ENDANGERED SPECIES MANAGEMENT COMPONENT FOR TODSEN'S PENNYROYAL (*Hedeoma todsenii*) at White Sands Missile Range, New Mexico

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Table of Contents

List of Figures

List of Tables

List of Photos

ACRONYMS

BLM – Bureau of Land Management

DA – Department of the Army

ESA – Endangered Species Act

ESMC – Endangered Species Management Component

ESMP – Endangered Species Management Plan

INRMP – Integrated Natural Resources Management Plan

LNF- Lincoln National Forest

MFRI – Mean Fire Return Interval

NMFRCD - New Mexico Forestry and Resources Conservation Division

TNC – The Nature Conservancy

USFS – United States Forest Service

USFWS – United States Fish and Wildlife Service

WSMR - White Sands Missile Range

EXECUTIVE SUMMARY

Todsen's pennyroyal (*Hedeoma todsenii*) is a federally Endangered mint endemic to the San Andres and Sacramento Mountains in south-central New Mexico. Fifteen of the 45 known populations occur on White Sands Missile Range (WSMR). WSMR supports the conservation of this species to comply with the Endangered Species Act, to recover the species, and to minimize future conflicts with the military mission. Management practices for this species include maintaining population buffer areas, minimizing mission-related impacts, continuing long-term monitoring, conducting searches for additional populations, minimizing disturbance from monitoring activities, and supporting research as directed by the recovery plan.

CHAPTER 1 – INTRODUCTION

Todsen's pennyroyal (*Hedeoma todsenii)* is a perennial mint (family Lamiaceae) endemic to the mountains west and east of the Tularosa Basin in southern New Mexico (Irving 1979). There are 45 known locations, 15 of which occur on White Sands Missile Range (WSMR) in the San Andres Mountains (Chalk Hills and Big Gyp Mountain), Sierra County. The other 30 populations occur approximately 46 miles to the East in the Sacramento Mountains. This species is restricted to steep, mid-elevation, north-facing slopes with gypseous soils. The limited distribution of known locations are an important reason for its federal endangered status.

Originally discovered in 1978 by Dr. Thomas K. Todsen, the initial population was found two kilometers south of Hardin Ranch, and the second was discovered the following year (Irving 1980). Biologists working under the direction of the White Sands Missile Range Environmental Stewardship Branch have conducted searches in suitable habitat on White Sands Missile Range since 1990, locating an additional 13 populations. A long-term monitoring program was initiated in 2006 (Sikula 2007).

Legal, Regulatory, and Policy Considerations

The United States Fish and Wildlife Service's (USFWS) reasons for listing Todsen's pennyroyal as endangered included activities that would result in increased disturbance of the extremely fragile habitat, the small number of individuals amongst known populations with low reproductive potential, and the lack of protection and management (USFWS 1981). Todsen's pennyroyal was originally listed as endangered—with critical habitat for two known populations—on January 19, 1981 (USFWS 1981). The USFWS developed a Todsen's pennyroyal Recovery Plan in 1985 and revised it in August 2001 (USFWS 2001). 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 Todsen's pennyroyal. In 2001, a Section 6 progress report on Todsen's pennyroyal was completed (Sivinski 2009). In 2011, the USFWS completed a 5-year review of the status of Todsen's pennyroyal (USFWS 2011). A status review was conducted in 2015 at the behest of WSMR (Britt 2015). Todsen's pennyroyal is currently listed as endangered by the State of New Mexico.

Federal agencies have additional regulatory responsibilities to conserve threatened and endangered species. Section 7 of the ESA requires all Federal agencies to carry out programs for the conservation of threatened and endangered species and to insure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of critical habitat. WSMR is also required to comply with the National Environmental Policy Act (NEPA), therefore every proposed action undergoes environmental review that assesses potential effects to threatened or endangered species. If a "no affect" determination can't be made, then a consultation with USFWS will be initiated. The Sikes Act requires each installation to write and implement an Integrated Natural Resources Management Plan for "the conservation and rehabilitation of natural resources."

The WSMR Integrated Natural and Cultural Resource Management Plan (INCRMP) has a General Goal, three General Objectives, and four In-house Actions to support the military mission of WSMR while meeting natural resource management and conservation requirements (WSMR 2015):

General Goal. *Apply ecosystem management tools, in the context of the current military mission, to preserve, maintain, and/or restore, where appropriate, native biodiversity and ecological integrity of natural biotic communities, in sufficiently large blocks to avoid ecological fragmentation and to protect sensitive and important cultural resources.*

General Objective 1. *Manage land use to sustain WSMR natural and cultural resources in concert with military mission requirements.*

General Objective 2. *Apply ecosystem management tools, in the context of the current military mission, to preserve, maintain, and/or restore, where appropriate, the native biodiversity and ecological integrity of natural biotic communities, in sufficiently large blocks to avoid ecological fragmentation.*

General Objective 3. *Preserve and restore, where necessary, unique natural ecological communities and landscape features.*

In-House Actions:

- *Use adaptive management principles to manage WSMR natural and cultural resources, using monitoring to guide management actions (ongoing).*
- *Promote biodiversity via the use of native species, protection of sensitive areas, and restrictions on activities that negatively affect biodiversity (ongoing).*
- *Protect sensitive and important cultural resources via coordinated planning that sustains the military mission and complies with cultural resources laws and regulations (ongoing).*
- *Consider effects of natural resource management on cultural/historical resources during natural resource management planning (ongoing).*

The INCRMP identifies the need to conduct surveys, monitoring, and research in order to implement the management actions. *Specific Operational Unit Conservation Constraints* include further discussion of constraints associated with WSMR resources and conservation-related constraints figures for OUs. Goals and objectives for specific resource areas were developed, and specific in-house actions and projects for attaining these goals and objectives were included. Actions that impact the military mission and are specific to particular OUs were identified and cross-referenced to that particular OU. Goals, Objectives, and In-house actions related to the management and conservation of Todsen's pennyroyal include:

Goal 20. Conserve federally-listed species, as well as their designated habitats, by using all methods and procedures necessary to bring them to the point where protections provided pursuant to the ESA are no longer necessary.

Objective 20.1. Implement the Todsen's pennyroyal ESMP to reach the interim recovery goal of downlisting and ultimately the final recovery objective of delisting.

Goal 22. *Conserve species at risk and sensitive species in accordance with laws, regulations, and guidance.*

Objective 22.1. *Document the distribution of federally- or state-listed species, species at risk, and sensitive species on WSMR and monitor their status.*

In-house Actions:

- *Ensure threatened and endangered species are protected, as mandated by ESA and NEPA and overseen by USFWS in coordination with Environmental Stewardship Branch (ongoing).*
- *Manage all federally-listed threatened and endangered species of plants and animals to avoid or eliminate adverse impacts to individuals, species, and important habitat, in consultation with USFWS (ongoing).*
- *Ensure USFWS is consulted on any federal action (funded, permitted, or authorized) that may affect species federally-listed or proposed for listing as threatened or endangered (as needed).*
- *Ensure federally-listed species are not "jeopardized" (i.e., actions are avoided that would be expected to directly or indirectly reduce appreciably the likelihood of survival and recovery of a listed species by reducing its reproduction, numbers, or distribution) (ongoing).*
- *Ensure USFWS is consulted whenever an installation action "may affect" a federally-listed species or designated critical habitat (as needed).*
- *Ensure biological assessments are conducted for construction (and other activities having similar physical impacts on the environment) if any federally-listed species or designated critical habitat is or may be present in the area directly or indirectly affected by the action (as needed).*
- *Ensure federally-listed fish or wildlife species are not "taken" and federally-listed plant species are not destroyed without a biological opinion from the USFWS (ongoing).*
- *If a listed, proposed, or candidate species or its designated critical habitat occurs on the installation, prepare and implement an ESMP in accordance with current Army guidelines and in consultation with the USFWS (as needed).*
- *Continue Todsen's pennyroyal pollination study (2015, 2017).*
- *Continue the genetic diversity study of Todsen's pennyroyal (2015, 2017).*
- *Support 100% inventories of suitable habitat using scientifically accepted methodologies for federally-listed, proposed, and candidate species that may occur on WSMR (2015-2019).*
- *Ensure the NEPA process is used to assess impacts of installation activities on state- and federally-listed species, species at risk, and sensitive species (as needed).*
- *Continue monitoring and support research efforts for state-listed or WSMR species or interest flora (ongoing).*

Department of Defense Instruction (DoDI) 4715.03, issued March 18, 2011, includes a biodiversity directive to:

> *maintain or reestablish viable populations of native species on an installation, when practical*

WSMR's management of Todsen's pennyroyal is also guided by regulations issued by the Department of the Army (DA) in accordance with Army Regulation (AR) 200-1, "Environmental Protection and Enhancement". While critical habitat only includes the original designation, White Sands Missile Range established a 0.5-km buffer around existing populations (TNC 2001a). This regulation has the following requirements for threatened and endangered species:

(a) Prepare and implement an Endangered Species Management Component to the INRMP consistent with current policy and guidance.

(b) Carry out mission requirements in compliance with the ESA.

(c) Integrate endangered species management and installation planning functions to ensure compliance with the ESA.

(d) Take appropriate actions to preclude critical habitat designation.

(e) Assess all activities (to include Military Construction) at the earliest opportunity to determine whether they may affect listed species or critical habitat.

(f) Coordinate threatened and endangered species actions or issues with commanders and other tenants that may be affected by them.

(g) Conduct biological assessments for activities that may have an effect on listed species or critical habitat where they are present or may be present in the action area.

(h) Informally consult with the USFWS; document the results in writing; and if necessary, conduct a biological assessment or biological evaluation to assess whether an action may affect a listed species or critical habitat. If the action is likely to adversely affect the listed species or its habitat, formal consultation is required.

(i) Coordinate with affected installation organizations and higher headquarters prior to initiating formal consultation.

(j) Formally consult with the USFWS when it is determined an action "may affect" a listed species or critical habitat. If the action is not likely to adversely affect the listed species or its habitat, and the USFWS concurs in writing, formal consultation is not required.

(k) Confer with the USFWS on any action that is likely to jeopardize the continued existence of any proposed species or result in the destruction or adverse modification of proposed critical habitat.

(l) Review all ongoing and proposed actions immediately upon listing of a threatened or endangered species or designation of critical habitat to determine if formal consultation is necessary (even if a conference has previously occurred).

(m) Complete a Biological Evaluation before initiating formal conference on actions affecting a proposed species or proposed critical habitat.

(n) Develop and implement strategies to promote, in cooperation with other landowners, the use of conservation banking and/or Army Compatible Use Buffer initiatives to minimize impacts of an action on threatened and endangered species and/or critical habitat.

(o) Within 24 hours report ESA violations, by telephone or electronic means, through the chain of command to Headquarters, Department of the Army. Submit a follow-up written report within 7 days.

(p) Coordinate with higher headquarters and Headquarters, Department of the Army in taking final action to correct any endangered species management problems contributing to the ESA violation(s).

(q) Ensure that threatened and endangered species awareness is included in unit training for personnel who may come in contact with listed species and/or their habitats or critical habitat. Coordinate training with the installation engineer, environmental directorate, and Integrated Training Area Management sustainable range component.

(r) Obtain Headquarters, Department of the Army approval before supporting USFWS's introduction and/or reintroduction of Federal and State-listed, proposed, and candidate species on Army lands.

(s) Protect water rights necessary for the survival and recovery of listed, proposed, or candidate aquatic or riparian species. Coordinate all water rights issues with appropriate legal counsel.

(t) Participate in the listing/delisting process, recovery plan development, and critical habitat designation where the species in question may impact installation military missions.

(u) Cooperate with State and local authorities in the management of Assistant Chief of Staff for Installation Management-designated Army species at risk and habitats with the goal of avoiding listings that could adversely affect military readiness.

(v) Participate in regional/habitat-wide efforts to conserve candidate and Assistant Chief of Staff for Installation Management-designated Army species at risk and habitats when it has the potential to benefit the Army.

(w) Include State-listed species in the installation INRMP.

The United States Fish and Wildlife Service Todsen's Pennyroyal Recovery Plan

The ESA [Section 4(f)] requires the Secretary of the Interior to develop and implement recovery plans. The objective of the Todsen's pennyroyal recovery plan is to outline steps to manage the species with a final goal of delisting (USFWS 2001). The benchmark is to protect and manage *H. todsenii* such that it will sustain itself indefinitely in its natural habitat. The 5-year review by USFWS noted that 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 (USFWS 2011). The recovery plan is currently being updated (Jennifer Davis, pers. comm.). The existing 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 known 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
6. Establish a working group for agency and public coordination

2015 Status Review of the 2011 5-Year Review

The 2011 5-year year review conducted a thorough evaluation of activities that could threaten or disturb populations and their habitat (USFWS 2011). A status review was funded by WSMR and conducted in 2015 (Britt 2015). This review included updates to aspects of the 2011 Recovery Plan 5-Year Review: assessment of threats, assessment of criteria necessary for recovery, and progress update for recommended actions.

Assessment of Threats

(1) **Human Disturbance:** All *H. todsenii* populations occur in rugged and remote areas with low potential for human disturbance outside of monitoring activities.

(2) **Erosion:** Natural erosion may occur due to steep topography and loose, gravelly substrates. However, most disturbance that might lead to erosion is likely to come from frequent, repeated monitoring.

(3) **Grazing:** WSMR is not open to cattle grazing, but stray cattle occur at times (Sikula et al. 2007). Oryx (*Oryx gazella*), mule deer (*Odocoileus hemionus*), and elk (*Cervus canadensis*) may also come across occupied habitat. Grazing impacts by these potential ungulates are not observed at the populations and do not appear to threaten the species on WSMR.

(4) **Military Activities:** The current Endangered Species Management Plan (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. The prevailing land use in and around the WSMR populations consists of fly-overs and possible military weapons testing, which could cause impact-related wildfires. It is possible that current testing may have small, limited impacts on individuals within populations. Any fires caused by a weapon testing event are unlikely to create a catastrophic wildlife due to vegetation spacing and a lack of fine fuel (D. Anderson, pers. comm.).

(5) **Tree Encroachment:** Substantial increases in cover and extent of piñon-juniper woodlands in New Mexico have taken place within the last 150 years (Laycock 1999). Most *H. todsenii* populations occur within piñon-juniper woodlands. The populations in the Sacramento Mountains occur in a Pinon-Juniper woodland habitat with a higher density of trees and shrubs than populations located in the San Andres Mountains (LANDFIRE 2015). It is unknown what impact additional shade has on reproduction; however, increased tree density may increase wildfire risks to populations.

(6) **Fire Suppression and Catastrophic Wildfire:** No known patches of *H. todsenii* have been burned, and there is no information on how fire affects this plant. Fire scarring on pinyon pines or

oneseed juniper have not been observed in the populations on WSMR and most populations (n=14) are in areas classified as having a mean fire return interval (MFRI) as 46-50 years (LANDFIRE 2015).

(7) **Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes:** 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 conduct genetic studies and establish garden populations at the Arboretum at Flagstaff in Arizona and the Cincinnati Botanical Garden in Ohio. Monitoring activities should be scheduled and conducted to limit the impacts within the populations, including long intervals between visits to populations and selecting pedestrian routes that limit ground disturbance.

(8) **Disease or Predation:** No disease or predation is presently known to be a threat to *H. todsenii*, although herbivory and nectar consumption by insects (Charles Britt, pers. obs., Tonne 2009) occurs.

(9) **Inadequacy of Existing Regulatory Mechanisms:** Regulatory mechanisms seem adequate at this time, particularly because the populations of *H. todsenii* are in areas either closed to the public or in remote habitats that receive little impact from human-induced threats.

(10) **Reproduction, Dispersal Ability, and Genetic Diversity:** Low genetic diversity has previously been identified as a threat to *H. todsenii* (USFWS 2001). In addition, the rates of viable seed production are generally low, possibly due to inbreeding depression. The continuing inability of *H. todsenii* to produce an abundance of seeds will severely limit its ability to recolonize habitats where populations maybe extirpated or to migrate to new habitats if climate change renders current habitats unsuitable.

(11) **Drought and Climate Change:** Climate change is likely the largest threat to *H. todsenii*. Recent analysis by IPCC (Romero-Lankao *et al*. 2014) indicate that the mean temperature for North America may increase between 2 - 4° C (3.6 – 7.2° F). Heat waves are expected to increase across the Southwestern United States (Gershunov *et al*. 2013). It is unclear how increasing temperatures will impact precipitation. The WSMR populations may be at greater risk than the Sacramento Mountains populations due to: 1) inhabiting areas at lower elevations, 2) occurring in smaller patches, 3) existing at what appears to be the upper elevation extent of available habitat at the local level.

Assessment of Criteria for Recovery

The recovery plan does contain an implementation table of prioritized tasks to recover *H. todsenii*. As of 2011, 11 of the 17 recommended tasks were either implemented or ongoing (USFWS 2011). The status of each task is noted in parentheses). These include:

1. Ensure compliance with laws and regulations (ongoing)
2. Develop and implement management plans to prevent detrimental land use impacts (implemented)
3. Protect populations from disturbance (implemented)
4. Initiate long-term monitoring (ongoing)
5. Study genetic structure of all populations (ongoing, more research required)
6. Study germination requirements (ongoing, more research required)
7. Protect new populations (ongoing)
8. Ensure appropriate personnel are aware of *H. todsenii* (implemented)
9. Study geology and soils (soil collected but not analyzed, research required)
10. Use research results to determine if populations can sustain themselves (ongoing, more research required)
11. Search for more populations (ongoing).

Remaining tasks to be completed at that time included:

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

Tasks from the Recovery Plan that are ongoing, need to be initiated, or need additional work include:

1. Initiate long-term monitoring
2. Study genetic structure of all populations
3. Study germination requirements
4. Protect new populations
5. Study geology and soils
6. Use research results to determine if populations can sustain themselves
7. Search for more populations
8. Study all aspects of reproductive biology
9. Determine growth requirements
10. Assess erosion and take corrective action
11. Study fire effects
12. Establish a working group for agency and public coordination

Progress Update for the Recommended Actions

(1) Field Surveys: Conduct additional surveys in previously unsearched areas based upon a new habitat model. Partner with Mescalero Apache Tribe to conduct searches in suitable habitat located on the Mescalero Apache Reservation in the Sacramento Mountains.

(2) Long-term Monitoring: Monitoring plots have been established at all known population locations. A standardized schedule needs to be established for all populations.

(3) Fire Effects: A study examining the effects of fire on Todsen's pennyroyal has yet to be conducted.

(4) Reproductive Biology Studies: Conduct studies on the reproductive biology of *H. todsenii* including pollination, seed development, and seed dispersal. Only one year of a two-year pollination study was conducted (Tonne 2009). Additional field studies are needed in each mountain range documenting pollinator species and activities should be undertaken with the goal of improving pollination, fertilization, and seed set.

(5) Planning: Long-term monitoring plots have been established at all populations. 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.

(6) Update of Recovery Criteria: There are currently no updates to the recovery criteria. However, a new review by USFWS is currently in progress. Updates should reflect the current number of colonies (populations), results from genetic studies, and the recent status of threats to provide measurable standards by which the species can be quantified in the San Andres and Sacramento Mountains populations.

Recommended Future Tasks for Recovery of Todsen's Pennyroyal

1. Collect pinyon pine/juniper core samples at all populations to examine climatic and fire history.
2. Continue collecting precipitation and temperature data at populations in conjunction to monitoring efforts to examine the response of sexual reproductive effort and vegetative growth to local ambient conditions.
3. Collect genetic samples at all populations to analyze genetic structure across all populations.
4. Use GIS habitat models and expertise to transplant individuals through root division to additional suitable areas.
5. Establish a test plot to examine the impact of fire on *H. todsenii*.
6. Develop a new habitat model to identify additional search areas within the region.
7. Continue conducting searches in suitable habitat in the San Andres Mountains.
8. Conduct additional searches in the Sacramento Mountains on BLM and USFS land.
9. Partner with the Mescalero Apache Tribe to conduct searches on the tribal lands.
10. Update recovery plan to reflect all known populations and research conducted.
11. Fund an analysis of the potential impacts of projected climate change on the long-term viability of Todsen's Pennyroyal in the San Andres and Sacramento Mountains.
12. Study population locality-specific soil characteristics.

Overview of the White Sands Missile Range Endangered Species Management Component

The intent of this Endangered Species Management Component is to:

- Present background information on Todsen's pennyroyal, including ecology, known distribution, and potential habitat;
- Discuss current and potential threats to the species;
- Define overall conservation goals, specific management objectives, and prescribe management actions;

This Endangered Species Management Component (ESMC) is consistent with the WSMR Integrated Natural Resources Management Plan (WSMR 2002) and the Todsen's pennyroyal Recovery Plan and 5-Year Review (USFWS 2001, 2011).

CHAPTER 2 – SPECIES INFORMATION

This section provides a description of Todsen's pennyroyal, including taxonomy and morphology, and information on the known distribution, abundance, habitat characteristics, ecology, life history, and threats to survival of the species in the wild.

Taxonomy and Morphology

Plants found within the genus *Hedeoma* are commonly known as false pennyroyals and are in the mint family, Lamiaceae (Fig. 2-1). Todsen's pennyroyal (*Hedeoma* todsenii Irving 1979) is described in the updated Recovery Plan (USFWS 2001):

> Todsen's pennyroyal is a perennial rhizomatous herb 10 - 20 centimeters (cm) (4 – 8 inches (in)) tall and somewhat woody at the base. The rhizomes are slender and unbranched. The leaves are opposite, 0.8 - 1.5 cm (0.3 - 0.6 in) long, 0.25 - 0.5 cm (0.1 - 0.2 in) wide, lance-shaped, margins smooth, tip rounded to acute, and the lower surface glandular-dotted. The flowers occur singly in the axils of the upper stem leaves. The calyx is 1.3 cm (0.5 in) long and two-lipped; the five calyx teeth are lance-shaped. The corolla is of five united petals, two-lipped, 3.6cm (1.4 in) long, and orange-red to yellow. Yellow-flowered plants are less common but have been seen at several places in the Sacramento Mountains. The corollas of the San Andres Mountains plants are slightly longer than those of the Sacramento Mountains plants (New Mexico Forestry and Resources Conservation Division [NMFRCD] 1991). There are two stamens. The fruits are of four nutlets; usually one or two develop to maturity, but all four may reach maturity (NMFRCD 1992; Huenneke 1993). The oblong lanceolate leaves and long, bright red-orange corolla easily distinguishes Todsen's pennyroyal from other members of the genus (Irving 1979).

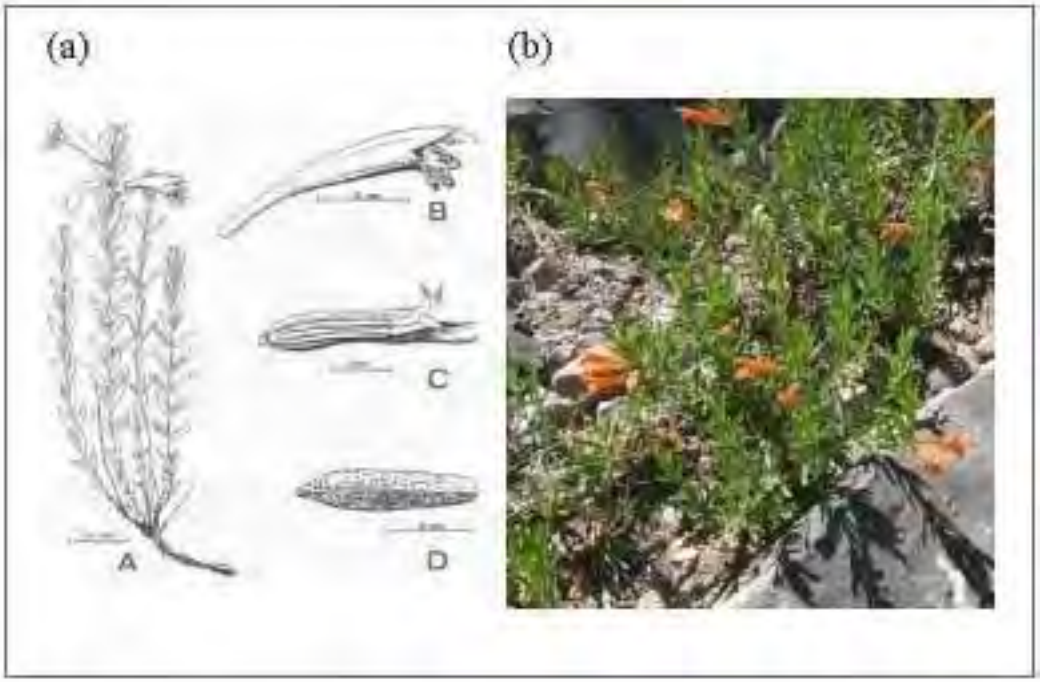

Figure 2-1. Todsen's Pennyroyal morphology (a) and example photo (b).

Discovery and Distribution of Populations

The historic distribution for this species in unknown; however, Sivinski (2009) suggested that it is a Pleistocene relict with a likely larger distribution in the past. There are currently 45 known populations—30 in the Sacramento Mountains and 15 in the San Andres Mountains (Fig. 2-2). Fifteen populations are located on DOD land, 20 on Bureau of Land Management (BLM) land, four on U.S. Forest Service (USFS) land, five shared populations occur between BLM and USFS land, and one on land administered by the New Mexico State Land Trust (Britt 2015, Britt 2018). The populations in the San Andres Mountains are concentrated in the Chalk Hills and Big Gyp Mountain, Sierra County, whereas the populations in the Sacramento Mountains are found on Cat Mountain, and between Mountain Lion Peak and Domingo Peak, Otero County.

San Andres Mountains

The original population (P16), discovered by Dr. Thomas K. Todsen on 18 Aug 1978, was two kilometers south of Hardin Ranch on a steep north-facing gravelly gypseous limestone hillside in open pinyon (Irving 1979). Dr. Thomas Todsen and Dr. Robert Irving discovered a second population (P17) in 1979 approximately 3.3 km south-southeast of P16 (Irving 1980). This population was not relocated until 8 August 2001 (2001a). The fourth known population (P18) was discovered in 1990 by Dr. Richard Spellenberg (New Mexico State University) and Paty Hoban of the United Stated Fish and Wildlife Service (TNC 2001b). In the summer of 2001, three populations (P19 – 21) were found in the Chalk Hills of the San Andres Mountains (TNC 2001a). P19 was discovered on 23-July about 700m southeast of Gyp Gap, P20 was discovered on 28-July 550m east of Grandaddy Peak, and P21 was discovered on 9-August about 900m east-northeast of Gyp Gap. In the summer of 2006, Charles Britt and Carl Lundblad discovered two populations (P22 – 23) on the eastern bajadas of Big Gyp Mountain. In the summer of 2007, Charles Britt and Carl Lundblad discovered one population approximately 1.2 km east of Pilot Knob (P24) and five populations (P25 – 29) on eastern bajadas of the Chalk Hills between Walson Gap/Loma Vista and Pilot Knob. On 13 September 2009, Charles Britt discovered one population (P30) south of population P17, approximately 2.1 km south-southeast of Grandaddy Peak in the Chalk Hills (Britt 2009).

Sacramento Mountains

In August 1988 Mike Howard (BLM) discovered the third known population (P1) on the boundary between BLM and United Stated Forest Service (USFS) land on the north slope of Domingo Peak on the western side of the Sacramento Mountains (T14S, R11W, Sec. 33, NE ¼). Fourteen new populations were discovered in the summer of 1990. Nine of these populations were discovered during fieldwork led by William W. Dunmire of The Nature Conservancy (TNC) (TNC 1990). Members of the team included Mike Howard, Tom Wootten, John Stockert, Melanie Florence, and Zeno Wicks. On 13 July 1990 a new population (P2) was discovered near Domingo Peak (Pk. 7, 204, Sec.28 and 33 (T14S)). Three populations (P3 – 5) were discovered on 14 August in drainages near Domingo Peak (Drainage 1, Sec. 28; Drainage 2, Sec. 28; and NW ¼ of SE ¼, Sec. 28).

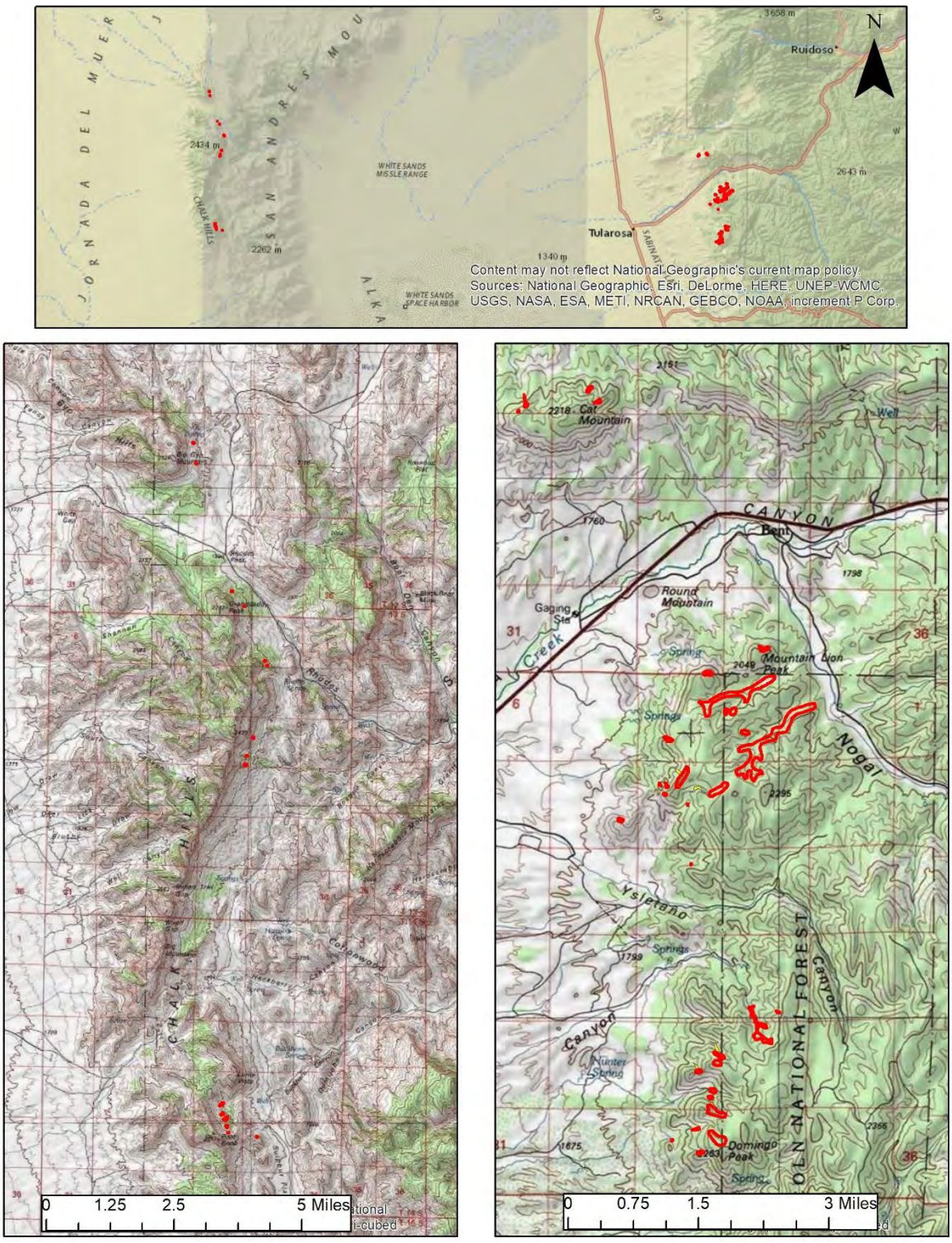

Figure 2-2. Distribution of Todsen's pennyroyal (Hedeoma todsenii) populations across the San Andres and Sacramento Mountains, New Mexico. There are a total of 45 populations; 15 and 30 in each mountain range, respectively.

On 16 August, three populations (P6 – 8) were discovered near Mountain Lion Peak (E ½ Sec. 34; Pk. 7,014, Sec. 33 (T13S); and Mountain Lion Pk., Sec. 34). On 4 September, two new populations (P9 and

10) were discovered (Pk. 7,181, Sec. 9; and Pk. 7,155, Sec. 9). During a separate search effort, Mike Howard and Bob Sivinski discovered an additional population (P11) on BLM land and four populations (P12 – 15) in the Lincoln National Forest (T14S R11E Sec. 3). Fifteen new populations were discovered by Charles Britt in 2017 in three general areas: four on Cat Mountain, seven near Mountain Lion Peak, and four near Domingo Peak (Britt 2018). On Cat Mountain, P42, P43, and P45 are solely on BLM land. P44 is partially located on BLM land; however, the majority of this population is on private land. In the Mountain Lion Peak area, P34 is located on State Land while the remaining new populations (P33, P35 – P37, P40 and P41) are located on BLM land. In the Domingo Peak area, P31 and P32 are located on USFS land, and P38 and P39 are located on BLM land.

Habitat

Topography

The populations in the Sacramento Mountains are generally found at higher elevations (1909 – 2257 m) than those populations located in the San Andres Mountains (1883 – 2095 m) (Table 2-1). None of the populations in the San Andres populations are located above 2100 m elevation, and two populations (P24 and P29) extend below 1900 m elevation. Four populations in the Sacramento Mountains (P2, 3, 7, 11) are found above 2200 m elevation. In the San Andres Mountains, two populations (P24 & P29) occurring between Loma Vista and Pilot Knob are found below 1900 m elevation.

Todsen's pennyroyal populations occur on a wide variety of slope angles, most commonly on slopes approaching or exceeding 30 degrees. Populations in the Sacramento Mountains exhibit a wider range of slope within a given population than those found in the San Andres Mountains. Six of the populations in the Sacramento Mountains have slopes as much as 40 degrees. Twelve of the 15 populations have some portion of the population that occur in areas with low slope (10 degrees or less). Three populations in the Sacramento Mountains have portions occurring along the bottom (no slope) of long drainages. Only the two populations (P22, 23) on the east side of Big Gyp Mountain in the San Andres Mountains have a portion of the populations with a slope of less than 10 degrees. Aspect is generally in a northerly direction, extending towards the northwest, northeast, or both, depending on the population. For example, populations in the Sacramento Mountains are often found in areas with aspects shifting from northwest to northeast whereas populations in the San Andres Mountains generally occur only on north facing slopes and may extend either northwest or northeast—but not both (Fig. 2-3, Photo 2-1).

Geology

All fifteen populations of Todsen's pennyroyal located in the San Andres Mountains occur on outcrops of gypseous strata of the Yeso Formation. Twenty-five populations located in the Sacramento Mountains occur on outcrops of gypseous strata of the Yeso Formation. Five of the populations (P10 & P13) are on the San Andres Formation, located above the Yeso Formation in elevation; however, these populations occur on the edge of the Yeso Formation and thus are likely influenced by this formation as well. It should also be noted that the resolution of the geologic map may have resulted in some inaccuracy. The Yeso Formation was formed in the Permian Period when increasing aridity and withdrawing seas led to the deposition of shallow-water carbonates, red beds and gypsiferous evaporates. Most of these evaporates are found in the Yeso Formation. The amount of gypsum content in this formation thickens northeastward into the Carrizozo Basin. Kottlowski (1956) observed a northward increase in gypsum content in the Yeso Formation and an overall increase in formation thickness from south to north in the San Andres Mountains.

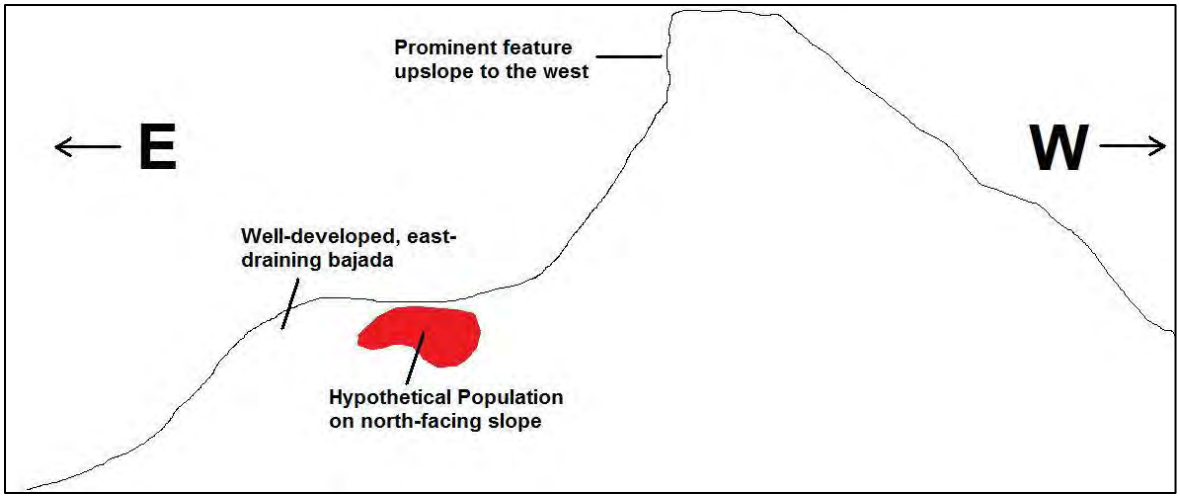

Figure 2-3. Typical landform for Hedeoma todsenii sites in the San Andres Mountains (Britt 2009).

Photo 2-1. Todsen's pennyroyal habitat in the San Andres Mountains.

Soils

Six of the 15 populations (P17-18, P21, P23-24, P30) in the San Andres Mountains are located on soils described as (838) Tanbark-Winona-Tulargo complex, 0 to 60 percent slopes (NRCS 2014). However, five of those are on the edge of (926) Ildecarb very gravelly loam, 0 to 25 percent slopes. Five populations (P25-29) are found on soil complexes described as (914) Deama-Rock outcrop complex, 30 to 90 percent slopes. Two populations (P19 & P22) are found on soils described as (926) Ildecarb very gravelly loam, 0

to 25 percent slopes. One of these is on the edge of (838) Tanbark-Winona-Tulargo complex, 0 to 60 percent slopes. Two populations (P16 & P24) are found on the soil complex described as (924) Deama-Penagua-Rock outcrop complex, 35 to 90 percent slopes. These are on the edge of (838) Tanbark-Winona-Tulargo complex, 0 to 60 percent slopes. The populations in the Sacramento Mountains are located on Deama-Rock outcrop-Holloman variant complex, 15 to 65 percent slopes, or Aztec-Rock outcrop-Lozier complex, 20 to 65 percent slopes.

Vegetation

The San Andres Mountains populations are in the Chihuahuan Desert level 3 ecoregion. The Chihuahuan Desert Ecoregion is dominated by Chihuahuan semi-desert grasslands and desert scrub vegetation (Bell *et al*. 2004). This desert ecoregion extends from the Madrean Archipelago (79) in southeast Arizona to the Edwards Plateau (30) in south-central Texas (Griffith *et al*. 2009). The physiography is generally a continuation of basin and range terrain that is typical of the Mojave Basin and Range (14) and the Central Basin and Range (13) ecoregions to the west and north—although the pattern of alternating mountains and valleys is not as pronounced as it is in Ecoregions 13 and 14. The mountain ranges (sky islands) are a geologic mix of Tertiary volcanic and intrusive granitic rocks, Paleozoic sedimentary layers, and some Precambrian granitic plutonic rocks. Outside the major river drainages, such as the Rio Grande and Pecos River, the landscape is largely internally drained. Vegetative cover is predominantly desert grassland and arid shrubland, except for high elevation islands of oak, juniper, and pinyon pine woodland. The extent of desert shrubland is increasing across lowlands and mountain foothills due to gradual desertification caused in part by historical grazing pressure. These populations are located within the Chihuahuan Montane Woodlands level 4 ecoregion. The Chihuahuan Montane Woodlands ecoregion comprises the higher elevation mountainous areas, generally above 5000 or 6000 ft (1500 m – 1830 m). These areas include the Chisos, Davis, Glass, and Apache Mountains of Texas and the Organ, Florida, San Andres, and Oscura Mountains of New Mexico. Increased precipitation in the mountains supports woodland areas except on sunny, exposed slopes that may have grass and chaparral only. Oaks, junipers, and pinyon pines predominate on all these mountain ranges. At lower elevations they occur in canyons and shaded hollows, and, with increasing elevation and moisture levels, form more dense woodlands. Coniferous forests are limited in extent: some ponderosa pine, southwestern white pine, and relict Douglas-fir grow at the highest elevations in a few areas. In these higher ranges, trees sometimes grow with a grassy understory, or with a brush cover of bigtooth maple, madrone, little walnut, oak chaparral, and grapevines.

The Sacramento Mountains populations are in the Arizona/New Mexico level 3 ecoregion. The Arizona-New Mexico Mountains Ecoregion encompasses the highlands of eastern Arizona and central and western New Mexico, encompassing 29 million ac (12 million ha) of land (Bell *et al*. 1999). The Arizona/New Mexico Mountains are distinguished from neighboring mountainous ecoregions by their lower elevations and associated vegetation indicative of drier, warmer environments, due in part to the region's more southerly location (Griffith et al. 2009). Many ranges are composed of Precambrian igneous rocks and once active volcanoes. This diverse physiographic region has elevations ranging from 4,500 ft (1,371 m) to 12,600 ft (3,840 m) and contains steep foothills, mountains, and plateaus rising above the surrounding desert grasslands and shrublands. Forests of spruce, fir, and Douglas-fir are only found in limited areas at the highest elevations in this region. Chaparral is common at lower elevations in some areas, pinyon-juniper and oak woodlands are found at lower and middle elevations, and the higher elevations are mostly covered with open to dense ponderosa pine forests.

The Sacramento Mountains populations are located within the Madrean Lower Montane Woodlands level 4 ecoregion. The Madrean Lower Montane Woodlands ecoregion covers the slopes of the

Guadalupe, Sacramento, Mimbres, Big Burro, and Mogollon Mountains, generally between 5500 (1670 m) to 7200 feet (2190 m), with densities of juniper, pinyon pine, and oak varying according to aspect. This ecoregion has milder winters, wetter summers, and inclusions of alligator juniper and Madrean evergreen oak species. At middle elevations, dense thickets of shrubs such as desert ceanothus, alderleaf mountain mahogany, and catclaw mimosa form chaparral communities. Other areas are grassy and park-like with scattered trees. There are a few small outlier areas of ponderosa pine, Douglas-fir, or southwestern white pine at the highest elevations.

All of the populations in the San Andres and Sacramento Mountains are found in the Madrean Pinyon-Juniper Woodland (Lowry *et al*. 2007). This system occurs on foothills, mountains and plateaus in the Sierra Madre Occidentale and Sierra Madre Orientale in Mexico, Trans-Pecos Texas, southern New Mexico and Arizona, generally south of the Mogollon Rim. Substrates are variable, but soils are generally dry and rocky. The presence of Mexican pinyon (*Pinus cembroides)*, border pinyon (*Pinus discolor)*, or other Madrean trees and shrubs is diagnostic of this woodland system. Redberry juniper (*Juniperus coahuilensis)*, alligator juniper (*Juniperus deppeana)*, Pinchot juniper (*Juniperus pinchotii)*, one-seed juniper (*Juniperus monosperma)*, and/or pinyon pine (*Pinus edulis)* may be present to dominant. Madrean oaks such as Arizona white oak (*Quercus arizonica)*, Emory oak (*Quercus emoryi)*, gray oak (*Quercus grisea)*, or Mohr oak (*Quercus mohriana)* may be codominant. Ponderosa pine (*Pinus ponderosa)* is absent or sparse. If present, understory layers are variable and may be dominated by shrubs or graminoids.

Vegetation communities are dominated by *Pinus* edulis and *Juniperus spp.* (generally, *Juniperus monosperma* but *Juniperus deppeana* as well). In the Sacramento Mountains, there is a lower elevation relict stand of ponderosa pine (*Pinus ponderosa)* and Douglas fir (*Psuedostuga menzesii*) in population P11 and *P. ponderosa* at P32. Dominant shrubs vary, but alderleaf mountain mahogany (*Cercocarpus montanus)*, desert ceanothus (*Ceanothus greggii)*, banana yucca (*Yucca baccata)*, *Ephedra spp.*, horsebrush (*Tetradymia filifolia*), and wavyleaf oak (*Quercus undulata)* are common shrubs. Spathleaf rabbitbrush (*Chrysothamnus spathulatus)*, skunkbush sumac (*Rhus trilobata)*, and littleleaf mock-orange (*Philadelphus microphyllus)* are commonly found in the Sacramento Mountains populations and featherplume (*Dalea Formosa*) in the San Andres populations. Plumed brickellbush (*Brickellia brachyphylla)* and *Thelosperma sp.* are common forbs. Drummond's onion (*Allium drummondii)* is common in the Sacramento Mountains and *Machaeranthera spp.* in the San Andres Mountains. Common grasses include few-flowered muhly (*Muhlenbergia pauciflora)* and *Achnatherum* (*Stipa*) *spp*.

Population Size and Density

Population size varies greatly in both mountain ranges. The populations in the San Andres (P16 – P30) were measured using a more accurate method—GPS points taken along the flagged perimeter—versus the visual estimates and hand-drawn extents on topographic maps for the populations occurring in the Sacramento Mountains (P1 – P15). Recently discovered populations in the Sacramento Mountains (P31 – P45), however, were mapped using GPS. In general, the estimated areal extents of the *H. todsenii* populations are much larger in the Sacramento Mountains (mean = 19,300 m^2 [4.8 ac]) than in the San Andres Mountains (mean = 1,399 m^2 [0.34 ac]). The median size is 6,750 m^2 (1.7 ac) for populations in the Sacramento Mountains and 793 m^2 (0.2 ac) in the San Andres Mountains. The size estimates for the populations in the San Andres Mountains range from 387 m^2 (0.10 ac) to 4942 m^2 (1.22 ac) while populations in the Sacramento Mountains vary more in size: 194 m^2 (0.05 ac) to approximately 202,343 m^2 (50.0 ac). There is an overall estimate of between several hundred thousand to several million individuals across these populations. The largest populations in the San Andres Mountains are P27

(4,942 m^2) and P29 (4,406 m^2); both are in the cluster of populations between Loma Vista and Pilot Knob in the Chalk Hills. These are approximately the same size as the medium-sized populations in the Sacramento Mountains.

Table 2-1. Topographical characteristics of the 45 Hedeoma todsenii populations located in the Sacramento and San Andres Mountains, New Mexico.

Sacramento Mountains				San Andres Mountains			
Popula-tion	Elev (m)	Slope (deg)	Aspect	Popula-tion	Elev (m)	Slope (deg)	Aspect
P01	2094 - 2140	16 - 38	NW	P16	2037 - 2056	15 - 29	N-NW
P02	2182 - 2257	2 - 34	NW-N-NE	P17	2021 - 2043	24 - 29	N-NE
P03	2088 - 2219	6 - 40	N-NW	P18	2057 - 2095	26 - 33	N-NE
P04	2027 - 2058	12 - 32	N-NW	P19	2052 - 2069	12 - 30	N-NE
P05	2022 - 2064	5 - 40	N-NW	P20	2031 - 2044	10 - 29	N
P06	2118 - 2145	1 - 35	N	P21	2072 - 2094	15 - 29	NE
P07	2181 - 2219	6 - 29	N	P22	2037 - 2051	8 - 28	N-NE
P08	2128 - 2182	10 - 41	NE	P23	2072 - 2088	4 - 29	N
P09	2156 - 2216	2 - 35	NW	P24	1883 - 1904	25 - 33	N-NW
P10	2109 - 2185	11 - 42	N-NW	P25	1989 - 2001	20 - 28	N
P11	1920 - 2206	1 - 42	NW-N-NE	P26	1956 - 1982	17 - 29	N-NW
P12	2077 - 2106	4 - 31	N	P27	1914 - 1968	11 - 34	N-NW
P13	1909 - 2145	1 - 37	NW-E	P28	1919 - 1954	18 - 33	N-NW
P14	2084 - 2139	7 - 42	NW-N-NE	P29	1884 - 1920	12 - 32	N-NW
P15	1977 - 2014	4 - 39	NW-N-NE	P30	2022 - 2043	22 - 32	N
P31	2186-2245	31-38	NW				
P32	2049-2236	2-41	W-N-E				
P33	2031-2037	15-27	W-NW				
P34	1962-1983	31-33	N				
P35	1914-1971	35-43	W-NW				
P36	1997-2019	20-33	W-NW-N				
P37	2030-2082	24-42	NW-N				
P38	1934-1958	35-38	NW-N				
P39	2054-2075	21-37	NW-N				
P40	2061-2107	31-40	W-NW				
P41	1991-2084	14-41	W-NW-N				
P42	2062-2086	23-30	N				
P43	1943-2080	19-42	NW-N-NE				
P44	2020-2080	33-44	NW-N				
P45	2093-2144	10-40	N-NE-E				

Population densities for populations in the San Andres Mountains vary between years and between populations within a given year (Table 2-2). For populations monitored in the San Andres mountains from 2006 to 2017 (Sikula 2009), densities at the monitoring plots showed no apparent overall trend; however, the two populations on Big Gyp Mountain and four populations near Grandaddy Peak exhibited a decline in density. Two of the three populations near Big Gyp increased clump density. The

six populations near Loma Vista were variable. Changes in stem density across populations over time were also quite variable as well (Fig. 2-4).

Plant densities in the populations monitored by Sivinski (2009) in the Sacramento Mountains were much higher than densities reported for populations in the San Andres Mountains (Table 2-3). There was a high degree of variability across all monitoring plots in the Sacramento populations. Declines in clump density were observed in 3 of the 4 populations.

Reproduction and Growth

Flowering

Sexual reproductive effort occurs during two general periods: late April – June and August – September, and possibly early October (Britt 2017, Sivinski 2009; Figs. 2-5 & 2-6). In general, very little flowering occurs during July. The amount of effort during this bi-modal reproductive effort varies, likely as a result of the timing and amount of annual precipitation at the local level. Given enough winter/spring precipitation as well as monsoonal rain, populations can flower during both reproductive periods. Monitoring in the Sacramento Mountains noted a large degree of fluctuation across years and variability between plots. In 1994 there were low flowering rates across plots. In the San Andres Mountains, the number of flowers present in monitoring plots appeared to be extremely low in 2006. There was a general decline from 2009 to 2012, followed by an increase in 2014; however, given the better understanding we have regarding the seasonal shifts in flowering effort, previous monitoring efforts likely missed some reproductive effort due to single monitoring efforts and inconsistent timing of visits across years.

Pollination

Britt (2009, 2012) noted broad-tailed hummingbirds (*Selasphorus platycercus*) pollinating plants in the San Andres populations. There were only a few of such observations, however, so perhaps the general lack of flowering plants near and in populations accounted for this paucity. An apparent important nectar food plant being utilized by hummingbirds in the Chalk Hills was rock sage (*Salvia pinguifolia)*. Tonne (2009) and Britt (2018) also noted that the primary pollinator in populations monitored in the Sacramento Mountains was the broad-tailed hummingbird, which rarely visited other flowering plants. The broad-tailed hummingbird breeds in mountains throughout the interior western United States, including New Mexico, where it breeds in mountain ranges nearly statewide—mainly above 6,000 feet (Parmeter *et al*. 2002). Britt (2012) observed that many calyces had puncture holes in the sides. This suggests either nectar predation or some sort of parasitism. Tonne (2009) observed two species of wasp robbing nectar by piercing the base of the calyx and corolla. He noted more sepal and corolla damage in 33% of flowers collected in the San Andres versus 4% in the Sacramento Mountains. Huenneke (1993) experimented with hand pollination on the Sacramento Mountains population. Only the self-pollinated within patch, and between adjacent patch, pollinations produced any seed. The between population pollinations did not produce any seed.

Table 2-2. Individual clump densities of Todsen's Pennyroyal at population monitoring plots and random quadrats in the San Andres Mountains. There were general density declines between 2006 and 2012 and an increase in 2014.

Popul-ation	Plots (Ind/m^2)								Quadrats (Ind/m^2)	
	2006	2007	2009	2012	2014	2015	2016	2017	2009	2012
P16	9.4	8.4		1	1	1	1.6			
P17			0.8	0.2		0.2	0.2		2.8	1.8
P18	4.6		5.2	4.2		2.8	6.8		6.4	1.8
P19	2.2			10.2	12	10.8	19.6			3
P20	1.4			0.2		0.4	0.6			0
P21	3.2	3.8		2.8		2	3	2		0
P22		4.4	7.8	2.4		2	1.8	2	4.8	0.8
P23		3.2		1.4	2.2	2	1.8			0.4
P24			5.2	1			1		3.2	0.2
P25			5.8	6.6		5	8		8.2	4.4
P26			7	4.6	3.8		6.2		10.6	4
P27				3			1.6	1.8		1.4
P28				8.8		3	4.2	3.2		4.2
P29				2.2	1.8	2	2.2			0.8
P30				1.8		0.6	1	1		1.2
Mean				3.36			3.97			1.71
SD				3.04			4.94			1.57
Max				10.20			19.60			4.40
Min				0.20			0.20	0.00	2.80	0.00

Table 2-3. Plot densities for populations occurring in the Sacramento Mountains (Sivinski 2009). Densities varied across plots and within plots across years. Densities were stable from 1991 – 1994 and exhibited declines in 1995 and 2009.

Plots	Plots (Ind/m^2)					
	1991	1992	1993	1994	1995	2009
HT1	22.75	27.75	26.5	27.25	22.5	12.5
HT2	40.75	38	42.5	34	30.75	
HT3	13.75	13.5	12.5	12.5	11	5.75
HT4	20.75	17.5	20.5	20	17.25	
HT5	12	10.5	13.5	12.75	11.5	21.5
HT6	14.5	13.5	16	15.75	12.75	11.75
Mean	20.75	20.13	21.92	20.38	17.63	12.88
SD	10.66	10.63	11.32	8.66	7.76	6.50
Max	40.75	38.00	42.50	34.00	30.75	21.50
Min	12.00	10.50	12.50	12.50	11.00	5.75

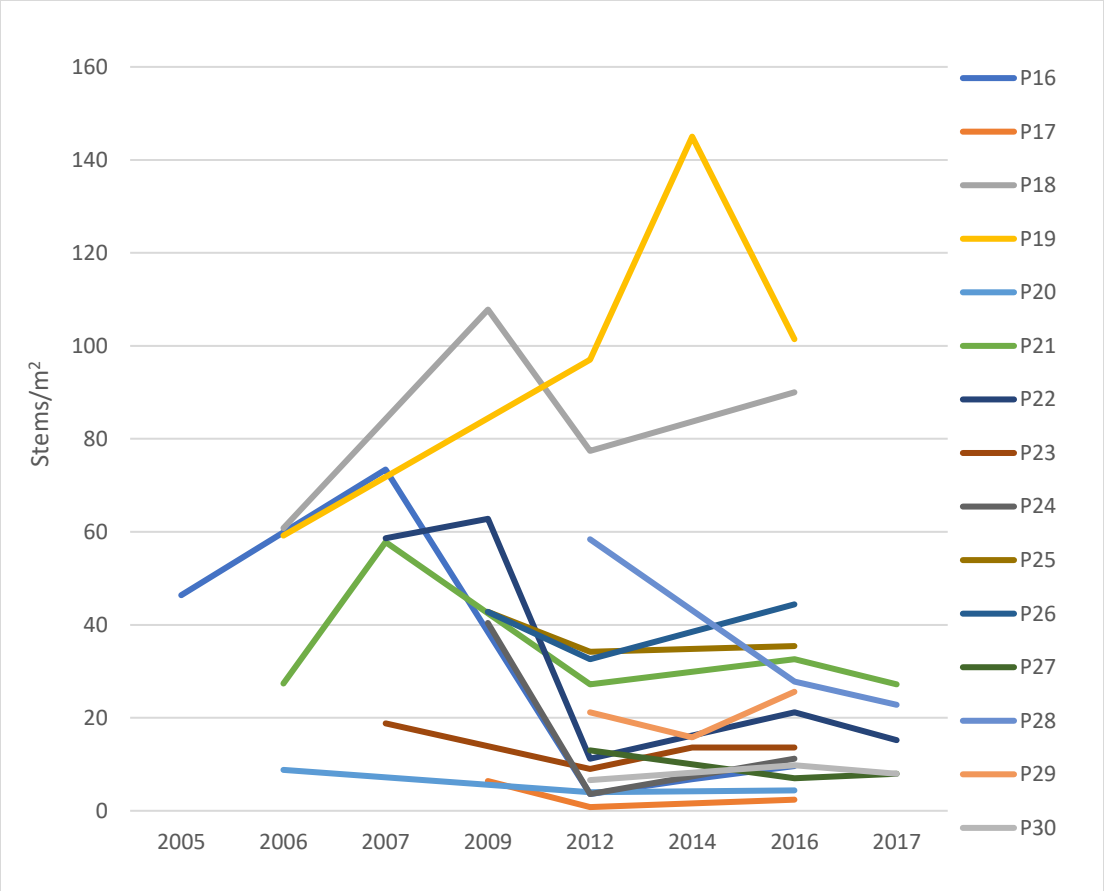

Figure 2-4. Stem density at long-term monitoring plots on White Sands Missile Range.

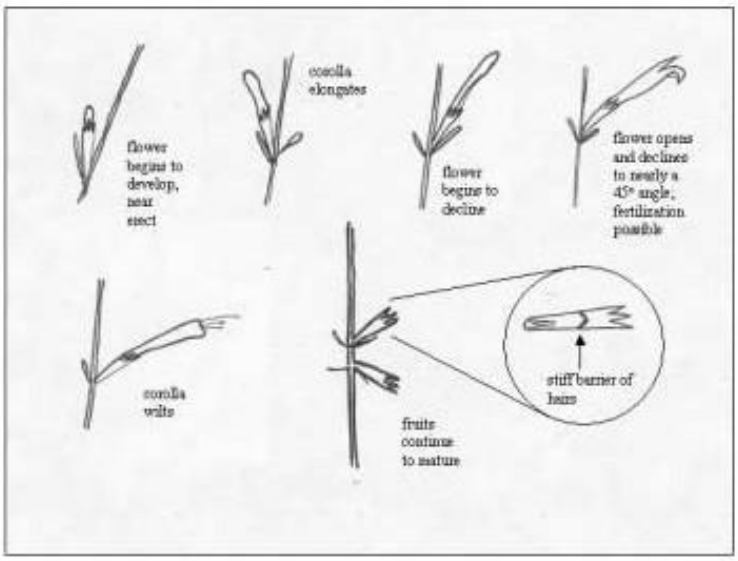

Figure 2-5. Stages of flower and fruit development in Todsen's pennyroyal.

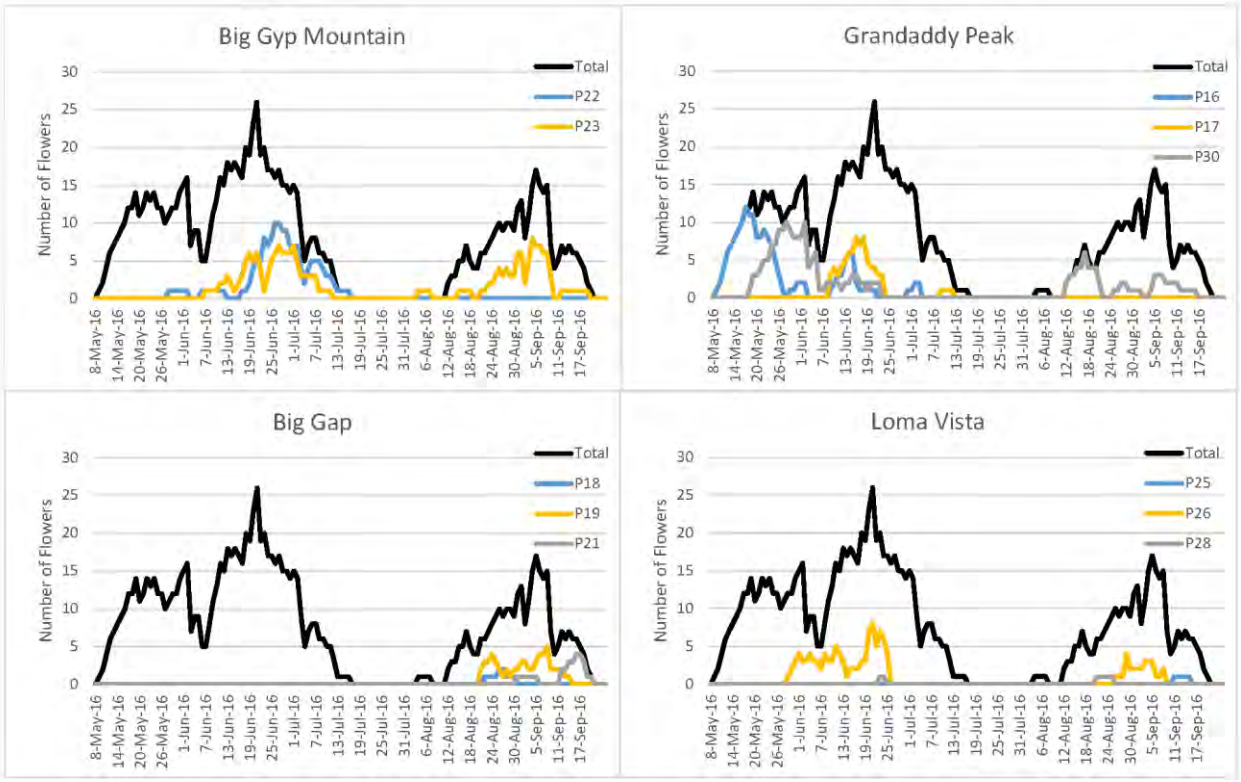

Figure 2-6. Number of flowers observed daily from camera stationed at populations. There is a general bi-modal reproductive effort. The Total indicates the total number of flowers captured on camera across all 15 populations in the San Andres

Seed *Viability*

Overall sexual reproductive output for this species is considered to be very low (USFWS 2011). In 2009, the percent of flowers producing viable fruit ranged from 0 to less than 5% (Sikula 2009); however, only one population was observed to be above 0.5%. Britt (2012) reported a continuing decline in the proportion of flowers with fruit when compared to earlier monitoring from 2007 and 2009 (Sikula). Eight of the 12 populations monitored produced no fruit at the time of the monitoring visits. Of the six monitored by Sikula (2009), three experienced a decline in reproductive output in 2012; two populations produced no fruit in 2009 and 2012; and one experienced a negligible increase in fruit production. Monitoring data collected by Sivinski (2009) indicates a very low level of seed set (Fig. 2-7), but the percent of individuals with fruit is much higher than noted by Sikula (2009) for populations monitored in the San Andres Mountains. Sivinski (2009) examined the number of nutlets per flower. Most flowers contained a single nutlet. Very few contained the maximum of four nutlets.

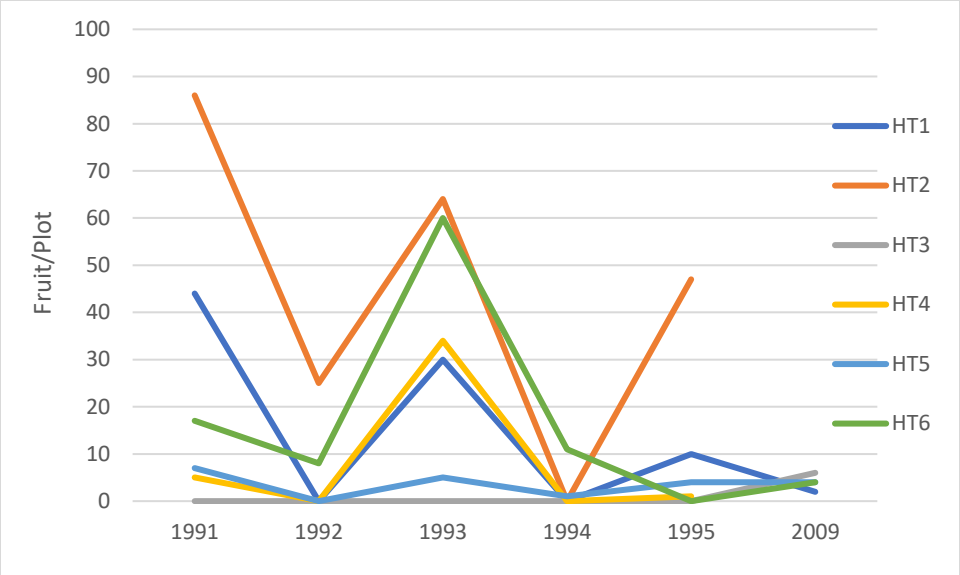

Figure 2-7. Number of fruits produced per plot in monitoring plots located in the Sacramento Mountains. There is a large degree of fluctuation between years.

From Sivinski (2009):

> Fruits develop 4 6 weeks after anthesis. Field observations indicate that the calyces retain the nutlets and are dispersed as a unit. After dispersal, the seeds become mucilaginous when they are moistened, which would allow them to adhere to the soil. About half way down the length of the calyx tube, a series of stiff hairs extend inward and upward from the walls of the calyx and form a cone whose point is aligned toward the mouth of the calyx. These hairs form a convex barrier that retains the nutlets within the calyx and may prevent the entry of some insects, which prey upon the seeds. Despite this barrier, a few fertile ovaries were observed to be eaten by some unknown insect. Flowers that were preyed upon had a hole chewed through the base of the calyx that appeared to be an emergence hole. Therefore, each infected flower probably received the insect egg while it was in bloom and the ovary was accessible through the corolla tube.

In laboratory germination attempts, only one out of 20 seeds germinated under conditions that have been used successfully for other Hedeoma species (Irving, 1980). Twenty-four seeds were collected from the Sacramento Mountain population in 1992 for a viability test. They were soaked in tetrazolium chloride for twenty-four hours and then dissected. Sixteen were found to be empty and only eight had endosperm. All eight of the filled seed had stained, viable embryos. Sheila Murray at the Flagstaff Arboretum (pers. comm.) noted that plants would flower in the greenhouse at the Flagstaff Arboretum, but never set seed. Murray noted that they propagate very easily by root divisions.

Vegetative growth

H. todsenii is a strongly rhizomatous species (Sivinski 2009)(Fig 2-8). Rhizomatous, asexual recruitment appears to be the most common form of reproduction. In fact, Sivinski notes that each of the populations could hypothetically be made up of a single individual plant cloning itself by vegetative reproduction from rhizomes. These rhizomes are often quite shallow, extending out from the plant in a near spider web pattern beneath the surface, thus forming a patch of individual clumps of plants. Britt (pers. obs.) noted two clumps attached by a single rhizome measuring approximately 50 cm.

Individual clumps tend to initiate new basal growth in the form of stem rosettes following the reproductive season (Britt 2014) (Fig. 2-9). In the San Andres Mountains, substantial growth was observed in the month of November. Following this month, the previous leaves then fell off as winter progressed. The basal rosettes persisted through winter and began to lengthen in March. The number of stems varies across years, likely as a response to fluctuations in precipitation.

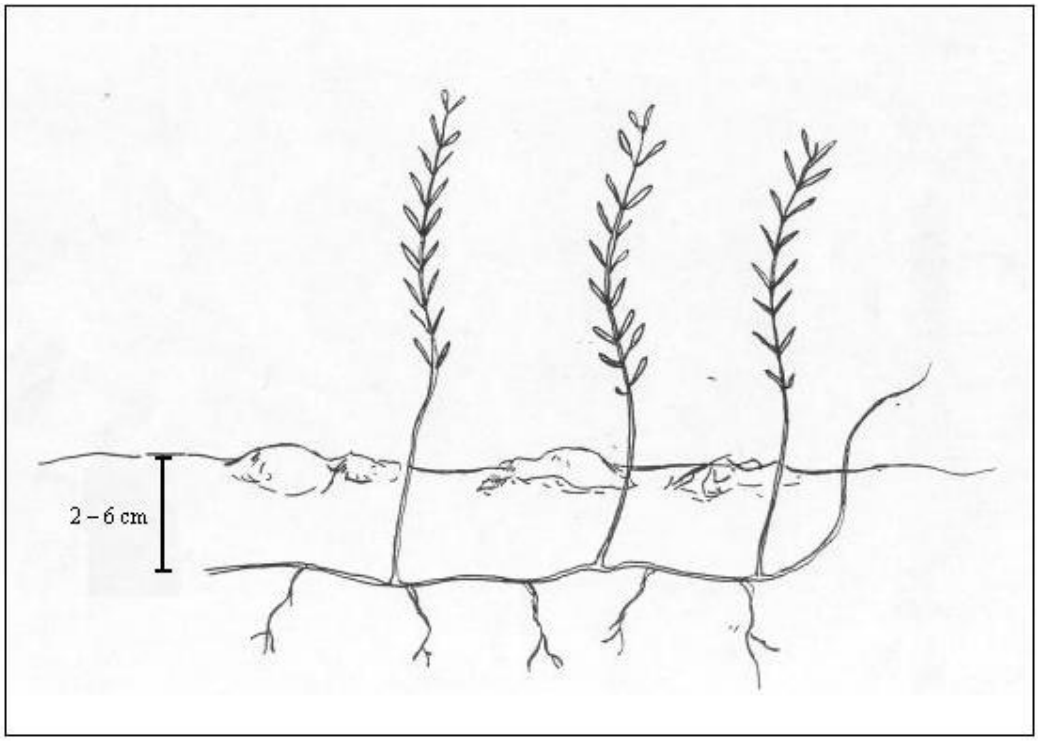

Figure 2-8. Sketch of the belowground root and rhizome structure of Todsen's pennyroyal.

Genetics

Several studies have been conducted examining the genetic diversity of this species across its known distribution. Pence *et al*. (2009) examined a limited set of genetic samples from the populations in the Sacramento Mountains. Even with this limited dataset (12 lines), their analysis found evidence of less diversity within populations and more diversity between populations. However, inter-population diversity was still determined to be low.

Bailey and Donmez (2011) analyzed 43 DNA lines extracted from populations in the San Andres and Sacramento Mountains. They also found more diversity between populations than between individuals within populations. Similar to what Pence *et al*. (2009) observed, there was little overall genetic diversity—likely due to low levels of sexual reproduction. Some samples from the populations in the San Andres and Sacramento Mountains show only slight segregation, suggesting genetic changes in some of the populations in the Sacramento Mountains.

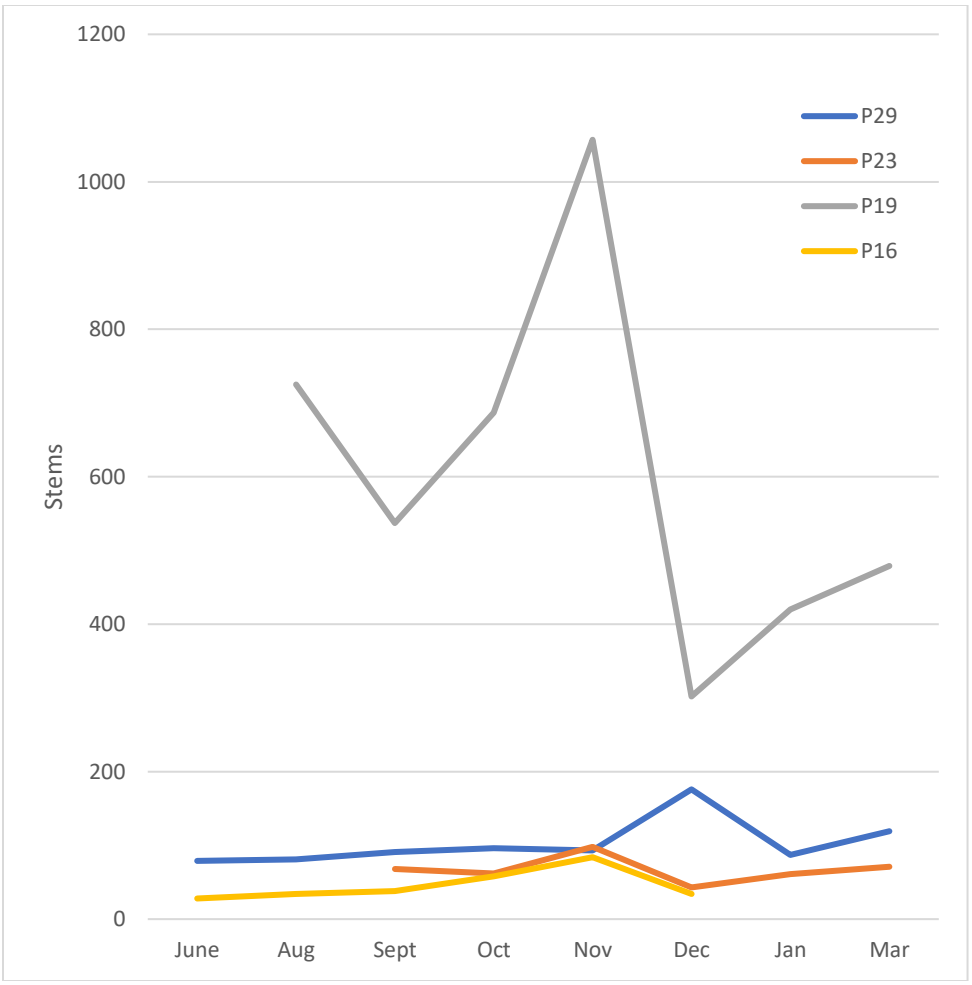

Figure 2-9. Number of stems with leaves present in monitoring plots in the San Andres Mountains. Clumps tend to have new basal growth following the end of the reproductive period. In 2014, this occurred in the month of November.

Donmez *et al*. (2014) analyzed 125 samples: 87 collected from WSMR in 2012 and 38 collected from WSMR and Lincoln National Forest (LNF) between 1998-2009. All samples were from four populations—two from WSMR and two from LNF. They found a substantial amount of genetic diversity in all populations. However, they found no correlation between genetic and geographic distances. The PCA results did suggest that populations separate among sites and throughout time. In addition, there may be the possibility of subpopulation structure.

Philpott and Pence (2018) examined genetic diversity from 3 populations from WSMR and 1 population from LNF. Results suggest substantial inbreeding within populations while still maintaining high levels of genetic diversity within populations. In addition, there is a high level of heterozygosity between populations as well. The populations on WSMR are genetically distinct from each other and the population sampled in LNF is genetically very different from the WSMR populations (Fig 2-10). While inbreeding is likely to occur, there appears to be a surprisingly high level of genetic diversity maintained and a high level of differentiation between LNF populations and between populations found in the San Andres and Sacramento Mountains.

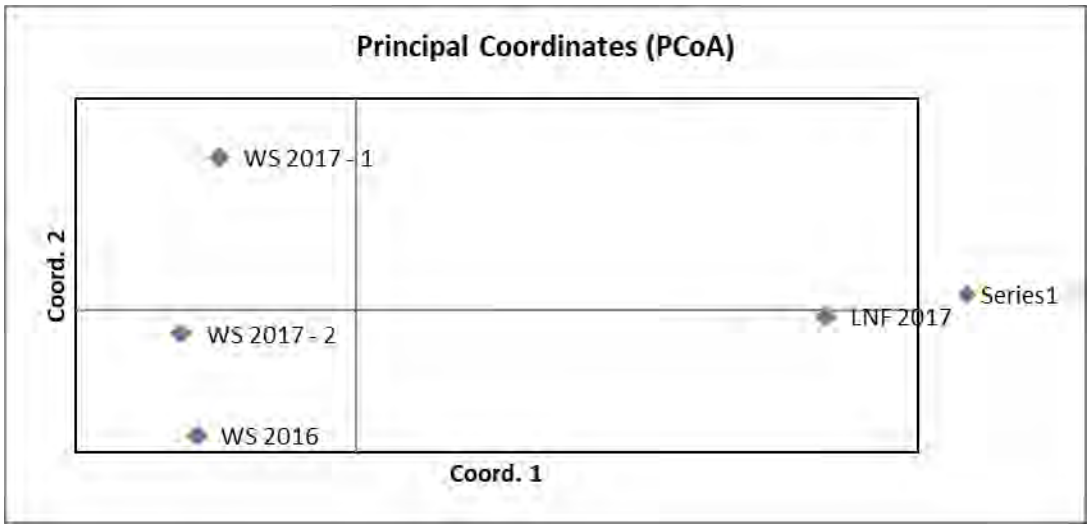

Figure 2-10. Principal coordinates analysis of the four sampled populations, based on Nei's genetic distance (D). From Philpott and Pence 2018.

Assessment of Threats to Survival

(1) **Human Disturbance:** All *H. todsenii* populations occur in rugged and remote areas with low potential for human disturbance outside of monitoring activities.

(2) **Erosion:** Natural erosion may occur due to steep topography and loose, gravelly substrates. However, most disturbance that might lead to erosion is likely to come from frequent, repeated monitoring.

(3) **Grazing:** WSMR is not open to cattle grazing, but trespass (feral) cattle occur at times (Sikula et al. 2007). Oryx may also cross occupied habitat; however, the impact of cattle or oryx does not appear to threaten the species on WSMR.

(4) **Military Activities:** The current 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. The prevailing land use in and around the WSMR populations is for fly-over, training (including chaff, flares, and live-fire air-to-air activities) at Yonder Air Space, and the possible impact of military weapons being tested there, which could cause impact-related wildfires. It is possible that current training and testing may have small, limited impacts on individuals within populations. The potential for live ammunition to hit individuals is low and any fires caused by training or weapon testing are unlikely to create a catastrophic wildlife due to a lack of fine fuel and vegetation spacing (USFWS 2009, D. Anderson 2014, pers. comm.). The NEPA review process in the Environmental Division of the Department of Public Works assures that all proposed actions are screened for potential affects to threatened and endangered species.

(5) **Tree Encroachment:** Substantial increases in cover and extent of pnyon-juniper woodlands in New Mexico have taken place within the last 150 years (Laycock 1999). Most *H. todsenii* populations occur within pinyon-juniper woodlands. The populations in the Sacramento Mountains occur in a pinyon-juniper woodland habitat with a higher density of trees and shrubs than populations located in the San Andres Mountains (LANDFIRE 2015). It is unknown what impact additional shade has on reproduction; however, increased tree density may put populations at risk to wildfire.

(6) **Fire Suppression and Catastrophic Wildfire:** No known patches of *H. todsenii* have been burned, and there is no information on how fire affects this plant. Fire scarring on pinyon pines or

oneseed juniper have not been observed in the populations on WSMR, and most populations (n = 14) are in areas classified as having a MFRI as 46-50 years (LANDFIRE 2015).

(7) **Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes:** 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 conduct genetic studies and establish garden populations at the Arboretum at Flagstaff in Arizona and the Cincinnati Botanical Garden in Ohio. Monitoring activities are scheduled such that there are at least three years between monitoring at a given population, limiting the impacts within the populations. In addition, pedestrian routes to access the monitoring plots are selected to limit within population ground disturbance.

(8) **Disease or Predation:** No disease or predation is presently known to be a threat to *H. todsenii*. Although herbivory and nectar predation from insects (Charles Britt, pers. obs., Tonne 2009) occurs.

Photo 2-2. Apparent herbivory on a leaf, to the left of the flower, at a population in the San Andres Mountains in 2014. There have been several instances of similar types of herbivory across the population in this region.

(9) **Inadequacy of Existing Regulatory Mechanisms:** Todsen's pennyroyal is currently known to primarily occur on Federally administered lands; one population occurs on land administered by the State of New Mexico Land Office. Regulatory mechanisms to protect endangered species include:

- Federal Endangered Species Act (ESA) of 1973. The ESA provides for the identification, listing, and protection of both threatened and endangered species and their habitats, and makes the taking of an animal or plant on the endangered or threatened species list illegal. Delivering, receiving, selling, purchasing, or transporting a threatened or endangered animal species is prohibited without a permit, whether the species is alive or dead. Section 7 of the ESA requires all Federal agencies to carry out programs for the conservation of threatened and endangered species and to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of

any threatened or endangered species or result in the destruction or adverse modification of critical habitat.

- National Environmental Policy Act (NEPA) compliance requires that every proposed action undergoes environmental review that assesses potential effects to threatened or endangered species. If a "no affect" determination can't be made, then a consultation with USFWS will be initiated.
- Sikes Act compliance requires each installation, including WSMR, to write and implement an Integrated Natural Resources Management Plan for "the conservation and rehabilitation of natural resources." This has been established with the current INCRMP (2015).
- DoDI 4715.03 includes a biodiversity directive to *maintain or reestablish viable populations of native species on an installation, when practical*.
- Army Regulation (AR) 200-1, also directs installations to take necessary and thorough steps to develop and implement plans to protect federal and state threatened and endangered species and their critical habitat (see above for details).
- The Endangered Plant Species Act of 1985 (New Mexico). This Act is administered by the Forestry Division of the Energy, Minerals and Natural Resources Department. Species are listed or considered proposed under the provisions of the Federal Endangered Species Act, or is a rare plant across its range within the state, and of such limited distribution and population size that unregulated taking could adversely impact it and jeopardize its survival in New Mexico. The taking of listed species is prohibited without a permit.

Regulatory mechanisms seem adequate at this time, as long as agencies work towards the recovery of the species.

(10) **Reproduction, Dispersal Ability, and Genetic Diversity:** Low genetic diversity has previously been identified as a threat to *H. todsenii* (USFWS 2001). In addition, the rates of viable seed production are generally low, possibly due to inbreeding depression. The continuing inability of *H. todsenii* to produce an abundance of seeds will severely limit its ability to recolonize habitats where populations maybe extirpated or to migrate to new habitats if climate change renders current habitats unsuitable.

(11) **Drought and Climate Change:** Climate change is likely the largest threat to Todsen's pennyoryal. Recent analysis by IPCC (Romero-LanKao et al. 2014) indicate that the mean temperature for North America may increase between 2 - 4° C (3.6 – 7.2° F). Temperatures in the southwestern U.S. may rise 3.5°F to 9.5°F by the end of this century (Garfin et al. 2014). The last decade is the warmest on record in New Mexico (Frankson et al. 2017), and the period since 1950 is hotter than any comparable time period in the past 600 years (Garfin et al. 2014) with the Southwest experiencing the most persistent drought in the last decade since 1895 (EPA 2016a). Heat waves are expected to increase across the southwestern United States (Gershunov et al. 2013); the number of extreme heat days (over 100°F) and warm nights (above 70°F) has increased over the past two decades and since the mid-1970s, respectively, in New Mexico (Frankson et al. 2017).

It is unclear how increasing temperatures will impact precipitation, including the North American monsoon; an important source of moisture across New Mexico. A key problem is the ability of climate models to reproduce extreme high-frequency precipitation is a key uncertainty in projections. Spring, already the dry season in New Mexico, is projected to experience

decreased precipitation; areas where Todsen's pennyroyal occurs might experience a 10-15% reduction in spring precipitation (Frankson et al. 2017). Winter precipitation is also projected to decline (Garfin et al. 2014). Projected reduction in snow pack (EPA 2016b) may impact the populations of Todsen's pennyroyal be decreasing the amount of winter precipitation that slowly permeates and saturates the soil.

Projected increases in temperature will likely decrease soil moisture, primarily in Spring and Winter, through evaporation and increase transpiration in plants, increasing the stress of drought (Garfin et al. 2014, Wehner et al. 2017). However, increased CO2 may reduce transpiration rates and improve water use efficiency (Setelle et al. 2014). Additional stressors associated with increasing temperatures include drought, wildfire, invasive species, pests, and distributional shift; likely higher elevation. Warmer, drier conditions may put the piñon pine-juniper woodlands, where Todsen's pennyroyal, resides more susceptible to pests such as the pine bark beetle (EPA 2016b). Infestations may lead to decreased canopy cover and increased threat of wildfires, especially in the Sacramento Mountains. Decreased canopy cover may increase solar exposure and desiccation under a higher temperature regime. Warmer winter temperatures may lead to the persistence of existing pests and herbivores, increasing foraging with a longer growing season, and the introduction of novel pests and diseases. Elevated CO2 levels may decrease the food quality of the leaves though increased C:N ratio and lead to increased herbivory in order to meet nutritional needs (Becklin et al. 2016, Settele et al. 2014). Increased herbivory could reduce plant fitness and population growth, as well as deplete genetic diversity.

Several aspects of climate change may impact the phenology and life cycle of Todsen's pennyroyal. Climate change will result in an increased growing season (EPA 2016a) through increased spring advancement and delayed autumn (Parmesan and Hanley 2015). Advancement in spring activities such as germination, leaf emergence, flowering, and fruiting by plants has been commonly observed in the northern hemisphere. Many plants which show delays are the results of climate-impacted vernalization response. Matthews and Mazer (2015) found that winter and spring mean minimum temperature and total precipitation interacted to impact early flowering phenology; increasing minimum mean temperatures led to spring advancement, while increasing total precipitation resulted in delayed flowering. The climatic requirements for germination are not understood for Todsen's pennyroyal. Climate change may impact seed production, germination, and seedling establishment through changes in the warm/cold and/or wet/dry periods (Parmesan and Hanley 2015). Mycorrhizal associations are currently unknown for Todsen's pennyroyal. Mutually beneficial associations are assumed to occur in nutrient-limited systems in which host plants trade carbohydrates for soil nutrients (Becklin et al. 2016). Mycorrhizae may be beneficial to adaptation to climate change with increased CO2.

Geographic distribution shifts for vegetative biomes are expected to change across 5-20% of the land in the US by the end of this century. This is generally to higher latitudes or elevation; resulting in either a range expansion, increased competition, or range reduction (Garfin et al. 2014, USGCRP 2009). However, the interactions between changing temperature, precipitation, and land use can lead to shifts in the opposite direction (Setelle et al. 2014). This may be driven by water availability (Parmesan and Hanley 2015). Herbaceous plants generally have a low displacement capacity, less ability to keep pace with climate change, except possibly in mountainous areas unless there are additional constraints from demographics, habitat fragmentation and competition. The use of gypseous habitats may be a constraint for Todsen's

pennyroyal. Human-assisted translocation might be necessary at some point (Parmesan and Hanley 2015).

Response to climate change has been documented in changes to arrival dates for migrating birds and butterflies, timing in bird nesting initiation, flowering phenology, and latitudinal and elevational distribution changes (Setelle et al. 2014). Of 305 North American birds studied, mean northern shift in winter range by 40 miles (EPA 2016a). Most (61%) shifted northwards, 27% southwards, and 12 % with no detectable change. For many migrant species, Spring advancement has occurred but there is not necessarily a change to autumn migration (Setelle et al. 2014). With changes to the timing of migration and plant phenology, asynchronies can arise, increasing species vulnerability. Plants with strong relationships to single pollinators and that flower early are more susceptible to developing asynchrony and reduced seed set (Forrest 2015). Reduced soil moisture may impact nectar production and corolla size (Gallagher and Campbell 2017). Warming may impact nectar volume (Parmesan and Hanley 2015). This could impact visitation by Broad-tailed Hummingbirds, the primary known pollinator of Todsen's pennyroyal (Britt 2015, Tonne 2009).

The Broad-tailed Hummingbird (BTAH) is a migrant flame-throated hummingbird that winters from southern Mexico to Honduras and breeds throughout the intermountain western part of the US (along the borderlands of west Texas to eastern Arizona, and north to southern Idaho and Montana) (Camfield et al. 2013, eBird 2019). With over 24,500 observations in New Mexico, they generally begin migrating to or through New Mexico in mid-March to May and depart to wintering grounds or migrate through by August to late October/early November (eBird 2019). From 2010 – 2019, in Sierra County they were observed from late March to early October, and from early March to the end of October in Otero County. There is much variability in the timing of Spring arrival that can likely be attributed to conditions at the wintering grounds (Graham et al 2016). McKinney et al (2012) examined changes to the arrival of BTAH as well as first flowering of a nectar species in southeastern Arizona and central Colorado. They found that both first arrival and first flowering were advancing over a period of 37 years in the northern site; however, first flowering was advancing at a faster rate. At the southern site there was no significant change to arrival nor first flower over a 27-year period (although interestingly, they did observe a weak trend towards later arrival and first flower). It is unclear if there are trends in the timing of BTAH migration and Todsen's pennyroyal flowering that indicate whether climate change is or will impact pollination. Todsen's Pennyroyal has extended flowering periods which overlap with the presence and migration of BTAHs.

The WSMR populations may be at greater risk than the Sacramento Mountains populations due to: 1) occurring in habitat at lower elevations, 2) occurring in smaller patches, 3) existing at what appears to be the upper elevation extent of available habitat at the local level. Species with limited genetic variation may have low potential for rapid evolution (Setelle et al. 2014). In addition, small populations also put it at risk of extinction. Some populations (or portions of populations) in the Sacramento Mountains are more susceptible to wildfire.

CHAPTER 3 – CONSERVATION AND MANAGEMENT GOALS

Conservation Goals for Todsen's Pennyroyal

WSMR supports recovery of Todsen's pennyroyal and has developed the following conservation goals to comply with the ESA, the Todsen's Pennyroyal Recovery Plan, 5-Year Review (USFWS 2001, 2011), and any updates to the Recovery Plan.

Goal 1: Environmental Compliance.
Section 7 of the ESA requires all Federal agencies to carry out programs for the conservation of threatened and endangered species and to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of critical habitat. Army Regulation (AR) 200-1 and the NEPA review process in the Environmental Division of the Department of Public Works assures that all proposed actions are screened for potential affects to threatened and endangered species, and that consultation is initiated with USFWS if an action "may affect" Todsen's pennyroyal or may destroy or adversely modify critical habitat.

WSMR is also required to report "take"—although there are no criminal or civil penalties for incidental (accidental) take. Intentional take is not permitted and could prompt criminal or civil penalties. Under the Federal Fish & Wildlife Permit for WSMR (currently TE105165-2), an annual report regarding any activities related to Todsen's pennyroyal must be submitted to the New Mexico Ecological Services Field Office. No more than 2 individuals may be taken each year due to survey efforts or clipping for collection.

Goal 2: Todsen's Pennyroyal Recovery.
The ESA (Section 2) states that "all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act." Section 7(a)(1) declares that "All other Federal agencies shall, in consultation with and with the assistance of the Secretary, utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species listed pursuant to section 4 of this Act." WSMR will cooperate with federal, state, and private organizations to recover Todsen's pennyroyal. Recovery efforts will include searches, monitoring, and protection of known population locations by minimizing potential impacts of military missions as well as supporting research efforts.

Goal 3: Monitoring of Known Populations
WSMR will continue annual monitoring of known populations by authorized individuals following established protocols via an Endangered Species Permit from the U.S. Fish and Wildlife Service. An annual report is required by 15 December each year.

Goal 4: Search All Suitable Habitat
WSMR will continue range wide searches for Todsen's pennyroyal in areas identified with moderate to highly suitable habitat. Searches will be conducted only by authorized individuals via an Endangered

Species Permit from the U.S. Fish and Wildlife Service. An annual report is required by 15 December each year.

Goal 5: Support Research
WSMR will continue to support research identified by the Recovery Plan with the goal of down-listing or de-listing Todsen's pennyroyal.

Management Objectives for Todsen's Pennyroyal

Each management objective is consistent with the WSMR military mission, the WSMR Environmental Impact Statement (WSMR 2009), and the Todsen's Pennyroyal Recovery Plan and 5-Year Review (USFWS 2001, 2011). The primary military mission of WSMR is to provide quality testing, evaluation, research, and other technical services to the Army and the Department of Defense (DoD). WSMR strives to ensure that the armed services of the United States have the best military equipment possible by providing high quality services in a cost-effective manner.

Management strategies and actions developed to accomplish objectives are detailed in Chapter 4. Techniques used to assess progress towards meeting these objectives are described in Chapter 5.

Objective 1: Contribute to Recovery of Todsen's Pennyroyal by Supporting Monitoring Efforts
Rationale: One third of known populations of this Endangered species occur on WSMR. Being part of a Federal agency, WSMR will support monitoring efforts as part of the recovery effort. Monitoring will increase the understanding of the long-term condition and survival of the species. This knowledge may help manage the species in such a way as to recover the species and eliminate conflicts with the military mission.

Objective 2: Contribute to Recovery of Todsen's Pennyroyal by Supporting Search Efforts
Rationale: Critical reasons behind the listing of this species as Endangered include the limited number and restricted range of occurrences. Finding additional populations will assist with the recovery of Todsen's pennyroyal by increasing the known abundance and distribution.

Objective 3: Contribute to Recovery of Todsen's Pennyroyal by Supporting Research Related to Phenology, Genetics, andlimpacts of Climate
Rationale: Key identified threats to this species in the recovery plan are still relatively under-researched. The importance of understanding the phenological response of Todsen's pennyroyal to annual local climatic conditions is critical to predicting what, if any, impacts climate change will have on the long-term survivability of this species. Climate change is considered the leading threat to this species. Continuing research into the genetic diversity of this species may be important to increase reproductive output, ensuring the highest level of diversity possible and guiding any future experimental population transplantation efforts.

Objective 4: Minimize Mission-related Impacts on Known Populations
Rationale: One third of the known populations may be impacted by military-related missions. By minimizing potential negative impacts of current military missions, long-term recovery is more likely to occur, subsequently eliminating conflicts with future military missions.

CHAPTER 4 – MANAGEMENT STRATEGIES AND ACTIONS

To meet the management objectives put forth in the previous chapter, WSMR land managers must implement strategies and actions under each scenario.

Objective 1: Environmental Compliance.

WSMR will initiate a consultation with the USFWS if a proposed action may affect the species or destroy or adversely modify critical habitat. For example, in 2009, WSMR completed an informal consultation with USFWS for the Air Force use of Yonder Impact Area (USFWS 2009a, Appendix A). Proposed activities included high altitude training chaff, training flares and live-fire air-to-air activities. All three of these activities were classified as "may affect, but unlikely to adversely affect" Todsen's pennyroyal and its critical habitat. In the same year WSMR also completed an informal consultation on the proposed action of the WSMR Rangewide Environmental Impact Statement (USFWS 2009b, Appendix B). In that consultation, the USFWS concurred with the impact determinations made by WSMR:

> *The NMESFO concurs with the determinations that the proposed development and implementation of range-wide mission and major capabilities at WSMR "may affect, but are not likely to adversely affect'" Todsen's pennyroyal and its critical habitat, the Mexican spotted owl and its critical habitat, and the southwestern willow flycatcher, and "are not hkely to jeopardize the continued existence of' the northern aplomado falcon.*

In compliance with the Federal Fish & Wildlife Permit for WSMR (currently TE105165-2), we will report any "take" and submit an annual report to the USFWS New Mexico Ecological Services Field Office regarding surveys and research conducted. No more than 2 individuals may be taken each year due to survey efforts or clipping for collection.

Objective 2: Todsen's Pennyroyal Recovery.

The U.S. Fish and Wildlife Service designated Todsen's pennyroyal as Endangered across its known distribution. WSMR recovery actions will include:

a) Monitoring known existing populations annually as part of a long-term effort to track the size, density, and reproductive trends for populations on WSMR.

b) Conducting searches in moderate to highly suitable areas in an effort to locate all occurrences of Todsen's pennyroyal on WSMR.

c) Collecting climatic and phenological data at populations each year to determine the effect of annual climatic fluctuations on sexual reproductive effort and vegetative growth.

d) Maintaining 0.5 km buffer areas around all known populations occurring on WSMR. Each buffer area was designed to meet several goals: (1) it should protect all habitat within.0. 5 km of the population; (2) it should encompass any critical habitat area established by the FWS; (3) it should exclude presently-used roads unless existence of those roads presents a significant threat to the pennyroyal or its habitat; and (4) it should protect the area within the watershed in which the population is located. All construction, mission-related, or hunting/grazing activities should be excluded within Todsen's pennyroyal buffer areas. If exception to any of the above restrictions is sought, WSMR Natural Resources Personnel must evaluate the potential risk that the proposed activity would entail. If these personnel determine that the activity would present a significant risk to one or more pennyroyal populations, the proponent of the proposed action will be notified and be asked to evaluate alternative implementations. If an alternative causing

risk to a pennyroyal population is pursued, WSMR Natural Resources personnel will consult the FWS Region 2 in accordance with ESA Section 7.

e) Support research recommended by the Recovery Plan.

f) Work with stakeholder agencies at the federal, state, and private levels to develop overall strategies for recovery of the species.

CHAPTER 5 – ACTION PLAN

Objective 1: Continue annual Todsen's pennyroyal population monitoring efforts following early and late season reproductive efforts.

Objective 2: Update the predicted suitable habitat map for Todsen's pennyroyal and continue to search for new populations in areas with identified suitable habitat.

Objective 3: Minimize mission-related impacts on known Todsen's pennyroyal populations by maintaining 0.5 km buffer areas.

Objective 4: Support additional research identified by the Recovery Plan.

Monitoring

Monitoring strategies for Todsen's pennyroyal include annual early (July) and late season (late September to early October) visitation of population plots and photopoints in order to document reproductive effort, growth, and density, following the monitoring protocols (Sikula 2009). In addition, collection of yearlong precipitation and temperature data at monitored populations is critical to understand the relationship between the timing and amount of precipitation and temperature on annual reproductive effort and growth at the population level. These data will also provide information necessary to predict potential impacts that climate change may have on this species in the future. It is likely that an update to the monitoring protocols will be needed and should be completed in collaboration with stakeholder agencies. Any personnel involved in monitoring activities will take precautions to minimize impacts to the populations. This includes selecting routes to monitoring plots and photopoints that balances minimum distance traveled within the population (e.g., entering the population close to the plot or photopoint) and terrain that minimizes ground disturbance. Additional care should be taken when walking in direct proximity of individual plants as disrupting the unseen rhizomes just under the soil surface may adversely impact a given individual.

Searches

Pedestrian search efforts should be guided by an updated, range-wide predicted habitat model. The current model used for searches is limited to the Chalk Hills, Big Gyp Mountain, Gyp Hills, and immediately adjacent areas. A new model will be developed using the software MAXENT (Phillips et al. 2014), which will incorporate geology, soils, elevation, solar exposure, and vegetation communities across WSMR. It is believed that most of the suitable habitat has been searched in the areas noted above. In addition, exhaustive search efforts were made in the Chupadera Mesa (Red Rio) area in 2006. Searches involve walking parallel contours in suitable habitat at approximately 20 - 30m intervals.

Buffer areas

WSMR will continue to utilize 0.5 km buffer areas around all known populations and provide guidance to minimize potential mission-related impacts known to populations. Such buffer areas will be established around any new populations discovered.

Research

WSMR will support research proposed by the USFWS Recovery Plan with the long-term objective of down-listing and/or de-listing Todsen's pennyroyal. Any research needs to be approved by WSMR and have the necessary permits obtained in order to ensure that research data collection procedures do not adversely impact the species.

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Appendix A. Informal Consultation in 2009 with the U.S. Fish and Wildlife Service Regarding Impacts of Use of Yonder Air Space and the Weapons Systems Evaluation Program at White Sands Missile Range.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna Road, NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525; Fax: (505) 346-2542

July 24, 2009

Cons. #22410-2006-I-0129

Jose A. Gallegos
Chief, Environmental Division
U.S. Army Garrison White Sands
100 Headquarters Avenue
White Sands Missile Range, New Mexico 88002-5000

Dear Mr. Gallegos:

Thank you for providing your June 22, 2009, request for informal consultation and Biological Assessment (BA) for Use of Yonder Air Space at White Sands Missile Range, New Mexico. In 2006, the U.S. Fish and Wildlife Service (Service) concurred with your Transforming the 49th Fighter Wing's Combat Capability Project regarding effects to northern aplomado falcon (*Falco femoralis septentrionalis*), bald eagle (*Haliaeetus leucocephalus*), Mexican spotted owl (*Strix occidentalis lucida*), its critical habitat, and southwestern willow flycatcher (*Empidonax traillii extimus*). However, your 2006 BA did not address potential effects to Todsen's pennyroyal (*Hedeoma todsenii*) and its critical habitat. The BA you sent to us was received by the Service on June 24, 2009 and clarifies the proposed action and analyzes the effects to Todsen's pennyroyal from Use of Yonder Air Space and the Weapons Systems Evaluation Program at White Sands Missile Range. You determined that the proposed project "may affect, is not likely to adversely affect" Todsen's pennyroyal and its critical habitat.

Proposed activities for Yonder Air Space include the use of training chaff, training flares, and live-fire air-to-air activities. The BA contains a complete description of the proposed action and is herein incorporated by reference.

We concur that the proposed action "may affect, is not likely to adversely affect" Todsen's pennyroyal and its critical habitat based on the following:

- There is an extremely low likelihood of munitions utilized in live-fire air-to-air activities to impact Todsen's pennyroyal and its critical habitat because they are fired at 12,500 feet to 20,000 feet above mean sea level and a very small percent of the area within the bullet impact area would be hit.

- There is an extremely low likelihood of chaff fibers or flare components to impact Todsens' pennyroyal because chaff and flares are used at very high altitudes and they disperse widely over the area.

- It is unlikely that a flare could cause a fire near Todsen's pennyroyal because the habitat lacks fine fuels to carry a fire and suppression of fires near Todsen's pennyroyal are required.

Please contact the Service if: 1) future surveys detect listed or proposed species in habitats where they have not been previously observed; 2) the project is changed or new information reveals effects of the proposal to listed species that have not been considered in this analysis; or 3) a new species is listed or critical habitat designated that may be affected by the action.

We appreciate the analyses provided in the letter and the BA and your efforts to protect endangered and threatened species. In future communications regarding this project, please refer to Consultation # 22410-2006-I-0129. If we can be of further assistance, please contact Lynn Gemlo of my staff at 505/761-4726.

Sincerely,

Wally Murphy
Field Supervisor

cc:
Director, New Mexico Department of Game and Fish, Santa Fe, NM
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, NM

Appendix B. Informal Consultation in 2009 with U.S. Fish and Wildlife Service Regarding the Development and Implementation of Range-wide Mission and Major Capabilities at WSMR.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
New Mexico Ecological Services Field Office
2105 Osuna NE
Albuquerque, New Mexico 87113
Phone: (505) 346-2525 Fax: (505) 346-2542

September 24, 2009

Cons. #22420-2009-I-0087

Thomas A. Ladd, Director, Public Works
Department of the Army
U.S. Army Garrison White Sands
100 Headquarters Avenue
White Sands Missile Range, New Mexico 88002-5000

Dear Mr. Ladd:

Thank you for your September 2, 2009, letter requesting section 7 consultation and conference under the Endangered Species Act (Act) for the development and implementation of range-wide mission and major capabilities at White Sands Missile Range (WSMR). Your updated, final biological assessment was received in the New Mexico Ecological Services Field Office (NMESFO) by electronic mail on September 16, 2009. It analyzes effects likely to result from implementing new mission requirements and developing new test and training capabilities at the installation. You have requested concurrence from the NMESFO with your determinations that the proposed project "may affect, but is not likely to adversely affect" the endangered Todsen's pennyroyal (*Hedeoma todsenii*), the endangered southwestern willow flycatcher (*Empidonax trailii extimus*), and the threatened Mexican spotted owl (*Strix occidentalis lucida*), and "is not likely to jeopardize the continued existence of" the nonessential experimental population of the northern aplomado falcon (*Falco femoralis septentrionalis*). You also determined that the proposed action "may affect, but is not likely to adversely affect" the critical habitat of either the Todsen's pennyroyal or Mexican spotted owl.

Your proposed action expands WSMR's capabilities and focuses on the types of activities, land uses, and physical development that are needed to support the range-wide requirements of users. The elements of your proposed action include:

- Changes in land use, including expansion of the Main Post and alterations in authorized uses of range areas to allow for off-road activities;
- Development of new and expanded infrastructure throughout the installation and increase in the level of test activities;
- Development of six new specialized areas, four for test operations and two to support Engineering Battalion training;

- Establishment of a Land-Use and Airspace Strategy Plan and siting process for facilitating future tests and training activities at WSMR;
- Construction of facilities on the Main Post for a Heavy Brigade Combat Team or equivalent unit, including new soldier and family housing, schools, infrastructure, administrative facilities, other garrison support facilities, and expanded utilities; and
- Development of the Southeast Multi-use Area, encompassing 120,000 acres, for intensive off-road maneuvers for tests and training.

The scope of this assessment is limited to the land and airspace in Socorro, Torrance, Lincoln, Sierra, Otero, and Doña Ana counties in New Mexico. Your biological assessment states that activities conducted on Fort Bliss in support of WSMR programs, including training of the Heavy Brigade Combat Team, are addressed in the Final Supplemental Programmatic EIS, Fort Bliss Texas and New Mexico Mission and Master Plan, 2007. Fort Bliss completed section 7 consultation for this project, Consultation #22420-2007-I-0061, on April 17, 2007, with Ecological Services offices in New Mexico and Texas.

The NMESFO concurs with your determinations that the proposed development and implementation of range-wide mission and major capabilities at WSMR "may affect, but are not likely to adversely affect" Todsen's pennyroyal and its critical habitat, the Mexican spotted owl and its critical habitat, and the southwestern willow flycatcher, and "are not likely to jeopardize the continued existence of" the northern aplomado falcon for the reasons listed below:

Todsen's pennyroyal and critical habitat

Most of the proposed activities are prohibited from occurring in the WSMR Designated Pennyroyal Habitat area, which includes all known populations, designated critical habitat, and unsurveyed suitable habitat. Activities may occur in unsurveyed suitable habitat only after the habitat has been adequately surveyed and Todsen's pennyroyal is determined to be absent. All known populations and critical habitat will remain protected, including an additional 0.5 km buffer zone around each population. Airborne releases over or adjacent to the WSMR Designated Pennyroyal Habitat area will only occur if: (1) WSMR makes a "no effect" determination for the activity; or (2) NMESFO concurs with a "may affect, but not likely to adversely affect" determination for the activity. Adverse effects from implementation of the Land Use Airspace Plan are not anticipated. Should an adverse effect determination result, the activity will only occur according to the terms of a biological opinion.

Mexican spotted owl and critical habitat

There are no confirmed records of the Mexican spotted owl occurring on WSMR, and the owl is not expected to occur on WSMR due to lack of breeding habitat. In addition, there will be no construction or ground-disturbing activities associated with the proposed action that may affect the primary constituent elements of Mexican spotted owl critical habitat. Studies have shown that noise associated with aircraft above 3,000 feet has minimal impacts on the Mexican spotted owl. WSMR's proposed over-flight activities would be conducted at 14,600 feet above the owl's habitat.

Southwestern willow flycatcher
Air-vehicle operations at Condron Airfield do not occur in close proximity to the suitable Southwestern willow flycatcher habitat at Davies Tank. There is also an activity constraint area around Davies Tank to avoid or minimize adverse effects to the subspecies. WSMR will conduct three-visit surveys annually for the flycatcher. Project-related five-visit surveys will be required for any proposed action that may affect the flycatcher. This includes, but is not limited to, any project at or near Davies Tank that could affect the flycatcher due to direct or indirect effects due to: (1) modification of the vegetation or soils; (2) change in the flow of water or effluent to Davies Tank; (3) effects to the insect community; or (4) an increase in noise levels. WSMR will use survey results to make the appropriate section 7 effect determinations and will consult with the NMESFO regarding any project that may affect the species. Surveys will also help determine if WSMR has resident flycatchers that would warrant development of a management plan specific to this subspecies.

Northern aplomado falcon
Proposed uses of northern aplomado falcon habitat will include measures to reduce adverse environmental impacts, in accordance with WSMR plans, permits, and regulations. Project siting includes measures for minimizing impacts to and fragmentation of grasslands, and for preserving large, complex yucca trees. New proposed actions, or actions not covered by this Environmental Impact Statement, will go through an environmental review process where potential affects to the falcon will be considered. WSMR has implemented conservation measures to ensure that: (1) personnel understand where northern aplomado falcons are located on WSMR; (2) all northern aplomado falcon sightings and nests are reported to the NMESFO; (3) intentional or unintentional take of northern aplomado falcons, nests, eggs, and nestlings is prevented; (4) incidental take is minimized through best management practices and coordination with NMESFO; (5) impacts to, and fragmentation of, grassland habitats is minimized; and (6) northern aplomado falcon recovery will be supported through WSMR's participation in the reintroduction program and restoration of grasslands when feasible and funds are available.

This concludes section 7 consultation and conference on the proposed development and implementation of range-wide mission and major capabilities at WSMR. As provided in 50 CFR Sec. 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this consultation; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this consultation; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

We appreciate your concern for endangered species in New Mexico and your commitment to coordination with the NMESFO on issues involving listed and rare species. In future communications regarding this project, please refer to Consultation #22420-2009-I-0087. If you

have any questions about this letter, please contact Dr. Patricia Zenone of my staff at the letterhead address or at (505) 761-4718.

Sincerely,

for Wally Murphy
Field Supervisor

cc:
Director, New Mexico Department of Game and Fish, Santa Fe, New Mexico
Director, New Mexico Energy, Minerals, and Natural Resources Department, Forestry Division, Santa Fe, New Mexico
Director of Environment, Fort Bliss Garrison Command, Department of the Army, Fort Bliss, Texas (Attn.: Dr. Brian Locke)