Sacramento Mountains Thistle
(*Cirsium vinaceum*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Albuquerque, New Mexico

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5-YEAR REVIEW
Sacramento Mountains thistle (*Cirsium vinaceum*)

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1.0 GENERAL INFORMATION

1.1 Reviewers:

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1.2 Methodology used to complete the review:

Robert Sivinski, Botanist for the New Mexico State Forestry Division, was contracted through a section 6 grant to gather the relevant information and prepare a draft of the background information for the review. This information was reviewed for scientific accuracy by Linda Barker, Forest Botanist, Lincoln National Forest (LNF). The final review and recommendation was prepared by a Regional recovery staff biologist in cooperation with the New Mexico Ecological Services Field Office (NMESFO).

1.3 Background:

Sacramento Mountains thistle (*Cirsium vinaceum*) is a short-lived, monocarpic perennial plant endemic to elevations between 2460 and 3020 meters (7,500 and 9,200 feet) in the Sacramento Mountains of Otero County, New Mexico. The geographic range of this species spans approximately 32 kilometers (km) (20 miles (mi)), with individual *C. vinaceum* found in association with 6 major canyon drainages. Sacramento Mountains thistle is a wetland-obligate species confined to wet travertine deposits on springs and seeps, and water-saturated alkaline soils in open valley bottoms. Suitable *C. vinaceum* habitats are relatively rare, spotty in distribution, and range in size from several square meters (m^2) to over 1000 m^2. These small habitats are often densely occupied, forming patches of *C. vinaceum* ranging from fewer than 10 flowering individuals up to several thousand and providing conditions for a set of metapopulations. The total area of habitat occupied by this species is estimated to be approximately 28 hectares (ha) (70 acres (ac)), with greater than 95 percent of known habitats occurring on the LNF.

Sacramento Mountains thistle was listed as threatened in 1987 due to threats from water diversion at spring habitats, direct and indirect impacts from grazing, competition with exotic plants, logging, and recreation. The U.S. Forest Service (USFS) has implemented measures that have reduced threats to the thistle at some grazing locations, in areas of heavy recreation, and during logging operations. Livestock grazing is the prevailing land use throughout the range of the Sacramento Mountains thistle, and consumption and trampling of the thistle as well as hoof damage to travertine substrates continue in areas

occupied by the thistle with unmaintained or inadequate fencing. Exotic weed species persist within Sacramento Mountains thistle habitats, and roadside spraying for weed control occasionally causes mortality to adjacent Sacramento Mountains thistle individuals.

A threat not covered in the original listing analysis for the Sacramento Mountains thistle is insect predation. In addition to four recently-noted native insect predators of the Sacramento Mountains thistle, the exotic seed-head weevil (*Rhinocyllus conicus*) arrived in the Sacramento Mountains during 2006, and initially attacked patches of exotic musk thistle (*Carduus nutans*) in close proximity to Sacramento Mountains thistle habitats. As of 2007, *R. conicus* has been present in the flower heads in the large, northern-most population of Sacramento Mountains thistle at Silver Springs. In August, 2009, *R. conicus* continued to damage flower heads within this population (Sivinski 2009b). One of the four native insect predators, the stem borer weevil (*Lixus pervestitus*), has recently become apparent in the same large thistle population, resulting in a significant loss of seed production since 2006 (Sivinski 2007, 2008). *Lixus pervestitus* continues to cause premature stem death in this population and, during the peak period of flowering in August, 2009, blooms were virtually non-existent (Sivinski 2009b). The combined effects of these native and introduced insect predators appear to be increasing both within and among thistle populations.

From the original 20 occupied population sites for the thistle, the USFS has identified a total of 104 extant, historic, or potential habitat locations for *C. vinaceum*. All of these sites are distributed within the historically known geographic range at the time of listing in 1987 (U.S. Fish and Wildlife Service (USFWS) 2010). Currently, 83 localities (or subpopulations) are monitored as *C. vinaceum* sites. The extent of occupied sites and plant population numbers for a given year fluctuates with precipitation conditions and both surface and subsurface water flow. Of the known, occupied sites, five small thistle patches disappeared from their habitat locations by 2003, and an additional five patches disappeared by 2005. By 2007, an additional patch disappeared and another patch was occupied by rosettes but had no reproducing individuals with flowering stems. Total numbers of flowering stems have steadily declined from a peak in 1998 of 39,849 individuals to 24,124 in 2007. Drought patterns in the Sacramento Mountains began in 1999 and coincide with the declining trend of flowering thistle numbers observed on the LNF.

1.3.1 FR Notice citation announcing initiation of this review

FR notice: 71 FR 70479
Date: 5 December 2006

1.3.2 Listing history

Original Listing
FR notice: 52 FR 22933
Date listed: 16 June 1987
Entity listed: Species

Classification: Threatened

Revised Listing
None

1.3.3 Associated rulemakings

The critical habitat proposed in the listing proposal (USFWS 1984, 49 FR 20739) was not adopted in the final determination to list the Sacramento Mountains thistle as a threatened species (USFWS 1987, 52 FR 22933). Critical habitat was withdrawn because the initial area proposed was considered too large to be essential for the thistle's conservation; the secondary option of designating small, separated parcels around each population was deemed too complicated for adequate management by the USFS (1987, 52 FR 22935).

1.3.4 Review history

The Sacramento Mountains thistle has not been reviewed by the U. S. Fish and Wildlife Service (Service) since adoption of the recovery plan in 1993. Various Biological Opinions rendered by the Service have incorporated any new information provided by project proponents.

1.3.5 Species' Recovery Priority Number at start of 5-year review

Recovery priority number: 2

1.3.6 Recovery Plan or Outline

Name of Plan: Sacramento Mountains Thistle (*Cirsium vinaceum*) Recovery Plan
Date issued: 27 November 1993
Dates of previous revisions: The Recovery Plan has not been revised.

2.0 REVIEW ANALYSIS

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

2.1.1 Is the species under review a vertebrate?

_____ **Yes**
__X__ **No**

2.2 Recovery Criteria

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

__X__ Yes
_____ No

2.2.1.1 Does the recovery plan contain objective, measurable criteria?

_____ Yes
__X__ No

Some of the recovery criteria are not measurable and objective, making it difficult to determine if recovery has been achieved. For instance, criterion two does not include a time period, define the populations addressed (core spring or riparian) or their proportions, provide a definition of occupied habitats, or specify a distance downstream of occupied habitat where unoccupied habitat should be protected.

2.2.2 Adequacy of recovery criteria

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

_____ Yes
__X__ No

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

_____ Yes
__X__ No

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

The recovery plan for Sacramento Mountains thistle contains delisting criteria but no uplisting criteria. The recovery criteria are given in abbreviated (italicized) and longer forms; the combined forms are:

1. *Acquire water rights for the sole purpose of protecting at least 30 percent of the occupied spring habitats.* Acquire water rights specifically for the maintenance of travertine spring habitats at a minimum of 30 percent of the occupied spring localities, including at least 1 occupied spring locality in each of the 20 known canyons of occurrence (Factors A, D, E);
2. *Develop and implement management plans that will encourage Sacramento Mountains thistle growth for at least 75 percent of the known*

occupied habitat. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of at least 75 percent of the known occupied habitats according to steps outlined in the plans. Sites should include both core populations at springs as well as other occupied riparian habitats. Unoccupied stream habitat downstream of occupied springs should be protected for future colonization by the thistle (Factors A, C, D, E);

3. *Establish a 10-year monitoring and research program to demonstrate the effectiveness of the management plan*. Establish a 10-year monitoring and research program to demonstrate the effectiveness of management implemented under the plans (Factors A, C, D, E).

The recovery criteria have not been met at present, as discussed in detail below. The recovery plan does discuss relevant biological factors and threats, generally covering listing factors pertaining to habitat destruction (Factor A), predation (Factor C), inadequate regulatory mechanisms (Factor D), and other factors affecting its existence (Factor E), but does not adequately address them in quantifiable terms in the recovery criteria. The listing factor regarding overutilization for commercial, recreational, scientific, or educational purposes (Factor B) is not relevant to the thistle. An approach to managing the emerging threat of insect invasion and predation at the scale observed within the past several years needs to be developed and implemented if insects continue to affect reproduction of the Sacramento Mountains thistle. The prescribed recovery actions do seek to develop new information to more clearly understand and assess biological factors and threats, however, uplisting from threatened to endangered is not mentioned as a possible result of such analyses.

The step-down outline prescribes the following actions to meet the recovery criteria:

1. Develop and implement a policy for spring development on LNF and acquire water rights to springs if in-stream flow legislation is ever passed in New Mexico.
2. Implement livestock management practices to protect plants and their associated spring and riparian habitats.
3. Implement logging practices that minimize indirect hydrologic and erosion effects on Sacramento Mountains thistle habitat.
4. Study impacts of exotic plant competitors and biological controls.
5. Conduct long-term monitoring to evaluate effectiveness of management.
6. Other (conduct genetic and hydrologic studies, locate new populations, manage recreation activities, engage in education and law enforcement).

Criteria for delisting:

1. *Acquire water rights for the sole purpose of maintaining at least 30 percent of the occupied spring habitats.*

Although the existence of the thistle is dependent upon constant water flow, no portion of this criterion has been met and is not likely to be met in the foreseeable future. Technically, the State of New Mexico owns the State's water, as determined by the U.S.

v. New Mexico case of 1978 (438 U.S. 696, 98 S. Ct. 3012). New Mexico water law permits the extraction of water only for "beneficial use", limited to livestock water, farming, domestic use, or recreational facilities; beneficial use has yet to include wildlife habitat. Federal landowners in New Mexico, in this case, the USFS, do not own the water located on federal lands, and therefore cannot deny a claim of a legitimate beneficial use water right. However, the landowner can designate the point of water diversion to a water claim. To protect the water source to the Sacramento Mountains thistle, the LNF could instigate a policy that would not allow diversion of any water above or within the thistle's habitat, but to date no such policy has been formulated.

In July, 2007, the State of New Mexico adopted legislation establishing a strategic water reserve to manage water for interstate stream augmentation to benefit threatened or endangered aquatic or obligate riparian species (NM ST § 72-14-3.3, 2007). Federal agencies are eligible to acquire such water rights, and for Sacramento Mountains thistles associated with riparian areas, this new law may serve to protect these habitats. However, the Sacramento Mountains thistle is not always found in association with riparian systems and is not located within river reaches that involve stream augmentation or interstate stream compacts. Thus, this recent law does not adequately protect most occupied sites of the thistle, particularly at its upland spring and travertine shelf habitats. The State Engineer does have the ability to protect a water resource to further a 'State Conservation Goal', but this has not been granted to protect Sacramento Mountains thistle habitat.

Under the Endangered Species Act (ESA), impacts to the Sacramento Mountains thistle are considered in all management plans and federal projects within the LNF. As a federally listed species, the thistle is included in National Environmental Protection Act (NEPA) analyses and Environmental Impact Statement (EIS) reports, and actions to preserve the thistle are recommended in these documents. However, the issues of water accessibility or specific quantities of water reserved for the Sacramento Mountains thistle have not been directly described in these reports or in any other documents. The Recovery Plan prescribed the formation and implementation of a policy for spring development on the LNF, but a policy directly addressing water apportioning has yet to be formulated. Protection of most thistle habitats from water withdrawal must rely upon the LNF special use permit process to approve suitable points of diversion for the exercise of a water right. Currently, the diversion intake point specified in a special use permit accounts for the presence of any Sacramento Mountains thistle occurrences to the extent allowed by state laws regulating domestic water intake. Amidst continuing drought conditions and reduced spring water flow (USFS 2007), combined with the need to maintain water for persistent livestock use and some residential development, water availability to the thistle remains uncertain.

2. *Develop and implement management plans that will encourage Sacramento Mountains thistle growth for at least 75 percent of the known occupied habitat.*

The development of general management plans that include at least 75 percent of the occupied habitat has been achieved; however the implementation of encouraging growth in 75 percent of the species' occupied habitat and protecting this proportion of the

population has not been accomplished. Management plans that mention Sacramento Mountains thistle habitat protection include: the LNF's Interim Management Plan for *Cirsium vinaceum* (USFS 1989); the 1996 Regional Amendments; the Sacramento Grazing Allotment Grazing System/Intensity and Improvements Management Plan (1995); the LNF Land and Resource Management Plan (2004); the Service's Programmatic biological conference opinion: The continued implementation of the Land and Resource Management Plans for eleven National Forests and National Grasslands of the Southwestern Region (LRMP) (2005); and the Biological Assessment for the Sacramento Grazing Allotment Management Plan and Ten-Year Grazing Permit of 2004 and Amendments to this Plan in 2007.

The LNF adopted an 'Interim Management Plan for *Cirsium vinaceum*' in 1989 that was intended to guide management of thistle habitats until a recovery plan was adopted by the Service, which occurred in 1993. This interim plan was a general guideline that did not address specific goals for the thistle's conservation or some of the recovery criteria identified in the Sacramento Mountains Thistle Recovery Plan. The 1989 interim management plan is the only Forest-wide plan specific to the Sacramento Mountains thistle and is still in effect. It does not contain a review process for approving points of diversion for water rights taken from, or near, thistle habitats. A subsequent USFS management plan to address other Sacramento Mountains thistle recovery criteria has not been produced.

The most recent management plan, the LRMP, evaluated Standards and Guidelines (S&Gs) directing management of rare resources. Standards and Guidelines were determined by the Service to be 77.8 percent suitable for maintaining thistle habitat or moving towards recovery, 17.7 percent as causing lethal or sublethal response, and 1.9 percent as being ill-defined and open to interpretation. Most S&Gs with potential negative effects for the thistle are mitigated by other S&Gs that require the USFS to consider the needs of threatened and endangered species when planning or permitting potentially harmful activities (USFWS 2005). Therefore, Sacramento Mountains thistle will receive special management consideration under the LRMP for as long as it is a threatened species under the ESA.

Appendix C of the LRMP contains Forest-wide S&Gs for Federal and State Threatened and Endangered Species. Broadly stated, S&Gs in this appendix are also applicable to species determined to be 'Sensitive' by the USFS. Therefore, a few S&Gs in this appendix would continue to apply to Sacramento Mountains thistle after it is recovered and removed from the list of federally threatened species, if it remains a New Mexico endangered species or is transferred to USFS's list of sensitive species or species of concern (USFS 2008a). These S&Gs include provisions to protect the species and its essential habitats.

Developing and implementing management plans remains important because roughly 95 percent of thistle habitat area falls within the LNF, and these are recorded as sites within 5 designated grazing allotments (Figure 8, page 35). Since listing, 104 thistle sites consisting of historically occupied, currently occupied, and potentially suitable sites within the known range of the thistle have been monitored. As of 1998, 83 sites have

been consistently visited, and 75 of these sites were occupied as of 2007 (Barlow-Irick 2007). As livestock presence has proven to have both direct and indirect negative effects on the Sacramento Mountains thistle (see sections 2.3.2.1 and 2.3.2.3), protection from livestock would be an integral part of 'encouraging' "growth" and "ensuring permanent protection for at least 75 percent of the known occupied habitat." Meeting the condition of 75 percent growth encouragement and permanent protection would require the impacts of livestock be eliminated from 62 sites of the 83 currently administered by the USFS. At this time, 32 occupied sites (43 percent) are protected from livestock access through fencing, resting allotments, or steep terrain, while 42 occupied sites (57 percent) remain exposed to livestock, falling short of the minimum of 62 sites required. Of the 75 occupied sites in 2007, 68 were within the Sacramento Grazing Allotment while the 7 remaining sites occurred in 4 other allotments. In the Sacramento Grazing Allotment, fenced sites occupied by the thistle do not represent long-term protection from livestock, because cattle continue to be observed in fenced areas due to gates left open and damaged fencing not being repaired (USFS 2007, Barlow-Irick 2008, USFS 2008b, USFWS 2010). Also, livestock forage utilization standards and rotation schedules have not been consistently followed (USFWS 2010). Posing another threat, recreationalists on ATVs and other vehicles have been observed driving and parking within opened livestock exclosures, potentially damaging individuals and the limited habitat of the Sacramento Mountains thistle on the LNF (USFS 2008b, USFWS 2010). Thus, the criterion to ensure growth encouragement and permanently protect 75 percent of occupied thistle habitats requires further action, particularly in response livestock and exclosure management in the Sacramento Grazing Allotment.

3. *Establish a 10-year monitoring and research program to demonstrate effectiveness of the management plan(s).*

Some of this criterion has been met by continuing studies of the population dynamics and ecology, and also of the Sacramento Mountain thistle's response to the mitigation of some threats, such as grazing and erosion, using approaches recommended in management plans. Monitoring has found that fencing around thistle habitats has increased thistle numbers in all instances, permitting recovery of populations at specific localities and even the extension beyond fence-lines for some thistle individuals. Seasonal cattle management has also proven effective for the thistle when reliably implemented (USFS 2007). The USFS has effectively prevented the destruction and erosion of thistle habitats during logging and road construction by implementing measures from the 1989 and 2005 management plans (USFS 2008b, USFWS 2008). Extensive monitoring of the thistle within the LNF was established by Dr. Laura Huenneke in 1995 and has been conducted approximately every other year through 2007, using standardized methods since 1998, primarily by Dr. Patricia Barlow-Irick. Other pertinent studies have been conducted on the species' ecology, as given below.

Although conservation actions are directed in management plans and could be effective if consistently implemented, in some cases these actions are not carried forth, preventing the demonstration of effectiveness or lack thereof (Barlow-Irick 2008). Management actions, such as maintaining and completing livestock exclosures surrounding Sacramento Mountains thistles, enforcing recommended seasonal livestock use of areas

occupied by the thistle within the Sacramento Grazing Allotment, and managing recreational use and preventing human destruction of Sacramento Mountains thistles within exclosed areas around Bluff Springs, require more effort to reduce negative impacts to the thistle (Barlow-Irick 2008). Moreover, based on new threats that may require additional management, research needs appear to be changing. Further studies are needed to understand and develop measures of controlling insect seed and stem consumers and exotic plant competitors, and investigate *Cirsium* hybridization and competition potential. Thus, despite the passage of 10 years and enhanced understanding of management actions and their effects through monitoring, this criterion has not been entirely met.

2.3 Updated Information and Current Species Status

The LNF has developed and funded Sacramento Mountains thistle ecology and population studies in cooperation with other federal and state agencies, private contractors, and university students. These studies provide data and analyses that substantially improve the information available for this species. Relevant research and observations include distribution and population trends (USFS, unpublished data; Barlow-Irick 2002, 2005, 2007), habitat and phenology descriptions (Thomson 1991), competition with exotic weed species (Thomson 1991, Huenneke and Thomson 1995, Huenneke 1996), pollination (Griswold 1990, Burks 1994, Tepedino 2002), seed dispersal (Craddock and Huenneke 1997), seed germination (Thomson 1991, Huenneke and Thomson 1995), livestock use (USFS 1994, 2003a), insect predation (Sivinski 2007, Gardner and Thomson 2008, Sivinski 2008), and various anecdotal observations.

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Sacramento Mountains thistle is a monocarpic, short-lived perennial initially forming robust rosettes of spiny leaves that live for one or more years as juvenile plants (Burks 1994). Each rosette eventually bolts a flowering stem, spends a single growing season as a reproductive adult, and dies upon seed set. Individuals may produce multiple rosettes along rhizomes or rooting rosette leaves and be able to produce more than one flowering stem during the same, or a different, year (Huenneke 1996).

Seed production usually occurs from cross-pollination, although this species is partially self-compatible. Pollen is carried by a variety of animal vectors including several species of native bees, flies, butterflies, and hummingbirds (Griswold 1990, Tepedino 2002). Burks (1994) studied pollen movement between thistles and found that native bee activity was lower, and heterospecific pollen loads on stigmas was higher, in small patches of thistles (<100 flowering individuals) than in large thistle patches (>1,000 flowering individuals). She also found that small patches of thistles were apparently not pollinator limited since there was no significant difference in seed set between small and large thistle patches. Therefore, small patches of Sacramento Mountains thistle are able to

experience reproductive success and must be considered "viable" or capable of persisting over time (Huenneke 1996).

Craddock and Huenneke (1997) studied water dispersal of Sacramento Mountains thistle seed, and determined that stream flow dispersal and occasional thistle establishment in streamside habitats were sufficient to genetically link some discrete patches of thistles. Craddock and Huenneke (1997) also mentioned finding thistle seed on the surface of snow during winter. Snow pack may provide large areas of smooth, unobstructed surface for wind transport of seed to adjacent thistle patches. Burks (1994) believed that discrete patches of thistles (or 'populations' of thistles known as subpopulations), interconnected by gene flow through pollen and seed dispersal, collectively could be identified as a metapopulation. A metapopulation is defined as a group of subpopulations, separated geographically but interconnected through patterns of gene flow (Lande and Barrowclough 1987). A few patches of thistles in the area of Silver Springs, located in the northern-most part of the known range, are sufficiently geographically isolated from the remainder of the species' range to the south to be considered a metapopulation. The larger, remaining thistle habitats occur in relatively close proximity and may be sufficiently connected genetically by pollen transfer and seed dispersal to form another metapopulation.

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

Since 1984, Sacramento Mountains thistle occurrence has been measured by three overall units:

1) site or locality, which are interchangeable in reports with 'population', or more accurately, subpopulation;
2) area of occupied habitat; and
3) number of individuals, as calculated based on several methods.

At present, the method of choice for calculating the number of individuals that presents the most standardized and comparable data across years involves counting individual bolted stems (or flowering, reproductive individuals) within a site, initiated in 1998 by Dr. Patricia Barlow-Irick.

At the time of listing in 1987, Sacramento Mountains thistle was estimated to be a species with only 10,000 to 15,000 sexually reproducing individuals (bolted, flowering stems) known from 20 sites. This number was up from the amount known when the thistle was petitioned for listing in 1984, when only 2,000 to 3,000 plants from 14 sites had been located by this time (USFWS 1987). A 1990 inventory of LNF habitats calculated 196,000 plants from 58 sites, including both reproductive stems and juvenile rosettes (USFWS 1993). This later survey also determined that Sacramento Mountains thistle is capable of adventitious root sprouting to produce multiple rosettes (clones) per genetic individual. To arrive at an estimate of genetic individuals, the total number of plants was arbitrarily divided by 4 to obtain a total of 49,000 individuals for the species (USFWS

1993). There are no data to support the use of four as the denominator in a calculation of genetic individuals and subsequent inventories have not employed this method.

In another attempt to estimate the number of plants, the Service and USFS estimated total population numbers of Sacramento Mountains thistles based on a 1995 adopted monitoring protocol of multiplying the number of flowering individuals by 10 to account for the numerous juvenile rosettes (USFS 2003a). This multiplier of 10 was based upon a 1989 count of all rosettes in 4 thistle patches, which found that flowering individuals ranged from 10 to13 percent of the rosettes in the 4 patches (Thomson 1991). For example, based on this method, the total number of Sacramento Mountain thistles for 2000 would be 304,600 individuals, comprised of both non-reproductive rosettes and reproductive, bolting/flowering stems, even if only 30,460 stems were actually counted. This protocol relied on a very limited sample in a single year and was likely not accurate for an entire population estimate in any given year. Actual counts of reproductive individuals have been conducted since 1998, offering a far more realistic and comparable assessment. Use of this reproductive count data of bolted stems instead of extrapolations is recommended for future Sacramento Mountains thistle population trends.

Six additional inventories of Sacramento Mountains thistle on the LNF have been conducted beginning in 1995 by Dr. Laura Huenneke, and between 1998 and 2007 by Dr. Patricia Barlow-Irick. These standardized inventories counted the number of flowering stems at most LNF locations known at the time (Figure 1, page 12). Total numbers of flowering individuals were: 34,228 in 1995; 39,849 in 1998; 34,710 in 2000; 30,460 in 2003; 28,063 in 2005; and 24,124 in 2007. Total numbers of habitat sites assessed were: 77 sites in 1995, 82 sites in 1998, and 83 sites in 2000, 2003, 2005, and 2007 (USFS, unpublished data; Barlow-Irick 2007). Sites occupied by flowering stems of Sacramento Mountains thistle by year were: 76 sites in 1995; 80 sites in 1998; 81 sites in 2000; 80 sites in 2003; 75 sites in 2005; and 74 sites in 2007 (USFS, unpublished data). Surveys of thistle numbers were not conducted in 2009.

The notable difference between the 1987 estimate within 20 sites in the listing determination and the count of 1990 covering a total 62 sites (58 sites were on the LNF) was probably the result of the additional funding and personnel available to obtain more field data after this species was listed as threatened. Furthermore, comparing survey data prior to 1998 with more recent numbers leads to an inaccurate picture of Sacramento Mountain thistle trends due to differences in survey scope and the use of extrapolating protocols prior to 1998 rather than true counts of bolted stems, used from 1998-onward, as mentioned above. Improved management of thistle habitats on the LNF also might account for some of this increase, but the questionable accuracy of population estimates made before 1998 makes the benefit of better management impossible to quantify.

The overall trend in flowering stems of Sacramento Mountains thistle during the 1995 to 2007 monitoring period is one of decrease in reproductive effort. Drier conditions became apparent in the Sacramento Mountains starting from 1999, a pattern reflected in the constant population downturn from the 1998 count to the 2007 count (Figure 1, page 13). The rate of decline in total flowering thistle numbers was 12.9 percent between 1998 and 2000, 12.2 percent 2000 and 2003, 7.9 percent between 2003 and 2005, and 14 percent between 2005 and 2007. The continuous decrease coincides with a severe long-term period of drought with higher than normal winter temperatures across most of New Mexico beginning in 1999. Plotting a statistically significant regression analysis of predicted trends (Figure 3, page 14) yields a further diminished population of 20,870.6 bolted stems for 2009 ($p = 0.0008$, $F = 201.9$, $R^2 = 0.9854$) (USFS 2008b). Should this trend extend into the future, by 2013 the number of bolting stems would approximate 14,264 reproductive individuals, approaching the population of under 15,000 individuals at the time of listing in 1987 (Figure 3, page 14).

This declining trend is not entirely consistent between thistle locations. While most thistle patches have decreased in number of flowering stems during the monitoring period, a few sites have increased in stem numbers (Barlow-Irick 2007). Additionally, between 1998 and 2007, two populations have been lost and subsequently recolonized (Barlow-Irick 2007). Barlow-Irick (2005) found that all thistles had disappeared from two marginal habitats between 2000 and 2003, and overall, another five small populations dwindled to less than five plants each during the same time period. By 2005, five more small habitats had lost all thistle plants. An additional small habitat disappeared during 2007, and another small habitat contained no stems but the site was occupied by rosettes. The end result between 2000 and 2007, when gains and losses among localities are totaled, reveals a balance of seven extirpated sites.

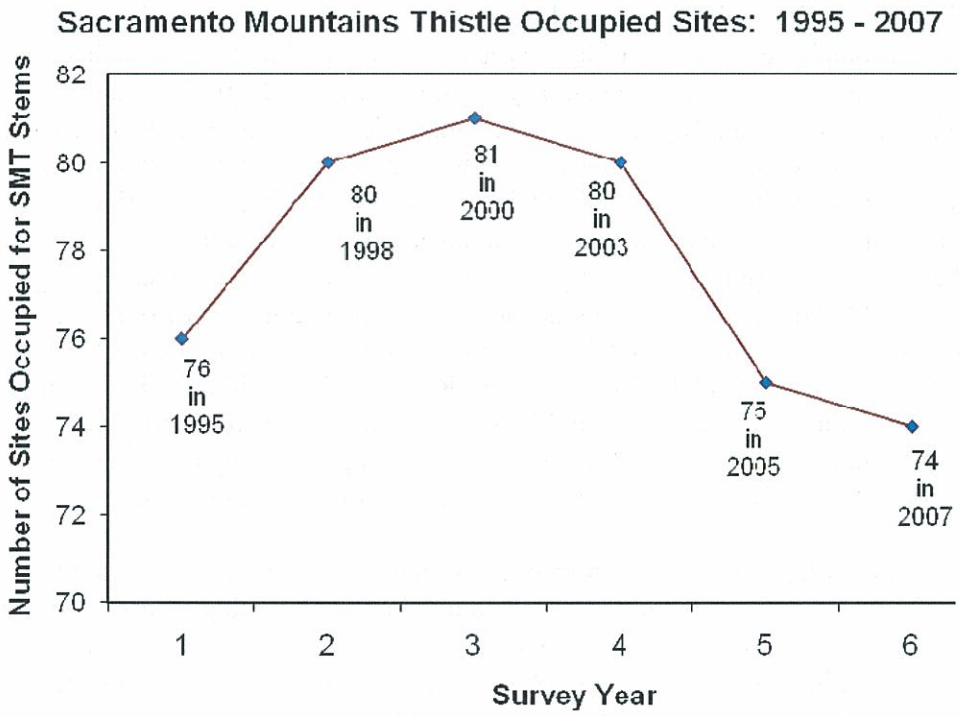

Figure 1. Number of occupied sites for Sacramento Mountains thistle (1995-2007).

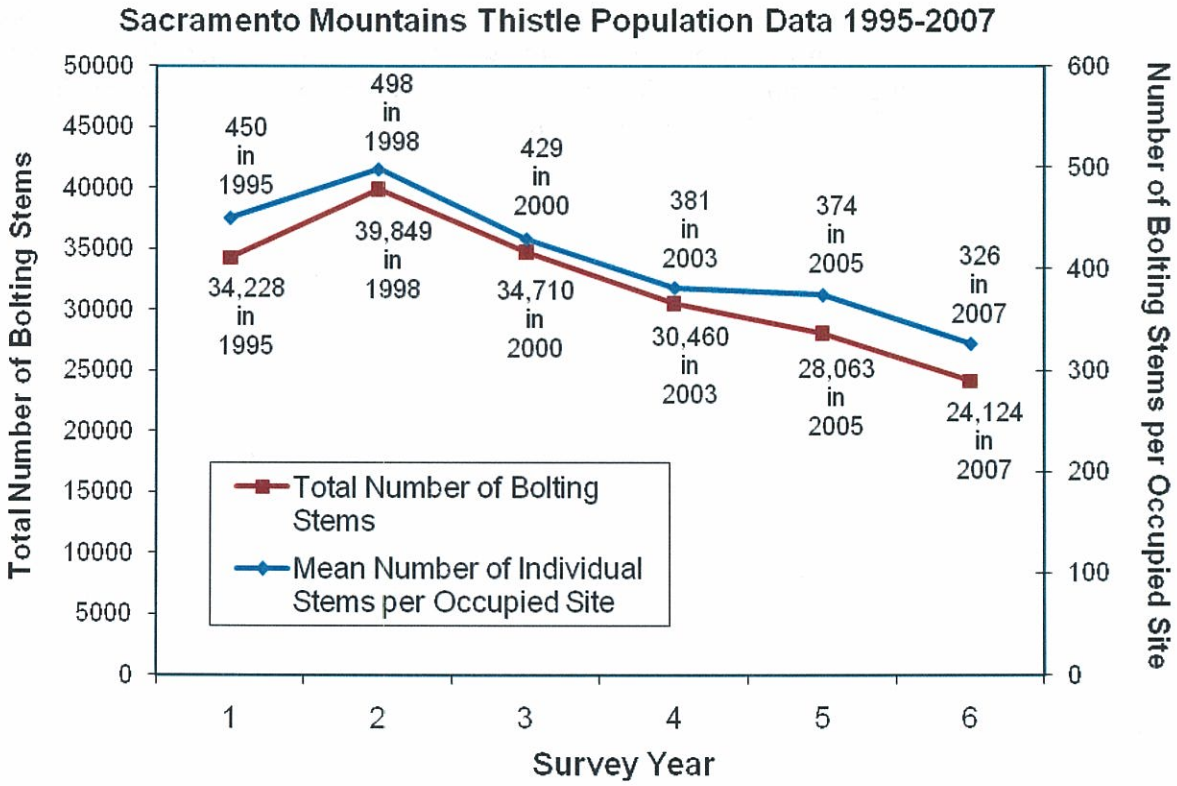

Figure 2. Number of bolting stems of Sacramento Mountains thistle (1995-2007).

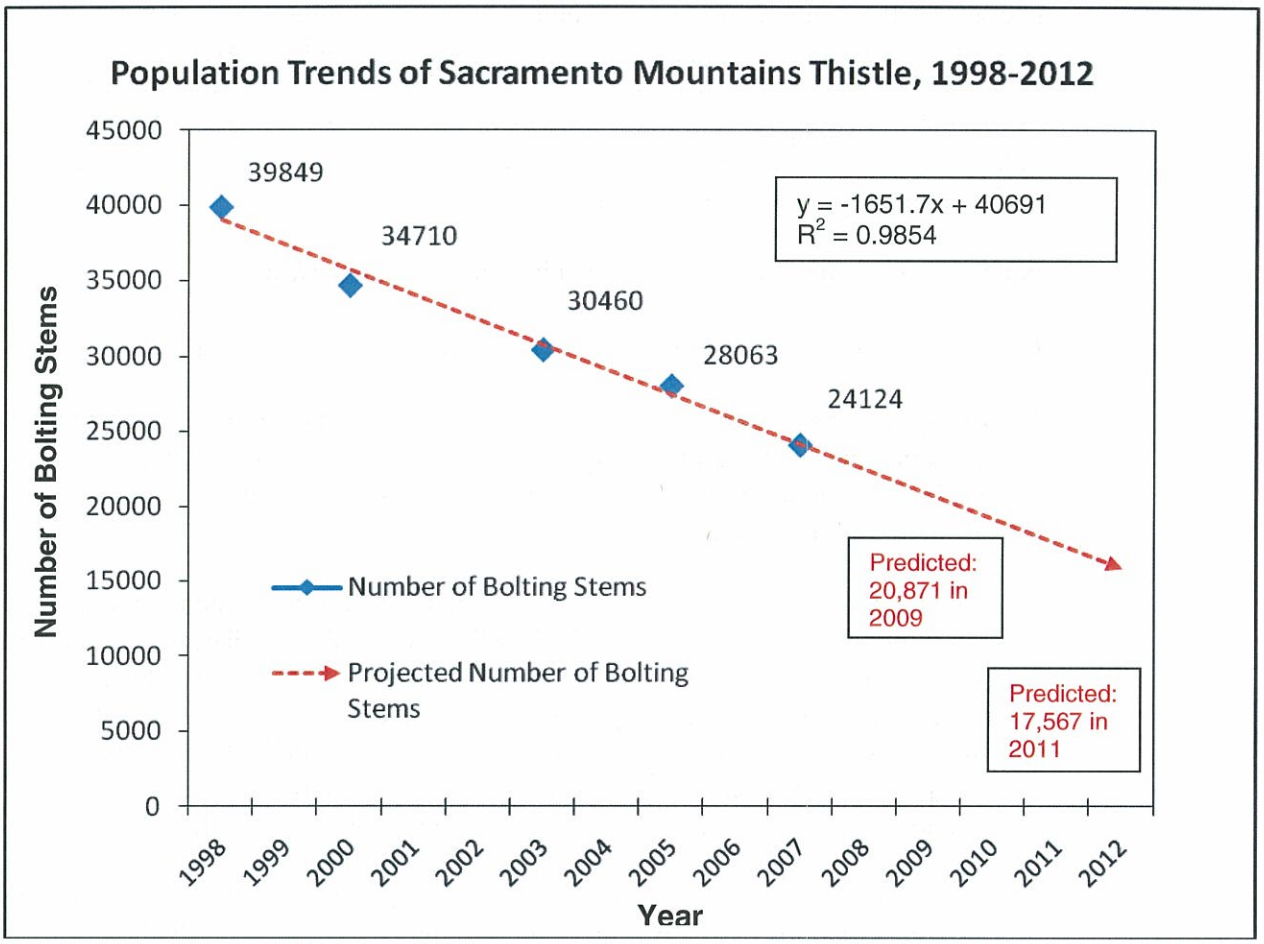

Figure 3. Future predicted number of bolting stems of Sacramento Mountains thistle for 2009 and 2011 using trend data from 1998 through 2007.

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

The sympatric native thistle species, Parry's thistle (*Cirsium parryi*) and Wright's marsh thistle (*Cirsium wrightii*), are capable of crossbreeding with *Cirsium vinaceum* to produce hybrid offspring (Barlow-Irick 2002). *Cirsium wrightii* is another endemic, wetland thistle and is sympatric with *C. vinaceum* at only one location (Silver Springs) where hybrid offspring are uncommon. *Cirsium parryi* is relatively common through much of the mountain range and will occasionally hybridize with *C. vinaceum* at a few other locations (Barlow-Irick 2007). Huenneke (1996) suspected that the barriers to hybridization between *C. vinaceum* and the sympatric congener *C. parryi* had broken down, and listed hybridization between these species as a potential threat. Keil (2006) stated that *Cirsium* species of remarkably different morphologies are able to hybridize but only the presence of complex hybrid swarms indicates a lack of breeding barriers. Barlow-Irick observed that in areas where *C. vinaceum* crosses with *C. parryi* and *C. wrightii*, only a few hybrid plants were produced and no hybrid swarms were present (Barlow-Irick, personal communication, 2006). However, during 2007,

hybrids between *C. vinaceum* and *C. parryi* were found at many of the sites, suggesting that the previous year of above-average precipitation was more favorable for the germination and survival of these hybrids (Barlow-Irick 2007). However it is unknown whether or not the hybrids are viable and if introgression of genes from *C. parryi* into the *C. vinaceum* population is possible (Barlow-Irick 2007). Neither the viability of these hybrid offspring nor their ability to backcross with the parent species has been studied.

2.3.1.4 Taxonomic classification or changes in nomenclature:

Cirsium vinaceum is a distinctive species without taxonomic controversy.

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

Sacramento Mountains thistle is a narrow endemic of the Sacramento Mountains, Otero County, New Mexico (NMRPTC 1999). At the time of listing, this thistle was known to occur in 20 populations that occupied wet travertine habitats at springs and alluvial seeps in an approximately 388 km^2 (150 mi^2) area of the Sacramento Mountains near the Village of Cloudcroft. The initial determination of 20 populations was an assessment of discrete patches of thistles, or clusters of proximate occupied sites, that were thought to experience little gene flow between patches because of geographic distance. Subsequent discoveries of several additional patches of thistles between these 'populations' and observations of seed dispersal by stream flows have significantly reduced the number of thistle patches that could conform to the traditional biological definition of a population (Craddock and Huenneke 1997). These thistle groups more likely represent subpopulations. There has not been a reassessment of the number of populations based upon this new information.

New, occupied habitat locations or sites have been discovered on the LNF since the Sacramento Mountains thistle was listed in 1987. By 1993, a total of 62 habitat sites had been identified, of which 58 were on National Forest land (USFWS 1993). In 1995 there were 77 habitat sites known to occur in the National Forest (USFWS 2004). In 2005 and 2007, the LNF cataloged 104 extant, historic, or potential thistle sites included in a monitoring program, but of these, 83 sites have been continuously surveyed since 1995 (USFS, unpublished data) (Figure 1, page 12). Most of these sites are subdivisions of the original 20 'populations', and several of these sites are very close to one another (sometimes separated by only a few meters) (USFWS 2005). Some sites consist of only a few plants that may come and go on small temporally suitable habitats that become dry during droughts and may be recolonized during wetter years (Barker, personal communication, 2006). Therefore, the 104 thistle sites identified by the USFS cannot be meaningfully compared for numeric significance to the original 20 populations identified at the time this species was listed as threatened.

The known geographic range of this thistle has not been significantly expanded by post-listing discoveries of additional thistle patches. The range occurs approximately 10 km (6 mi) northeast to 27 km (17 mi) south of Cloudcroft. All but one (Fresnal Canyon) of the new thistle locations are located within the 401 km^2 (155 mi^2) critical habitat area identified in the 1984 listing proposal (USFWS 1984). The small patch of thistles in Fresnal Canyon (outside this area) is probably the type locality for the species. It was believed to be extirpated when this species was listed, but this habitat is a historical location that is now known to still exist. This site likely became reoccupied as a result of a USFS road management action that increased water supply to the site (USFS 2004). Within the range, habitat areas covered by thistle patches vary in size from a few tens of square meters to several thousand square meters. The total habitat area occupied by all Sacramento Mountains thistle patches in 2007 comprises roughly 28 ha (70 ac), based on estimates from field monitoring.

Greater than 95 percent of the known thistle habitats occur on the LNF (Figure 4, page 17). There are two patches of Sacramento Mountains thistle on the Mescalero Apache Reservation near its southern boundary (Mendez, pers. comm. 2006). The extent of thistle habitats on private property in-holdings in the national forest is unknown, but there is one small patch of thistles on a private property seep in Fresnal Canyon that is visible from State Highway 82 (Sivinski 2009a).

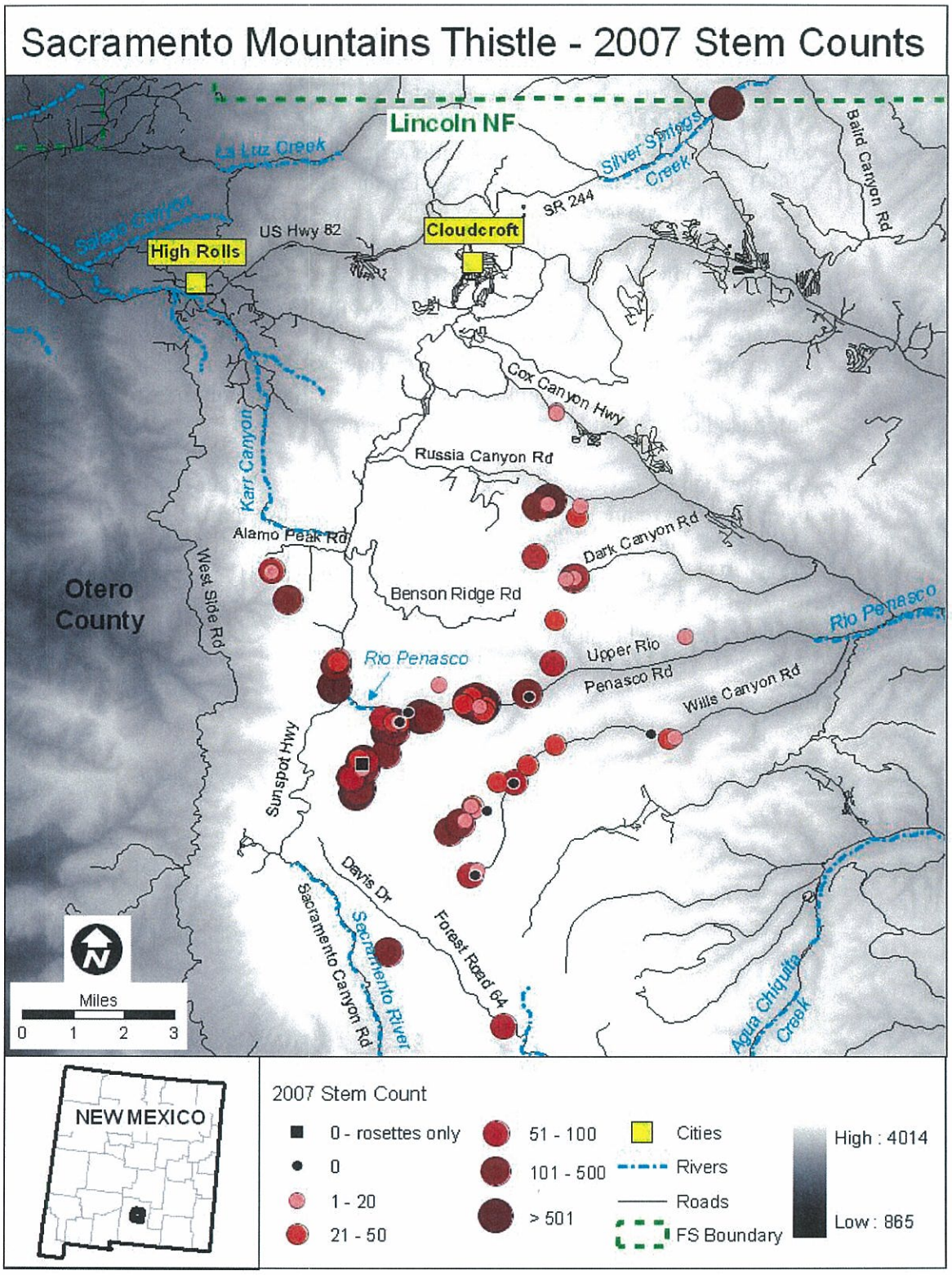

Figure 4. Map of Sacramento Mountains thistle locations and stem counts.

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

This thistle is a wetland species confined to wet travertine deposits at alkaline springs and seeps and permanently wet alkaline soils in valley bottoms. Many of the wet travertine deposits form on very steep slopes and are covered with dense patches of Sacramento Mountains thistle to the point of being nearly a monoculture of this species (Thomson 1991). Thistle patches range from fewer than 10 flowering individuals in a season to several thousand (Burks 1994).

Thistle habitats occur in mixed conifer forests and open valleys. The predominant land uses are wildlife habitat, livestock grazing, recreation, timber production, and home construction. Some land uses have directly and indirectly modified the local ecosystem from it natural condition. Disturbance and use have especially contributed to the significant variety and abundance of exotic weed species in the Sacramento Mountains. Exotic plant species associated with Sacramento Mountains thistle habitats include teasel (*Dipsacus fullonum*), musk thistle (*Carduus nutans*), poison hemlock (*Conium maculatum*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), Queen Anne's lace (*Daucus carota*), dandelion (*Taraxicum officinale*), water-cress (*Nasturtium officinale*), salsify (*Tragopogon pratensis*) and mullein (*Verbascum thapsus*) (Thomson 1991, Huenneke 1996, USFS 2000). These invasive plants have the capacity to compete with the Sacramento Mountains thistle for light (Huenneke and Thomson 1995), and possibly for water under drier conditions.

Depending on climatic conditions and other factors, native insect population fluctuations and invasions of non-native insects may impact the condition, reproduction, and distribution of the thistle (Sivinski 2007, 2008; Gardner and Thompson 2008). Sacramento Mountains thistle is a host to an undetermined number of native insect species that prey upon this plant and its flower heads. Observed seed predators include: a native, specialist Tephritid gall fly, *Paracantha gentilis*; the native Pterophorid artichoke plume moth, *Platyptilia carduidactyla*; a native, generalist Scarabaeid bumble flower beetle, *Euphoria inda*; and an introduced Curculionid seed-head weevil, *Rhinocyllus conicus* (Figure 5, page 19) (Sivinski 2007, 2008; Gardner and Thompson 2008). A fifth insect predator, the native, Curculionid stem borer weevil, *Lixus pervestitus*, appeared during field surveys in 2006, 2007, 2008, and 2009 (Sivinski 2007, 2008, 2009b). Prior to 2006, *R. conicus*, the exotic seed-head weevil, and *L. pervestitus*, the native stem boring weevil, had not been noted as predators of Sacramento Mountains thistle in its native habitat, suggesting that both may be recent immigrants to the Sacramento Mountains with the potential for future predation (Sivinski 2007, 2008, 2009b).

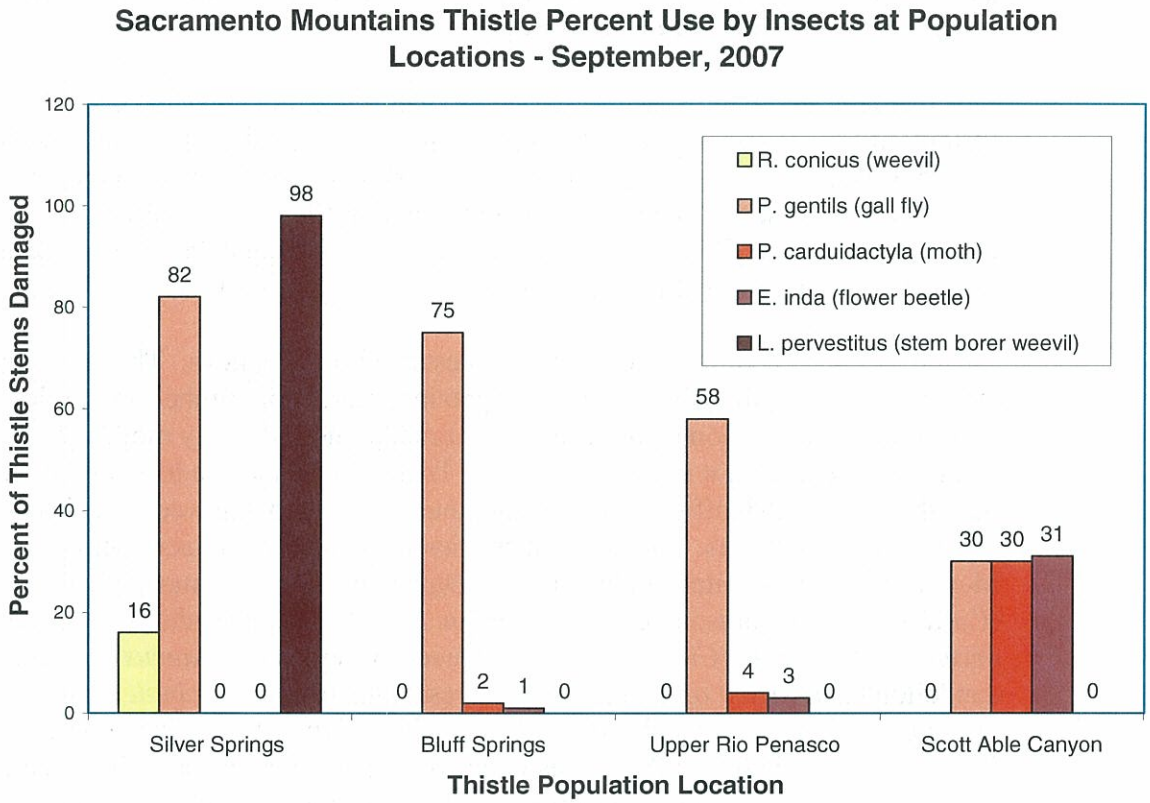

Figure 5. Damage to Sacramento Mountains thistle stems by insects at four sites in autumn, 2007 (Sivinski 2007).

Predation on Sacramento Mountains thistle by ungulate herbivores was described as minimal in the 1987 listing determination. Subsequent monitoring of herbivore impacts at several thistle patches has determined that this thistle is a forage plant of some value to livestock and, although not a preferred forage species, appears to be part of the cattle diet throughout its range. Thistle rosettes that have been grazed by herbivores early in the growing season have the ability to make compensatory growth, if the grazing ceases. Flower stems that are destroyed or severely damaged later in the season by grazing or trampling do not recover and the plant dies without producing seed. Thistle habitats may also become degraded by trampling of fragile travertine crusts (USFS 1994, 2003a, 2008a, Barlow-Irick 2008). Furthermore, long-term monitoring trends show interactions among thistles, herbivores, and climate. Thistle populations with above-average numbers of reproductive individuals are associated with sites that exhibit consistently greater levels of water flow and lower levels of grazing, compared to sites with lower average water flows and increased levels of grazing (Barlow-Irick 2007).

Surface waters through some Sacramento Mountains thistle habitats appear to flow from shallow aquifers that can become depleted during periods of drought. Habitat observations made during the dry conditions of 1994 to 1996 found that many areas of travertine surface were completely dry and several areas previously mapped as springs or seeps had no water flow at all. Large thistle rosettes were

persisting in these areas, but few or no seedlings were found at these drier sites (Huenneke 1996). Between 1998 and 2005, Barlow-Irick (2005) observed the complete loss of thistles at 10 of the National Forest habitat sites, presumably from the effects of a long period of drought. By 2007, 1 population had returned but 2 more were lost, totaling 11 populations lost in the past 10 years (Barlow-Irick 2007), possibly associated with drought conditions (USFS 2007).

2.3.2 Five-factor analysis (threats, conservation measures, and regulatory mechanisms):

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

***Water*:** Sacramento Mountains thistle is a wetland plant that occurs only on water-saturated substrates of springs and seeps on hillsides and valley bottoms. Loss of water from thistle habitats occurs naturally through precipitation patterns and shifts in travertine deposits and slopes, or as a result of human impacts from direct or indirect water diversion. Appropriation of water rights from springs for a "beneficial use", such as livestock water, farming, domestic use, or recreational facilities, usually uses points of diversion that curtail natural surface flows. At the time of listing, one point of diversion for a water right was taking spring water from an occupied Sacramento Mountains thistle habitat on the LNF under a special use permit (USFS 1989). A few water diversions from travertine springs in this region presently exist on the Tularosa Basin side of the Sacramento Mountain range. One diversion for a residential subdivision currently is taking water from an aquifer on private property above a small thistle habitat in Fresnal Canyon and has been for several years (Sivinski, unpublished observation, 2005). The most notable is an Alamogordo municipal water diversion that has completely captured and dried a large travertine spring complex in upper Alamo Canyon.

There have been no additional special use permits issued by the USFS for diversion of water from thistle habitats since this species was listed as threatened in 1987 (Barker, personal communication, 2006). If any other points of diversion exist within thistle habitats on private lands, they are not known to the reviewers.

The 1987 listing determination for Sacramento Mountains thistle prompted the USFS, Region 3, Deputy Regional Director to ask the Forest Supervisor of the LNF to prepare a Memorandum of Understanding (MOU) between the USFS, Service, and State of New Mexico detailing a process for site selection of water diversions from thistle habitats (USFS 1987). To date, an MOU concerning points of diversion has not been pursued or accomplished.

The Sacramento Mountains thistle recovery plan prescribes the acquisition of water rights for the sole purpose of protecting 30 percent of the thistle habitats on springs as a criterion for recovery (USFWS 1993). Water rights at upland travertine springs sites have not yet been acquired for this purpose and may be

difficult to acquire in the foreseeable future. The State of New Mexico recently adopted legislation establishing a strategic water reserve to manage water for interstate stream augmentation to benefit threatened or endangered aquatic or obligate riparian species (NM ST § 72-14-3.3, 2007). Sacramento Mountains thistles associated with riparian areas potentially could be protected in these habitats. However, the Sacramento Mountains thistle is not always found in association with riparian systems, leaving most occupied sites, particularly at upland spring and travertine shelf habitats, inadequately protected. In areas outside of riparian habitats supporting rare aquatic species, New Mexico water law allows the acquisition of a water right only for a beneficial use, which has yet to include the benefit of maintaining water flow to provide habitat for wild plants or animals that have no direct economic purpose. The State Engineer does have the ability to protect a water resource to further a 'State Conservation Goal;' however, such an action involving the actual granting of a water right for protection of Sacramento Mountains thistle habitat has not yet occurred.

Protection of most thistle habitats from water withdrawal must rely upon the LNF special use permit process to approve suitable points of diversion for the exercise of a water right. Currently, the diversion intake point specified in a special use permit takes into account the presence of any Sacramento Mountains thistle occurrences to the extent allowed by state laws regulating domestic water intake. However, there is no solid protection of water access for the thistle by the state of New Mexico because there is no process through which to review a proposed action and its consequences. Recovery action 1.11 in the recovery plan specifies a clear, written policy by the USFS on points of diversion that will maintain surface flow through thistle habitats before the water is diverted. The LNF has not yet proposed or adopted such a policy.

Several thistle habitats have been subjected to direct and indirect impacts from land uses that damage travertine substrates and hydrological characteristics. Some of the roads and trails that support regional access for timber harvest and management, ranching operations, recreation, and residential developments occur in, or adjacent to, many thistle habitats. In 2001 and 2002, a riparian improvement project in Water Canyon and the Rio Penasco improved drainage under roads. This conservation measure has increased water availability in former occupied habitat, allowing the thistle to reoccupy these sites (USFWS 2005). Concentrated use by livestock, recreationists, and elk may also damage some of these fragile thistle habitats. The USFS mitigates some of these impacts by closing and rerouting trails and roads, designating no-impact buffer zones, and enclosing thistle habitats with fences, and other methods to disperse concentrated use whenever specific land use conflicts are anticipated or become obvious. These remedies are often the result of management proposals or permitting actions that require Section 7 Consultation or NEPA review. Sacramento Mountains thistle will receive consideration for impact mitigation during the management planning and land use permitting on the LNF for as long as it is listed a threatened species under the ESA.

The human population in Otero County, New Mexico, increased by 4.3 percent from 1990 to 2000 and is expected to increase 12.7 percent between the years 2000 and 2020 (UNM 2006). This increasing population and associated agricultural and economic activities will require additional water from this relatively dry region. Aquifers in the Sacramento Mountains are susceptible to appropriation by existing water rights and development of new water rights, which could drain thistle water sources and pose future threats to the thistle.

Huenneke (1996) expressed concern that climate change resulting from global warming and altered precipitation patterns could have a severe effect on Sacramento Mountains thistle's chances of survival if it produced an increased frequency of drought in the Sacramento Mountains region. This species has survived several previous long-term droughts during the last 2,000 years, which are indicated by New Mexico tree ring analysis (Grissino-Mayer et al. 1997). However, the potential influences of exotic plants, introduced insect predators, livestock grazing, and water appropriations were not important variables during previous periods of long-term drought. These additional factors cumulatively could affect this species' ability to withstand future drought conditions.

Exotic Weeds: Thomson (1991) studied the germination requirements of Sacramento Mountains thistle and exotic teasel and found that teasel germinates well in light and dark conditions while Sacramento Mountains thistle seed germinates best in well-lit conditions. Huenneke and Thomson (1995) surmised that if a dense cover of teasel, or other exotic weeds, became established in thistle habitats, thistle germination would be inhibited by access to light, and the population might decline. Huenneke (1996) also noted that during drought, the drying soils in thistle habitats provided excellent conditions for teasel and other non-native plants, possibly lending non-natives a competitive edge in drier conditions.

Field observations during the biennial monitoring of thistle patches from 1998 to 2005 by Dr. Barlow-Irick do not support the inferences made by Huenneke and Thomson (1995) and Huenneke (1996) concerning the potential for the existing group of exotic plant species in the Sacramento Mountains to modify Sacramento Mountains thistle habitats. This monitoring period occurred during a prolonged period of drought and did not document an increase of weeds in thistle habitats. In 2005, Barlow-Irick (2005) noted that "Weed numbers, in general, were less than in prior years. Most notably hemlock was almost totally absent. Five years of observing these sites leads me to conclude that the weeds do not crowd out the thistles, but rather occupy the margins of the (Sacramento Mountains thistle) habitat in a stable pattern."

The presence of teasel, musk thistle, bull thistle, and poison hemlock in and near Sacramento Mountains thistle habitat has been cause for concern and has been observed and monitored for many years. Of these, only poison hemlock is an obligate wetland species and it, apparently, does not compete well with Sacramento Mountains thistle (Barlow-Irick 2005). The other three weed species

are facultative for soil moisture, but cannot tolerate the continuously saturated substrates that are typical in thistle patches on spring habitats. These weeds can grow side by side with Sacramento Mountains thistle in drier habitat margins and in alluvial habitats where Sacramento Mountains thistle is sub-irrigated and the root systems of these weeds occupy the drier near-surface soils (Sivinski, unpublished observations, 1992-2006). As present, musk thistle is infesting much of the forest (Barlow-Irick 2007) and continues to intermingle with Sacramento Mountains thistle.

The Sacramento Mountains presently lack large, aggressive, exotic wetland weeds, such as purple loosestrife (*Lythrum salicaria*), that can dominate thistle habitats. Purple loosestrife is a Eurasian species that has been modifying wetlands and crowding out native species in North American for many decades (NRCS 2006). Purple loosestrife arrived in New Mexico in the 1990s and is extant in the Mimbres Mountains of Grant County and the Sandia Mountains of Bernalillo County. The Sandia Mountains occurrence of this invasive weed covers an alkaline spring seep similar to thistle habitats in the Sacramento Mountains (Sivinski, unpublished observations, 2006). If it also arrives in the Sacramento Mountains, this aggressive wetland weed would be capable of seriously impacting Sacramento Mountains thistle habitats.

***Forestry*:** Historically, negative effects of timber harvest and management on Sacramento Mountains thistle habitats have been associated with roads and other surface disturbance that directly impacted thistle habitats or made changes in habitat hydrology and erosion. To prevent further damage to travertine substrates from roads supporting regional access to timber harvest, timber sale proposals by the LNF have prescribed 200-foot buffer zones between timber harvest and wetland areas, and the exclusion of all equipment from wetland areas with thistle habitats (USFWS 1991) in accordance with the guidelines of the Interim Management Plan (USFS 1989). Soil and vegetation disturbance can cause indirect hydrologic and erosional impacts to thistle sites and be detrimental to thistle individuals. Despite managed protection, mortality to thistles growing in moist areas along roadsides occasionally occurs from mowing, road maintenance, or herbicides (Tonne 2007; Guaderrama, pers. comm. 2007).

***Recreation*:** Recreational impacts to Sacramento Mountains thistles from human destruction have been noted to occur at the Bluff Springs habitat location (USFWS 1993, USFWS 2008, Barlow-Irick 2008, USFS 2008b, USFWS 2010). The LRMP (2005) prescribed managing Bluff Springs for dispersed recreation while providing for Sacramento Mountains thistle management. Fencing around thistle stands in this area has been maintained and foot trails rerouted to protect this population (USFS 2003b). After construction of the fence in 1983, thistles exhibited a rebound at Bluff Springs, but since 1995 the number of individuals declined to one-fourth the abundance in 2005, with a small rebound in 2007 (Figure 6, page 24). Barlow-Irick (2008) believes the systematic destruction of Sacramento Mountains thistle that she has observed over the years at the Bluff Springs waterfall habitat is partly due to the public not being informed about this

plant species and its conservation status. Recreationalists have also been observed driving ATVs through other exclosures typically fenced to exclude livestock; cut fences and opened gates have been noted in the same exclosed areas (USFS 2008b).

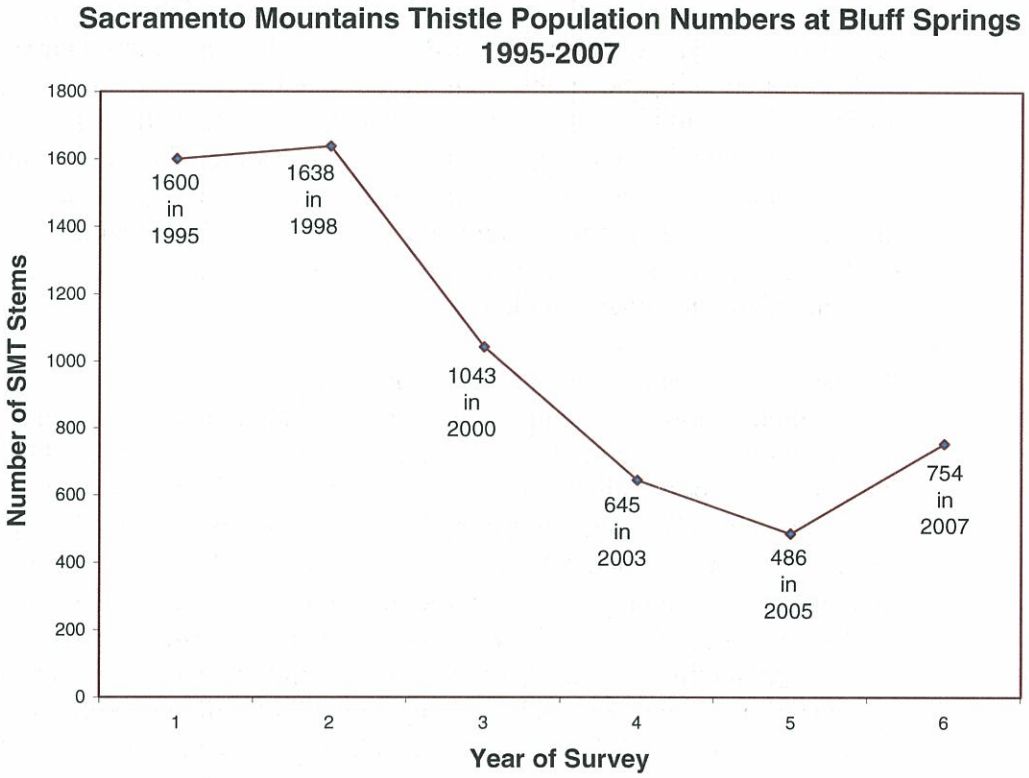

Figure 6. Bluff Springs Sacramento Mountains thistle numbers in response to fencing constructed in 1983 to protect thistles from human foot traffic.

***Livestock and wildlife*:** Grazing and trampling of Sacramento Mountains thistle by livestock and wildlife can reduce photosynthetic tissue, damage seedlings, rosettes, and flowering stems, as well as inflict hoof damage to travertine and soft substrates in occupied and potential habitat (Thompson 1991; USFS 1994). During the recent period of drought, Dr. Barlow-Irick expressed concern regarding the compaction and pulverization that she observed in drying travertine sites (thistle habitats) subject to livestock trailing (Barlow-Irick 2005). This damage causes a loss of normal structure that may inhibit seed germination and seedling establishment when water flows return to these sites. In addition, water-flow channels within the travertine may be damaged or redirected by heavy trampling (USFS 2003a), which may adversely affect germination substrates and inhibit thistle seed movement and dispersal by flowing water. Under normal conditions, but especially during droughts, thistle habitats on travertine springs and the soft-bottom valley habitats provide the majority of watering locations for livestock and elk. These fragile habitats are subjected to trampling and hoof damage, but the effects of this damage on thistle reproduction and persistence have not been specifically studied.

The Interim Management Plan (USFS 1989) prescribes salting locations for livestock located no closer than one-half mile to thistle habitats to avoid further concentrating livestock in these areas.

At present, Sacramento Mountains thistle habitats continue to be exposed to livestock with consistently detrimental effects to the thistle, particularly on the Sacramento Grazing Allotment (USFS 2007). The Sacramento Grazing Allotment contains the greatest number of potential sites, occupied sites, numbers of individuals, and acreage of the Sacramento Mountains thistle. It also contains the greatest number of extirpated populations. Of the 75 occupied sites in 2007, 68 were within the Sacramento Grazing Allotment, with approximately 62 percent of the total number of thistle stems for the species. The remaining sites occurred in 4 other allotments, consisting of 7 occupied sites and a combined total of 38 percent of the flowering thistle population.

Livestock management practices to control herbivory and trampling and to ensure the suitability and sustainability of thistle habitat have been implemented, such as the construction of 23 exclosure fences covering approximately 117 ha (290 ac) around thistle populations located in the Sacramento Grazing Allotment. Within the Sacramento Grazing Allotment, fencing exclosures protect 23.5 percent of the area of known occupied habitat in the Sacramento Allotment. Three more grazing exclosures have been proposed in the Sacramento Allotment (Telephone Canyon, Wills Canyon, and Water Canyon) with the goals of restricting cattle access to thistles, protecting bank stability, and maintaining vegetative cover, but the construction of these fences is pending based on funding (USFS 2007). Some fenced sites now have Sacramento Mountains thistle extending outside exclosures, indicative of the positive effects of excluding cattle.

Within the Sacramento Allotment, livestock routinely have been sighted in exclosed areas due to unmaintained fencing and have been documented drifting from their prescribed winter range into resting summer pastures before the set entry date (USFS 2003a, 2007, Barlow-Irick 2008). One occupied site continues to be a location for cattle drives twice each year (USFS 2003a). Forage use in the Sacramento Allotment regularly exceeds 35 percent utilization as measured by stubble height, as given in the range use guidelines (USFS 2007).

In 2007, the USFS changed from a deferred rotation grazing strategy (i.e. each pasture would be grazed during half of the summer season, alternating early and late season use annually) to a continued seasonal grazing system within the Sacramento Allotment. Implementation of this change allows livestock to be present in the two summer pastures occupied by the Sacramento Mountains thistle within the Sacramento Allotment for the entire summer season (May 15th to October 31st) (USFW 2006, 2007). Given that forage use and documented thistle herbivory peak early and late in the summer, increased exposure to livestock during the summer season may not provide the thistle an opportunity to recover within grazed areas (USFS 2007). Dry conditions in the region also have exacerbated grazing effects at thistle sites (Barlow-Irick 2007). Sites protected

from livestock appear to demonstrate higher flowering stem densities than those sites not protected. Effects of this extended grazing season upon the thistle since 2007 and the reissuance of a new 10-year term grazing permit in December 2009 are currently undergoing section 7 consultation (USFS 2009).

Of the 104 Sacramento Mountains thistle sites monitored within all allotments, with 75 occupied as of 2007, 32 occupied sites (43 percent) are protected from livestock access through fencing, resting allotments, or steep terrain, and 42 occupied sites (57 percent) are exposed to livestock. In terms of the 24,124 individual thistle stems counted during 2007, 17,180 individuals (71 percent) are protected from livestock and 6,944 individuals (29 percent) remain exposed.

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

Sacramento Mountains thistle is not being used for any commercial or recreational purposes. Scientific and educational activities have taken a few thistle seeds and seed heads for research projects intended to understand and benefit this threatened thistle. Such research requires permits from the Service, USFS, and State of New Mexico.

2.3.2.3 Disease or predation:

***Exotic diseases*:** At least three exotic species of fungi in the genus *Puccinia* have been released and have become established in North America as biocontrol agents for non-native thistles and knapweeds (Dodge 2005, APHIS 2002). Lab tests for risk analysis with Sacramento Mountains thistle showed no susceptibility to *Puccinia jaceae* var. *solstitialis* (APHIS 2002) or *Puccinia carduorum* (APHIS 1997). Risk analysis for *Puccinia punctiformis* showed no persistence on tested North American species of *Cirsium* (Dodge 2005). These exotic fungi could spread to, or be released in or near, the Sacramento Mountains, which would determine Sacramento Mountains thistle's susceptibility under actual field conditions. To date, no obvious symptoms of disease have been reported in any Sacramento Mountains thistle populations.

***Insect predators*:** The number of species preying upon Sacramento Mountains thistle is not precisely known, and likely consists of occasional generalists and some specialists whose populations respond to climatic conditions and variations in the thistle's quality and availability as a food source. Generalist grasshoppers, beetles, and aphids use the thistle but generally do not impact thistle populations (Sinviski 2007). Burks (1994) determined that overall seed predation by insects consumed or damaged roughly 17 percent of the seeds produced by this thistle before dispersal. She also found the level of seed predation within individual patches of thistles was not significantly correlated to thistle population size, but did increase as thistle density increased. Burks' (1994) study of predispersal seed predation did not identify the insect predators, but they were assumed to be native species.

More recently, Sivinski (2007, 2008) documented insect seed predation and herbivory of Sacramento Mountains thistle in late summer within four thistle population zones: Silver Springs, Bluff Springs, Upper Rio Penasco, and Scott Able Canyon (Figure 7, page 31). Four native and one introduced insect species damaged flower heads or caused premature stem death of the thistle (Sivinski 2007, 2008). Four significant flower head and seed predators were: 1) a native, specialist tephritid gall fly (*Paracantha gentilis*); 2) a native pterophorid artichoke plume moth (*Platyptilia carduidactyla*); 3) a native, generalist scarabaeid bumble flower beetle (*Euphoria inda*); and 4) an introduced curculionid flower head weevil (*Rhinocyllus conicus*) (Sivinski 2007). The fifth insect predator, the native curculionid stem borer weevil, *Lixus pervestitus*, appeared during field surveys in 2006, 2007, 2008, and 2009 (Sivinski 2007, 2008, 2009b). In September, 2007, these insect predators collectively had damaged flowering stems in significant proportions: up to 98 percent within the Silver Springs population; 80 percent of the Bluff Springs population; up to 66 percent in the Upper Rio Penasco population; and 90 percent of the Scott Able Canyon population (Sivinski 2007). Although Sacramento Mountains thistle rosettes can reproduce asexually from rhizomes, seed production from insect attack was significantly reduced from 2007 to 2009 in the large, Silver Springs population, particularly as a result of the stem boring weevil (Sivinski 2007, 2008, 2009b).

Native thistle gall fly: The native tephritid, *Paracantha gentilis* Hering, was the most common and significant seed head predator across the 4 surveyed populations, with use ranging from 28 to 82 percent of thistles randomly sampled in September of 2007 (Sivinski 2007). This is a native *Cirsium*-specific gall fly that lays its eggs in thistle flower heads on the floret corollas as flowers are emerging from the phyllaries (Sivinski 2007). The fly maggots consume many, and sometimes most, of the developing seeds in a host flower head and then pupate in the flower head. Sivinksi (2007) found flower heads with 1-5 puparia can produce several mature seeds, but flower heads with more numerous puparia, possibly from multiple females, produce little or no seed. Smaller Sacramento Mountains thistle populations or low flower stem densities within larger populations had lower numbers of fly puparia overall and generally fewer puparia per thistle flower head (Sivinski 2007).

Native artichoke plume moth: This pterophorid moth is widespread across North America. Larvae of *Platyptilia carduidactyla* eat the apical meristems and flower heads of the Sacramento Mountains thistle as well as other thistle species, including agricultural crops of artichokes (Sivinski 2007). Silky cocoons with emerging parasitoid wasps of this moth species also were found in the flower heads (Sivinski 2007). These moths were common at the Scott Able Canyon sites (30 percent of flower heads) but were rare at the Rio Penasco sites (4 percent) and Bluff Springs (2 percent) (Sivinski 2007). No larvae of this species were found in the Silver Springs population (Sivinski 2007).

Native bumble flower beetle: This species, *Euphoria inda* (Linnaeus), is a large, generalist scarab beetle that consumes flowers and fruits (Sivinski 2007). It is

found throughout the Sacramento Mountains and in other localities in New Mexico. As a larva, this beetle develops in the soil consuming detritus (Sivinski 2007). Attacking the thistle late in the season, the adult form of this beetle burrows into the flower heads through the corollas and pappas and consumes the ovaries (Sivinski 2007). Uneaten ovaries can remain to form seeds, but often all seeds are consumed (Sivinski 2007). During 2007, *E. inda* was detected in 31 percent of the thistle flower heads in Scott Able Canyon but was far less common in Rio Penasco (3 percent) and Bluff Springs (1 percent) seed heads (Sivinski 2007). Flower heads at Silver Springs did not show any evidence of this beetle (Sivinski 2007).

Native stem boring weevil: *Lixus pervestitus* (Chittenden) was responsible for an extreme die off in the several thousand-stem Silver Springs (also known as James Canyon Allotment) population in September of 2006 and 2007, before most of the flowers had set seed (Sivinski 2007). The population totaled 8,727 stems in the summer of 2007. By the end of September, 98 percent of these stems were prematurely dead or dying (Sivinski 2007). The timing of the stem borer's attack left the possibility of seed maturity and production to only the earliest blooming flower heads, greatly reducing the thistle's reproductive output for this population (Sivinski 2007, 2008). Immature thistle rosettes, however, did not experience significant use by any native or non-native insects during a 2006-2007 field study (Sivinski 2007). Insect damage to the Silver Springs site was compounded by effects of the flower head weevil and the gall fly reducing seed production earlier in the flowering season, followed by the stem borer weevil severely damaging flowering stems into early fall (Sivinski 2007). Surveys in Silver Springs Canyon in autumn of 2008 and 2009 found that *L. pervestitus* had killed the vast majority of the flowering stems, again exhibiting almost a complete die-off at this locality (Sivinski 2008, 2009b).

At the Silver Springs site, stems of *Carduus nutans* and native *Cirsium parryi*, growing alongside *C. vinaceum*, were healthy and not used by *L. pervestitus*, indicating a preference for the Sacramento Mountains thistle (Sivinski 2007). Although *L. pervestitus* is an indigenous weevil, little is known of its biology, and its presence in the Sacramento Mountains was not noted before 2006 (Sivinski 2007). It is a strong flier and may spread to other Sacramento Mountains thistle populations. Its sudden population explosion may be part of a typical boom-bust cycle for this weevil, and it could be interacting with favorable environmental conditions created by the recent intermittent drought and mild winters (Sivinski 2007). Furthermore, it has not been found in thistle populations other than the Silver Springs habitat, which suggests this insect is a recent immigrant to the Sacramento Mountains (Sivinski 2007).

To investigate whether *Lixus pervestus* had other host plants within the plant community, Sivinski (2008) surveyed Otero and Lincoln county thistle species along with other large species in the plant family Asteraceae. No other alternate plant hosts were identified in the survey, leaving the use of plants other than *Cirsium vinaceum* a mystery (Sivinski 2008).

Exotic seed head weevil: *Rhinocyllus conicus* (Frolich) was identified as a potential threat to the Sacramento Mountains thistle in the recovery plan, even though this invasive weevil had not yet reached the Sacramento Mountains (USFWS 1993). This seed-head weevil (indigenous in Eurasia) was intentionally introduced to North America in 1969 as a biological control agent for musk thistle, a noxious weed. It subsequently spread to at least 26 states on both musk thistle and native thistle species and is also frequently distributed by deliberate introduction on both private and public lands (Dodge 2005).

Rhinocyllus conicus eggs are laid externally on bud bracts, either individually or in small clusters of two to five eggs. Caps of masticated host plant material, which appear as warts, cover the eggs. Larvae hatch after six to nine days and bore through the bracts into the receptacle. Larvae feed on both the developing receptacles and the florets. The pupal period is 7 to 10 days, and pupae usually are found from mid-June through July. A partial second generation may be found in late August and September (USFS 2005).

The ability of *R. conicus* to attack native thistle species, decrease their seed production, and displace native insect thistle predators is well documented (Louda 2000, Louda et al. 2003, Dodge 2005, Rose et al. 2005). A greenhouse trial at Utah State University demonstrated that *R. conicus* is capable of attacking Sacramento Mountains thistle (Huenneke 1996), and this recently has been demonstrated in the field (Sivinski 2007).

In 2001, *R. conicus* was found attacking musk thistle in two locations in the Sacramento Mountains near Ruidoso (USFWS 2004). By 2006 and into the summer of 2007, it was found in musk thistle heads in the Silver Springs area and as far south as the upper Rio Peñasco, in the immediate environment of Sacramento Mountains thistle (Thompson, personal communication, 2006; Barlow-Irick 2007).

Sivinski (unpublished observations, September 4, 2006) found all the Sacramento Mountains thistle mature seed heads he examined (n = 50 in 2006) at the Silver Springs population were damaged by insects. Most contained the puparia of *Paracantha gentilis*, a native gall fly. No pupae of *R. conicus* were found, possibly because the adult weevils had already emerged and were no longer detectable. A preliminary field study of the presence and damage of *R. conicus* in the Silver Springs area found the weevil using 63.8 percent of the flower heads in mid July, 2007 (Sivinski 2007). During mid-August, 2007, a similar survey of flowering stems was conducted which determined use had dropped to approximately 17 percent of the remaining flowering stems that had not yet experienced premature stem and floral death from *Lixus pervestitus*, the stem borer weevil (Sivinski 2007). In July, 2008, 87 percent of the early flower heads examined contained *R. conicus* egg caps, up 22 percent from 2007 (Sivinski 2008). During autumn 2007, 2008, and 2009, most of the mature flower heads had died prior to seed maturation (Sivinski 2008, 2009b). Damage to late flower heads was caused by combined effects of both *Paracantha gentilis* and *R. conicus*

(Sivinski 2008). Stands of musk thistle can be reduced by 80 to 95 percent when *R. conicus* becomes established (USFS 2003a). Musk thistle is common throughout this range of mountains and will continue to facilitate the spread of this invasive weevil.

Rhinocyllus conicus is not the only exotic insect released in North America to control weedy thistles. Thus far, at least eleven exotic insect biocontrol agents have been released for control of noxious non-native thistles and at least eight of them readily accept *Cirsium* species as hosts (Dodge 2005). Three of these may be problematic for Sacramento Mountains thistle because they are presently established on native and non-native thistles in the southern Rocky Mountains of Colorado (Dodge 2005) and could eventually spread to the Sacramento Mountains, or be deliberately released there. These are *Larinus planus* – another seed-head weevil released to control Canada thistle, *Trichsirocallus horridus* – a rosette weevil released to control musk thistle, and *Urophora stylata* – a tephritid seed-feeding fly released to control bull thistle. The thistle rosette weevil has been released and has established in Colorado, creating the possibility of a migration into New Mexico in the future.

Native insect seed predators can consume from 17 to 98 percent of this thistle's seed production within a population, but thus far have not limited the thistle's ability to fully occupy suitable habitats (Burks 1994, Sivinski 2007). The addition of an invasive seed predator would further decrease seed production, but the effect on this thistle's populations is, as yet, unknown. The ability of Sacramento Mountains thistle to reproduce asexually via rosettes on rhizomes may mitigate the effects of increased seed predation or stem boring in large patches of thistles, if exotic rosette weevils arrive and contribute to predatory pressures. Small thistle patches, under attack by seed predators, may more easily die-out because of seed limitations. These small habitats could remain unoccupied for longer periods because nearby large patches of thistles would be dispersing fewer seeds for the recolonization of unoccupied habitats.

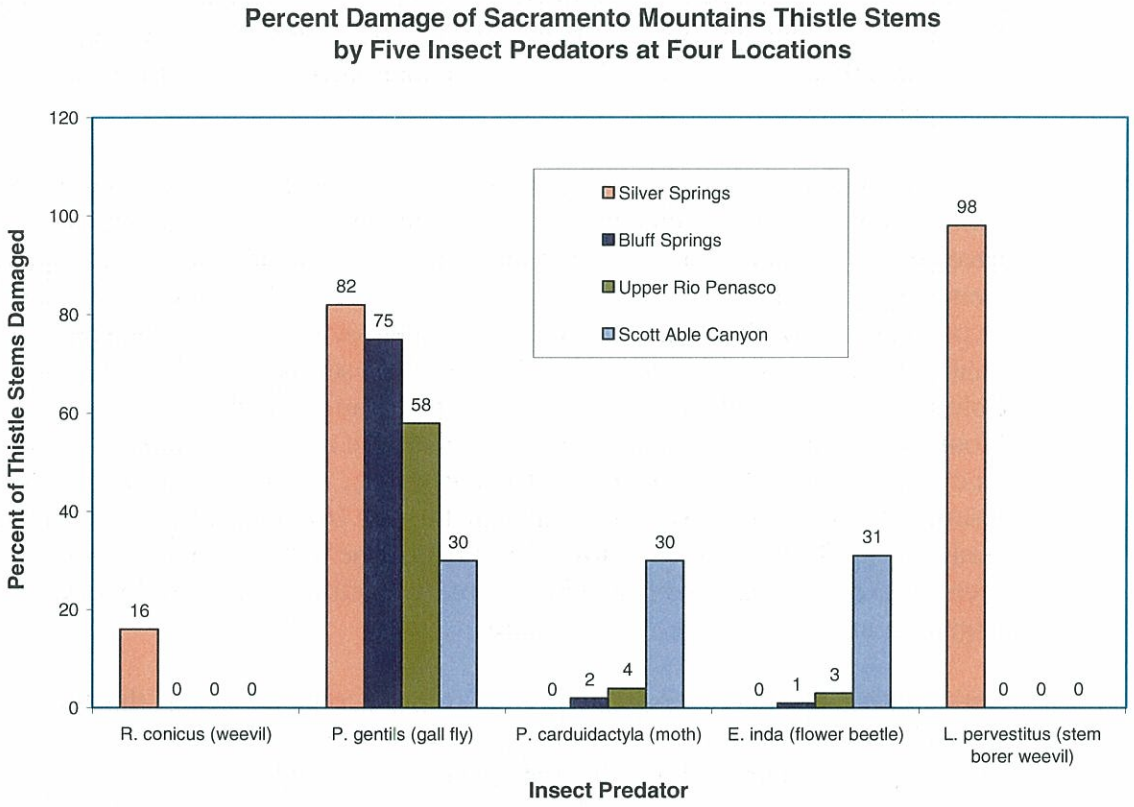

Figure 7. Damage by five insect species to Sacramento Mountains thistles at four locations (Sivinski 2007).

***Livestock grazing*:** Predation by livestock was determined to be a minimal threat when Sacramento Mountains thistle was listed as a threatened species despite some pre-listing observations that domestic livestock grazing caused severe impacts on some patches of thistle. Todsen (1976) noted that the thistle population in Silver Springs Canyon had only a few scattered plants on the side of a pasture fence where livestock were permitted to graze. The USFS (1978) noted that the thistles in a wet meadow above Bluff Spring occurred only within a small fenced-in area that excluded livestock and not in the adjacent grazed habitat. The USFS (1984) later noted that recent livestock exclusions from some habitats at Silver Springs, Bluff Springs, and Rio Peñasco had "led to a remarkable increase in numbers of *Cirsium vinaceum*" while the population in Lucas Canyon was "considerably smaller" because of livestock conflicts.

At the time of listing, the Service attributed the majority of detrimental effects on ground disturbance to livestock use of thistle habitats. Livestock threats to this thistle have since been described by several observers to include direct impacts such as loss of photosynthetic tissue to herbivory and damage to vulnerable seedlings, rosettes, and flowering stems (Thomson 1991, USFS 1994). Thomson (1991) observed that rosettes were smaller in an unexclosed, grazed population (mean rosette diameter = 17.4 ± 5.1 cm) adjacent to an exclosed population subjected only to wild herbivores (mean rosette diameter = 62.8 ± 11.3 cm).

Furthermore, the discrepancy between average rosette sizes continued for 2 months even after grazing pressures had declined (Thomson 1991). Although thistles have been documented to recover within a few weeks from light grazing (impacting less than 10 percent of known plants), livestock grazing of a thistle's flowering stalk and leaves of rosettes can contribute to the loss of the entire reproductive output of the plant (USFS 2003a). Livestock grazing in allotments with thistle habitats is permitted from May to October with peak use on the thistle occurring in June and again in September through October (USFS 1994).

The USFS (1994) conducted an intensive monitoring study of herbivory on Sacramento Mountains thistle in 1992 and 1993. Plants were monitored to determine if herbivory was significant enough to require management action. Of particular note is the annual precipitation totals for the years 1991, 1992, and 1993 that were 5 to 12 inches above the long-term mean of 27.04 inches (USFS 2003a). Due to the unusually wet conditions during the span of the study, forage other than the thistle and surface water may have been more available than during average precipitation or dry years (USFS 2003a). The biological assessment (USFS 2003a) of the Sacramento Allotment management plan summarized the conclusions of this herbivory study:

1. Wildlife herbivory on Sacramento Mountains thistle was non-existent to negligible compared to livestock herbivory. (Use was reported during the monitoring only for sites accessible to livestock.)
2. Herbivory on the thistle occurred in all months studied, May to October.
3. During 1992, percent use peaked in June (76 percent of accessible rosettes) and again in September (over 90 percent) and October (over 90 percent). In 1993, use peaked during September and October at over 90 percent.
4. This thistle was found to have the ability to put on "substantial compensatory growth following herbivory when it occurred early in the growing season prior to flowering. It is assumed that this type of compensatory growth is characteristic in all years, except possibly those of severe or prolonged drought.
5. A comparison of thistle use and other forage use was not made due to the difference in the type of data collected and the inability to conduct a statistical analysis. Use levels on other forage species were determined to have little or no obvious relationship to herbivory on the thistle. Use amounts on the thistle appeared to be more correlated to the number of plants available, time of year, and proximity to travel ways, gentle topography, and livestock congregating/resting areas.
6. Small thistle patches may be more vulnerable and at a higher risk, if grazing seriously impacts growth, vigor, seedling establishment, and reproductive output. Of the 13 monitored sites that approached or exceed grazing thresholds during the study, all but two were small or medium size thistle patches.
7. Frequency of use (the number of sites with some measurable herbivory) was generally very high throughout the study period. Within one month of cattle entering a pasture, at least 75 percent and up to 100 percent of the thistle sites

visited were found to have been impacted. This indicates that the thistle is of some value as a forage plant for livestock and appears to be part of the cattle diet throughout its range. After livestock entered South Pasture in August 1993, and in spite of widely available forage, herbivory on this thistle was detected at 100 percent of sites accessible to livestock. No herbivory was present when cattle first entered.

8. Actual use of thistle forage was relatively low overall. Over half the site visits detected less than 10 percent use of the available thistle forage. This suggests that the thistle is not an especially preferred species since a high number of sites did not receive consistently high use levels.
9. Sites that experienced heavy grazing impacts during 1992 had stable or increased plant numbers in 1993. Some other thistle sites on the National Forest that were not grazed at all also showed numerical increases during this period. Therefore, the increased thistle numbers in some grazed plots could not be attributed to the effects of grazing.

Grazing use of this thistle by elk to near threshold levels was subsequently reported for a patch of thistles in Wills Canyon where no cattle were present in 1995 (USFS 2003a).

Exceeding established threshold levels for use of thistle forage on the National Forest has occurred many times, especially during years of drought when cattle congregate and linger in wetland areas (thistle habitats) or where forage production is greater than in the dry uplands (USFS 1994, 2003a). Very dry conditions in early summer of 1996 led to an emergency consultation with the Service that resulted in use of temporary electric fencing to minimize impacts to the thistle (USFS 2003a). At other times, the USFS has allowed grazing allottees 30 or more days to move their livestock after use thresholds had been reached or exceeded (USFS 2003a).

The USFS sometimes responds to perceived Sacramento Mountains thistle/grazing conflicts by building fences intended to exclude livestock, often with good effect for thistle recovery. A habitat in Hubbell Canyon that had zero thistles in 1984, when an exclosure was built, had about 500 plants within the exclosure in 1991. A grazing exclosure built around a Lucas Canyon habitat that had 350 plants in 1984 had 3,414 thistles in 1991. A wet meadow above Bluff Spring that had only one thistle in 1976 has supported a patch of about 750 thistles since 1984 when a livestock exclosure fence was erected (USFS 2003a).

A total of 13 exclosures that enclosed a combined 293.5 acres of thistle habitat plus some adjacent areas had been constructed by 1991 (USFWS 1993). At present, 40 of the 86 population sites located within the LNF have been fenced to exclude livestock or are considered to be inaccessible due to very steep slopes or cliffs (Todsen 1976; USFS 1978, 2003a; USFWS 2005). Protection from grazing has allowed thistle populations to recover and even expand outside fenced areas (USFWS 2005).

However, the LNF has had difficulty maintaining cattle exclosure fences around thistle habitats. Some exclosures are often open to cattle entry for various reasons (USFS 2003a, Barlow-Irick, personal communication, 2006). Two of the larger fenced areas containing thistle habitats have been used as grazing exclosures during the early and mid-grazing season and then used as traps to gather cattle in the late season (USFS 2003a, Barlow-Irick, personal communication, 2006).

The thistle's low tolerance for freezing and drought also may interact with predation. Grazing and trampling of seedlings, particularly in spring, may reduce the density of plants and leave seedlings more exposed to adverse temperatures. Livestock grazing during periods of long-term drought may also affect this thistle's ability to recover reproductive vigor. Barlow-Irick (2005) surveyed 85 thistle monitoring sites in late summer of 2005 after the first relatively wet season following several years of drought conditions. Overall, the population of flowering thistles was still decreasing, but five sites were showing good recovery with increased numbers of flowering individuals. Protection from easy access by cattle was the unifying factor among the sites showing good recovery.

The Sacramento Grazing Allotment, located on the Sacramento Ranger District of the LNF, contains over 60 percent of the Sacramento Mountains thistle population dispersed in 68 occupied sites as of 2007. Within the allotment boundary, 264 acres have been fenced off from livestock and are not considered part of the usable grazing acres within the Allotment (USFS 2007). As of March, 2007, the USFS changed the grazing strategy on the Sacramento Allotment allowing cattle to be present within both summer pastures throughout the entire summer grazing season. This change exposes the Sacramento Mountains thistle to potentially six months of continued livestock grazing (USFS 2006, 2007). The previous management strategy distributed livestock in one summer pasture from May to August and then deferred the herd to another summer pasture from August to October, thus reducing the thistle's exposure to livestock approximately half of the time. The Forest Service initiated section 7 consultation in 2007 on the effects of continued seasonal grazing to the thistle and consultation is still on-going.

Sacramento Mountains thistle is frequently grazed upon by livestock, with peak use occurring early and late in the grazing season (USFS 2007). Season-long presence of livestock within both pastures may increase grazing and trampling impacts to the thistle during times when the thistle needs to recover from grazing. Although the timing of germination for the thistle is not known, the extended presence of livestock may adversely affect seedlings and their rate of successful establishment and recruitment into the population (USFS 2007). Furthermore, broken or consumed flowering stems render affected thistles incapable of reproduction. Longer exposure to livestock also increases the chances of damage to travertine substrates, water flow channels, and wetlands upon which the thistle critically depends (USFS 2007).

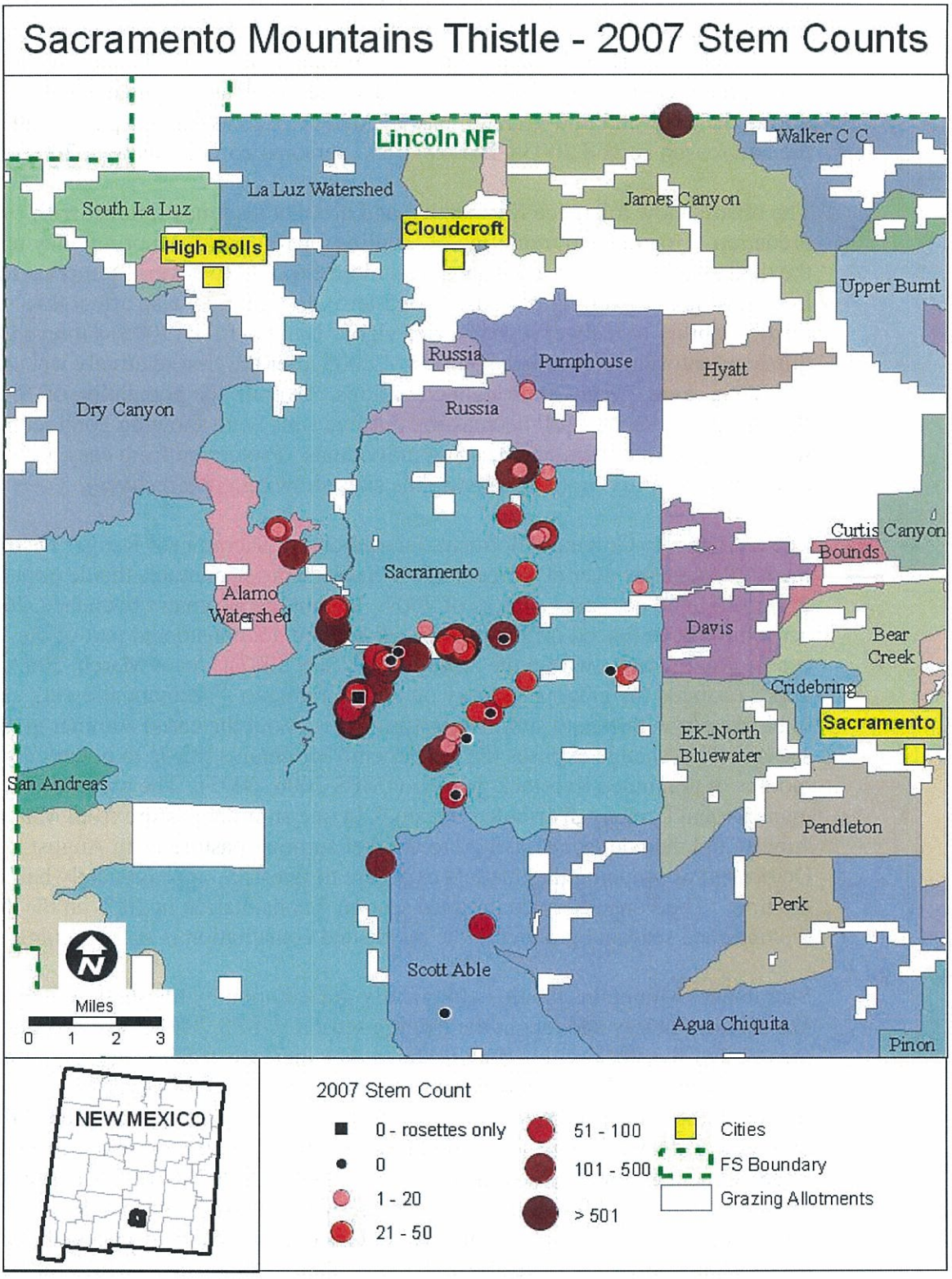

Figure 8. 2007 Stem counts of Sacramento Mountains thistle by grazing allotment.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

Sacramento Mountains thistle is protected as a threatened species under the ESA of 1973, amended. Federal land management actions and other project proposals that use federal funding or require a federal permit must not cause this plant to become an endangered species. However, there are no federal reserved water rights strictly for plant and animal habitats. Actions that may affect this thistle must be accomplished in consulting with the Service.

Listed in the state of New Mexico as endangered, this thistle is also protected from unauthorized collection, transport, or sale by the New Mexico Endangered Plant Species Act, 9-10-10 NMSA, the federal Lacey Act Amendments of 1981, and National Forest regulations found in 36 CFR 261.9(b).

All appropriate laws and regulations have been applied to protect the Sacramento Mountains thistle, however, the water necessary to support the thistle to the point of recovery remains unprotected by New Mexico state law. Because the persistence of the Sacramento Mountains thistle is inextricably linked to the preservation of its watery, limestone substrates, loss of available water from occupied thistle sites can lead to retractions of occurrence boundaries, a reduction in the numbers of individuals, and potentially the extirpation of all plants in a subpopulation. Legal protection from water withdrawal at thistle locations would prevent the loss of thistle populations. At this time, New Mexico state water laws do not consider the preservation of wild plants and animals to be a "beneficial use" worthy of protection by granting a right to water accessibility at springs and seeps, which are the main habitat type for the Sacramento Mountains thistle. Application of the recent legislation (NM ST § 72-14-3.3, 2007) to establish a strategic water reserve for the provision of water to Sacramento Mountains thistle sites in riparian habitat could help protect the thistle, but the effectiveness of this legislation on the ground has yet to be demonstrated.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

Pesticides. The Service (2005) noted that USFS Standards and Guidelines allow for the use of pesticides to control forest pests and such use is likely to adversely affect the thistle by reducing pollinator populations. Potential for such an adverse effect depends on the pest species, the pesticide used to control it, and the application methods and concentrations. For instance, application of the pesticide, *Bacillis thuringiensis* (BT), to specific trees to control spruce budworm would affect non-target butterflies and moths if their larvae were in the active eating stage, but would reputedly not reduce populations of native bees, which are the principal pollinators of Sacramento Mountains thistle (Burks 1994). Other USFS Standards and Guidelines require that the needs of threatened and endangered species be considered in pest management planning, which should minimize the potential for adverse effects.

Herbicides. A USFS (2000) Biological Assessment for noxious weed management proposed to use only wicking or spot-spraying of herbicides, hand-pulling, or use of various hand tools to experimentally treat noxious weeds within some selected patches of Sacramento Mountains thistle. Should these methods fail, and musk thistle be allowed to proliferate, the musk thistle could facilitate the arrival and spread of invasive seed-head weevils into the immediate environment of Sacramento Mountains thistle.

Climate change. Predictions of climate change for the Southwest region of the United States involve slightly drier and warmer weather in all projected models produced by scientists on the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2007, Archer and Predick 2008). Wind patterns and rates of evaporation, along with aspects of extreme weather such as droughts, severe rainstorms with intense runoff, and temperature fluctuations, are expected to be more pronounced and variable (IPCC 2007). Winter snowpack and snow cover is predicted to continue a declining trend in concert with drought conditions, leaving less water available for groundwater recharge to springs and substrate moisture, and possibly earlier warmer temperatures in the spring (Agency Technical Work Group State of New Mexico 2005, IPCC 2007, Archer and Predick 2008). For mountain tops in New Mexico, weather patterns remain unpredictable, yet most likely will reflect regional trends of warming and drying, leading to the shrinking of cooler and moister habitats associated with higher elevations (Agency Technical Work Group State of New Mexico 2005, Archer and Predick 2008). Drought conditions have been detected in the Sacramento Mountains based on decreased water flows at occupied springs and the contraction of the numbers and area occupied by Sacramento Mountains thistle (USFS 2007). Diminished water availability can lead to moisture stress, which can negatively influence metabolic and reproductive processes of plants (Burkett et al. 2005). Drought may not only reduce the area, availability, and quality of wetland habitat for the thistle, but also may compound the effects of other potential threats, such as grazing, exotic plant competition, insect predation, or fungal disease, making the thistle more susceptible to extirpation.

2.4 Synthesis:

The Sacramento Mountains thistle is an endemic, short-lived perennial plant confined to travertine seeps and their outflow creeks on limestone substrates in the Sacramento Mountains of southern New Mexico. The rarity of Sacramento Mountains thistle can be attributed to the rarity of its wetland habitats, which are relatively small and spotty in distribution.

Since the thistle was listed in 1987, additional historical, potential, and occupied sites of the thistle have been documented and monitored. Most of these increases in numbers and locations, however, can be attributed to increased survey efforts, or are subpopulations of the original 20 populations that wax and wane and redistribute themselves in accordance with typical metapopulation dynamics. Although population numbers rose from 1987 to 1998, intensive field monitoring shows a downward trend in occupied sites, overall population numbers, and flowering stems from 1998 to 2007. This decline coincides with a period of long-term drought,

however, some thistle patches have suffered fewer losses than others and a few have actually increased (Barlow-Irick 2007; USFS, unpublished data).

Some threats to the Sacramento Mountains thistle and its habitats have been reduced or locally eliminated, primarily by erecting fencing around thistle populations and sensitive wetland habitats to limit livestock and human access, and by implementing protective buffers around thistle habitats during logging and road maintenance operations to control habitat destruction, soil disturbance, and erosion. However, fencing protecting thistles is in disrepair and livestock continue to be observed in wetland localities occupied by the Sacramento Mountains thistle. Exclosure projects proposed in the 1990s that would help toward the goal of protecting 75 percent of occupied thistle habitat have yet to be constructed, and seasonal deferments that would alleviate livestock pressure upon the thistle during summer months have been recently eliminated (USFS 2007). Competition with exotic plants is not evident this time, but climate change may alter relationships, forming conditions more favorable to weedy invasions into thistle habitat. Threats to the thistle continue to be linked to the need for a constant water supply; demands for freshwater are not declining in the region due to increased human water consumption, invasive plants competing for similar resources, continued livestock water use, and the unpredictable interaction with global temperature increases, predicted precipitation decreases, and estimated increased evaporation rates in the Southwest.

Novel threats of insect predators present an unpredictable threat that also may respond to future climate changes. A 1992 study found larvae of native insect predators to consume or damage approximately 17 percent of the developing thistle seeds at 20 thistle patches, but no insect species were specifically identified. Recent studies reveal five identified insect species inflicting several types of insect damage to the Sacramento Mountains thistle that ultimately inhibit thistle reproduction, including flower receptacle consumption, seed consumption, and stalk damage (Sivinski 2007, 2008). Decimation of flowering thistle stems in the large population at Silver Springs, approaching 98 percent by September 2007, 99 percent by September 2008, and preventing most stems from flowering in September 2009, had not been observed prior to 2006 (Sivinski 2007, 2008, 2009b). The high number of insect predators observed in 2007 and 2008 may be part of a boom – bust cycle of insect species that peak in late summer and may soon become undetectable. Alternatively, these numbers could represent recent invasions of insect species that could become permanent residents within Sacramento Mountains thistle habitats.

The Sacramento Mountains thistle is currently listed as a threatened species, i.e., one that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. As a wetland obligate species, the thistle occurs exclusively at springs, seeps, or drainage areas that are often widely dispersed and collectively comprise the significant portions of the thistle's range. Threats to this species include but are not limited to increased water diversion, grazing and trampling by livestock, increased predation by insects, lack of ensured water availability, the inadequacy of existing regulatory mechanisms other than the ESA, and, potentially, climate change. These threats, combined with recent declines in reproducing thistle numbers and population sites, lead us to conclude that that the Sacramento thistle should retain its current listing status as a threatened species.

3.0 RESULTS

3.1 Recommended Classification:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist:
_____ *Extinction*
_____ *Recovery*
_____ *Original data for classification in error*
__X__ No change is needed

3.2 New Recovery Priority Number: 2C

Brief Rationale:

The Sacramento Mountains thistle Recovery Priority Number should be changed from 2, indicative of a highly threatened species with a high potential for recovery, to 2C, indicative of a highly threatened species with a high potential for recovery with some conflict. The conflict designation is added due to current conflicts with livestock and human use of wetland, occupied habitats and the high potential for water development, particularly in light of possible climate change effects in mountain-island systems. Despite the increased effort by the USFS to protect the thistle from destructive impacts caused by road building and logging operations, as well as livestock and human exposure by the construction of fenced exclosures, the thistle remains highly threatened by livestock, insect predation, lack of ensured water flow, inadequate regulatory protection apart from the ESA, and possible interactions with climate change.

3.3 Listing and Reclassification Priority Number, if reclassification is recommended

Reclassification (from Threatened to Endangered) Priority Number: N/A
Delisting (Removal from list regardless of current classification) Priority Number: N/A

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

The recovery plan should be revised or amended. Recovery plans are not regulatory documents and are instead intended to provide guidance for the dynamic process of species recovery. As discussed in sections 2.2 and 2.3 of this document, information on the species has been learned that was not known at the time the recovery plan was finalized. The criterion for acquiring water rights to maintain Sacramento Mountains thistle habitats does not reflect the legal challenges in obtaining such rights through legislation in the State of New Mexico, particularly to upland springs or travertine seeps that are not associated with riparian zones. Types and placement of points of diversion are within the regulatory control of the federal government on the LNF and this authority may be used to protect the aquifers and surface water flows in thistle habitats. A revised criterion that also relies upon suitable points of diversion could have an additive effect on

recovery, in conjunction with the existing criterion for water rights acquisition, and should be considered. The recovery plan should also be amended to include criteria for uplisting Sacramento Mountains thistle to endangered species status.

The arrivals of an invasive seed-head weevil, *Rhinocyllus conicus*, and a stem boring weevil, *Lixus pervestitus*, in the immediate environment of Sacramento Mountains thistle are potential new threats to the survival of this threatened species. The thistle specialist, *R. conicus*, has attacked the northernmost population of Sacramento Mountains thistle, however, long-term susceptibility of this thistle under field conditions has not been determined. Additional research should be conducted to track the distribution of both weevil species in the Sacramento Mountains and the presence or absence of these weevils in Sacramento Mountains thistle seed heads and stems. Effects of *R. conicus* and native seed predators on seed production of the Sacramento Mountains thistle need to be ascertained. If seed production is affected, the monitoring program of flowering plant numbers at thistle locations should be continued to determine effects on population numbers. Impacts from the five insect predators discussed in this review should be monitored as long as they continue to be observed on thistle individuals.

Exclosures preventing livestock access to wetland thistle habitats should be constantly maintained. Resources to construct fencing around thistle populations exposed to livestock, especially those on the Sacramento Grazing Allotment, should be obtained and additional exclosures should be constructed to protect thistles and promote thistle recovery. The recovery criterion of at least 75 percent of thistle habitats receiving protection is attainable and will be reached with the construction of several more exclosures within the Sacramento Grazing Allotment.

Erecting signage, indicating the value and conservation status of the Sacramento Mountains thistle, should be considered at the Bluff Springs site. This could help to educate the public about the uniqueness of the native thistle and deter destruction of the plant.

Continue to monitor invasive plants in thistle habitat. Should invasive thistle and teasel in the region continue to encroach upon Sacramento Mountains thistle habitats, careful, hand-applied use of an EPA-approved, novel herbicide, aminopyralide, commercially known as Milestone, may be warranted (Fletcher, pers. comm. 2007). Milestone has had 90-100 percent success with control of musk thistle (Fletcher, pers. comm. 2007). It is also effective with teasel, the species considered the more imposing threat to the Sacramento Mountains thistle. Milestone is applied using a backpack sprayer directly to the base of stems, just before bolting occurs. Given the invasive plant species and Sacramento Mountains thistle can grow in very close proximity, care must be taken to use Milestone on invasive plants no closer than 5 meters from Sacramento Mountains thistle (Fletcher, pers. comm. 2007).

Monitoring of the Sacramento Mountains thistle populations, reproductive individuals, and rosettes should be conducted biennially by experienced biologists. Demonstrated impacts of invasive wetland plants and insect predators in particular should be studied to prevent further population declines of the thistle. Interactions among thistle population trends in response to grazing, exclosures, invasive plants, and insect herbivory, along with predictions of warmer average temperatures and potentially less average precipitation potentially associate with climate change, should be monitored to direct future management for the thistle.

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Personal Communication

Barker, Linda, Botanist, Lincoln National Forest. Provided information for this 5-year review.

Barlow-Irick, Patricia, Botanical Consultant and *Cirsium* monitoring volunteer on Lincoln National Forest. Provided information for this 5-year review.

Fletcher, April. Invasive Species Biologist, USFWS Region 2 Regional Office, Albuquerque.

Guaderrama, R. Wildlife Biologist, Sacramento Ranger District, Lincoln National Forest.

Mendez, Greg. Natural Resource Manage, Bureau of Indian Affairs – Mescalero Apache Reservation, Mescalero, NM. Provided information for this 5-year review.

Thompson, David. Associate Professor, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University. Provided information for this review.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Sacramento Mountains Thistle (*Cirsium vinaceum*)

Current Classification: Threatened.

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Julie McIntyre, Endangered Species Biologist
U.S. Fish and Wildlife Service, Southwest Region

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 6-25-2010

REGIONAL OFFICE APPROVAL:

Acting **Assistant Regional Director, Ecological Services, Fish and Wildlife Service, Region 2**

Approve Susan Jacobsen Date 8-20-10