* can sustain itself indefinitely at present or higher population levels (Listing Factors D and E).

Recovery criterion 1 for downlisting requires that plans are developed and implemented to permanently protect occupied *H. todsenii* habitat from human degradation or destruction. In addition to the Recovery Plan, several plans address *H. todsenii*, yet only one, guiding management on WSMR, directly addresses specific needs and monitoring for the plant. The Endangered Species Management Plan for Todsen's Pennyroyal (*Hedeoma todsenii*) at White Sands Missile Range, New Mexico (ESMP), which is part of the White Sands Missile Range Integrated Natural Resource Management Plan (INRMP) (2001), specifically addresses the use of adaptive management for maintaining *H. todsenii* populations, surveying potential habitat for additional populations, developing and implementing monitoring techniques, and measuring habitat change. Within the INRMP (2001), the management of *H. todsenii* is addressed more generally in terms of conducting inventories to determine the presence of all federally listed species, protecting the plant's critical habitat for consultation issues, as well as managing for fire and post-fire tree plantings. Since 2001, measures recommended in the ESMP have been implemented for *H. todsenii* on WSMR when applicable.

On the Lincoln National Forest, *H. todsenii* is managed under the U.S. Fish and Wildlife biological opinion for the 11 Forest Service Land Management Plans (LRMP) (USFWS 2005). The LRMP (USFWS 2005) included *H. todsenii* in the comprehensive assessment for all threatened and endangered species in the LNF. The LRMP (USFWS 2005) concluded that continued implementation of the Lincoln National Forest's management operations were not likely to adversely affect the *H. todsenii*, and emphasized that prescribed fires and minerals activities would be excluded from *H. todsenii* habitat.

At this time, specific management plans for this species have not been developed by the BLM district for *H. todsenii* growing on BLM lands. The BLM expects to conduct a field survey in the near future to assess the status of recently discovered populations and determine if undiscovered locations exist in the vicinity. Approximately 2,400 acres in the Sacramento Mountains, which support 12 of the 13 known Sacramento Mountain populations of *H. todsenii*, have been nominated by BLM for Area of Critical Environmental Concern (ACEC) designation (R. Lister 2011, pers. comm.). This ACEC nomination requires a certain level of management protection to ensure the resource values of the area for which it was nominated are not impacted so as to disqualify the area from official, final designation.

The majority of this recovery criterion has been accomplished, with the development and implementation of management plans on WSMR and the LNF. However, the populations growing on BLM land are not covered in management plans, and no specific management actions on the LNF and BLM lands have been implemented with the direct intention of recovering *H. todsenii*. Thus this criterion is not entirely fulfilled at this time.

Recovery criterion 2 for downlisting requires that the responsible land management agencies verify through monitoring that protective management is successful. White Sands Missile Range has initiated a formal monitoring program and has recently conducted several field surveys to locate new populations (TNC 2006; Sikula *et al*. 2007; Sikula 2007, 2009). The WSMR did not continue monitoring in 2008 but secured funding for monitoring in 2009 and hopes to have funding to continue their monitoring program over a period of several years (D. Anderson 2009, pers. comm.). Recent discoveries of *H. todsenii* locations in the Gyp Hills of the San Andres Mountains indicate a high potential for populations on adjacent BLM land in that area, and BLM hopes to conduct a field survey in the near future (M. Howard 2010, pers. comm.). This recovery criterion has been partially accomplished; yet each of the three federal agencies is taking a different approach, and regular, standardized monitoring is occurring only on WSMR. Results of management through monitoring data remain in the future, and this recovery criterion has not yet been completed.

Recovery criterion 1 for delisting, identifying the factors responsible for the low sexual reproduction and restricted distribution of *H. todsenii* through research results, has been explored through a preliminary genetics study and two studies of the plant's breeding system and seed production (see sections 2.3.1.1, 2.3.1.2, and 2.3.1.3). Although it is suspected that genetic limitation and low fertility might be partly responsible for the restricted sexual reproduction and distribution of the species, other factors remain uncertain, leaving this delisting criterion not accomplished.

Recovery criteria 2 and 3 for delisting have not been met.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

Hedeoma todsenii is an edaphic specialist which grows on gypseous soils on north-facing slopes within pinon-juniper communities in the San Andres Mountains and Sacramento Mountains (USFWS 2001). It also occurs in scattered ponderosa pine and Douglas fir woodlands in the Sacramento Mountains (USFWS 2001). *Hedeoma todsenii* may be a relict species surviving only where aspect and soils create cooler, moister environments (USFWS 2001). The plant was known from only two locations at the time of listing in 1981. Between the time of listing and when the second Recovery Plan revision was completed in 2001, 16 additional, previously unknown locations had been discovered, forming a total of 3 locations in the San Andres Mountains on WSMR, and 15 new sites in the Sacramento Mountains on BLM and LNF lands. The Sacramento Mountains are situated 75 (km) (45 mi) to the east of the San Andres Mountains, and both ranges have an overall north to south orientation and straddle opposite sides of the lower and drier Tularosa Basin. As of 2009, 32 locations are known, forming the latest totals of 17 locations in the Sacramento Mountains and 15 locations in the San Andres Mountains. All 32 known populations occur on Federal lands: BLM has 7 populations; BLM and the LNF share 6 populations; and the LNF has 4 populations (M. Howard 2009, pers. comm.). White Sands Missile Range has 15 populations (N. Sikula 2009, pers. comm.).

Although exact numbers of individual *H. todsenii* plants are not known, some of the small patches of the plant appear to consist of a few thousand individuals, while other localities support as few as 10 to 20 plants. Most observed plants are assumed to be cloned from networks of underground rhizomes. Thus far, the patches are persisting as stable populations at the 32 known locations, even as the abundance at localities fluctuates.

2.3.1.1 New information on the species' biology and life history

Recent efforts to study pollination and reproductive success in the populations in the San Andres Mountains found that broad-tailed hummingbirds (*Selasphorus platycercus*) were using the flowers of *H. todsenii* and were relatively frequent visitors (Sikula 2009, Tonne 2009), compared to rare observations of hummingbirds in the Sacramento Mountains populations of this plant (USFWS 2001). Tonne (2009) also observed broad-tailed hummingbirds as the primary visitors of *H. todsenii* flowers in the Sacramento Mountains. Tonne (2009) noted two other wasp visitors (Sphecidae) were observed. No other pollen vectors have been seen at the flowers of *H. todsenii*. Based on this recent field data, hummingbirds appear to be primary pollinators of this plant.

Funding from DOD was allocated in 2009 to initiate a pollinator study of *H. todsenii* populations on WSMR, LNF, and BLM lands in both the San Andres and Sacramento mountain ranges. The study is designed to assess the structure and function of the pollinator community and evaluate *H. todsenii*'s breeding success. The study will further examine issues pertaining to the breeding system of this endangered plant and attempt to answer the following questions:

(1) Do *H. todsenii* plants in either the Sacramento or San Andres Mountains show any evidence of self-compatibility or autogamy?
(2) Is there any indication of limitation of sexual reproduction in any or all local populations?
(3) Are the important flower visitors in the San Andres Mountains the same, either taxonomically or ecologically, as those visiting Sacramento Mountains flowers?
(4) What recommendations can we make to conservationists and land managers to enable seed production of this rare taxon?

Tonne (2009) has completed the first year of this pollinator study. Results state the broad-tailed hummingbird is the likely pollinator and primary visitor to *H. todsenii* in all areas. Seed set varied from site to site with between 0 to 46 percent of fruits bearing seed.

Monitoring has demonstrated that flowering varies by year and location. Sikula *et al.* (2007) assessed the reproductive efforts of 4 San Andres Mountains populations in 2007 and found from 23 to 69 percent of individual plants produced flowers. In 2009, Sikula found flower production in 0 to 50 percent of individual plants, revealing a decline in reproductive output. This frequency of

flowering was not seen at 6 monitoring plots in 2 Sacramento Mountains populations, where a range of 0 to 31 percent of individuals produced flowers during 5 years of monitoring from 1991-1995 (Sivinski 2001).

Seed production within the Sacramento Mountains monitoring plots has varied greatly between years. For instance, in plot number 4 there were 20 flowers in 1991, but only 4 (20 percent) produced seed; in 1992 the 38 flowers in the plot produced no seed; and in 1993 a total of 16 (80 percent) of the 20 flowers in this plot produced seed. Most of the stem clumps in this plot were the same individuals during each year of sampling. Variation also occurred within monitored populations of *H. todsenii* in the San Andres Mountains. As an example, during 2007, 23 percent of all individual plants in a population flowered (Sikula *et al.* 2007). In 2009, the same population of individuals remained stunted in vegetative growth with less than one percent producing flowers and no flowers maturing to produce seed (Sikula 2009). Tonne (2009) reported that seed set was low in the samples with low seed production throughout its range. However, percent seed set was notably higher in more mesic sites (Tonne 2009), suggesting that the production of seed may interact with moisture availability. Therefore, environmental conditions, such as precipitation or the presence or absence of pollen vectors, may greatly influence fertilization and seed set.

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

To study density, abundance, and recruitment trends of *H. todsenii*, six permanent study plots were established in October, 1991, in two unnamed canyons west of Nogal Canyon and south of Mountain Lion Peak of the Sacramento Mountains on BLM land. Study plots were monitored each autumn to 1995. Plant density was fairly consistent from 1991 to 1994, but showed a decrease of approximately 15 percent in 1995 (Sivinski 2001). Densities between 1991 and 1995 ranged from 12 to 41 per m^2 (1.1 to 3.8 per square foot [ft^2]) (Sivinski 2001). A subsequent visual assessment of these two populations was made in 2009, but only four of the six plots could be located. The populations appeared to be healthy and occupying the same area of habitat observed in 1995 (Sivinski 2009). However, in 2009, population densities in the Sacramento Mountains ranged from 1 to 5 individuals per m^2 (0.1 to 0.46 individuals per ft^2), revealing a sparser distribution of *H. todsenii* compared to the densities observed between 1991 and 1995.

Two populations of *H. todsenii* were monitored in the San Andres Mountains on WSMR in 2006, 2007, and 2009 (Sikula 2009). Plant density in the two initial populations was not significantly different between the 2006 and 2007 growing season. The number of stems per individual clump was counted in all four populations to assess the relative ages of individuals. The shape of the age distribution curve was bimodal and similar for all populations. Each had a relatively high frequency of young (2-stem) individuals; a drop in frequency for the next size class; then a normal bell-shaped distribution for frequencies of greater stem numbers

(up to 64 stems) (Sikula *et al.* 2007, Sikula 2009). This distribution of age classes indicates a normally aging group of long-lived perennial plants that are actively recruiting new individuals to the population.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation

Sikula (2009) determined the 2009 sexual reproduction efforts in four San Andres Mountains populations to be relatively low in floriferous individuals (0 to 50 percent) that generally failed to produce any seed (0 to 5 percent fertile flowers). This finding confirms previous observations of *H. todsenii* producing few seeds in other populations (Huenneke 1993, Sivinski 2001), and further substantiates this low level of sexual reproduction as characteristic of the species. There is some evidence that most seeds produced by *H. todsenii* are not viable (Irving 1980, Sivinski 2001), which also indicates a genetic basis for most sexual reproduction failures.

An initial genetic study using random amplification polymorphism DNA (RAPD) analysis of 12 *H. todsenii* lines indicated that there is less genetic diversity among lines established from plants that exist in close proximity in situ than among lines that are separated by more distance (Pence *et al*. 2007). This is an expected result of the isolated pattern of distribution of this rhizomatous plant, which perpetuates patches of stems by asexual reproduction and sexual inbreeding.

In 2008, a study of *H. todsenii* genetics at different plant localities was initiated, and samples were taken in both 2008 and 2009. Plants have been established for the past two years in the nursery, but DNA results are not expected for at least another year (D. Andersen 2011, pers. comm.). Another research project that has not been completed included mapping of current populations as well as potential suitable habitat. In 2009, WSMR also initiated a soils study designed to determine soil types occupied by *H. todsenii*. This specific project was never done even though Natural Resources Conservation Service is expected to complete an overall soils classification report for the entire WSMR by the end of 2011 (D. Anderson 2011, pers. comm.).

2.3.1.4 Taxonomic classification or changes in nomenclature:

No changes in taxonomy are known at this time.

2.3.1.5 Spatial distribution, trends in spatial distribution or historic range

Since the development of the revised Recovery Plan in 2001, the 32 locations have expanded the known range of this species by approximately 13 km (8 mi). All of the new populations occur within habitats similar to known locations. One of the new populations occurs within designated critical habitat.

San Andres Mountains
The revised Recovery Plan (2001) identified a total of three *H. todsenii* populations in the San Andres Mountains of WSMR and stated that one of the original locations used to describe the species (P17), near Rhodes Canyon, had not been relocated since its initial discovery in 1978 (USFWS 2001). Recent field surveys on WSMR have relocated P17, and an additional 12 *H. todsenii* locations were discovered in the San Andres Mountains (TNC 2006, Sikula *et al*. 2007, Britt 2009).

One of the new locations discovered in 2009 in the San Andres Mountains on WSMR was the result of 14 search days covering 92 linear km (57 mi) (Britt 2009). This single, new site, P30, is located in the northern Chalk Hills, near P17, and has an aerial extent of 830 m^2 (8,934 ft^2 or 0.2 square acres [ac^2]) (Britt 2009). It is found on a similar landform as other populations within the San Andres Mountains - the north-facing slope of a well-developed, east-draining bajada with a prominent topographic feature upslope and to the west of the population.

All of the 15 *H. todsenii* locations on WSMR occur on gypseous strata of the Yeso Formation where it outcrops in the northern San Andres Mountains. Patch sizes (occupied habitat) range from 474 m^2 (0.1 ac^2) to 1,627 m^2 (0.4 ac^2) (Sikula 2009). Five of the patches in the Chalk Hills occur within very close proximity to one another. These patches of plants are separated by only two or three hundred meters of unsuitable habitat and comprise a single fragmented population. Most of the other locations are separated by several hundred meters, often across several drainages, or even several kilometers, and are less likely to exchange pollen via hummingbird vectors.

Sacramento Mountains
The revised Recovery Plan (USFWS 2001) identified a total of 15 *H. todsenii* populations in the Sacramento Mountains. Eight sites are near Domingo Peak and seven sites near Mountain Lion Peak. Recent field surveys on BLM lands found two additional *H. todsenii* locations (M. Howard 2010, pers. comm.).

The Sacramento Mountain populations of *H. todsenii* usually cover larger areas than the San Andres populations. A more moist soil condition in the Sacramentos may explain this size difference since the Sacramento populations occur at a higher average elevation. Like the San Andres populations, the Sacramento plants usually occur in dense patches. A small patch with an area of 30 x 70 m had 3,300 clumps, and the larger patch of 50 x 150 m had 66,000 clumps of plants (Sivinski 2009). Therefore, the combined known locations of *H. todsenii* in the Sacramento Mountains probably represent several hundred thousand plant clumps. However, the number of genetically distinct individuals would be significantly lower, because of this species' rhizomatous nature (Sivinski 2009).

2.3.1.6 Habitat or ecosystem conditions

All habitats occur on the Permian-age Yeso Formation and are associated with strata that produce gypseous, sandy loam soils, often with loose limestone gravel and cobble. These calcareous soils have high percentages of sand and silt for good water penetration and holding capacity. Habitats are generally on steep slopes with northern exposures that limit the evaporation potential of direct sunlight during long periods of the day.

Most *H. todsenii* populations occur within piñon-juniper woodland, where the species may grow under the tree and shrub canopy or in grassy woodland openings without the presence of tree or shrub canopy (USFWS 2001). One of two new monitoring plots established in the San Andres Mountains was placed in relatively dense woodland (31.9 percent overstory cover) and the other plot was placed in an open area (0 percent cover). *H. todsenii* densities at the woodland canopy and no canopy plots were roughly similar at 5.5 individuals per m² (0.5 per ft^2) and 4 individuals per m² (0.37 per ft^2) respectively. The average number of stems per individual was dissimilar between plots; plants in the woodland canopy plot tended to have more stems than did plants growing in the open (Sikula *et al.* 2007). It is uncertain whether plants under trees live longer with more time to accumulate stems or if plants growing in open areas with greater insolation need fewer stems with leaves. Increased stem formation could be related to greater soil moisture retention in the plot with woodland canopy than in the open plot, due to less exposure to sunlight and soil moisture evaporation compared to conditions in the open plot. However the reason for increased stem occurrence in spots with greater canopy cover is unknown.

A greater proportion of *H. todsenii* may flower in open conditions compared to conditions with more overstory cover. In 2007, the woodland canopy plot had 23 percent of individual plants flowering while the no canopy plot had 69 percent flowering. None of the flowers in samples examined at each plot produced any seed (Sikula *et al.* 2007). Sikula (2009) stated there could be a relationship between canopy cover and reproductive effort and this interaction may warrant further investigation.

2.3.2 Five-Factor Analysis

In the proposed and final listing rules, any activities that would result in increased disturbance of the extremely fragile habitat; the small number individuals and known populations with indications of low reproductive potential; and the lack of protection and management were given as reasons for listing the plant (FR 45-49858 [July 28, 1980]; FR 46-5730 [January 19, 1981]).

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

Human disturbance
All *H. todsenii* populations occur in rugged and remote areas that have no vehicle entry and receive very little land use by the managing agencies or the public. WSMR is closed to the public.

Erosion
Erosion was noted as a potential human threat in the 2001 Recovery Plan. Erosion, as a natural disturbance, may occur within habitat occupied by *H. todsenii* as a result of steep topography and loose, gravelly substrates, but the very limited use of these sites by the public does not appear to be exacerbating erosional impacts at this time.

Grazing
Livestock grazing was listed as a potential threat to *H. todsenii*, more in terms of trampling the plants and exacerbating erosion in fragile habitat than from direct herbivory (USFWS 2001). Populations on the LNF in the Sacramento Mountains are closed to grazing by livestock (USFWS 2001; D. Salas 2007, pers. comm.). However, elk and deer graze in the area and there are reports of feral hogs. Habitats on BLM in the Sacramento Mountains are open to entry by cattle but are little used because of steep topography (M. Howard 2010, pers. comm.). White Sands Missile Range is not open to cattle grazing, but trespass (feral) cattle were reported grazing in and around the San Andres populations in 1982 (USFWS 2001) and trespass cattle continue to be occasionally reported grazing on or near some of the populations (Sikula *et al.* 2007). Introduced oryx may also cross occupied habitat at times, but the impact of grazing either by cattle or oryx does not appear to threaten the species on WSMR.

Mineral extraction
No economic minerals have been located or developed in or near any of the known occupied habitats.

Military activities
The prevailing land use in and around the WSMR populations is for fly-over and the possible impact of military weapons being tested there, which could cause impact-related wildfires. However, the ESMP established that no ground disturbing activities can occur within 0.5 km (0.3 mi) of any *H. todsenii* population on WSMR, and there is no evidence of fire scars or shrapnel within the immediate habitat of *H. todsenii* populations.

Tree encroachment
Substantial increases in cover and extent of piñon-juniper woodlands in New Mexico have taken place within the last 150 years because of a warming climate, a period of heavy use by European livestock, and a decrease in wildfire frequency (Laycock 1999). Most *H. todsenii* populations occur within piñon-juniper woodlands that were probably less dense in the past and could continue to expand in the future. *Hedeoma todsenii* grows and flowers under piñon-juniper woodland

canopy and in open areas without canopy. Some very limited data suggest that a minor change in growth form and a decrease in flowering may result from increasing shade, but a definitive study has not been conducted (Sikula *et al.* 2007, 2009). Even if flowering is somewhat suppressed in the shade, the fact that few viable seeds are produced from *H. todsenii* flowers decreases the significance of producing fewer flowers.

Fire suppression and catastrophic wildfire
All of the populations of *H. todsenii* are susceptible to wildfire. The BLM and LNF both report heavy fuel loads in the areas of known plant populations. As woodland canopy increases and woody fuels accumulate, the potential and severity of wildfire also increases. No known patches of *H. todsenii* have been burned, and there is no information on how fire affects this plant. With its extensive underground rhizome system, *H. todsenii* would be expected to resprout after fire removed the above ground stems, if it did not kill the rhizomes. Burned habitats may have less competition for light, water and nutrients, resulting in increased vigor or reproductive success. Conversely, removing vegetation and exposing the soil could increase erosion and due to the reduction in shade make the soil hotter and drier from greater insolation, which could potentially diminish a population (USFWS 2001).

The only recent project requiring a section 7 consultation was a prescribed fire proposal for BLM land in the Sacramento Mountains that had suitable habitat for *H. todsenii*, but no known populations. The BLM determined that fire is not likely to adversely affect *H. todsenii* (BLM 2007).

If the status quo of suppressing fires is maintained, dense woodland canopies may be suppressing many populations of *H. todsenii* until fuel accumulations result in catastrophic fires. If even moderate fires diminish the suitability of habitat, then appropriate woodland management actions can be prescribed to protect them from burning. At present, land managers do not know how to manage these wooded habitats, which may be a potential threat to *H. todsenii*.

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

There is no past or current demand for *H. todsenii* for any commercial, recreational or educational purposes. This species has been collected under appropriate permits to establish garden populations at the Arboretum at Flagstaff in Arizona and the Cincinnati Botanical Garden in Ohio. These are plant research and preservation institutions that maintain conservation collections of endangered species. Individuals and tissue cultures of 23 genetic lines including *H. todsenii* patches from both the San Andres and Sacramento Mountains are presently in cryo-storage at the Cincinnati Botanical Garden or are growing at the Flagstaff Arboretum (S. Murray and V. Pence 2007, pers. comm.).

Concern has recently been expressed that frequent monitoring of *H. todsenii* populations may result in increased erosion due to the unstable nature of steep talus slopes (Sikula *et al.* 2007). It is unknown whether this impacts the species.

2.3.2.3 Disease or predation – Factor C:

No disease or predation is presently known to be a threat to *H. todsenii*. Although herbivory from insects (Ulaszek 1993), rodents, and native ungulates might occur, the impact on *H. todsenii* is unknown (USFWS 2001).

2.3.2.4 Inadequacy of existing regulatory mechanisms – Factor D:

Hedeoma todsenii was federally listed as endangered with critical habitat in January, 1981 (46 FR 5730). The plant is also listed as endangered in the state of New Mexico; however The Endangered Species Act (ESA) is the primary law providing protection for the species. Beyond the actual listing of the species, these protections are afforded particularly through sections 7 and 9 of the ESA. Section 7 of the ESA requires Federal agencies to ensure that any action authorized, funded, or implemented by them is not likely to jeopardize the continued existence of listed species or modify their critical habitat. Section 7 also encourages Federal agencies to use their authorities to carry out programs for the conservation of listed species. Section 9 of the Act prohibits the removal, damage, or destruction of listed plants on Federal lands and on other areas in knowing violation of any State law or regulation or State criminal trespass law. The USFWS has addressed some projects through informal section 7 consultations with WSMR and BLM. All Federal landowners of occupied *H. todsenii* habitat (LNF, BLM, and WSRM) are aware of this endangered species and its locations within their jurisdictions.

The most recent informal section 7 consultation occurred in 2008, when WSMR entered their draft programmatic Environmental Assessment (EA) for a Directed Energy Test Site Operations (22420-2008-I-0029) and the Draft EA for Aero-acoustic Research Complex (22420-2008-I-0040) and Helicopter Gunnery Training. All of the potential threats of these proposed activities were addressed in the consultation, which concluded there were no adverse effects to *H. todsenii* that were likely to occur.

In the biological opinion (USFWS 2005) for the eleven National Forests Land and Resource Management Plan (LRMP), the USFWS concluded that continued implementation of the Forest LRMP was not likely to adversely affect *H. todsenii* for the following reasons: (1) grazing, logging, and fuel wood harvest have been excluded from the areas where *H. todsenii* exists (steep slopes with fragile soils) to protect the watershed; (2) watershed health will be maintained through the exclusion of potentially damaging activities rather than through restoration projects; (3) no prescribed fires or wild land-urban interface fuel reductions will be carried out in these areas; and (4) the LRMP direction is to protect threatened

and endangered species from minerals activity through surface use stipulations in operating plans and permits. Although there are few if any direct effects from federal activities on the LNF, the potential impacts of wildfire were not considered in this consultation.

The National Environmental Policy Act (NEPA) may provide some protection for *H. todsenii* for projects with a Federal nexus (i.e., funding, authorization, or permitting). Under NEPA the planning process for Federal actions must be analyzed to ensure that effects on the environment are considered. The NEPA process is intended to help public officials make better decisions based on an understanding of the environmental consequences of their actions and to take actions to protect, restore, and enhance the environment (40 CFR 1500.1). Carrying out the NEPA process ensures that agency decision makers have information about the environmental effects of Federal actions and information on a range of alternatives that will accomplish the project purpose and need.

Regulatory mechanisms seem adequate at this time, particularly because the populations of *H. todsenii* are located in areas either closed to the public or in remote habitats that receive little impact from human-induced threats. An approach to manage for tree encroachment into the future for possible wildfire spread into occupied habitat would benefit this plant. As long as *H. todsenii* remains protected by the ESA, activities within its Federal jurisdiction must be reviewed and assessed through the National Environmental Protection Act and the Endangered Species Act section 7 consultation processes, which have served thus far to protect the species.

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

Reproduction, dispersal ability, and genetic diversity
Low genetic diversity has previously been identified as a threat to *H. todsenii* (USFWS 2001). An initial genetic study using RAPD analysis of 12 *H. todsenii* lines indicated that there is less genetic diversity among lines established from plants that exist in close proximity in situ than among lines that are separated by more distance (Pence *et al.* 2007). This is an expected result of the isolated pattern of distribution of this rhizomatous plant, which perpetuates patches of stems by asexual reproduction and sexual inbreeding.

Inbreeding depression in this species could be a contributing factor to the very low level of seed set observed throughout all populations of *H. todsenii*. If inbreeding and long-term asexual reproduction have caused an accumulation of lethal alleles in a population, many embryos would fail to survive and would be aborted. The possibility of increasing genetic variability by purposely out crossing distant populations with pollen or seed transfers would run the risk of breaking up co-adapted gene complexes that confer adaptation to local environmental conditions, i.e. out breeding depression.

Purposeful transfer of gene complexes between populations may further reduce embryo survival in ways that have not yet been identified. Huenneke (1993) showed that self-pollination and transfers of pollen between individuals within a patch and between nearby patches produced at least a few seeds. However, her hand-pollen transfers between two distant populations in canyons 1.2 km apart failed to produce any seeds. Infrequent seed set likely may be a genetic characteristic of the species as a whole and probably cannot be modified by a few attempts to purposely transfer gene complexes between the various inbred populations. The continuing inability of *H. todsenii* to produce an abundance of seeds will severely limit its ability to recolonize habitats where populations may be extirpated or to migrate to new habitats if climate change renders current habitats unsuitable.

Drought and climate change

Periods of drought in the southwest are common. However, the frequency and duration of droughts may be altered by climate change. Global warming and associated effects on regional climatic regimes are not well understood, but weather predictions for the southwestern United States include less overall precipitation and longer periods of drought. Based on broad consensus among 19 climate models, Seager *et al*. (2007) predicted that the southwest will become drier in the 21st century and that this drier climate change is already occurring. Increased aridity associated with the current on-going drought and the 1950s drought will become the norm for the American southwest within a timeframe of years to decades if the models are correct.

The 2007 Intergovernmental Panel on Climate Change (IPCC) report outlines several scenarios that are virtually certain or very likely to occur in the 21st century. These are: 1) over most land, there will be warmer and fewer cold days and nights, and warmer and more frequent hot days and nights; 2) areas affected by drought will increase; and 3) the frequency of warm spells/heat waves over most land areas will likely increase. The IPCC makes equally sobering predictions for ecosystems; the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects), and other global drivers (IPCC 2007). With medium confidence, IPCC predicts that approximately 20 to 30 percent of plant and animal species assessed so far are likely to be at an increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5ºC (IPCC 2007). Almost certainly *H. todsenii*, along with its habitat, will be affected in some manner by climate change; the magnitude and extent of the change cannot be quantified at this time.

Climate change also involves an increase in atmospheric carbon dioxide which is commonly associated with increased temperatures and the greenhouse gas effect. Since 2000, the observed emissions of greenhouse gases, which are a key influence on climate change, have been occurring at the mid- to higher levels of the various emissions scenarios developed in the late 1990s and used by the IPPC

for making projections (e.g., Raupach *et al.* 2007, Pielke *et al.* 2008, Manning *et al.* 2010). This increased carbon dioxide directly affects plant photosynthesis (Huxman and Scott 2007). At the plant level, adapting to drought involves the ability to balance carbon sequestration (the uptake and storage of carbon), carbon respiration (efflux back into the atmosphere), and maintain sustainable evapotranspiration rates (Huxman and Scott 2007). Adaptation would also require a plant to change its phenology (timing of life cycle events) to coincide successfully with extreme shifts in temperature, precipitation, and soil moisture (Walther *et al*. 2002) which are all part of the evapotranspiration equation. The potential for rapid climate change, which is predicted for the future, could pose significant challenges for plants because they may not be able to adjust their phenology or photosynthetic mechanisms quickly enough.

In the southwest region of the United States, the average annual temperature in is predicted to rise by about 2.5 to 3.9 º C (4.5 to 7 º F) during this century (IPCC 2007). This increasing rate of 0.56 º C (1.0 º F) every 14 years has already been surpassed in Arizona since the 1970s, and New Mexico is just slightly below this rising temperature rate (Lenart et al. 2007). Hydrologic trends are less clear except when considering snow; less snowpack and earlier spring melt and runoff in the Intermountain West states is substantiated (Parmesan and Galbraith 2004; Udall and Bates 2007), yet the southwestern states show a long-term trend of increased precipitation since the 1970s (Parmesan and Galbraith 2004; Udall and Bates 2007; Enquist and Gori 2008).

New Mexico precipitation changes show more variation than temperature changes, with about 54 percent of the state trending toward wetter conditions, 41 percent toward drier, and 5 percent with no discernable change between 1991 and 2005 (Enquist and Gori 2008). The spatial heterogeneity of drought, as defined by temperature, and particularly precipitation, is extremely variable in the state of New Mexico (Enquist and Gori 2008). At this time, most of New Mexico is experiencing severe drought conditions, with October 2010 through June 2011 noted as the driest nine month period on record (NOAA National Climatic Data Center, August 12, 2011). During these last nine months, central and southern New Mexico, where the San Andres and Sacramento Mountains are located, has been in a state of Exceptional Drought Conditions (http://droughtmonitor.unl.edu/ accessed August 12, 2011). Exceptional Drought Conditions – D4 Drought surpass Extreme Drought Conditions – D3 Drought, and are considered a 25 to 50 year recurrence event. Impacts from notable drought conditions anticipated by the 2005 Potential Effects of Climate Change on New Mexico report (Agency Technical Work Group 2005) include decreases in soil moisture availability, increases in evapotranspiration, and decreases in plant productivity. Because *H. todsenii* has not been monitored since the summer of 2009, effects of these drought conditions on the colonies have not been documented; however, given the plant's positive response to more mesic conditions, the drought impacts are likely not positive for the species.

Hedeoma todsenii is a relict species persisting as small, scattered patches of plants in a few places where gypseous soils and topographic aspect create cooler, moister microclimates in a relatively hot and arid region. These microclimate habitats and the *H. todsenii* populations they contain would probably expand if the regional climate became cooler or wetter. Conversely, a climatic change that made these microclimate habitats drier could shrink or eliminate *H. todsenii* populations. Localities in the San Andres Mountains may be vestiges of relict populations and incapable of spreading: whereas, colonies in the Sacramento Mountains inhabiting more mesic areas could hold more promise for the species' persistence, making their protection all the more imperative (P. Tonne 2011, pers. comm.). If predicted warming is accompanied by less precipitation over the longer term, or no increase in precipitation, it is possible that *H. todsenii* populations could be diminished. Thus climate change poses a significant threat into the future for this plant.

2.4 Synthesis

Hedeoma todsenii is a rare, regionally endemic mint that occurs only in the San Andres and Sacramento mountains in Otero and Sierra counties of south-central New Mexico. This plant was listed as an endangered species with critical habitat in 1981. Only two locations for *H. todsenii* were known at the time of listing. Critical habitat was identified as 1 km² areas around each of the two original locations. Since the time of listing, 30 additional locations have been discovered, only 1 of which occurs within previously designated critical habitat. The 11 new locations in the San Andres Mountains on WSMR have expanded the known range of *H. todsenii* on WSMR by approximately 13 km (8 mi) and occur in habitats similar to previously known locations. There are now 17 known locations in the Sacramento Mountains and 15 locations in the San Andres Mountains. Today, all 32 known populations of this species occur on Federal lands including BLM, LNF, and WSMR. The total number of plants is unknown, but *H. todsenii* localities range from a few thousand plants growing in patches that cover small areas of usually less than one acre, to localities supporting a few dozen plants. Although infrequently monitored, these small colonies of plants appear to be persisting as stable populations that are free of unusual diseases or predators. No invasive, non-native plant species have been found in *H. todsenii* habitats.

Hedeoma todsenii reproduction appears to be predominantly asexual with most new individuals being clones arising from the rhizomes of existing plants. Individual clones flower infrequently and when they do bloom, few or no seeds are produced by the flowers. Seed set varies between years and between patches of plants indicating an environmental influence on seed production or an uneven or inadequate presence of pollinators. Initial field results did not suggest pollinator limitation by the primary pollinator (the broad-tailed hummingbird); however, seed set was found to be greater at more mesic sites in the Sacramento Mountains than at more arid sites in both the Sacramento and San Andres Mountains. Increased plant abundance and seed set found associated with moister habitats suggests a positive response to increased moisture and a potentially negative response to increased drought. Additionally, even the flowers that are purposely pollinated by hand make few or no seeds and most of the seeds that are produced are not viable, which points to a genetic basis for most failures in sexual reproduction.

A genetic study to determine the cause of *H. todsenii*'s low level of seed set would be unlikely to provide a remedy to curing limited sexual reproductive success. Infrequent seed set appears to be a genetic characteristic of the species as a whole and probably cannot be modified by a few attempts to purposely transfer gene complexes between the various inbred populations. The continuing inability of *H. todsenii* to produce an abundance of seeds will severely limit its ability to recolonize habitats where populations may be extirpated or to migrate to new habitats if climate change renders current habitats unsuitable.

Most *H. todsenii* populations occur within piñon-juniper woodlands that are becoming more dense due to a history of fire prevention, and more susceptible to wildfire due to current drought conditions. The proximity of *H. todsenii* populations to each other increases the chances that any given fire could affect multiple populations. However, the ground cover in more arid habitats, particularly in the San Andres Mountains, might not be dense enough to carry a fire a great distance. The underground rhizomes of *H. todsenii* would probably survive a moderate fire, but the suitability of burned habitat for this species is not known because woodland canopy removal by fire might actually increase *H. todsenii* vigor, but could also result in hotter and drier habitat with eliminated colonies (depending on fire severity and on climatic conditions) or a smaller overall population.

Thirty-two locations of *H. todsenii* are known to occur in very remote and inaccessible areas. With the exception of the DOD-WSMR, none of the Federal land management agencies has developed a species-specific management plan for *H. todsenii*. The foreseeable threats to all *H. todsenii* populations fall into three categories of: 1) a changing climate, with Exceptional Drought Conditions at the present time; 2) the inability of land managers to manage for increasing piñon-juniper woodland densities within the habitats of this species, and the related increasing threat of wildfire; and 3) apparently inherent genomic constraints to sexual reproductive success and dispersal. Much needed research on the reproductive potential and fire response of the species has yet to be conducted. It is foreseeable that wildfire could threaten a significant number of *H. todsenii* colonies. At that time, the lack of reproductive success may become profound and could further endanger the continued existence of *H. todsenii* in a significant portion of its range. Further, since the impacts of climate change and inadequate habitat management are gradual and cumulative, it is likely that threats to this species will remain in the foreseeable future. Therefore, no change in classification is warranted at this time.

3.0 RESULTS

3.1 Recommended Classification: No change; remain as endangered.

Upon examining the partial attainment of recovery criteria for downlisting, the status of threats to this endemic species, and the discovery of 30 additional colonies of *H. todsenii* since the species was listed in 1981, we believe this plant is making progress toward consideration for downlisting. However, of the three Federal agencies with *H. todsenii* growing on their lands, DOD-WSMR is the only agency that has accomplished recovery criteria for downlisting by developing and implementing a detailed management plan for *H. todsonii* as well as conducting standardized monitoring of the 15 colonies found on WSMR. The 17 remaining colonies on BLM and LNF lands have yet to be protected by a similar level of active management. The additional colonies found since listing have notably enhanced the number of individuals of *H. todsenii*; yet, their genetic distinctness remains unknown due to their proclivity for vegetative reproduction and the paucity of information on long-term fecundity and dispersal. Assured implementation of systematic monitoring on LNF and BLM lands, development of species-specific management plans for BLM and LNF areas, and continued management of Federal lands to protect this plant from threats would promote recovery and move toward a status of threatened for this plant throughout its restricted range.

Given we have yet to understand the basis for observed genetic and reproductive limitations, the response of *H. todsenii* to fire, and the effects of continued long-term drought in the range of the species, we believe more time is needed to analyze the response of this plant to changing conditions and to develop and enact long-term management and monitoring plans. The increased potential for more frequent and severe fires, compounded by predicted effects from warmer and drier conditions could serve to contract suitable habitats of moist, upslope, north-facing areas with gypsum substrates, the only specialized habitat type that appears to support this species. The interacting and cumulative threats of fire, tree encroachment, and climate change with threats from limited genetic diversity, sexual reproductive success, and dispersal ability, still leave the plant as endangered. The lack of information concerning long-term effects to the plant of existing threats, the need to complete recovery criteria for downlisting, and the lack of permanent protection and monitoring on BLM and LNF areas preclude a recommendation to downlist *H. todsenii* at this time. The status of *H. todsenii* will be closely reconsidered during the next 5-year review.

3.2 New Recovery Priority Number: No change; remain at a recovery priority of 8.

This indicates that *H. todsenii* is a full species with a moderate degree of threat and a high recovery potential. No change is recommended at this time.

3.3 Listing and Reclassification Priority Number: N/A.

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

Field Surveys: Recovery Action 3.0 in the Recovery Plan recommends using information from previous studies to identify potential habitat and search these areas (USFWS 2001). There are additional suitable habitats in the northern San Andres Mountains in and around the Gyp Hills and Chalk Hills that still need to be surveyed on both WSMR and adjacent BLM lands. There are also potential habitats on the Mescalero Apache Reservation in the Sacramento Mountains that have not been surveyed. A partnership with the Mescalero Apache Tribe should be established to survey and manage any extant populations in a manner consistent with their sovereign authorities.

Long-term Monitoring: Recovery Action 1.7 prescribes establishing long-term monitoring (USFWS 2001). Permanent monitoring plots have been established in two canyons in the Sacramento Mountains on LNF and BLM lands and at five *H. todsenii* locations on WSMR in the San Andres Mountains. However, monitoring has not occurred at the LNF or BLM locations since the plots were established in the 1990s. Additional plots should be established and monitored in the Sacramento Mountains to assess differences in plant density and vigor under varying degrees of piñon-juniper woodland canopy closure. To achieve recovery criteria for downlisting, standardized monitoring should occur at approximately five year intervals to detect any trends. Population trends need to be compared with climatic data obtained from the nearest permanent weather stations to investigate relationships to climate change. Monitoring dates should coincide with flower maturation (September) for an assessment of sexual reproduction success. These periodic assessments of seed production and canopy cover influences are prescribed by Recovery Actions 2.1.2 and 2.2.2 (USFWS 2001).

Fire Effects: Recovery Action 2.2.4 prescribes studying the effects of fire on *H. todsenii* (USFWS 2001). At least one patch of *H. todsenii* should be burned by prescribed fire to determine the effects of fire on plant density and vigor. This population should occur in woodlands of sufficient density to carry a fire of at least moderate intensity. Permanent monitoring plots should be established and assessed prior to the fire and for at least five years after being burned. Additionally, any permanent monitoring plots that are unexpectedly burned by wildfire should be monitored annually for five years to determine the effects of the fire.

Reproductive Biology Studies: Recovery Action 2.1.1 recommends conducting studies on the reproductive biology of *H. todsenii* including pollination, seed development, and seed dispersal. Low sexual reproduction, poor seed viability, and limited seed dispersal are considered to be inherent threats to this species. The only pollinators documented for this plant are broad-tailed hummingbirds, a mating system supported by the red, tubular flowers of this plant species. Other, undocumented pollinators could be important to reproduction or simply absent due to pollinator limitation or an overall lack of conspicuous flowering plants in the community. Field studies in each mountain range documenting pollinator species and activities should be undertaken with the goal of improving pollination, fertilization, and seed set.

Planning: Recovery Action 1.2 prescribes the development and implementation of management plans for *H. todsenii* (USFWS 2001). The Federal permitting and consultation requirements and oversight under the Endangered Species Act, along with NEPA are adequate to protect known

Todsen's pennyroyal habitats from serious land use impacts. Monitoring plans that are specific to this species need to be adopted by all three Federal agencies with *H. todsenii* populations. These plans should commit agency time and personnel to establishing and monitoring permanent monitoring plots and at least one agency should prescribe a fire across monitoring plots in *H. todsenii* habitat. If monitoring data indicate a need for active woodland treatments specific to *H. todsenii* habitats, plans for woodland thinning or prescribed fire could be implemented by these agencies.

Update of Recovery Criteria: To ensure that the recovery plan for *H. todsenii* continues to be a current, living document, the recovery criteria should be updated to reflect the current number of colonies, upcoming results from genetic studies, and the recent status of threats to provide measureable standards by which the species can be quantified in the San Andres and Sacramento Mountains populations.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW
Todsen's Pennyroyal *(Hedeoma todsenii)*

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

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

Review Conducted By: This review was a team effort comprised of biologists from the New Mexico State Forestry Division, the New Mexico Ecological Services Field Office, and the U.S. Fish and Wildlife Service Region 2 Regional Office.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 8/4/11

REGIONAL OFFICE APPROVAL:

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

Approve _____ Date 8/15/11