CONSERVATION PLAN

FOR THE

SACRAMENTO MOUNTAINS CHECKERSPOT

BUTTERFLY

(*Euphydryas anicia cloudcrofti*)

Developed cooperatively by:

U.S. Fish and Wildlife Service - Southwest Region
Otero County
The Village of Cloudcroft
U.S. Forest Service – Lincoln National Forest

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Judy Bunn, Cloudcroft, New Mexico

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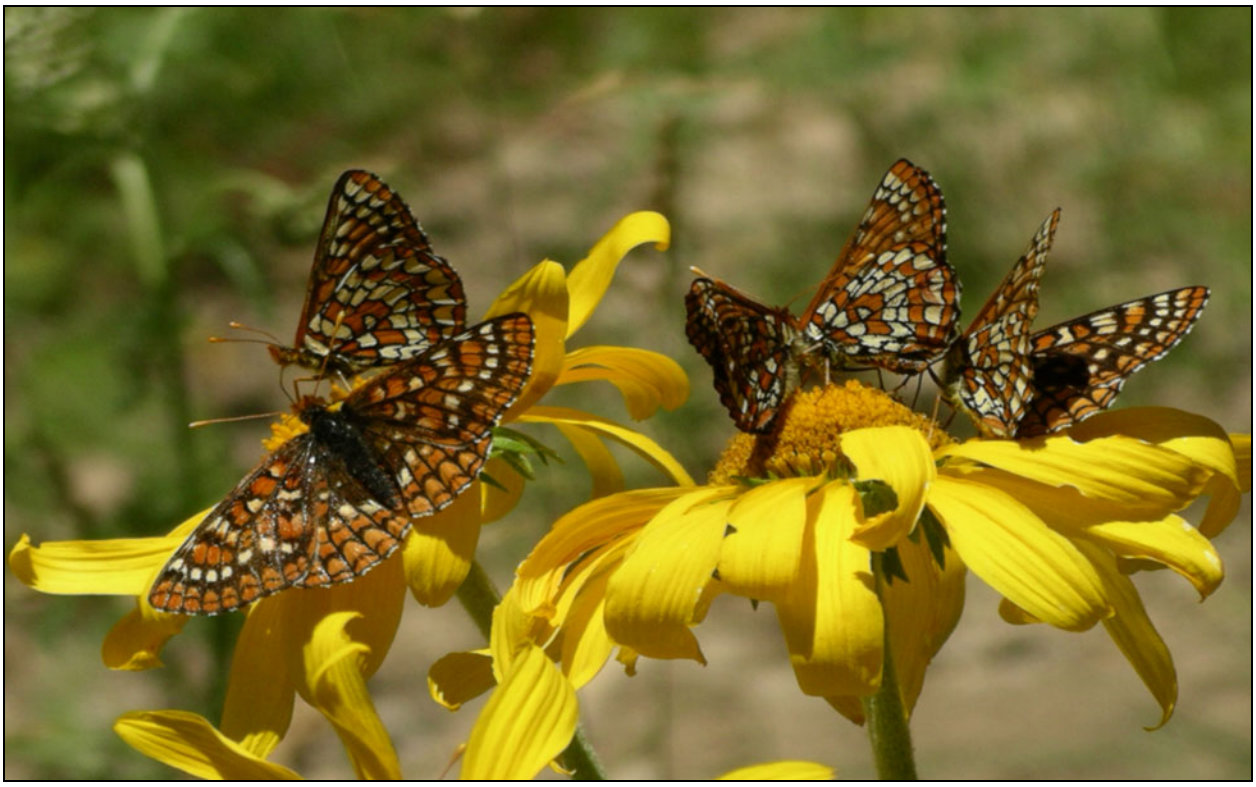
EXECUTIVE SUMMARY

The Sacramento Mountains checkerspot butterfly (*Euphydryas anicia cloudcrofti*) Conservation Plan (Conservation Plan) provides guidance for the conservation and management of this species. The checkerspot butterfly is found only in high elevation mountain-meadows within the Sacramento Mountains of central New Mexico. On September 6, 2001, the U.S. Fish and Wildlife Service (USFWS) proposed to list the Sacramento Mountains checkerspot butterfly as endangered with critical habitat. Habitat loss from proposed development, stochastic events such as drought and wildfire, and threats from collection were stated as the reasons for the proposed listing. Due to a paucity of data on population trend, no evidence of a decline was stated. Since the publication of the proposed rule, there have been reductions in the severity of certain threats to the butterfly. For example, the Village of Cloudcroft has curtailed development outward into butterfly meadow habitat.

Interest by local parties to proactively address conservation needs of the Sacramento Mountains checkerspot butterfly prompted several meetings in Cloudcroft to develop a conservation strategy for this species. Representatives from Federal agencies and local governments prepared this Conservation Plan. A Memorandum of Understanding was signed by these parties to confirm commitments to the implementation of this Conservation Plan. The planned actions in this Conservation Plan are organized in a step-down format used by the USFWS in recovery plans.



Sacramento Mountains checkerspot butterfly feeding on sneezeweed nectar in Lincoln National Forest, New Mexico. Photo by Julie McIntyre.

TABLE OF CONTENTS

I. INTRODUCTION

The Sacramento Mountains checkerspot butterfly (*Euphydryas anicia cloudcrofti*) is a high elevation, mountain meadow butterfly endemic to the Sacramento Mountains, located in south-central New Mexico. On September 6, 2001, the USFWS proposed to list the Sacramento Mountains checkerspot butterfly as endangered with critical habitat under the authority of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. § 1531, *et seq.*). This species' known range is within a 9.7 kilometer (km) or 6 mile (mi) radius around the Village of Cloudcroft, New Mexico, in open meadows within mixed-conifer forest at elevations between 2440 to 2740 meters (m) or 8000 to 9000 feet (ft). The species is proposed endangered due to habitat loss, fragmentation, and degradation, stochastic events such as drought and wildfire, and over-collection.

In January 2004, local, regional, and Federal representatives began collaboration on a plan to protect the Sacramento Mountains checkerspot butterfly and conserve the species' limited habitat. The USFWS formed the collaborative working group in response to new information about the species and its habitat, reductions in the severity and imminence of certain threats since the publication of the September 6, 2001, proposed rule to list the butterfly, and interest by local parties to proactively address conservation needs of the Sacramento Mountains checkerspot butterfly.

This Conservation Plan for the Sacramento Mountains checkerspot butterfly represents a collaborative effort between Federal agencies and local governments. The most current information on the butterfly's life history, habitat needs, and status has been assembled. A comprehensive discussion of the known threats to this species is included. Conservation measures have been developed for the Sacramento Mountains checkerspot butterfly with an accompanying implementation schedule. The general approach is a combination of protection of both occupied meadow habitats as well as meadow habitat that is unoccupied but that has the vegetational attributes important to the butterfly. Following an adaptive management concept, this Conservation Plan may be modified as needed in response to management, monitoring, and research data. Yearly meetings are planned with the partners and all other interested parties pursuant to the Memorandum of Understanding (see Appendix A).

A. Purpose and Goal

The primary purpose of the Conservation Plan is to develop, coordinate, and implement conservation actions to alleviate known threats to the Sacramento

Mountains checkerspot butterfly. The goal of the plan is to manage occupied and unoccupied habitat on both public and private lands. In addition, the plan identifies information gaps that need to be addressed to inform long-term conservation and management. After reviewing the species' life history, habitat requirements, and threats, the plan identifies the specific conservation measures, agreed upon by participating parties and signatories, which will be taken to achieve the goal.

B. Objectives of this Plan

Conservation measures needed for the continued existence of the Sacramento Mountains checkerspot butterfly focus on four primary objectives. In order to alleviate known threats to the species, the conservation measures must:

1. Eliminate the present destruction, modification, or curtailment of the species habitat or range, and identify and implement measures to curb and control future threats to the species and its habitat;

2. Ensure that over-utilization of the species for commercial, recreational, scientific, or educational purposes does not occur;

3. Ensure adequate protection of the species through agreements and regulatory measures.

4. Continue to support research, public outreach, and education.

II. BIOLOGY AND ECOLOGICAL RELATIONSHIPS

A. Taxonomy

The Sacramento Mountains checkerspot butterfly, *Euphydryas anicia cloudcrofti* (Ferris & R. W. Holland), is a member of the brush-footed butterfly family (Nymphalidae) within the subfamily Melitaeinae (checkerspots and fritillaries). The *E. chalcedona* complex, or 'variable checkerspots', a group distributed across western North America, currently consists of three distinct species, *E. chalcedona, E. colon, and E. anicia*, and 38 subspecies (Ferris & Brown 1981, Glassberg 2001). The subspecies *E. a. cloudcrofti* was first described as *Occidryas anicia cloudcrofti* by Ferris and Holland in 1980, based on 162 adult specimens collected at the Pines campground, 1.6 km (1 mi) northeast of Cloudcroft (Ferris & Holland 1980). Subspecies are differentiated based on wing shape and coloration, the morphology of male genitalia, and host plant selection (Holdren & Ehrlich 1982, Austin et al. 2003). According to Ferris and Holland (1980), the Sacramento Mountains checkerspot is most closely related to *E. anicia chuskae* (Ferris & R. W. Holland), a subspecies found above 2288 m (7500 ft) in the Chuska Mountains of northwestern New Mexico. The Sacramento Mountains checkerspot butterfly appears to have been geographically isolated from sister taxa during climate changes following the Pleistocene era, resulting in the unique phenotypic variation and local adaptation present in the subspecies today (Pittenger & Yori 2003).

B. Description

Adult Sacramento Mountains checkerspot butterflies have a wingspan of approximately 5 centimeters (cm) or 2 inches (in). The dorsal (top) sides of the wings are checkered with dark brown, red, orange, white, and black spots and lines (Figure 1). Markings on the ventral (bottom) sides of the wings resemble the dorsal sides, with alternating orange and cream-colored checkered bands outlined in black. The body is black with rust-colored hairs on the head and whitish hairs on the thorax (middle segment containing the legs) (Figure 2). The abdomen is black with light horizontal stripes and a circle of yellowish hairs at the end of the abdomen. Females tend to be slightly larger than males, and the female abdomen is more rounded in shape compared to the tapered male abdomen. The antennae are tipped with yellow-orange clubs, the legs are orange, and the eyes are brown (Glassberg 2001). Prediapause larvae of the butterfly (the August to October larval stage before the winter inactive phase) range from 0.5 to 1.0 cm (0.2 to 0.4 in) in length and change from bare, brownish larvae to wooly, black caterpillars with orange hairs. Post-diapause larvae (larvae that emerge in the spring after the hibernation stage) are larger caterpillars, with an average length 1.8 cm (0.7 in), a minimum length of 1.3 cm (0.5 in), and a maximum length of 2.5 cm (1.0 in) (Pittenger & Yori

2003). Caterpillars are marked with black, linear patterns, orange spots, and black, bristly tubercles protruding from a smooth, cream-colored body (Figure 3). The pupal case, or chrysalis, has a striking pattern of symmetrical black, rust-colored, and yellow marks upon a whitish background and is approximately 1.5-2.0 cm (0.6-0.8 in) long and 0.8 cm (0.3 in) wide (Figure 4). Chrysalises generally are attached to a stiff vertical structure ranging from 25 cm (1 ft) to 175 cm (7 ft) above the substrate, although they are rarely encountered.

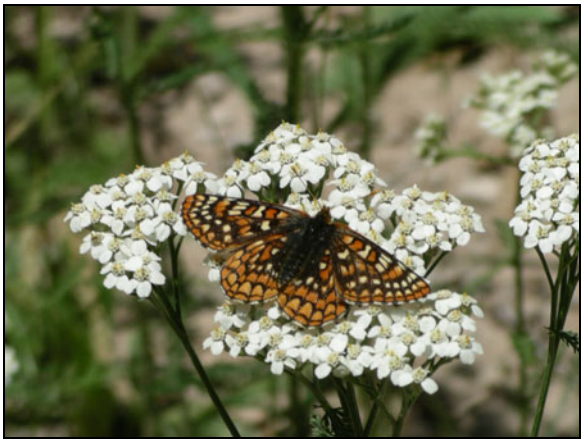


Figure 1. Sacramento Mountains checkerspot butterfly. Photo by J. McIntyre.

Figure 2. Sacramento Mountains checkerspot butterfly. Photo by J. McIntyre.

Figure 3. Post-diapause caterpillar. Photo by J. McIntyre.

Figure 4. Pupal case. Photo by J. McIntyre.

C. Habitat

Known records indicate that the Sacramento Mountains checkerspot butterfly inhabits meadows within the upper montane and subalpine mixed-conifer forest (Lower Canadian Zone) at an elevation between 2,380 and 2,750 m (7,800 and 9,000 ft) in the vicinity of the Village of Cloudcroft, Otero County, New Mexico (Figures 5-6). The adult butterfly is often found in association with the larval food plants, New Mexico penstemon (*Penstemon neomexicanus* Wooton and Standley) and valerian (*Valeriana edulis* Nutt.), and adult nectar sources such as orange sneezeweed (*Helenium hoopesii* Gray, also named *Hymenoxys hoopesii*). Specialist insects, such as the Sacramento Mountain checkerspot butterfly, typically are highly selective of oviposition (egg-laying) sites and larval food sources, and are not known to survive far from their host plants (Janz 2003). *P. neomexicanus*, the primary host plant, is a narrowly endemic perennial forb (Sivinski & Knight 1996) (Figure 7). It grows in south-central New Mexico, within Lincoln and Otero counties, in the Capitan and Sacramento Mountains (New Mexico Rare Plant Technical Council Website 2002). Throughout its range, the species is common and relatively abundant (Pittenger & Yori, 2002). *V. edulis* may be a secondary larval host plant, particularly in early spring if environmental conditions have not been favorable for growth of *P. neomexicanus* (Weiss et al. 1988). Consistent with the role of a secondary host plant, *V. edulis* has been used as a food resource in the spring by post-diapause larvae, but eggs have not been found in association with *V. edulis* (eggs are generally found only with the primary host plant) (E. Hein USFWS, pers. comm. 2004).

Figure 5. Butterfly habitat in Lincoln National Forest, New Mexico. Photo by J. McIntyre.

Figure 6. Butterfly habitat in Lincoln National Forest, New Mexico. Photo by J. McIntyre.

The preferred adult food is nectar from sneezeweed, (*H. hoopesii)*, a native perennial forb that flowers from mid-June through August, with the appearance of the Sacramento Mountains checkerspot butterfly (Figure 8). Although the flowers of *H. hoopesii* are most frequently used by adults for nectar, the Sacramento

Mountains checkerspot butterfly has been observed sipping nectar at other plants including: New Mexico elder (*Sambucus cerulea*), yellow salsify (*Tragopogon dubius*), western yarrow (*Achillea millefolium*), spike verbena (*Verbena macdougalii*), dandelion (*Taraxacum officinale*), figwort (*Scrophularia montana*), short-rayed coneflower (*Ratibida tagetes*), cutleaf coneflower (*Rudbeckia laciniata*), musk thistle (*Carduus nutans*), Arizona rose (*Rosa woodsii*), Wheeler's wallflower (*Erysimum capitatum*), and wild onion (*Allium* spp.) (Pittenger & Yori 2003, G. Wood photo 2004, J. McIntyre, pers. obs. 2004). Other plants that have been documented in butterfly habitat include: arrowleaf groundsel (*Senecia triangularis*), curly-cup gumplant (*Grindelia squarrosa*), figworts (*Scrophularia* sp.), penstemon (*Penstemon* sp.), skyrocket (*Ipomopsis aggregata*), and milkweed (*Asclepias* sp.), (Forest Service 1999d).

Figure 7. New Mexico penstemon *Penstemon neomexicanus* Photo by J. McIntyre.

Figure 8. Orange sneezeweed *Helenium hoopesii* Photo by J. McIntyre.

A survey of ground cover characteristics associated with habitats occupied by Sacramento Mountains checkerspot butterfly post-diapause larvae found a relationship of 37% vegetation, 33% bare ground, 25% litter, 3% rock, and 2% *P. neomexicanus* (Pittenger & Yori 2003). The vegetation cover in this survey consisted mainly of grasses (18% of the total ground cover) (Pittenger & Yori 2003). Precise soil associations for the Sacramento Mountains checkerspot butterfly are unknown. Based on field observations, *P. neomexicanus* prefers well-drained, sandy to rocky loams that are situated just above drainage areas, whereas *H. hoopesii* tends to be found in more mesic soils occurring at the bottom of drainages.

D. Life Cycle

The life cycle of the Sacramento Mountains checkerspot butterfly is usually univoltine, producing a maximum of one generation of adults per year under favorable conditions (E. Hein, pers. comm. 2004). If environmental conditions are not conducive to completing the life cycle, larvae can remain in an inactive state (diapause) for more than one year (E. Hein, pers. comm. 2004). Individual adults

live up to 14 days within a 4 to 6 week flight period between June and August (E. Hein, pers. comm. 2004). The emergence of adult butterflies from pupation is staggered during the flight season, with peak emergence in the second week of flight (USFWS 2001). Males typically eclose (emerge as a butterfly after pupation) prior to females. Females are mated within days after their emergence, usually on the first day of emergence for other *Euphydryas* species (Ehrlich et al. 1975, USFWS 2003). Oviposition for Sacramento Mountain checkerspot butterflies has been recorded only on the primary host plant, *P. neomexicanus*. Typically, a cluster of 10-100 eggs is laid on the underside of a *P. neomexicanus* leaf in July or August. A female butterfly can lay 2-3 sets of eggs in her lifetime, but the majority of eggs fail to reach adulthood (White 1986, Erhlich & Hanski 2004). After about 10 days, larvae hatch, cluster together, form a larval tent (communal webs spun by larvae) and consume the host plants. Throughout the 1st through 4th larval instars (growth phases between molts), larvae feed on host plants close to the larval tent and are referred to as pre-diapause larvae.

Between September and October, half-grown larvae in the 4th or 5th instar enter an obligatory and extended diapause, generally as the food plants die back in the fall from freezing. The diapause stage is similar to hibernation, involving a decrease in metabolism and a thickening of the skin, enabling the resting larvae to survive winter conditions without feeding or becoming dessicated. Exact diapause locations are unknown; however, distances of travel from the larval tent to diapause sites are probably restricted due to the small size and slow movement of the pre-diapause larvae. It is speculated that diapause larvae remain in leaf or grass litter near the base of shrubs, under the bark of conifers, or in the loose soils associated with pocket gopher (*Thomomys bottae*) mounds (Moore 1989, E. Hein, pers. comm. 2004). Diapausing larvae of other *Euphydryas* species have been observed curled up beneath rocks or sticks, and wrapped in a light webbing (USFWS 2003).

In early spring (March-April) diapause is broken and larvae (now post-diapause larvae) locate and feed on *P. neomexicanus* and possibly *V. edulis* as they grow through three to four more instars before pupating (entering the inactive stage within a chrysalis). Two to three months later, adults eclose from pupation in mid-summer (June-July). Triggers to begin and end larval diapause and pupation are unclear, but may involve photoperiod, moisture, temperature, and chemical cues.

For *Euphydryas* species, the timing of life cycle events with plant phenology (flowering periods, in response to climatic and genetic cues) is crucial to the survival of the butterfly (Ehrlich & Murphy 1987). Larval and pupal development, in tandem with host plant growth, establish the phase relationship among adult butterfly flight, oviposition, and host plant senescence. This chronology, in turn, determines future food plant availability and mortality rates of prediapause larvae later in the season. Consequently, highest survivorship occurs when the developmental stages of *Euphydryas* species and their oviposition plants, larval

hosts, and nectar plants exist within the same phase, in spite of climate variability from year to year (Weiss et al. 1988). Interaction between macroclimate and microclimate mediates much of this phase relationship and microclimate varies with slope and exposure of the terrain (Ehrlich & Murphy 1987). Thus, for the Sacramento Mountains checkerspot butterfly population, habitat diversity is very important for capturing optimal conditions where phase relationships can be synchronized in time and space in response to changing environmental conditions.

E. Distribution

The extent of the historical range of the butterfly is not known due to limited information collected on this subspecies prior to its description (Ferris & Holland 1980). Earliest documented collections of the butterfly were made in 1963 at Pines Campground, the type locality for the Sacramento Mountains checkerspot butterfly, 1.6 km (1 mi) northeast of Cloudcroft at 2622 m (8600 ft) in elevation (Toliver et al. 1994). Due to their conspicuous nature, butterflies in the genus *Euphydryas* are widely collected and well studied, and are known to be restricted to specific habitats (Ehrlich et al. 1975, Cullenward et al. 1979, Murphy & Weiss 1988). Over the last forty years, lepidopterists have surveyed and collected throughout the Sacramento Mountains within suitable habitat and have not located the species outside of the currently occupied locations (Ferris & Holland 1980, Cary & Holland 1992, Toliver et al. 1994, Hager & Stafford 1999, Forest Service 2003).

As of October, 2004, the known range of the butterfly is within a 6-mile radius around the Village of Cloudcroft, spanning an area of 85 square km (33 sq mi). The butterfly occurs on lands administered by the Sacramento Ranger District of the Lincoln National Forest as well as private lands. Within this area, the butterfly's distribution is patchy and disjunct. The known range of the butterfly is delimited on the north by Mescalero Apache Nation lands, on the west by Bailey Canyon at the mouth of Mexican Canyon, on the east by Spud Patch Canyon, and on the south by Cox Canyon (Forest Service 2000a, 2000d).

To estimate the extent of existing Sacramento Mountains checkerspot butterfly habitat, the FS devised a model using survey results and a Geographic Information System (GIS)(Forest Service 1999b). The model incorporated non-forested openings visible on 1:24,000 scale orthophoto quadrangles, preferred elevational ranges (2440-2744 m or 8000-9000 ft), and known occupied locales. Based on the model, the Forest Service estimated there are approximately 2,104 hectares (ha) or 5,198 acres (ac) of potential habitat (1 hectare is equal to 2.5 acres). Potential butterfly habitat is roughly evenly divided between private lands (1,034 ha or 2,553 ac) and Forest Service lands (1,070 ha or 2,645 ac) (Forest Service 1999a, 1999b, 1999d, 2000a, 2000d). To ground-truth the model and estimate the current range of the butterfly, extensive surveys for larvae and adult butterflies were conducted within and outside of the modeled potential butterfly habitat during the butterfly's seasons

of activity each year between 1997 and 1999 (Forest Service 1999b, 1999d, 2000a, 2000d, Custard 2003). These surveys documented that the distribution of the butterfly within the known range is discontinuous and generally located in non-forested openings along drainages, roadways, campgrounds, and valleys. According to GIS maps and the model provided by the Forest Service, about 46 of 202 ha (114 of 498 ac) and 240 of 813 ha (592 of 2,010 ac) of suitable habitat surveyed during 1998 and 1999, respectively, were occupied by the butterfly. Based on these data, it appears that 15 to 35 % of suitable habitat is currently used by the butterfly. Thus, an estimated 316 to 736 ha (780 to 1,819 ac) of the potentially suitable 2,104 ha (5,198 ac) are currently used by the butterfly.

F. Population Estimates

In addition to defining the actual range of the Sacramento Mountains checkerspot butterfly, the Forest Service surveys are also directed at counting actual numbers of individuals to understand population dynamics. Four types of population data have been gathered: 1) observational data, or the number of total observations of larvae, larval tents, and adults, combining all areas per year (1997-2003) (Forest Service 2003); 2) plot data, or the number of larval tents and number of adults counted in established plots in each locality (1999-2003) (Forest Service 2003); 3) mark-release-recapture sampling, where adults are captured, marked, and released and then sampled twice again at 12 day intervals to calculate residence rates and population growth rates (2002 only) (Pittenger & Yori 2003); and 4) transect data to estimate adult population density (2000-2002) (Pittenger & Yori 2003).

Using the observational method, in 1997 and 1998, there were sightings of 595 adults and 114 larval tents (communal webs that contain larvae) at 15 general localities. Observational surveys in 1999 documented 1,629 adults, 26 post-diapause larvae, 800 pre-diapause larvae, and an unknown number of larval tents at generally the same localities (Forest Service 1999a 1999b, 1999d, Pittenger 1999). Surveys during 2000 documented approximately 1,000 adults, 26 post-diapause larvae, and 157 larval tents (Forest Service 2000a, 2000d). No new butterfly localities were documented during the 2000 field season, although the known range of the butterfly was expanded slightly (Forest Service 2000d). The Forest Service also conducted surveys on 231 ha (570 ac) within the Smokey Bear Ranger District, north of the Mescalero Apache Nation, during 1999, but no Sacramento Mountains checkerspot butterflies were documented at this location (Forest Service 2000a).

In 1999, the Forest Service established permanent plots in 10 localities (Bailey Canyon, Cloudcroft Horse Pasture, Cloudcroft Yard, Cox Canyon, Deerhead Canyon, Pines Campground, Pumphouse Canyon, Silver Springs Canyon, Sleepy Grass Canyon, and Spud Patch Canyon). These plots allow for standardized sampling with results that can be compared in the same location from year to year.

Total larval tent numbers tallied from each set of plots reveal a decreasing trend in larval tent numbers from 1999 to 2003. Collective surveys from plots within all sites found 139 larval tents in 1999, 138 tents in 2000, 65 tents in 2001, 74 tents in 2002, 52 tents in 2003, and 46 tents in fall of 2004 (Forest Service 2003, D. Salas, pers. comm. 2004). Several interpretations can be reached from this data: (1) the trend may be indicative of a declining butterfly population; (2) the butterfly population may be fluctuating in response to the drought of the past several years, and may increase in response to the more moist conditions of this past year, or more favorable conditions in the future; (3) some tents have disintegrated due to the large amounts of rain and hail received in butterfly habitat between August and October of 2004, but the larvae could still be persisting in other tents or habitat crevices; (4) monitoring methods allow for only the number of tents per visit, thus missing tent turnover which could involve more tents than are being counted; and (5) because *P. neomexicanus* tends to grow in broadly-spaced clusters within the habitat, plots established in 1999 may no longer be capturing *P. neomexicanus* patches if they gradually move over time. Adult survey data for 2002 detected 60 butterflies within plots only (Forest Service 2003). In 2003, the Forest Service tallied a total of 222 adults, both within sampling plots and immediately surrounding sampling plots (Forest Service 2003). Adult surveys in 2004 of the same plots revealed 221 butterflies (D. Salas, pers. com. 2004). Data from the observation or plot sampling methods have not provided a basis for estimates of actual population size, because methods have been inconsistent and no formal population estimation procedures have been used with these data.

Mark-release data were collected only in 2002 on sunny to partly cloudy, windless days over a span of three weeks from June 28 to July 23. None of the 232 total marked Sacramento Mountains checkerspot butteflies were found to have moved between sites and only 4 butterflies had moved to different meadows within sites (Pittenger & Yori 2003). Of the nine sites sampled during the flight season, marked checkerspots were recaptured at two sites: Pumphouse Canyon and Spud Patch Canyon. No marked butterflies were found at Apache Canyon, Bailey Canyon, South Fork La Luz Canyon, Pines Campground, Silver Springs Canyon, Zinker Canyon, or Forks Tank Canyon sites in 2002 (Pittenger & Yori 2003).

At Pumphouse Canyon, from a total of 130 adult individuals marked from 28 June through 23 July, 2002, 35 individuals, or 27%, were recaptured (Pittenger & Yori 2003). From these data, the peak population at one time in Pumphouse Canyon was estimated to be 127 individuals (Pittenger & Yori 2003). Thirty-one individuals, or 89%, of the number recaptured remained at the meadow site and four individuals, or 11%, had moved into different meadows within Pumphouse Canyon (Pittenger & Yori 2003). The four individuals that dispersed to different meadows moved across distances ranging from 460 m (1607 ft) to 890 m (2912 ft) (Pittenger & Yori 2003). At Spud Patch Canyon, a total of 102 adult Sacramento Mountains checkerspot butterflies were marked and released. Of these, only three

resident individuals were recaptured, representing 3 % of the population at this site. No butterflies were found in different meadows within Spud Patch Canyon, indicating no within-site movement for this community. Because it was unclear if a loss of an individual from the population was due to death or emigration, Pittenger and Yori (2003) equated the mean expected residence time with mean survival time for this study. For Pumphouse Canyon, mean residence time was estimated to be 8.4 days and at Spud Patch Canyon, the mean expected residence time was 3.5 days (Pittenger & Yori 2003).

Peak adult density, as obtained with the transect methods in occupied meadows, differed for each site and for each year and ranged from an estimated maximum of 205 butterflies/ha (82 butterflies/ac) to an estimated minimum of 13 butterflies/ha (five butterflies/ac) (Pittenger & Yori 2003). Density was estimated as the number of butterflies observed per hectare (2.5 acres). At the South Fork La Luz Canyon site, peak estimated densities were 42 butterflies/ha (17 butterflies/ac) in 2000, 50 butterflies/ha (20 butterflies/ac) in 2001, and 32 butterflies/ha (13 butterflies/ac) in 2002. Peak densities at Pumphouse Canyon were 53/ha (21 butterflies/ac) in 2000, 16/ha (6 butterflies/ac) in 2001, and 48/ha (19 butterflies/ac) in 2002. At Spud Patch Canyon, peak densities each summer were 118 butterflies/ha in 2000 (47 butterflies/ac), 47 butterflies/ha (19 butteflies/ac) in 2001, and 31 butterflies/ha (12 butterflies/ac) in 2002. Pines Campground contained 16 butterflies/ha (6 butterflies/ac) in 2001 and 205 butterflies/ha (82 butterflies/ac) in 2002 at peak density. Silver Springs Canyon had 13/ha (5 butterflies/ac) in 2001 and 105/ha (42 butterflies/ac) in 2002 at peak density. Data for Apache Canyon was collected only in 2002, which had a peak density of 28 butterflies/ha (11 butterflies/ac). Bailey Canyon contained 38 butterflies/ha (15 butterflies/ac) at peak density in 2002. For each site, the timing of measured peak density differed, ranging from July 11 to August 1. Regression analyses of total peak density of adult Sacramento Mountains checkerspot butterflies from 2000 to 2002 showed stable trends at South Fork La Luz Canyon (ungrazed by cattle) and Pumphouse Canyon (grazed by cattle), and a slight downward trend that was not statistically significant in Spud Patch Canyon (Pittenger & Yori 2003).

G. Population Structure

Sacramento Mountains checkerspot butterflies occur as small, separated groups with low population densities (Pittenger & Yori 2003). Because the Sacramento Mountains checkerspot butterfly has a life history pattern similar to other butterflies in the genus *Euphydryas* that exist as metapopulations, it is likely that this butterfly has a metapopulation structure (Murphy & Weiss 1988, Harrison 1989, Hanski & Gilpin 1991). A metapopulation is a set of local, discrete subpopulations that comprise a single total population within an area. Migration from one local population to other areas containing suitable habitat occurs but is

not routine. At smaller temporal and spatial scales, individual subpopulations may blink in and out of existence in response to demographic (related to population trends such as births, deaths, immigration, emigration, ratios of females to males, or distribution) or environmental impacts (Hanski 1998). Long-term persistence of a metapopulation depends on the recolonization of extirpated areas or dispersal of individuals to unoccupied areas from source populations so that the overall metapopulation numbers remain stable (Hanski & Gilpin 1991, McCullough 1996, Hanski 1999). Although overall population density estimates for the butterfly slowly declined between 1997 and 2003, methods of population calculation were inconsistent and conducted only at certain sites within the total range of the butterfly. For the whole population, rates of extinction and colonization, population growth rates, flight ranges, and average dispersal distances are unknown, so precise metapopulation dynamics for this species cannot be quantified at this time.

Often, movement between areas containing suitable habitat (i.e., dispersal) is restricted due to extrinsic factors, such as inhospitable conditions around and between areas of suitable habitat or extensive distances to suitable habitat patches. For example, the butterfly's dependence upon solar radiation and air temperatures to attain body temperatures necessary for flight prohibits travel through broad, shaded patches of trees. Additionally, the butterfly appears to favor flight close to the ground (E. Hein, pers. comm. 2004) and, like other *Euphydryas* species, may avoid flying over objects taller than 2 m (7 ft) (USFWS 2003), such as buildings or forested areas. For the endangered Bay checkerspot, *E. editha bayensis*, suitable habitat patches separated from a source population by level ground were more likely to be colonized than patches separated by hilly terrain (Harrison 1989). Thus flatter areas, with low-growing vegetation within the flight range of the butterfly may be necessary for successful dispersal.

For *Euphydryas* species, intrinsic factors, such as body size, sedentary habits, and other behavioral dynamics (Ehrlich et al. 1975), also contribute to low rates of migration. Generations of *Euphydryas* butterflies tend to remain at a site for many reasons including: lack of rapid locomotion due to small body size with short legs (larvae) and weak flight (adults) which prohibits long-distance movement; short adult life span which offers little time to migrate; immediate mating of eclosed females which reduces mating opportunities for migrating males; and the use of a mating plug by male butterflies to prevent additional inseminations which decreases receptivity and stimulates searches for specific oviposition host plants in female butterflies (Labine 1964). In other *Euphydryas* populations, females are more likely to emigrate than males (Wahlberg et al. 2002) and probabilities of migration increase with age (Ehrlich 1965). Conflictingly, a female's genetic contribution to a population decreases with lateness in the season due to the decline in egg loads (Harrison 1989), the diminishing suitability of host plants as they senesce (Erhlich et al. 1975), and the lack of time remaining for pre-diapause larvae to accumulate sufficient reserves before entering diapause (USFWS 2003).

Areas of suitable habitat, such as sunny meadows with adequate host-plant, nectar, structural (pupal attachment), and litter (diapause location) resources, may be small and capable of supporting only low numbers of butterflies. As smaller pockets of individuals are more susceptible to random demographic events, climatic extremes, or disturbance, local extinction of these small populations may be common. Furthermore, populations with fewer individuals suffer from higher extinction rates because of an unavoidable increase in matings with close relatives, or inbreeding (Saccheri et al. 1998). Inbreeding within butterfly subpopulations has been linked to a reduction in egg hatching rate and larval survival, a lengthened pupal period, which increases chances of parasitism, and a shortened female lifespan which lowers the number of eggs laid (Saccheri et al. 1998). Thus small, isolated populations of butterflies may experience an increased probability of extinction due to a reduction in fitness, or inbreeding depression, from the interaction among decreased heterozygosity (genetic variation), demography, and environmental stochasticity.

To balance the local extirpations with recolonization events, dispersal is a key factor in maintaining a metapopulation's resilience. Dispersal is affected not only by the amount of usable habitat but also by the spatial configurations of habitat across landscapes. Corridors linking usable habitats provide access to additional resources and are correlated with the success of foraging, mate-finding, and dispersal to new meadows in response to environmental changes and natural disturbances (Schumaker 1996). Additionally, a corridor must provide conditions that invite a species to pass through the landscape at its own pace, a feature especially important for small and relatively sedentary organisms (Beier & Loe 1992), such as the Sacramento Mountains checkerspot butterfly, that may migrate in a stepping-stone approach over more than one season (USFWS 2003). For the butterfly, travel appears to be limited during the larval stages, with pre-diapause larvae known to move up to 2 m (6.6 ft) and post-diapause larvae known to move up to 24.8 m (81 ft), with an average movement of 2.6 m (8.5 ft) (Pittenger & Yori 2003). At the adult stage, the average dispersal distance or the maximum flight distance is unknown, but the maximum recorded distance of movement for this subspecies is 890 m (2919 ft) (Pittenger & Yori 2003). Thus, habitat loss can reduce the size of and connectivity between pockets of suitable butterfly habitat.

The reduction in the extent of meadows and other suitable non-forested areas due to commercial and private development in suitable habitat and small amounts of conifer encroachment into suitable habitat as a result of grazing and fire suppression on public and private lands (Belsky & Blumenthal 1997, Garrett & Garrett 2001) may have decreased connectivity among some localities. Also, these factors may have increased the distance beyond the normal dispersal ability of the butterfly, making recolonization of some patches following local extinction more difficult (Cullenward et al. 1979, Hanski 1999). Diminishing habitat area can

lower the quality of remaining habitat by reducing the diversity of microclimates and food plants for larvae and adult butterflies (Murphy & Weiss 1988, Thomas et al. 1996, Hanski 1999) and the opportunities for mate-finding and reproductive success (Erhlich et al. 1975).

Based on available information concerning climate, topography, soils, and vegetation, the distribution of the Sacramento Mountains checkerspot butterfly may have been more extensive and continuous prior to commercial and private development, road construction, extensively grazed range conditions, and the increase in trees. On a landscape scale, the isolated localities, tight associations with food and nectar sources, and limited geographic range of the butterfly indicate that the species is particularly vulnerable to perturbations (Ehrlich et al. 1972; Thomas et al.1996).

III. STATUS AND THREATS

The Sacramento Mountains checkerspot butterfly was proposed for listing as endangered with critical habitat on September 6, 2001 (USFWS 2001). Section 4(a)(1) of the ESA lists five listing factors that must be considered when determining if a species should be designated as threatened or endangered. These include:

(A) present or threatened destruction, modification, or curtailment of its habitat or range;
(B) over-utilization for commercial, recreational, scientific, or educational purposes;
(C) disease or predation;
(D) inadequacy of existing regulatory mechanisms; and
(E) other natural or manmade factors affecting its continued existence.

A species may be designated as endangered or threatened due to one or more of these five listing factors.

The 2001 proposed rule stated that the Sacramento Mountains checkerspot butterfly is endangered as a result of destruction and fragmentation of habitat from private and commercial development, catastrophic wildfire, habitat degradation and loss of host plants from grazing, some recreational activities, encroachment of conifers and nonnative vegetation into non-forested openings, over collection, and vulnerability to local extirpations from climate changes such as drought (USFWS 2001). However, several of these threats have become less severe since the publication of the September 6, 2001, proposed rule to list the butterfly. Below, we address each of the previously identified threats and discuss the changes that have occurred in the last three years. The result is an accurate, current picture of the threats that remain to the species, so that we can prioritize and maximize the effectiveness of conservation measures aimed at ameliorating remaining threats (See Section IV).

A. Destruction, Modification, or Fragmentation of Habitat

The butterfly's reliance on meadows makes it particularly sensitive to habitat loss and degradation because meadows are easily accessed, clear of obstacles, and inviting for human activities. Actions resulting in removal and ultimately loss of host or nectar plants may threaten the survival of the species. In addition, reduction and loss of habitat lowers the quality of remaining habitat by reducing the diversity of microclimates and food plants available for larvae and adult butterflies (Murphy & Weiss 1988, Thomas et al. 1996, Hanski 1999). Ground disturbance and vegetation clearing can disturb soils, remove or eliminate diapause

sites (i.e., leaf litter, grasses, rocks) and larval or adult food plants, and kill or injure individuals (Wilcox & Murphy 1985, Murphy & Weiss 1988). This type of habitat loss or modification can occur through the following activities: development, wildfire and suppression, inappropriate grazing, highway improvement activities, recreation, and invasive plants and insects.

Habitat fragmentation can further separate isolated localities containing small populations of butterflies, making these groups even more vulnerable to natural perturbations and local extinctions. As discussed previously, the Sacramento Mountains checkerspot butterfly likely exists as a metapopulation (i.e., local populations connected by dispersing individuals). Because many of the areas of suitable habitat may be small, and support low numbers of butterflies, local extinction of these small populations may be common. A metapopulation's persistence depends on the combined dynamics of these local extinctions and the subsequent recolonization of these areas by dispersal (Hanski & Gilpin 1991, 1997, McCullough 1996, Hanski 1999). For habitat specialist butterflies, open corridors between occupied woodland clearings are known to increase butterfly population densities by facilitating dispersal between meadow patches (Sutcliffe & Thomas 1996, Haddad & Baum 1999). The reduction in the extent of meadows and other suitable non-forested areas may eliminate connectivity among some localities and increase the distance beyond the normal dispersal ability of the Sacramento Mountains checkerspot butterfly, making recolonization of some patches following local extinction more difficult (Cullenward et al. 1979, Hanski 1999). Therefore, even around sites of human land use, it is important to maintain meadow continuity and connectivity where possible to encourage dispersal and recolonization.

Commercial and Private Development

Expansion of the Village of Cloudcroft and subdivision development were cited as two of the primary reasons for the 1998 petition and were cited in the 2001 proposed rule. Approximately 50% of all lands that might support the butterfly are in private ownership, where recommendations of habitat management for the butterfly can be suggested but not regulated (USFWS 2001). Of the 1034 ha (2553 ac) of potential butterfly habitat estimated to occur on private lands, from 155 to 362 ha (383 to 894 ac) may be occupied by the butterfly. Non-forested lands often are preferred by developers because these areas are less costly to develop (i.e., there are no trees to clear and the land generally lacks steep topography and is accessible from roads). Heavy clearing and mowing activities on improved (i.e., with existing structures) or unimproved private lands, to reduce the threat of wildfire or improve the residential appearance, could eliminate larval or adult food plants and/or localities that are used by the Sacramento Mountains checkerspot butterfly. Additionally, the conversion of native landscapes to nonnative vegetation (e.g., lawns or gardens) could fragment localities, eliminate movement corridors, or cause

additional loss of suitable habitat (Wood & Samways 1991, Holland 2001). Development reduces blocks of native vegetation to fragments that are insularized, creating a matrix of native habitat islands that have been altered by varying degrees from their natural state.

Developed areas within and around Cloudcroft include two golf courses, 12 private developments, several recreation parks, a ski area and a network of paved and gravel roadways (USFWS 2001). The Woodlands subdivision, developed on the east side of the Village, was constructed upon a previously forested area at the edge of butterfly habitat. Additionally, Otero County is drafting a county-wide ordinance to require contractors to consider effects upon sensitive, threatened, or endangered species within development plans. This ordinance will obligate developers to ensure that the butterfly's habitat is maintained.

According to population estimates from the U.S. Census Bureau, the population of Cloudcroft has remained stable for the past four years with a slight decline since 2001 (Bureau of Business & Economic Research 2004) (see Table 1). In 2003, the reported estimated population of Cloudcroft was 724 (Bureau of Business & Economic Research 2004). According to the U.S. Bureau of Census (2000), there were six housing structures built from 1999 to 2000 for the Village of Cloudcroft. Furthermore, Otero County reported that eight to 10 new homes have been constructed each year in areas that have already been subdivided (Otero County *in lit*). Within Cloudcroft and the surrounding community, there is not enough development to support a viable construction industry. Currently, ensuring the supply of ground water to existing residences is becoming an increasingly important issue to the Village. Thus, according to the Village of Cloudcroft, commercial development is no longer being encouraged as stated in the 2001 proposed rule.

Table 1. Human population estimate for the Village of Cloudcroft from 1960 to 2003 (Bureau of
Business and Economic Research 2002, 2004).

Year	2003	2002	2001	2000	1990	1980	1970	1960
Village of Cloudcroft	724	726	730	749	612	521	525	464

National Forest Service lands surround the Village of Cloudcroft, making the Lincoln National Forest the only lands available for annexation and village expansion. In August 2001, the Forest Service signed a decision notice and finding of no significant impact for an application to transfer public land to the Village under the Townsite Act of 1958. The application included a formal development

plan that stated the Village's intent to use the land as: 22 acres for a sports field; 42 acres for greenbelts; and eight acres for a wastewater plant. However, to date, this proposal has not been implemented. The Village of Cloudcroft has stated its intention to keep all new land annexed from the Forest Service as greenbelt. Both prior to and during the formulation of the Village's application under the Townsite Act, various areas adjacent to the Village's boundary were screened by the Forest Service to determine their suitability for the purposes intended. Many areas were eliminated by the Forest Service from further analysis because of substantial environmental concerns.

The Forest Service is also in the planning phase of a three-way proposal with the Village of Cloudcroft and the Otero County Electrical Cooperative to acquire 80 acres of butterfly habitat, 15 of which are occupied butterfly habitat. This land is currently owned by Cloudcroft and is adjacent to the Ski Cloudcroft ski area. The Village of Cloudcroft would in turn receive five commercial lots in the center of town that total approximately one acre owned by the Otero County Electrical Cooperative. The Otero County Electrical Cooperative would acquire 40 acres of Forest Service land that is not butterfly habitat outside of town to relocate their offices. According to the Forest Service and USFWS, the proposed three-way transfer would be entirely beneficial to the butterfly because 80 acres of butterfly habitat will become Forest Service administered lands.

Catastrophic Wildfire, Fire Suppression, Thinning

Due to the small known range and low abundance of the Sacramento Mountains checkerspot butterfly, the subspecies is vulnerable to catastrophic wildfires. Although at least nine catastrophic wildfires have burned over 34,000 ha (90,000 ac) during the last 50 years in the Sacramento Mountains (Kaufmann et al. 1998), a significant fire has not been documented within occupied or proposed critical habitat since 1916 (R. Guaderrama, pers. comm. 2004). Thus the effect of fire upon this species is unknown and the natural fire regime in the habitat of the butterfly is non-existent due to the lack of fire occurrence since the butterfly was recognized as a subspecies. Because the butterfly is a non-migratory, fairly sedentary, host-plant specialist, the whole population could be eliminated should the entire occupied butterfly habitat severely burn. It is possible, however, that surrounding habitat and unburned inclusions within catastrophically burned areas may serve as butterfly sources to recolonize cleared areas, provided there are enough survivors to form a viable population. Favoring low-lying meadows may benefit the butterfly, since fires in the region tend to burn in a mosaic pattern and are less likely to burn in meadows compared to surrounding forests (R. Guaderrama, pers. comm. 2004). Fuels in meadows may burn quickly and may not have pronounced heat effects in the soil or seedbank (R. Guaderrama, pers. comm. 2004). The disturbed, rocky areas where the larval host plants grow tend to have a lack of continuous fine fuels

which may not carry a fire as effectively as substrates beneath a forest. Re-starting succession in these communities may or may not increase opportunities for *Penstemon*, *Valerian*, or *Helenium* species' establishment and growth. As the long-term fire response of this subspecies, its required host plants, and meadow habitats remains uncertain, inferences based on historical patterns, current conditions, the butterfly's needs and life history, and the effects of fire upon other butterflies must be examined.

A century of fire suppression, logging of old-growth trees (Garrett & Garrett 2001), and livestock grazing (Waltz & Covington 2004) has altered the structure of the Lincoln National Forest, creating novel fire conditions to which the butterfly and other native species may not be adapted. Generally these conditions manifest as changes in intensity, severity, duration, and timing of fires in response to season, climate, fuels, topography, and community assemblages (Swetnam & Baisan 1996, Touchan et al. 1996, Kaufmann et al. 1998). As systems that were previously shaped by fire, forests defined by ponderosa pine 1,680-2590 m (5,500-8,500 ft) and mixed conifer 2440-2900 m (8,000-9,500 ft) have been affected significantly by past land uses (Touchan et al. 1994, Swetnam & Baisan 1996, Garrett & Garrett 2001). Prior to 1900, the mean natural fire interval for forests in the Sacramento Mountains ranged from 3-10 years in ponderosa pine dominated communities, from 4-12 years in the lower elevations of mixed conifer zones, and from 5-25 years in the upper portions of mixed conifer areas (USDA 1992, Kaufmann et al. 1998, Garrett & Garrett 2001). In the lower transition zones, frequent, low-intensity, surface fires historically did little damage to the large, old-growth trees, cleared away flammable organic material within the forest, and maintained meadows by preventing the encroachment of trees into open areas (Kaufmann et al. 1998, Garrett & Garrett 2001). Spruce-fir communities within the higher elevations sustained less frequent, mixed-severity fires, with both patchy surface fires and stand-replacement fires (USDA 1992, Touchan et al. 1996). During this period, 10-15% of the forest was occupied by meadows (Garrett & Garrett 2001). To have persisted until the present, the butterfly appears to have been adapted to this natural disturbance regime of fires. Forests, which were once open stands of mature trees with greater moisture availability and higher biodiversity, have developed into dense stands of small-diameter trees with less moisture availability and lower biotic diversity (Garrett & Garrett 2001). Present forest conditions, combined with the current drought, have put an estimated 65% of the ponderosa pine/mixed conifer region at risk for fire (Garrett & Garrett 2001), increasing the likelihood of a burn in forests surrounding butterfly habitat.

Depending on a fire's severity and the butterfly's life stage, the direct and indirect consequences of fire upon the butterfly could range from deadly to inconsequential. Catastrophic fires can occur as high intensity fires, where heat is released upward into the canopy consuming foliage, or as high severity fires, during which litter and duff consumption sends heat penetrating downward through the soil (Farris et al.

1996). For the butterfly, an intense canopy fire concentrated on forested slopes, while larvae are diapausing beneath the soil surface in low-lying meadows, may have relatively little impact, as the larvae may be protected from flames, radiant heat, or smoke. However, the same fire event during the pupal, adult, or egg stage, all of which occur above ground, could lead to butterfly damage or mortality through exposure. Nonvagility can be a significant predictor of an initial negative response to fire, but it has not affected mean recovery times for some butterfly communities (Panzer 2002). Alternatively, a ground fire involving deep soil heating due to the formation of mats of imported grasses such as Kentucky blue grass (*Poa pratensis*) could be lethal to any life stage of the butterfly (Society of American Foresters 1984). Grazing may reduce the ability of a meadow to carry a fire, by consuming fine fuels and forming a discontinuous fuel pattern. This interaction between fire and grazing could be positive for the butterfly, at least in the short term.

The butterfly appears to select environments based on favorable microhabitats, involving direct sunlight, mixed topography, host and nectar plants, and certain ground cover characteristics (as discussed in the biology section). Fire alters vegetation structure and composition, decreases litter depth, redistributes nitrogen, changes soil chemistry, modifies soil moisture and temperature, transforms host and nectar plant quality, and reduces overall cover (Anderson et al. 1989, White 1996, Siemann et al. 1997, Waltz & Covington 2004). Areas cleared by fire allow grasslands to spread, and expanded areas have been associated with increased butterfly immigration (Krauss et al. 2003). Opened canopies enhance the reception of sunlight, a factor that is correlated with nectar production (Schultz 2001). However, creating new openings may also invite bird predation along woodland edges (Ries & Fagan 2003). Additionally, the removal of vegetation could make individuals or eggs more susceptible to environmental extremes or other predators, such as ants. These indirect effects of fire upon the butterfly may be significant because the butterfly is so closely associated with certain plants and specific habitat requirements. If fire increases the presence or productivity of host and nectar plants, improves ground cover conditions, or modifies vegetative structure to facilitate feeding, mate-finding, and travel, then fire would have a positive long-term impact on the butterfly. Contrastingly, if fire eliminates the butterfly's required physical or biological habitat features, such as favorable microclimates, host plants and their seed banks, or duff and litter layers for potential diapause locations, butterfly populations could drop or subpopulations could go extinct. Small, cool-season burns that stimulate nutrient recycling and add heterogeneity to the landscape, as opposed to severe, dry-season ground fires, may provide potential benefits to the butterfly's habitat needs.

Although data on the ecology of large fires in mixed conifer forests and meadows (Allen (ed.) 1996, Farris et al. 1998, McCarthy & Yanoff 2003), as well as data on post-fire butterfly and plant recovery after such fires are lacking (Waltz & Covington 2004), a few studies have examined butterfly responses to fire. Results of these studies tend to be species specific and span a range of outcomes. Fire has

caused the extirpation of populations of other butterflies in the genus *Euphydryas* (Murphy & Weiss 1988; 62 FR 2313). Butterfly individuals in savannas in Minnesota were between 0-5 times lower in number in burned areas than in unburned areas (Siemann et al. 1997). For rarer butterflies in this study, results suggested that natural population perturbations in combination with fire could result in extinction (Siemann et al. 1997). On the other hand, butterfly communities in tallgrass prairie experienced full recovery after fire within the second year (Panzer 2002). Controlled burns in a Great Basin, montane watershed did not significantly affect butterfly species richness or community similarity among the following areas: 1) burned two years before butterfly sampling; 2) burned one year before butterfly sampling; and 3) unburned (Fleishman 1998). Here, the total area of burn units and controls comprised a small proportion of the total watershed area (Fleishman 1998). Moreover, although burn units were larger than the home ranges of many butterfly species in the central Great Basin, burn units were situated within a matrix of undisturbed vegetation, allowing recolonization from the surrounding area (Fleishman 1998). In an Arizona ponderosa pine community, fire and thinning restoration treatments doubled butterfly species richness and tripled species abundance of butterflies within one year (Waltz & Covington 2004). After two years of treatment, butterfly diversity decreased by 25% and abundance increased by 14% (Waltz & Covington 2004). When analyzed by family, Nymphalid butterflies revealed a different trend, with a slight decrease in abundance for the first year after treatment followed by an increase in the second year. These changes, however, were not supported statistically and much of the increase in the second year was driven by greater numbers of migratory Nymphalid butterflies, such as the painted lady (*Vanessa cardui*) (Waltz & Covington 2004). Species richness of host and nectar plants showed little difference between treated and controlled ponderosa forest in this study (Waltz & Covington 2004). Sunlight, however, was significantly greater in restored forests, suggesting that butterflies respond to the effects of fire and thinning prior to forbs, and that thermoregulatory influences of light and warmth for butterfly activities are important in this process (Waltz & Covington 2004).

Some local information is available from postfire monitoring of the Scott Able fire that burned 24 km (15 miles) southeast of the Village of Cloudcroft. In May, 2000, the Scott Able fire burned 6,400 ha (16,000 ac) in the Lincoln National Forest, covering elevations between 2250-3000 m (7000-9300 ft) (S. Cary NM Parks & Recreation, pers. comm. 2004). The Sacramento Mountains checkerspot butterfly does not occur in the location of the burn, but *P. neomexicanus* and *H. hoopseii* can be found (S. Cary, pers. comm. 2004). The response of the butterfly communities to this fire appears to be largely determined by guild, or habitat/food preference (S. Cary, pers. comm. 2004). Between 2001 and 2003, mobile butterflies associated with shrubs, grasses, and forbs have shown a positive response to the fire, with most species peaking in 2001 after abundant spring precipitation (S. Cary, unpublished data). Riparian butterfly species exhibited depauperate populations at

burned sites, while butterflies associated with edge habitats are more plentiful at burned sites (S. Cary, unpublished data). This intense, wind-driven fire burned an estimated 0-10% of the meadows and 85-90% of the forested canopies within its scope (S. Cary, pers. comm. 2004), meeting the qualifications for a stand-replacement fire in much of the burned area (McCarthy & Yanoff 2003). Meadows in mixed conifer habitat that did not burn were situated primarily along drainages (S. Cary pers. comm. 2004). The first meadow area that the fire did burn through did not burn completely and vegetation began coming back within a few weeks (R. Guaderrama, pers. comm. 2004). These data suggest that meadows and drainages may be less likely to burn than mixed-conifer canopies, which could protect the Sacramento Mountains checkerspot butterfly.

Fire management through thinning may not only reduce fire size and intensity, but may also mimic aspects of stand removal from fire that may be advantageous for the Sacramento Mountains checkerspot butterfly. In general, old-growth specialists tend to decline in logged forests, while local invertebrate species richness increases as forest generalists persist and numerous open-habitat species appear (Niemela 1996). Benefits to the butterfly could involve enhancements in meadow size, early-successional plants, solar radiation to the soil surface, and habitat connectivity, providing that these benefits outweigh any harm done to the butterfly during the logging process. Grassland butterfly species diversity and abundance can increase after clear-cutting but decline as secondary succession progresses (Inoue 2003). In thinned and slash-mulched pinyon-juniper woodlands of New Mexico, significant increases in butterfly diversity and abundance in a treated watershed compared to an untreated watershed were correlated with greater forb and grass cover in the treated area (Kleintjes 2004). However, in Indonesia, tropical butterflies showed higher species richness, abundance, and evenness in unlogged forest compared to forest that had been selectively logged five years previously (Hill et al. 1995). But other studies in Borneo and Belize found no evidence that selective logging had changed the richness and abundance of butterflies (Willott et al. 2000, Lewis 2001). Canopy openness, close proximity to primary, unlogged forest, and adaptation to natural hurricane and fire disturbance were cited as factors that helped to maintain the butterfly communities (Willott et al. 2000, Lewis 2001). At the landscape scale, however, if logging becomes too intensive, forest habitats can become dessicated and homogenized which eventually could lead to a decline of sensitive species (Niemela 1996).

Woodland canopy reduction is important for open-habitat butterflies, which readily move from meadows into corridors, but rarely from meadows into dense woodlands (Sutcliffe & Thomas 1996). Also, open-habitat specialist butterflies are known to reach higher densities in patches connected by corridors than in isolated patches (Haddad & Baum 1999). The formation of cleared corridors or stepping-stone patches by thinning could allow the Sacramento Mountains checkerspot butterfly to migrate between suitable meadows (Maina & Howe 2000), thus encouraging colonization of new sites or genetic exchange among the subpopulations. Pollinators

of the New Mexico penstemon and valerian host plants may also take advantage of these corridors. Thinning has been associated with the establishment of plant and butterfly edge specialists which helps to diversify the ecosystem and could provide potential microhabitats or nectar sources for the Sacramento Mountains checkerspot butterfly (Bergman 2001).

In the Sacramento Mountains, several locations adjacent to occupied butterfly habitat have been progressively thinned since 2002. Thinned areas occur in Bailey Canyon (215 ha, 532 ac), Pineywood Canyon (262 ha, 647 ac), Deerhead Canyon (146 ha, 360 ac), and along Cox Canyon (72 ha, 178 ac). An additional 373 ha (921 ac) are designated for thinning in Apache Canyon and 81 ha (201 ac) are projected for a different part of Deerhead Canyon (R. Guaderrama, pers. comm. 2004). Thus far, neither the butterfly nor its host plants have been observed in the thinned forest edges (R. Guaderrama pers. comm. 2004). Colonization of these areas may take longer time frames, as an *E. editha* population in California took 12 years to colonize a nearby clear-cut area within coniferous forest (Thomas et al. 1996). Over time, thinned locations adjacent to suitable butterfly habitat in the Lincoln National Forest may begin to exhibit the habitat characteristics the Sacramento Mountains checkerspot butterfly prefers.

Since 2000, the Forest Service has invested almost $11 million to reduce hazardous fuels on more than 46,000 acres on the Lincoln National Forest, with funding and acreage treated in 2004 nearly 3 times the 2000 level (CFRP Press Release No. 0255.04). As part of the Healthy Forests Initiative, in June, 2004, the Lincoln National Forest received $750,000 to thin an additional 1,500 to 2,000 acres of overgrown stands of trees adjacent to communities in Lincoln and Otero counties. The goals of these thinning treatments are to reduce the threat of catastrophic wildfire in the wildland-urban interface (WUI) and to assist in the economic sustainability of these communities. The Forest Service concluded that fuel load reduction projects are not expected to change the existing habitat conditions for the butterfly, or positively or negatively impact the butterfly (Forest Service 1999h). The Forest Service has agreed to inform project managers and equipment operators of butterfly locations in order to prevent damage to the butterfly during thinning operations by redirecting the placement of access routes, machinery, slash piles, and other project materials, and to monitor on-site during implementation of such activities. Given the novelty of the extensive thinning approach in the Lincoln National Forest, there exists no data to make adequate predictions concerning the response of the butterfly to the increase in thinning. However, reducing ladder fuel accumulation and tree densities in forests surrounding the meadows may effectively control the intensity of fires in the area and reduce the threat of catastrophic wildfire to the butterfly.

Highway and Forest Road Reconstruction

According to the 2001 proposed rule, construction of roadways and associated activities can eliminate or reduce the quality or quantity of checkerspot butterfly habitat. During the late 1990s, the New Mexico State Highway and Transportation Department (NMSHTD) improved a stretch of highway approximately 2 miles long from State Highway 130 near the Village of Cloudcroft. As mitigation for impacting butterflies and butterfly habitat during the road widening project, the NMSHTD undertook a $30,000 population study that was conducted between 1999 - 2003. Although the Service stated that Sacramento Mountains checkerspot butterflies may have been killed, results of the study conducted by NMSHTD increased our knowledge of this species (see above). In addition, $10,000 was spent on translocation of plant species used by the butterfly.

Recreation Activities and Off-Highway Vehicles

The beauty, openness, and accessibility of meadows in the Lincoln National Forest make the butterfly's habitat appealing to outdoor recreationalists, such as campers, hunters, hikers, mountain bikers, and off-highway vehicle (OHV) users. The history of light human impact in campgrounds located in occupied habitat attests to the compatibility of the butterfly with limited human activity. There are fourteen campgrounds in the Lincoln National Forest that over lap with butterfly habitat. In addition, the Lincoln National Forest allows for dispersed camping (i.e., camping outside of designated campgrounds) along a 91 m (300 ft) corridor on both sides of existing roads (Forest Service 1986). However, according to the Forest Service, most visitors tend not to camp in the meadow areas, thus impact to the butterfly is not likely to be significant.

The ever-growing number of OHV users on public lands presents a significant threat to the butterfly and its habitat. The definition of an OHV includes any vehicle that can involve any vehicle that can travel off road, such as sport utility vehicles, all-terrain vehicles (ATVs), minibikes, off-highway motorcycles, go-carts, motorized trail bikes, dune buggies, amphibious vehicles, and snow-mobiles (Forest Service Proposed OHV Rule 2004). Nationally, use of OHVs has increased 109% since 1982 (Forest Service Proposed OHV Rule 2004), and an estimated "tens of millions" of OHVs are in use today (Bosworth 2004). Consistent with this trend, OHV use in New Mexico in general and the Lincoln National Forest in particular is on the rise (Forest Service 1996). The majority of riders tend to remain on designated trails, but a distinct minority drive off trails and do not ride responsibly. The creation of renegade trails by these riders causes most of the resource damage (Issa 2004), which takes place primarily in meadows, riparian areas, and steep slopes (Forest Service 1986). As OHV use appears to be rising rapidly along with the rise of traditional hunting, hiking, or camping activities in the area, the understanding and management of OHV use is an important issue that requires immediate attention if it occurs in meadow habitats occupied by the butterfly.

Although there is a dearth of scientific information concerning the impact of OHVs, mountain bikes, highway vehicles, or roads on the Sacramento Mountains checkerspot butterfly, detrimental effects of off-road riding of vehicles or heavy foot traffic in occupied meadows could cause mortality to the butterfly through direct crushing of the larval, pupal, egg, or diapause stages and could damage adults as they are stationary or flying. Clusters of soft-shelled, minute eggs of the butterfly are attached to *Penstemon* leaves from 7 to 40 cm (3 to 16 in) above the ground (J. McIntyre pers. obs. 2004). Not only are eggs susceptible to being crushed by recreationalists, but also eggs can be brushed off of the host plant subjecting them to an increased likelihood of exposure and predation on the ground below. Larval tents contain from 10-100 prediapause larvae in late summer to early fall, so the impact from tires on the butterfly population at this time may be substantial. Springtime, post-diapause larvae in the genus *Euphydryas* have gregarious tendencies, often clustering in areas of open soils, such as trails and roads, to thermoregulate (Weiss et al. 1987, Osborne & Redak 2000). Adult butterflies using roads or trails as thermoregulation sites expose themselves more to the risk of mortality than those alighting at natural patches of open ground that are not impacted by recreational activities. Other butterflies have been damaged by OHVs, including the endangered Quino checkerspot, *E. editha quino*, which displays habits similar to that of the Sacramento Mountains checkerspot (USFWS 2003).

Indirect impacts upon the butterfly by recreational vehicles may include the destruction of host and nectar plants, the modification of microclimates, the disintegration of soil crusts, the compaction of soil, the relocation of soil, the formation of ruts leading to erosion, and the alteration of the local hydrology (Smith et al. 2002). The formation of trails or ruts may divert water away from host plant sites, negatively impacting the food source of the butterfly. While some plant communities may benefit from light physical disturbance, few plants are adapted to withstand repeated disturbance by frequent OHV use. Alterations of physical habitat in unoccupied meadows could limit the butterfly's colonization of new territory if environmental features preferred by the butterfly are degraded by OHVs. Dust thrown up from dry soils may be detrimental to the butterfly by covering its body with extra mass requiring an additional allocation of energy for movement or possibly delaying predator evasion. Covering host or nectar plants with dust may impede photosynthesis and plant growth, making plants less palatable and visual cues for the butterflies less cognizable (Farmer 1993). Vehicles are known to deposit toxic substances in the environment such as exhaust fumes and oil, which may endanger the life stages of the butterfly that are associated with areas close to the substrate. Thus, the use of OHVs in butterfly habitat could harm the butterfly and its supporting ecosystem.

Recreational disturbance can impact soil, water, vegetation, fish, wildlife, National Forest visitors, and cultural and historical resources (Forest Service Proposed OHV Rule 2004). The growing magnitude and intensity of OHV use has been associated

with reduced soil depth, water quality, air quality, audio and visual aesthetics, and a decline in grasses, forbs, and shrubs (Webb & Wilshire 1983, Northwestern Great Basin Resource Advisory Council Meeting Notes 2003, Issa 2004, Forest Service Proposed OHV Rule 2004). OHV use is known to increase: rutted areas on roads; the density of tire tracks; soil compaction and runoff; wind and water erosion rates that permanently affect the productivity of National Forest lands; trail connectivity and fragmentation of habitats; the spread of noxious weeds along trails; disturbance of wildlife and wildlife habitat; damage to cultural and historical sites; human safety concerns; and conflicts between National Forest users (Webb & Wilshire 1983, Watkins et al. 2003, Forest Service Proposed OHV Rule 2004).

Studies investigating the effects of OHVs on insects are scarce. In one study, however, the impact of dune buggies on beach invertebrates produced a 15% drop in ground-dwelling arthropod populations on beaches with low level OHV use (Pearson 2004). Even heavy foot traffic can reduce specialist butterfly species richness (as opposed to generalist species, that have broader distributions, longer flight seasons, and a greater array of food sources) (Kitahara & Fuji 1994, Kitahara et al. 2000). Although light foot traffic may benefit the disturbance-dependent host plants of the Sacramento Mountains checkerspot butterfly, intensive human foot traffic can alter soil and vegetation properties, and in one case foot traffic produced a 68% decrease in total above ground biomass and a 30-fold increase in erosion at a military site in Colorado (Whitecotton et al. 2000). Yet, light impacts may be beneficial to some butterflies. A Wisconsin study found the abundance of the Karner Blue Butterfly's host plant, wild lupine, and associated nectar-producing plants to be greater in the median strip between vehicle tracks than within a track or 5 m (15.2 ft) beyond a track (Smith et al. 2002). Lupine stem density and the proportion of lupine stems with larval feeding were enhanced by moderate human activity (Smith et al. 2002). Therefore, occasional low to moderate levels of human recreational activities could have beneficial effects on butterfly populations, depending on the adaptability of the butterfly.

Roads and trails also have been implicated as a source of mortality for many species of wildlife (Haskell 1999, Trombulak & Frissell 1999). A review of all kinds of roads revealed seven effects: 1) mortality from road construction; 2) death due to collision with vehicles; 3) modification of animal behavior; 4) alteration of the physical environment; 5) transformation of the chemical environment; 6) spread of exotics; and 7) increased use of areas by humans (Trombulak & Frissell 1999). The actual ecological impact of trails and roads can extend up 100 m into the surrounding habitat forming a "road-effect zone" that represents a larger area of influence on plants and animals than the dimension of the road itself (Forman 2000, Watkins et al. 2003). In the Lincoln National Forest, roads and trails create an adjacent area of soil disturbance, which restarts succession and may stimulate the germination of *Penstemon* and sneezeweed. However, positive effects of roads and trails in butterfly habitat may be offset by the increased destruction to the butterfly and its habitat by unauthorized trails carved through meadows, and may serve to provide

access for butterfly collectors. Roads and moving vehicles also fragment habitats and isolate invertebrate populations by impeding movement and dispersal (Mader 1984, Mader et al. 1990, Haskell 1999, Trombulak & Frissell 1999), which could negatively impact the butterfly. Alternatively, due to the inviting thermoregulatory qualities of roads to butterflies, roads may serve as corridors for butterfly dispersal and help enhance the colonization of new meadows (Tiebout & Anderson 1996).

As New Mexico's human population climbs, vehicular use and demands for recreational access, particularly during the spring, summer, and fall months (the same activity period as the Sacramento Mountains checkerspot butterfly), are expected to increase (FS 1986). The FS estimates there are at least 1368 km (850 mi) of OHV routes on National Forest land in the Southwest, with at least 80 km (50 mi) being added annually (FS 1986). The Sacramento district contains 415 km (258 mi) of trails and over 1610 km (1000 mi) of Forest Service roads (Mountain Monthly, July 2004). Maintenance of these roads is costly, as is the closing and restoration of illegally created trails. The demand for riding opportunities versus the resulting environmental damage creates a situation in which the needs of recreation provision and resource protection must be balanced.

To reduce the threats of OHVs and recreational activities upon the butterfly, monitoring by the Forest Service of OHV use in suitable butterfly habitat is currently underway. Meadow areas are being mapped using GIS technology and renegade trails within meadows are being measured and their impacts on the habitat are being documented. Recently, Frank Martinez, District Ranger for the Forest Service, issued a statement to the Cloudcroft community to raise awareness of proper OHV use and to help protect the Lincoln National Forest from illegal OHV damage (Mountain Monthly, July 2004). Plans for education, trail design and maps, set-asides in the form of meadow closures, and enforcement are in the developmental stages to increase community awareness of where trail use is permitted and to protect the Sacramento Mountains checkerspot butterfly from potentially damaging OHV and recreational activities.

Domestic Livestock Grazing

The issue of livestock grazing is important in relation to the Sacramento Mountains checkerspot butterfly due to the preference of both livestock and the butterfly for meadow habitats along drainages and forest edges. Cattle tend to seek out the moisture, forage, and shade found along drainage areas and at the interface of meadow and forest (Belsky et al. 1999). The butterfly depends on the microclimate and food plants associated with the moist soils of drainages, and possibly on the habitat heterogeneity of forest edges for escape and diapause locations. Currently, public livestock grazing occurs in approximately one third of the known occupied butterfly habitat within the Lincoln National Forest (D. Salas, pers. comm. 2004)

and wild ungulate grazing occurs throughout the butterfly's known range. However, cattle grazing is expected to be reinstated on parts of the Jones Allotment in May, 2005, which would expand the area of grazing on National Forest land in occupied butterfly meadows (D. Salas, pers. comm. 2004). Precisely, of the 5,376 ha (13,439 ac) comprising the James Allotment, 2,624 ha (6,561 ac) are expected to be grazed by 70 cattle, while 2,751 ha (6,878 ac) are to be left ungrazed (R. Guaderrama, pers. comm. 2004). The outcome of the interactions among grazing regime, climate, and habitat type upon the butterfly is unknown.

Grazing can affect the butterfly population directly by trampling, consuming, or disturbing eggs, larvae, pupae, or sedentary adults (White 1986). Indirect effects of grazing upon the butterfly include: 1) changes in the abundance and distribution of larval food plants and adult nectar plants; 2) removal of herbaceous plant biomass and litter ground cover; 3) overall alteration of the plant composition and architecture of meadow habitats; 4) disturbance, compaction and erosion of soil; and 5) interactions with gopher activities and nesting sites of host plant pollinators, whose presence may increase host plant vigor and fecundity (Scholl 1989, Archer & Pike 1991, Fleischner 1994, Rittenhouse & Rosentreter 1994, Brown & McDonald 1995, Belsky & Blumenthal 1997, Donahue 1999). In addition, an indirect interaction may exist between grazing, fire, and the butterfly. Cattle grazing tends to form discontinuous distributions of fine fuels in meadows by opening up the grass canopy, decreasing litter cover, and increasing the proportion of bare soil. As a result, grazing may retard the spread of surface fires in butterfly habitat, possibly protecting the butterfly from fire exposure.

The relationship between grazing and Sacramento Mountains checkerspot butterfly populations is unclear based on preliminary surveys of larval tents, adults, and *P. neomexicanus* host plants. Pre-diapause larval tent counts of the butterfly using the plot method were tallied from 1997-2003 (Forest Service 2003). Of the three grazed sites, larval tent numbers declined at two sites (Cloudcroft Horse Pasture, Cox Canyon) and rose at one site (Pumphouse Canyon). Of the six ungrazed sites, four sites yielded declining trends in tent numbers (Bailey Canyon, Pines Campground, Silver Springs Canyon, and Spud Patch Canyon) and two sites experienced stable population fluctuations within those five years (Cloudcroft Crew Quarters/Yard, Deerhead Canyon) (Forest Service 2003). Different patterns emerge for the adult butterflies using the plot sampling method. Adult counts using years 2001 and 2003 (2002 is omitted because different sampling methods were used) revealed decreases within the plots at four ungrazed sites measured (Bailey Canyon, Spud Patch Canyon, Pines Campground, Silver Springs Canyon) and increases at the two sites where grazing occurred (Pumphouse Canyon, Cloudcroft Horse Pasture), although grazing at Cloudcroft Horse Pasture was very light and primarily by horses (Forest Service 2003). Plot counts of *P. neomexicanus* individuals in two grazed areas from 2001 to 2003 displayed increasing trends at one site (Cloudcroft Horse Pasture) and decreasing trends at the other grazed site

(Pumphouse Canyon). Of the five ungrazed areas sampled during this time, four areas showed a decline in *P. neomexicanus* numbers (Bailey Canyon, Pines Campground, Silver Springs Canyon, Spud Patch Canyon) and one site (Cloudcroft Crew Quarters/Yard) showed a stable trend (Forest Service 2003). Several conclusions can be drawn from these results: 1) sampling methods did not capture butterfly population trends in relation to grazing; 2) grazing may not be a determining factor of butterfly population patterns; 3) grazing by elk or deer may be confounding results; or 4) other factors (climate, predators, parasitoids) may be interacting with grazing to produce the population dynamics captured during this brief period.

Of the few known studies that have investigated the effects of grazing on insects, the majority have found that decreased grazing, from heavy to lighter or non-existent levels, can enhance species richness for adult butterflies (Wettstein & Schmid 1999, Balmer & Erhardt 2000, Kruess & Tscharntke 2002). A single study found no difference in insect diversity (including butterflies) between grazed and ungrazed areas (Rambo & Faeth 1999). In support of these findings, overall butterfly abundance increased as grazing intensity decreased in forested meadows in northern Germany (Kruess & Tscharntke 2002) and a ponderosa pine-grassland community study in Arizona reflected the same pattern, with a 4-10 fold increase in insect abundance as grazing intensity decreased (Rambo & Faeth 1999). Taking different approaches, two studies concluded that grazing was beneficial to butterflies (WallisDeVries & Raemakers 2001, Weiss 1999). One study showed the number of butterflies per species, including 4 threatened species, rose with light grazing and no grazing, but fell in response to mowing (WallisDeVries & Raemakers 2001). Butterfly diversity in this study was not significantly different between the three treatments. The other study, in California, reported population crashes for Bay checkerspot butterflies (*E. e. bayensis*) in areas where grazing was discontinued (Weiss 1999). Following the cessation of well-managed cattle grazing, butterfly populations dropped and some subpopulations even became extinct as a result of the rapid invasion by introduced annual grasses that crowded out the butterfly's host plants (Weiss 1999). The grasses flourished in response to the release of grazing pressure and the increase in atmospheric nitrogen deposition in the Bay checkerspot's nitrogen-poor habitat (Weiss 1999).

The gradient among light, moderate, or heavy grazing is captured by grazing intensity, or grazing density, and affects plant species in different ways. Plant species that decline with livestock grazing are either damaged by destruction of their reproductive and photosynthetic organs or are intolerant of trampling or drier conditions that vary under different grazing regimes (Belsky et al. 1999, Kreuper et al. 2003). Many of these are long-lived perennial forbs and palatable shrubs (Noy-meir et al. 1989). Plant species that increase tend to be unpalatable species, exotics, or species that benefit from disturbed conditions, sub-dominant species that are released from competition when more dominant species are consumed, or

upland species that prefer the drier conditions created by grazing in wetlands (Chew 1982, Ohmart 1996, Belsky et al. 1999).

Impacts of livestock grazing on native wildlife in Southwestern montane ecosystems vary depending on timing, duration, and intensity of grazing. For the butterfly, all three of these factors are important since grazing may affect the butterfly's life stages in different ways. The passive larval, egg, and pupal phases may be the most sensitive and, if adult checkerspot butterflies live approximately two weeks, these more vulnerable stages constitute roughly 96% of the lifetime of the butterfly. In the spring, grazing can result in increased mortality of post-diapause larvae via trampling, accidental consumption, and a reduction in forage quality (Pittenger & Yori 2003). According to White (1986), the proportion of pupae crushed by cows (~10%) was great enough to suggest that this might be an important mortality factor of *Euphydryas* spp. in a moderately grazed California grassland. Overgrazing can substantially reduce the availability of native nectar plants for some butterfly species (USFWS 2001). The availability of nectar and the amount consumed by female butterflies greatly influences the number of eggs produced and subsequent adult recruitment and thus, long-term population survival (Murphey et al. 1983, Boggs & Ross 1993). Overgrazing by stock animals has led to extinction of some butterfly populations in the United States, including butterflies in the genus *Euphydryas* (Murphy & Weiss 1988, Ehrlich 1989, Weiss et al. 1991).

Because *P. neomexicanus* and *H. hoopseii* appear to favor sites with disturbed soils, the presence of cattle may increase the density of these species (Pittenger & Yori 2003), which could be favorable to the butterfly. However, forage quality and not quantity could be more important to the butterfly (Ryan & Kuserk 2003) and cattle herbivory and trampling of *P. neomexicanus* may reduce forage quality for larvae (Pittenger & Yori 2003). In general, sites that are ungrazed or lightly grazed tend to offer greater vegetation height and heterogeneity, which would provide more microhabitats for the butterfly, compared to heavily grazed sites (Balmer & Erhardt 2000, Kruess & Tscharntke 2002). Observations of oviposition by female checkerspot butterflies have been correlated with taller, flowering *P. neomexicanus* individuals (Forest Service 2003), generally with wider stem diameters than average (J. McIntyre, unpublished data). Cropping of *P. neomexicanus* by cattle could reduce potential oviposition sites and, consequently, overall breeding success. The timing of *P. neomexicanus* clipping could be important, however. Herbivory of the meristem early in the growing season could stimulate secondary growth and produce denser foliage with delayed flowering (J. McIntyre, pers. obs 2004), which may be attractive to females for oviposition sites. Consumption of *P. neomexicanus* later in the season, during flowering or after eggs have been laid, could be detrimental to the butterfly if *P. neomexicanus* stalks providing sites for oviposition, eggs, or tents are removed. Cattle and elk tend to avoid consumption of the sneezeweed, which may permit sneezeweed to flourish under grazed conditions. Plant species richness and evenness, as a measure of butterfly nectar plants, in

response to light-moderate grazing, have been documented as increasing in some montane rangelands (Rambo & Faeth 1999), decreasing in some (Belsky et al. 1999), and showing no difference in others (Curtin 2002). Excessive grazing decreases the biomass, vigor, and architectural diversity of rangeland vegetation, and alters species composition and ecosystem function (USFWS 2002). Presumably, overgrazing, associated with grazing intensities and durations that exceed the ability of herbaceous plants to recover or survive, would be detrimental to the Sacramento Mountains checkerspot butterfly. Thus grazing management is not only critical to sustainable grazing practices, but also may be important in determining the quality of butterfly habitat.

Environmental factors such as climate, geology, hydrology, topography, or nitrogen deposition may accentuate grazing effects (Brown & McDonald 1995, Weiss 1999, USFWS 2002). In the Southwest, where rangelands are water-limited, setting the optimal timing, duration, and intensity for grazing depends primarily on short- and long-term precipitation trends (Brown, Valone, & Curtin 1997). Spring grazing during dry periods can intensify grazing pressure upon *P. neomexicanus*, as it can be among the few available green plants (Pittenger & Yori 2003). During drought years, it may be necessary to reduce grazing pressure by decreasing the number of cattle at a site, delaying the onset of spring seasonal grazing, or shortening the time livestock are in an area in order for plants to develop enough below-ground and above-ground biomass to withstand herbivory and disturbance. Constant cattle presence in wetlands and drainages can alter soil properties, microtopography, and overland water flow through soil compaction, erosion, and dessication, and removal of herbaceous plants and litter. Over time, this serves to create drier conditions in riparian areas, wetlands, and drainages as the water table is lowered (Belsky et al. 1999, Kreuper et al. 2003). Reduced access to moisture may inhibit host and nectar plant growth and have a negative affect on the Sacramento Mountains checkerspot butterfly.

Grazing interacts with other variables such as historic and current human land use and fire management strategies. The combination of grazing and recreational use may pose a greater threat to the persistence of the butterfly through increased disturbance, but preliminary data comparing larvae and adult butterflies exposed to grazing and recreational use has been inconclusive (Forest Service 2003). In most of the montane West, fire suppression over the last 100 years combined with logging and selective herbivory by grazers has enabled woody species to encroach into meadow habitat (Belsky & Blumenthal 1997, Knapp & Soule 1998). Pre-settlement conditions of widely spaced, fire-tolerant trees within forests underlain by deep grasses have developed into dense, spreading stands of smaller trees (Belsky & Blumenthal 1997, Kaufmann et al. 1998). By consuming the understory grasses and sedges that typically outcompete conifer seedlings and inhibit steady tree recruitment, cattle have facilitated the dwindling of meadow habitat (Belsky & Blumenthal 1997). As the butterfly may be dependent on habitat area and associated microhabitat choices, persistent grazing along forest edges could affect

butterfly populations by reducing meadow area and connectivity. Grazing also can diminish the spread of ground fires by consuming biomass and creating a landscape with more exposed soil. The reduction of standing vegetation may have beneficial effects by preventing fire expansion into meadows during sensitive life phases of the butterfly.

Recent studies suggest that soil disturbance by gophers enhances conditions for *Penstemon* recruitment and vigor (Pittenger & Yori 2003). Gopher mounds may offer tilled, bare patches for butterfly thermoregulation and diapause locations (Pittenger & Yori 2003). Contrastingly, gophers were agents of Sacramento Mountains checkerspot butterfly larval tent destruction during 2003 as the gophers either buried *P. neomexicanus* plants containing the larval tents or pulled the plants into their burrows (presumably to consume) (Forest Service 2003). Results of interactions between cattle and gopher activities are not yet understood. Also unknown are the effects of interactions between cattle and the insect pollinators of *P. neomexicanus* and *V. edulis*, the primary and secondary larval host plants of the Sacramento Mountains checkerspot butterfly, respectively.

Because information disclosing the relationship between the Sacramento Mountains checkerspot butterfly and domestic livestock grazing remains to be researched, how the butterfly will respond to the proposed increase in grazing area within butterfly habitat is unknown. In order to create varied habitat structure throughout the butterfly's range, and reduce potential impacts to the butterfly from the reinstatement of grazing, the Forest Service is committed to excluding Spud Patch Canyon from livestock grazing for at least 10 years. Covering the northeast portion of the James Allotment, this area contains a total of 2785 ha (6880 ac), including 51 ha (125 ac) of occupied butterfly habitat (R. Guaderrama, pers. comm. 2004). The USFWS has procured funding to begin research on baseline data in 2004 and 2005. Additional funding is being procured to support research on the effects of grazing upon the butterfly, and field research concerning this question is underway as of May, 2004. By October, 2005, data will be available to assess the response of the butterfly, associated vegetation, and soil properties to different intensities of grazing. Over the next few years, the butterfly populations in grazed and ungrazed locations and related habitat variables, including climate, will be monitored to analyze relationships in response to grazing. From these data, an adaptive management plan will be developed and implemented to permit flexibility in cattle management in order to secure butterfly populations. Subsequent monitoring of the butterfly and its habitat will provide an empirical and objective basis for determining whether the management guidelines will lead to desired outcomes. Creating optimal butterfly habitat that incorporates soil disturbance for thermoregulation sites and increased *Penstemon* and sneezeweed growth but minimizes soil compaction and damage to *Penstemon* and the butterfly, may involve a mosaic of light-moderately grazed to ungrazed meadow habitat to encourage the widest array of habitat heterogeneity and biodiversity.

Nonnative Vegetation

Nonnative vegetation was cited as a threat to the checkerspot butterfly in the 2001 proposed rule by out-competing and reducing or eliminating food plants for larvae and nectar plants (Forest Service 1995). A 1993 Forest Service survey found that approximately 737 ha (1,822 acres) in the vicinity of the Village of Cloudcroft had infestations of noxious weeds (Forest Service 1999). On the Sacramento Ranger District, nonnative plant species such as Russian knapweed (*Acroptilon repens*), musk thistle (*Carduus nutans*), bull thistle, Canada thistle, leafy spurge (*Euphorbia esula*) and others occur. Nonnative plants can affect plant community structure by reducing native plant production and changing habitat structure and composition. For example, Russian knapweed produces compounds that suppress the growth of other plant species, allowing it to form dense stands (Forest Service 1996).

On May 1, 2001, the Forest Service signed a record of decision to implement management for noxious weed control. This management included using manual methods and herbicides to treat all noxious weed acres on the Forest. Herbicides will be applied using ground spray and backpack sprayers (i.e., hand spraying). According to the Forest Service, no spraying or application of herbicides shall occur within occupied Sacramento Mountains checkerspot butterfly habitat (Forest Service 2001 *in litt*). In addition, in occupied Sacramento Mountains checkerspot butterfly habitat, manual hand pulling of noxious weeds will occur during the adult flight period (i.e., from June 20 to July 31).

Insect Control

As stated in the 2001 proposed rule, large portions of the Sacramento Mountains were treated in 1984 with carbaryl or *Bacillus thuringensis* to control an outbreak of forest insects. Carbaryl is considered moderately to highly toxic and is lethal to many non-target species. *Bacillus thuringensis* can kill larval stage of many insects, including butterflies (Cornell University 1998). However, it is unknown what affect these treatments may have had on the Sacramento Mountains checkerspot butterfly from the 1984 application because no data on pre-treatment exists. According to the Forest Service, there are no proposals to spray for insect outbreaks currently or in the future.

B. Over-utilization for Commercial, Recreation, Science, or Education - Collecting

As previously stated, due to their conspicuous nature, butterflies in the genus *Euphydryas* are widely collected and well studied, and are known to be restricted to specific habitats (Ehrlich et al. 1975, Cullenward et al. 1979, Murphy and Weiss 1988). Listing has been known to increase the publicity and interest in a species'

rarity, and thus may directly increase the value and demand for specimens (Ehrlich 1989).

To protect the Sacramento Mountains checkerspot butterfly from collection, the Forest Service issued a closure order throughout the region in 2000 that restricts the collection of the Sacramento Mountains checkerspot butterfly without a permit. Pursuant to 36 C.F.R., § 261.58(s), the Forest Service specifically prohibited "capture, collection, killing, possession, storage, or transportation of the Sacramento Mountains checkerspot butterfly, and of life stages or parts thereof." Violation of these prohibitions is punishable by a fine of up to $5,000 for an individual or $10,000 for an entity other than an individual, or imprisonment for not more than six months or both (16 U.S.C. § 551).

C. Disease or Predation

Spiders, pocket gophers, ants, and birds are documented predators for butterflies in the genus *Euphydryas* (Ehrlich 1965, Brown & Ehrlich 1980, Moore 1987, 1989). Although the proposed rule stated that wasps have been documented parasitizing the butterfly, there are no indications at this time that parasites or predators might be a limiting factor for the Sacramento Mountains checkerspot butterfly (USFWS 2001).

D. Inadequacy of Existing Regulatory Mechanisms

This species is not listed as threatened or endangered under the New Mexico Wildlife Conservation Act because New Mexico Department of Game and Fish does not list insects (Wildlife Conservation Act of New Mexico 1978). Private lands constitute about 50% of the estimated range of the butterfly. The threats on private land are currently unknown (USFWS 2001).

The Village of Cloudcroft already has in place Town Ordinances that implement local zoning regulations related to open space that are expected to benefit the butterfly. The Village of Cloudcroft's Village Code document states that Greenbelt Zones shall consist of open space with no structures or commercial signs allowed. Further, there shall be no overnight parking or camping allowed within these areas. The Village of Cloudcroft will implement greenbelts in any annexed lands.

The County of Otero has drafted an ordinance that would require green belt or open space set-a-sides for new subdivision development within the County. In addition, the County plans on implementing best management practices for new construction on private lands within butterfly habitat. These best management practices will ensure that butterfly habitat is maintained or enhanced for any new development on private lands within the Otero County. Management practices may include, but

are not limited to, recommending butterfly surveys, maintaining current habitat if present, and establishing native plants that are associated with checkerspot butterfly habitat. In addition, Otero County has drafted, and intends to adopt, a County Resolution to demonstrate commitment to conservation of the butterfly (See Appendix B.).

Pursuant to section 7(a)(4) of the ESA, the Forest Service has coordinated with the Service on seven conference opinions concerning the butterfly since 2001. Activities discussed in the conference opinions include: utility projects, recreation projects, land transfers, fire management, insecticide application, vegetation management, and research on the butterfly. Conservation measures have included butterfly surveys, host plant relocation, habitat flagging, revegetation and restoration efforts, monitoring, compliance reporting, seasonal restrictions, minimizing habitat impact, and/or herbicide application restrictions. All conference opinions concluded no jeopardy to the species as well as recommending that a regional conservation strategy be developed for the butterfly.

E. Other Natural Factors Affecting the Species

The Sacramento Mountains checkerspot is also vulnerable to changes in climate. Thus, the effect of climate change is discussed in detail below. It should be noted that this does not imply that the species cannot survive natural events such as drought. Instead, it is being addressed here because it was disclosed in the proposed rule to list the species. Although the species evolved in an environment subject to periodic atypical weather events, it is worth discussing because it could be an additive risk to the species.

Climate Change

Climate change and associated atmospheric effects are predicted to alter the global distribution of organisms (Parmesan 1999, Chapin et al. 2000, Thomas et al. 2004). Since 1951, the average minimum winter temperature in the Northern Hemisphere has risen 2.9ºC while the average summer maximum temperature has risen 1.3ºC (Crozier 2003). Other mechanisms of global change, such as rising CO2 levels, drought cycles, and increasing nitrogen deposition may also impact species of the Southwest. Although most short-term changes in a species' distribution are caused by natural population fluctuations in response to environmental and land use changes, small trends may produce substantive effects in the long term. Next to land use, climate change is projected to have the second largest impact on biodiversity (Chapin et al. 2000). Climate change has been and will continue to be a long-term threat to the Sacramento Mountains checkerspot butterfly, and its effect on the butterfly is unclear.

Recently derived models have calculated extinction threats based on temperature changes, rises in atmospheric CO2, geographical range size, biome type, and species' dispersal ability (Thomas et al. 2004). For endemic species with low dispersal capabilities and small geographic ranges, like the Sacramento Mountains checkerspot butterfly, the probability of extinction within the next 50 years ranges from 22%, based on minor temperature changes (0.8-1.7°C), to 52% with maximum expected climate change (>2.0°C) (Thomas et al. 2004). Species that have good dispersal and are not dependent on specific plants will not be affected as much as species that have low dispersal patterns and narrow host plant distributions (Warren et al. 2001, Crozier 2003). The Sacramento Mountains checkerspot butterfly falls into the latter category.

Climate change is expected to be of particular importance at high latitude/altitude biomes (McDonald & Brown 1992, Halpin 1997, Fleishman 1998). For herbivorous insects, temperature directly affects development, survival, range and abundance (Bale et al. 2002). The maintenance of optimal temperatures for high elevation species may involve range shifts up the mountain to counteract warming trends. Moving up in altitude to keep cool may eventually translate into contracted habitat area as the mountain ends or as survival limits determined by minimum temperatures or exposure set an upper boundary. Phenology for plants and insects is determined by the interaction of temperature and photoperiod (Bale et al. 2002). If range shifts of the butterfly, its host and nectar plants, and their pollinators do not occur together, this may affect the butterfly by limiting the availability or productivity of its food plants (Crozier 2003).

Another facet of climate change that could impact the Sacramento Mountains checkerspot butterfly is the multidecadal drought cycle (McCabe et al. 2004). Drought is known to cause a decrease in the population sizes of some butterfly species (Ehrlich et al. 1980) and cause population extinctions (Murphy & Weiss 1988, Thomas et al. 1996, Boughton 1999). Other than inducing larval death by dessication, drought conditions may reduce growth and nutritional content of the host plants, which could stunt the butterfly's growth and prohibit the completion of its life cycle. For example, drought in California between 1975-77 is associated with the extinction of several *E. editha* populations and the decline of *E. chalcedona* populations, although a few montane populations of *Euphydryas* remained stable or experienced population increases from local orographic effects (Ehrlich et al. 1980). Negatively affected populations failed to survive due to: the lack of host plant germination, causing low host plant densities; drought stress on the available host plants, leading to rapid senescence before oviposition could occur; intraspecific competition for the few surviving host plants; and the resulting inability of larvae to become large enough to enter diapause (Ehrlich et al. 1980). A different study suggests that two populations of the Bay Checkerspot, *E. e. bayensis*, became extinct due to a combination of habitat loss and precipitation fluctuations (McLaughlin et al. 2002). Models have not ruled out the chance of a multi-decadal

drought, occurring in a 50-80 year cycle and related to variations in the Atlantic Multidecadal Oscillation, co-occurring with a smaller-scale Pacific Decadal Oscillation, which regulates the El Nino Southern Oscillation pattern (McCabe et al. 2004). Should these two cycles amplify one another a megadrought may result, which could pose serious problems for the maintenance of the butterfly's host plants and, consequently, the butterfly.

Current drought conditions in New Mexico are already impacting the local climates. Recently, the Sacramento Mountains have experienced higher average winter temperatures resulting in lower snow accumulation (D. Salas pers. comm. 2004). Warmer temperatures and the loss of precipitation have created drier soils in the spring and decreased spring runoff from melting snow (D. Salas pers. comm. 2004). Specific temperature and moisture impacts upon the Sacramento Mountains checkerspot butterfly, the plants *P. neomexicanus*, *V. edulis*, and *H. hoopesii*, and their pollinators are presently unknown. However, reduced quantity and duration of spring soil moisture may decrease water availability to spring plants and diapausing larvae. Furthermore, earlier increased spring temperatures could alter reproductive phenologies that could diminish butterfly populations.

Climate change can affect the resilience of an ecosystem, by weakening its ability to return to its original state or switch to a new set of conditions (Scheffer et al. 2001). Butterflies are highly sensitive to both short- and long-term changing abiotic conditions and have been deemed 'model systems for understanding and predicting climate change' (Hellman 2002). Future climates that significantly impact butterfly and host plant populations in the Sacramento Mountains may force the butterfly to adapt to a novel host before becoming extinct. Changes in host preference have occurred in this genus, usually as a result of migration followed by local evolution (Radtkey & Singer 1995, Thomas et al 1996). The uncertainty of the short-term and long-term response of the Sacramento Mountains butterfly to predicted climate change creates a situation that local management is incapable of addressing.

IV. CONSERVATION STRATEGY

This section describes the cooperators involved and specifies the approaches and strategies for conserving the Sacramento Mountains checkerspot butterfly. These approaches and strategies are based on principles of conservation biology as well as our knowledge of the biology and ecology of the species, providing a long-term approach to the protection and management of the butterfly. Conservation biology is defined as an integrative approach to the maintenance of biodiversity that uses appropriate principles and experiences from basic biological fields such as genetics and ecology; from natural resource management fields such as wildlife management; and from social sciences such as anthropology, sociology, philosophy, and economics (Meffe et al. 1997). Conservation measures are a complex mix of biological, economic, and humanistic endeavors. The conservation measures below are a set of tools and approaches that require implementation to become useful and appropriate.

A. Cooperators

Below are the various cooperators that joined together to formulate this Conservation Plan. These entities compiled information, developed conservation measures, and recommended actions. The conservation of the butterfly will require continued active participation by these partners. Each of these cooperators will play a crucial role in the implementation of the Conservation Plan, as outlined below.

Village of Cloudcroft

The Village of Cloudcroft, founded in 1898, is a small mountain village of approximately 724 residents located within the Sacramento Mountains. Cloudcroft is approximately 9,000 ft (2,750 m) in elevation and is located 26 km (16 mi) from Alamogordo, New Mexico. The Village population has been essentially stable over the past several decades with a slight decline in population over the past four years. The local economy is primarily dependent upon tourism as opposed to the industry-based economy (i.e., resource extraction such as timber) of the past. Today, outdoor recreational activities include camping, hiking, hunting, mountain biking, off-highway vehicle-riding, skiing, and snowmobiling.

Otero County

Otero County lies in south-central New Mexico extending to the Texas border. Otero County is a co-lead with the Forest Service to identify problems and implement restoration on public lands at the local level. The County role includes acting as a co-convener of the collaborative process, providing socio-economic

information, facilitating community outreach, and incorporating knowledge and skill from colleges and universities to provide scientific assessments.

Lincoln National Forest

The Sacramento Ranger District of the Lincoln National Forest, headquartered in Cloudcroft, manages 180,168 ha (450,419 ac) of the Sacramento Mountains. The Sacramento Mountains are characterized as high elevational mixed-conifer forests and meadows. The Lincoln National Forest is a mecca for outdoor activities that attracts people from communities adjacent to the forest as well as Texas and other areas. Recreational opportunities include camping, hunting, hiking, OHV-use, skiing, star-gazing, and wildlife viewing. Several miles of trails and old railroad grades are used by hikers, mountain bikers, OHVs, and cross-country skiers. No designated wilderness areas occur on the Sacramento Ranger District. The mission of the Forest Service is "caring for the land and serving people."

United States Fish and Wildlife Service

The USFWS is the principal Federal agency responsible for conserving, protecting and enhancing fish, wildlife and plants and their habitats for the continuing benefit of the American people. The USFWS manages the 95-million-acre National Wildlife Refuge System, which encompasses 544 national wildlife refuges, thousands of small wetlands and other special management areas. It also operates 69 national fish hatcheries, 63 fish and wildlife management offices and 81 ecological services field stations. The agency enforces Federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Federal Assistance program, which distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to State fish and wildlife agencies. The mission of the USFWS is: "working with others to conserve, protect and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people."

B. Conservation Actions

The Sacramento Mountains checkerspot butterfly was proposed for listing because of a variety of factors, the primary reason being loss and degradation of habitat. However, many of these factors have been curtailed since the proposed rule was published. Furthermore, there are continuing commitments to the long-term

protection and survival of the species as stated below. Thus, the actions outlined below steer a course for what will be effective conservation (both short- and long-term) of the Sacramento Mountains checkerspot butterfly. This outline categorizes conservation actions into four types:

1. Protect and manage occupied and unoccupied Sacramento Mountains checkerspot butterfly habitat on public lands.

2. Manage habitat and promote conservation, through education and outreach, of Sacramento Mountains checkerspot butterfly on non-Federal and other private lands.

3. Conduct research to fill information gaps and inform management.

4. Provide adequate regulatory protection.

C. Funding

Below is a summary of funding commitments by the involved parties. Funding is necessary for surveys, research, monitoring, habitat enhancement, public outreach, and further implementation of this Plan.

Village of Cloudcroft

The Village of Cloudcroft is dedicated to public outreach and education programs to promote conservation of the butterfly. The Village will encourage interested private citizens and organizations to attend meetings and participate voluntarily. The Village will work with private landowners (in cooperation with the County) to educate landowners about butterfly conservation. This includes, but is not limited to, restoration of areas and planting butterfly food and larval host plants, and communication with landowners through the local newspaper and Village Council Workshops. Outreach and educational programs are planned for the local community, within the Village of Cloudcroft and the County. The Village of Cloudcroft will share in the cost of public outreach and education.

Otero County

Through the CPR program, Otero County is expected to contribute $100,000 towards threatened and endangered species and the butterfly. Specifically, the County has allocated this funding in the category of science and monitoring. In addition, the USFWS and Otero County are drafting a cooperative agreement that

would allocate funds for on-going research on the effects of grazing on the butterfly and its habitat in 2005-2006.

Forest Service

Estimated costs incurred by the Forest Service associated with the butterfly efforts since 2001 have been approximately $100,000. The Forest Service will continue to allocate resources towards coordination with the USFWS on butterfly conservation.

The Forest Service has conducted a biological study of the butterfly between 1999-2003 which was completed at a cost of $30,000. The Forest Service will continue to fund surveys and monitoring activities. In addition, the Lincoln National Forest will receive $750,000 from the USDA to conduct forest restoration and community protection projects on the forest that will benefit the butterfly.

United States Fish and Wildlife Service

The USFWS has procured $13,000 for an initial research study of the effects of grazing on the checkerspot butterfly. Using maps of occupied butterfly habitat prepared by the Forest Service, this study will collect field data over the summer of 2005 in three canyons that will be grazed by May of 2005. Ecological variables of these canyons will be compared to baseline variables sampled in 2004 prior to the introduction of grazing. At each canyon, data concerning adult and larval butterfly demographics, host and nectar plants, percent ground cover, soil characteristics, topography, and climate will be recorded. In particular, butterfly larval and adult densities and grazing densities will be compared to formulate adaptive grazing regimes that will benefit the butterfly.

The Sacramento Mountains checkerspot butterfly is currently a priority for the USFWS's Partners for Fish and Wildlife Program. This program has been working diligently with the Forest Service and non-Federal entities regarding conservation efforts related to the butterfly. For example, the Forest Service gathered *P. neomexicanus* seeds from sites on the Lincoln National Forest. During 2003 and 2004, the Plant Materials Center in Los Lunas, New Mexico, in cooperation with the National Resource Conservation Service, cleaned, graded, and planted *P. neomexicanus* seed. The Otero County Chapter of the Native Plant Society of New Mexico and the Otero County Extension Office (Master Gardener Program) have expressed interest in being "foster parents" for *Penstemon* plants until they are needed for community projects. In addition, these entities would like to be advocates in the community for the butterfly and its larval and nectar plants, as

well as being "on-call" to assist with relocating and transplanting plants during Forest Service activities.

The USFWS will continue to seek resources and funding for research, monitoring, and surveys. In addition, the USFWS will continue to allocate resources towards coordination with the partners on butterfly conservation.

D. Adaptive Management and Monitoring

Adaptive management is the process in which information is gained from monitoring and research and is then used to modify future management practices. In short, adaptive management is a feedback loop; if conditions deviate substantially from predictions, management activities are adjusted to achieve the desired outcomes. Thus, adaptive management is primarily dependent upon reliable data from monitoring and research results. Adaptive management is a crucial element of any conservation strategy that will be accomplished through development of a monitoring program, research, and evaluation.

Monitoring is a key component of adaptive management and a needed activity for implementation of this conservation strategy. Monitoring is necessary in order to assure that the conservation measures in this plan are successful. Adaptive management will be successful only to the degree that it is based upon accurate and credible monitoring.

Monitoring programs for assessing project-level objectives are called *implementation monitoring* and *effectiveness monitoring*. These activities are primarily administrative in nature (Thompson *et al.* 1998). Implementation monitoring evaluates whether a monitoring program was actually put in place, whereas effectiveness monitoring judges the successfulness of a monitoring program in meeting its predetermined goals (MacDonald *et al.* 1991).

In order to ensure implementation of this plan, a Sacramento Mountains Checkerspot Butterfly Conservation Plan Interagency Coordination Committee will be formed (ICC) (see Appendix A. Section V.). The involved cooperators of this Plan shall designate a representative to serve on the ICC. This committee shall monitor the implementation of the Conservation Plan and provide a forum for exchange of information on the species. Through mutual agreement among designated representatives of all involved parties, the ICC may recommend changes in the tasks and scheduling of task implementation pursuant to monitoring and research results. In addition, the ICC shall meet annually to review progress and coordinate work priorities and further research.

E. Research

The primary objectives of a research program are to (1) enhance understanding of checkerspot butterfly biology and, (2) assess how land management practices affect the butterfly's abundance and distribution. These types of information, along with monitoring, are necessary for the information feedback loop as discussed above under adaptive management. The following is an outline of research recommended for the checkerspot butterfly. Clearly, a large number of research questions could be developed that address all aspects of the biology of the Sacramento Mountains checkerspot butterfly for which knowledge is lacking. However, the most crucial questions that need to be addressed for management are proposed below:

Basic Biology on Life-stages, Oviposition Behavior

The life cycle of the Sacramento Mountains checkerspot butterfly is unusually complex. If environmental conditions are not conducive to completing the life cycle, larvae may remain in an inactive state (diapause) for more than one year (E. Hein, pers. comm. 2004). Key questions include:

- ♣ Where do the diapause larvae occur when they are inactive?
- ♣ How long can the diapause larvae stay inactive?
- ♣ Do the larvae use more than one plant?

Habitat

More information is needed on habitat selection by various life-stages of the butterfly. Specifically, information is needed to answer the following key management questions:

- ♣ What influence does fire (i.e., frequency, severity) have on habitat for the butterfly?
- ♣ What influence does grazing (i.e., frequency, intensity, seasonal) have on habitat for the butterfly?
- ♣ To what extent does planting host plants such as *Penstemon* increase habitat quality for the butterfly?

Population Biology

Currently, little is known about checkerspot butterfly population dynamics. Key questions to be answered include:

- ♣ Is the Sacramento Mountains checkerspot butterfly population stable?
- ♣ Does the butterfly population function as a metapopulation?
- ♣ If a metapopulation, what is the structure?

F. Stepdown Outline of Conservation Actions

The stepdown outline of actions needed to achieve the objectives of the Plan follows. Individual actions are discussed in the subsequent Narrative Outline.

1.0 Protect and manage occupied and unoccupied butterfly habitat on public lands.

- **1.1** Apply appropriate weed and pest control practices in or near occupied meadows.
- **1.2** Decrease risk of catastrophic wildfire; prioritize treatment areas near known, occupied habitat.
- **1.3** Manage public recreation.
  - **1.3.1** Manage campgrounds near butterfly meadows to contain vehicles, tents, and other equipment in confined areas.
  - **1.3.2** Inventory and identify important butterfly meadows being impacted by OHVs, and close these meadows to further OHV use.
  - **1.3.3** Develop and install an interpretive kiosk at Pines campground.
  - **1.3.4** Continue issuance of Special Use Permits sensitive to the butterfly.
- **1.4** Manage domestic livestock grazing.
  - **1.4.1** Implement appropriate grazing regimes for domestic livestock.
  - **1.4.2** Control trespass livestock.
- **1.5** Protect butterfly from threat of collection.
- **1.6** Ensure effective contract administration for projects occurring in butterfly habitat.

1.7 Implement best management practices during maintenance of powerline corridors.

2.0 Manage and promote conservation of the butterfly and its habitat on private lands.

2.1 Curtail expansion of the Village of Cloudcroft into butterfly habitat.

2.1.1 Annex available lands for designation as greenbelts.

2.1.2 Conduct land exchange to transfer occupied habitat into Forest Service management.

2.1.3 Conduct outreach and education in the Village of Cloudcroft.

2.2 Promote butterfly conservation in the County.

2.2.1 Amend the County Subdivision Ordinance to direct the use of best management practices to minimize effects from future subdivisions.

2.2.2 Pass a County Resolution committed to conservation of the butterfly.

2.2.3 Develop partners for Fish and Wildlife projects for butterfly conservation.

2.3 Conduct public education programs in Otero County.

3.0 Fill information gaps as needed to support adaptive management.

3.1 Conduct research needed to inform management on basic biology, habitat, distribution, and population biology.

3.1.1 Determine where diapause larvae occur.

3.1.2 Determine the duration of diapause.

3.1.3 Investigate plant use by diapause larvae.

3.1.4 Investigate influence of fire on butterfly habitat.

3.1.5 Investigate grazing systems, strategies, and intensities for butterfly habitat maintenance.

3.1.6 Determine whether planting host plants influences butterfly occupancy.

3.2 Monitor species, habitat, and threats.

4.0 Conduct annual coordination meetings.

G. Narrative Outline for Conservation Actions

1.0 Protect and manage occupied and unoccupied butterfly habitat on public lands.

1.1 Apply appropriate weed and pest control practices in or near occupied meadows. On May 1, 2001, the Forest Service signed a record of decision to implement management for noxious weed control Forest-wide (Forest Service 2001 *in lit*). This management included using manual methods and herbicides to treat all noxious weed acres on the Forest. According to the Forest Service, no spraying or application of herbicides shall occur within occupied Sacramento Mountains checkerspot butterfly habitat. In addition, in occupied Sacramento Mountains checkerspot butterfly habitat, manual hand pulling of noxious weeds will occur during the adult flight period (i.e., from June 20 to July 31). In addition, as stated above, the Forest Service has no proposals to spray for insect outbreaks currently or in the future.

1.2 Decrease risk of catastrophic wildfire; prioritize areas surrounding known, occupied habitat. The Rio Penasco II project is located on the north-central portion of the Sacramento Ranger District of the Lincoln National Forest. The primary purpose of this project is to reduce fuel loading (natural and activity created) and reduce overly dense forested stands through timber harvest activity, prescribed fire, and fuels treatments. According to the Forest Service's Environmental Assessment for this project, these treatments will reduce the risk of stand-replacing wildfire and insect/disease epidemics especially in the wildland/urban interface areas. In addition, these treatments will improve, protect, and enhance the health of forest stands as well as habitat for endangered, threatened, and sensitive species. This project will be conducted over a 15-year period. A record of decision was signed on November 15, 2002, and the Service provided a conference opinion on this project on September 27, 2002. The Rio Penasco II project proposes to treat approximately 13,200 ha (33,000 ac). Of the 13,200 ha (33,000 ac), roughly 200 ha (500 ac) are considered meadow habitat and are occupied by the checkerspot butterfly. However, no treatments will occur within the meadows. Treatment areas may require access through meadows. Any damage to butterfly habitat caused by access will be minimized through effective contract administration in treatment areas.

The proposed 16 Springs Watershed forest thinning project (Elk Canyon) encompasses a total of 33,886 ha (84,716 ac). Approximately 19,386 ha (48,465 ac) are within the National Forest administrative boundary, with roughly 1,822 ha (4,556 ac) in private in-holdings. Activities associated with the 16 Springs analysis will focus on reducing risk of insect and density related mortality of trees, reducing fuels to lessen the risk of large-scale, stand replacing fires, and maintaining important ecological components that focus on listed and sensitive species.

In 2003, the Forest Service, Otero County, and other local and Federal government entities signed a Memorandum of Understanding to cooperate under the National Forest County Partnership Restoration Program. The National Forest County Partnership Restoration Program (also known as CPR) is an innovative partnership to restore watersheds and landscapes to more desirable and sustainable conditions. The Program will establish a community-based, collaborative effort, integrate current science, and test new processes and budget authorities. Community-based collaboration is based on the premise that citizens have the right and privilege to participate in a decision making process on public land management issues that affect them. Seventeen county governments and forest managers will lead local efforts to meet landscape and community restoration goals on the Lincoln National Forest (as well as other National Forests in New Mexico, Arizona, and Colorado).

The CPR Program encompasses four principal dimensions: (1) community-based collaboration with stakeholders; (2) integration of best available science; (3) expedited implementation of watershed and landscape restoration and enhancement projects; and (3) flexibility in authorities and programming. The Program also develops restoration treatments to respond to concerns of Congress, managers, scientists, and communities regarding the decline in watershed resource conditions in the West. This Program requires a 10-year program commitment by public agencies and supplementary funding above current levels that is flexible, programmable, and allows for multi-year phasing.

In June of 2004, the Lincoln National Forest received $750,000 from USDA to work on forest restoration and community protection projects on the forest. This funding is part of the Healthy Forests Restoration Act of 2003 to reduce the risk of catastrophic fire to communities and help conserve threatened and endangered species.

1.3 Manage public recreation.

1.3.1 Manage campgrounds near butterfly meadows to contain vehicles, tents, and other equipment in confined areas. The type locality for the butterfly is Pines Campground, and its description is based upon individuals collected at that location in 1964, 1976, and 1978. Prior to 1997, the estimated extent of the range of the butterfly was primarily from two campgrounds (Holland 1999). The Forest Service set forth conservation measures during the Capital Improvement Project for the Pines Campground including such actions as significantly reducing the visitor capacity, constructing retaining

walls, installing fences and signs, enforcing camping closures, and building a split-rail fence around the central butterfly meadow. Similar improvements and conservation measures will be implemented in other Forest Service campgrounds including Sleepy Grass, Aspen, Black Bear, Deer Head, and Slide Campgrounds. The overall goal is to reduce the number of people-at-one-time in a campground.

1.3.2 Inventory and identify important butterfly meadows being impacted by OHVs, and close these meadows to further OHV use. The Forest Service is currently mapping illegal OHV-use in occupied butterfly meadows. The Forest Service will meet with interested parties and internal experts to formulate approaches to alleviate problems within meadow areas, including meadow closures.

1.3.3 Develop and install an interpretive kiosk at Pines campground. The kiosk is an informational sign developed by the Forest Service highlighting butterfly life-cycle and habitat requirements. This will be installed at the split-rail fence at the Pines Campground for public education.

1.3.4 Continue issuance of Special Use Permits sensitive to the butterfly. The Forest Service issues special use permits for parties over 70 people or for special events. The Forest Service must conduct the appropriate analyses before issuing a special use permit such as archeological and biological reviews. When issuing these types of permits, the Forest Service's recreation staff redirects the activities when possible, and educates the permitees regarding conservation of the butterfly.

1.4 Manage domestic livestock grazing.

1.4.1 Implement appropriate grazing regimes for domestic livestock. The Forest Service will manage to achieve good to excellent range conditions. The primary allotments that overlap with butterfly habitat are the James and Pumphouse Allotments. On the Pumphouse Allotment, 4 ha (10 ac) of occupied butterfly habitat in Snow Canyon will be excluded from domestic livestock grazing. Approximately half the James Allotment, containing occupied and unoccupied butterfly habitat, including Spud Patch Canyon, is being proposed to remain as ungrazed. The Forest Service is committed to light to moderate grazing regimes (30-40% with the goal of 35%); once these utilization levels are met or exceeded, changes in grazing management will occur. This is being implemented in conjunction with research (see below).

1.4.2 Control trespass livestock. Trespass horses have been observed on the northern portion of the Sacramento Ranger District within occupied butterfly habitat. Range improvements from the James Allotment Management Plan include replacement of fencing along portions of the northern boundary of the District. Horses have been reproducing and thus, are increasing in numbers each year. The Forest is preparing a contract to remove the horses pursuant to New Mexico Livestock Board regulations. In addition, the Forest Service is attempting to work with non-Federal landowners regarding the recurrence of this issue.

1.5 Protect butterfly from threat of collection. Pursuant to 36 C.F.R. § 261.58(s), the Forest Service issued a closure order that prohibits collection specifically of the Sacramento Mountains checkerspot butterfly. According to the Forest Service, this order became effective on April 1, 2000, and remains in force until rescinded. Forest Service Law Enforcement is aware of possible threat of illegal collecting. Penalty for illegal collection is a maximum of $5,000 and 6 months in jail. To date, illegal butterfly collecting of the Sacramento Mountains checkerspot butterfly has not been documented.

1.6 Ensure effective contract administration for projects occurring in butterfly habitat. The Forest Service recognizes that ineffective contract administration can be problematic and a source of impacts to the butterfly and its habitat. The Forest Service continues to improve internal and external communications for projects, from inception through implementation, to reduce impacts to butterfly habitat. The Forest Service is actively incorporating measures to protect butterflies and habitat. For example, if project implementation occurs during the active season (i.e., non-diapause life-stage), additional surveys are conducted prior to project implementation to further minimize effects to the butterfly. If butterfly larvae are located in the project area, they are relocated to other suitable habitat outside of the project area and monitored.

1.7 Implement best management practices during maintenance of powerline corridors. Some existing right-of-ways are currently occupied by the butterfly. Maintenance activities include vehicle use within the right-of-way to maintain the powerline operation. Forest Service is developing an agreement (i.e., an Operation and Maintenance Plan) with the Otero County Electric Cooperative that will implement best management practices to minimize impacts to the butterfly.

2.0 Manage and promote conservation of the butterfly and its habitat on private lands.

According to the Forest Service, private lands constitute about 50 percent of the estimated range of the butterfly. However, the threats on private land are currently unknown. Otero County's Resolution (See Appendix B.) and actions illustrate that they are committed to conservation of the butterfly as well as all threatened and endangered species in the County. Other sensitive, threatened, or endangered species in Otero County include: Mexican spotted owl, Sacramento Mountain salamander, New Mexico prickly poppy, and the Sacramento Mountains thistle. The County continues to partner with the Village of Cloudcroft, Forest Service, USFWS, Boy Scouts of America, Native Plant Society, The Garden Club, Rails-to-Trails, Youth Conservation Corps (YCC), Cloudcroft municipal school system, and others on conservation projects concerning the butterfly.

2.1 Curtail expansion of the Village of Cloudcroft into butterfly habitat. The Village has committed to improving the status of the butterfly and contributing to its long-term conservation through the following: (1) implementation of "greenbelt zones" and open space with no structures in recently annexed (and any future annexed) lands; (2) committing to a land exchange with the Forest Service; and (3) community education and outreach for the conservation of the Sacramento Mountains checkerspot butterfly.

The Village of Cloudcroft is currently writing a comprehensive plan for the Village through a community development block-grant from the State. This comprehensive plan sets forth the future directions and goals of the Village for the next 40 years.

2.1.1 Annex available lands for designation as greenbelts. Under the Townsite Act of 1958, the Village originally planned to acquire 640 acres of surrounding National Forest lands for potential development in 1988. Of the 640 acres, 81 acres have been approved by the FS for Village of Cloudcroft acquisition. Of the 81 acres, 21 acres have been annexed. Annexation does not change ownership, thus, the Forest Service will continue to have ownership of the lands.

Lands annexed by the Village remain under the management and jurisdiction of the Forest Service. Annexed lands from the Village will be designated as "greenbelt with no structures" and no commercial signs (Chapter 7 of the Village Code, Ord. 277A, 8-10-1999). Thus, no subdivision or development will occur within these areas. In addition, there shall be no overnight parking or camping allowed within these areas (Ord. 277A, 8-10-1999). A potential use of these annexed lands could be day-use recreation (e.g., hiking, biking).

2.1.2 Conduct land exchange to transfer occupied habitat into Forest Service management. The Village of Cloudcroft is proposing to offer 40

acres (some of which contains occupied habitat) near the Cloudcroft Ski Area in James Canyon to the Forest Service. In exchange, the Forest Service has allotted 40 acres that is not butterfly habitat to the Village. Funding is needed to complete requirements associated with this land exchange (arch surveys, land survey). This would bring additional habitat under Forest Service management.

2.1.3 Conduct outreach and education in the Village of Cloudcroft. The foci of outreach and education programs will be developed during annual meetings. Interested private citizens and organizations will be encouraged to attend meetings and participate voluntarily. The County will work with private landowners (in cooperation with the Village) to educate landowners about butterfly conservation. This includes, but is not limited to, the following: (1) using native plants important to the butterfly, (2) restoration of areas and planting butterfly food and larval plants, (3) communication with landowners through local newspapers and Village Council Workshops. Outreach and educational programs are planned for the local community, within the Village of Cloudcroft and the County.

2.2 Promote butterfly conservation in the County.

2.2.1 Amend the County Subdivision Ordinance to direct the use of best management practices to minimize effects from future subdivisions. The construction of all new subdivisions must be approved by Otero County. Otero County is proceeding with an amendment to the existing County Subdivision Ordinance. This process involves public hearings, planning commission hearings, and attorney review prior to final approval. The amendment will commit to set-a-sides to reduce effects to the butterfly and promote best management practices in new subdivision developments within butterfly habitat.

2.2.2 Pass a County resolution committed to conservation of the butterfly. During the previous four years, there have been no new subdivisions permitted within the 2001 proposed critical habitat of the butterfly (Ed Bunn, Otero County Planning Commission, pers. comm. 2004). The County will work with any new developers so that best management practices are implemented within any new land developments.

The County intends to pass a resolution on October 19, 2004, outlining the County's commitment to conservation of the Sacramento Mountains checkerspot butterfly (See Appendix B). This resolution

commits to using Best Management Practices for the conservation of the butterfly and gathering and using science for the purposes of ensuring the conservation and persistence of the Sacramento Mountains checkerspot butterfly.

2.2.3 Develop Partners for Fish and Wildlife Projects for checkerspot conservation. The Sacramento Mountains checkerspot butterfly is currently a priority for the Fish and Wildlife Service's Partners for Fish and Wildlife Program. This program has been working diligently with the Forest Service and non-Federal entities regarding conservation efforts related to the butterfly. For example, the Forest Service gathered and banked *P. neomexicanus* seeds from sites on the Lincoln National Forest. The Otero County Chapter of the Native Plant Society of New Mexico and the Otero County Extension Office (Master Gardener Program) have expressed interest in being "foster parents" for *Penstemon* plants until they are needed for community projects. In addition, these entities would like to be advocates in the community for the butterfly and its larval and nectar plants, as well being "on-call" to assist with relocating and transplanting plants during Forest Service activities. Further, members of the Mescalero Apache Tribe and the Service's Partners program have participated in field trips and discussed habitat needs of the butterfly.

2.3 Conduct public education programs in Otero County. The County will develop sound scientific Best Management Practices for management of the butterfly. In addition, the County will promote public support for butterfly conservation through development and distribution of informational and educational materials. The County is currently drafting a comprehensive plan for the County of Otero. This planning document sets forth direction and guidance for the next 40 years.

3.0 Fill information gaps as needed to support adaptive management. Some threats to the Sacramento Mountains checkerspot butterfly are obvious and amelioration is straightforward, based on our current understanding of the species and its habitat. However, long-term conservation and management of the species requires a thorough knowledge of its life history, habitat requirements, susceptibility or sensitivity to certain threats or anthropogenic activities, and responses to management activities. The following research needs were developed and prioritized in order to maximize the utility of the information gained such that it can be directly applied to management and conservation of the species.

3.1 Conduct research needed to inform management on basic biology, habitat, distribution, and population biology. The Forest Service has supported several other research projects including genetics work and the effects of

grazing on butterfly habitat. In addition, the County is committed (through the CPR program) to fund science and monitoring for sensitive species.

3.1.1 **Determine where diapause larvae occur.** Tents and associated larvae will be monitored prior to the onset of colder temperatures, shorter photoperiods, and *P. neomexicanus* senescence, usually around October 1, to observe larval behavior. A grid of systematically placed holes, replicating natural soil cracks, will be created around selected larval locations prior to diapause and delicately checked after the onset of diapause to detect larval use. Places beneath or between stones, litter, soil aggregates, and nearby tree bark will be carefully investigated near larval locations and other habitat characteristics, such as soil type, soil moisture, slope, and aspect, will be recorded.

3.1.2 **Determine the duration of diapause.** Based on daily observations at larval sites, the timing of the onset of diapause will be obtained, as will the dates of larval emergence in the spring. These data will be compared and averaged with dates collected by the Forest Service and modeled with other variables, such as photoperiod, temperature, soil moisture, and direct solar radiation, to predict average diapause durations.

3.1.3 **Investigate plant use by larvae.** Larval activity upon plants and substrates, and consumption of *P. neomexicanus* or any other plants will be examined. Attributes of plants selected by larvae will be measured and analyzed to determine what features are useful or attractive to larvae. Relationships among host plant features, host plant abundance, and larval abundance will be investigated and results may be used to restore butterfly habitat.

3.1.4 **Investigate influence of fire on butterfly habitat.** Occupied meadow areas will be subdivided into partitions to receive different treatments, including mowing, burning, aeration and control. Butterfly larval and adult use of these areas will be monitored to gather information pertaining to fire effects on the butterfly. If a natural fire burns through butterfly habitat, subsequent impacts upon the butterfly population will be monitored and incorporated into adaptive management plans for the butterfly's conservation.

3.1.5 Investigate grazing systems, strategies, and intensities for butterfly habitat maintenance. Research capturing baseline conditions in the James Allotment areas to be opened to grazing in May, 2005, is underway. Habitat variables and butterfly larval and adult abundance before cattle grazing (2004) will be compared with the same variables over the next two years to uncover effects of grazing. Differences among grazing regimes involving (1) both cattle or elk grazing, (2) elk grazing but no cattle grazing, and, (3) neither cattle nor elk grazing, will be analyzed.

3.1.6 Determine whether planting host plants influences butterfly occupancy.

3.2 Monitor species, habitat, and threats. Monitoring provides informational feedback so that management can be adjusted appropriately (i.e., adaptive management). The cooperators will develop a long-term monitoring protocol. The Forest Service continues to survey areas before projects are planned and implemented. Also, the Forest Service is surveying areas adjacent to occupied areas and previously unoccupied meadows (R. Guaderrama, pers.comm. 2004). Funding is available within the Forest Service's budget to continue these monitoring efforts.

4.0 Conduct annual coordination meetings. The cooperators will establish a Sacramento Mountains Checkerspot Butterfly Conservation Plan Interagency Coordinating Committee (See Appendix A. Section V.). This Committee will monitor the implementation of the Conservation Plan, provide a forum for exchange of information on the species, will set annual priorities, seek funding sources, and provide feedback to the cooperators.

V. IMPLEMENTATION SCHEDULE

The following Implementation Schedule outlines actions and costs for the conservation of the Sacramento Mountains checkerspot butterfly. It is a guide for meeting the objectives elaborated throughout this Conservation Plan. This schedule indicates action numbers, descriptions, duration, potential partners, and estimated costs. Specific priorities will be established by the ICC. The costs estimated are intended to assist in planning. Although cooperation and collaboration with private landowners is an important tenant of this Conservation Plan, private landowners are not obligated to expend any funds. In some instances, it not possible to estimate costs until related actions have been completed.

TASK #	RESPONSIBLE PARTIES/ POTENTIAL PARTNERS	TASK DURATION	COST ESTIMATE (in 1000's)			Comments
1.1 Apply appropriate weed and pest control measures in or near occupied meadows.	Forest Service	Continuous				Implementation began in 2001. Cost estimates available from Forest Service?
1.2 Decrease risk of catastrophic wildfire.	Forest Service	15+ years	TBD	TBD	TBD	Rio Penasco II will be implemented over a 15-year period. Other projects may occur within and beyond that timeframe.
1.3.1 Manage campgrounds near butterfly meadows to contain vehicles, tents, and other equipment in confined areas.	Forest Service	1-5 years	$500	TBD	TBD	Pines Campground renovations are underway. Sleepy Grass, Aspen, Black Bear, Deer Head, and Slide campgrounds will also be modified.
1.3.2 Inventory and identify meadows appropriate for off-highway vehicles.	Forest Service	1 year	$5	--	--	Mapping will be complete by September 2004.
1.3.3. Develop and install an interpretive kiosk at Pines campground.	Forest Service	1 year	$10	--	--	Kiosk will be installed by September 2004.
1.3.4 Continue issuance of Special Use Permits sensitive to the butterfly.	Forest Service	Continuous	--	--	--	No additional costs incurred.

TASK #	RESPONSIBLE PARTIES/ POTENTIAL PARTNERS	TASK DURATION	COST ESTIMATE (in 1000's)			Comments
1.4.1 Implement grazing regimes for domestic livestock.	Forest Service		TBD	TBD	TBD	
1.4.2 Control trespass livestock.	Forest Service	1-3 years	>$50	>$50		Cost to remove horses is $40-50k plus approximately $10k/mile of 4-strand barbed-wire fencing.
1.5 Protect butterfly from threat of collection.	Forest Service, Law Enforcement	Continuous	--	--	--	No additional costs incurred; monitoring for activities prohibited on the Forest is ongoing.
1.6 Ensure effective contract administration for projects occurring in butterfly habitat.	Forest Service	Continuous	--	--	--	No additional cost incurred.
1.7 Implement best management practices during maintenance of powerline corridors.	Forest Service, Otero County Electric Cooperative	Continuous	TBD	TBD	TBD	
2.1.1 Annex available lands for designation as greenbelts.	Village of Cloudcroft	TBD	*	*	*	*Based on 1996 appraisal, cost to annex is approximately $5.5k/acre. 21 acres have been annexed; 60 acres are under consideration.
2.1.2 Conduct land exchange to transfer occupied habitat into Forest Service management.	Village of Cloudcroft, Forest Service	7-10 years	*	*	*	*Land exchange valued at approximately $100k.

TASK #	RESPONSIBLE PARTIES/ POTENTIAL PARTNERS	TASK DURATION	COST ESTIMATE (in 1000's)			Comments
2.1.3 Conduct outreach and education in the Village of Cloudcroft.	Village of Cloudcroft	3 years	*	*	*	*Cost dependent on specific educational programming; focus to be determined during annual coordination meetings.
2.2.1 Amend the County Subdivision Ordinance to direct the use of best management practices to minimize effects from future subdivisions.	Otero County	1 year	--	--	--	No additional costs incurred.
2.2.2 Pass a County Resolution to demonstrate commitment to conservation of the butterfly.	Otero County	Within 1 year	--	--	--	Draft Resolution developed in July, 2004.
2.2.3 Develop Partners for Fish and Wildlife projects for checkerspot conservation.	Otero County, others	Ongoing	Vari-able	Vari-able	Vari-able	Cost will be project specific.
2.3 Conduct public education programs in Otero County.	Otero County	Ongoing	*	*	*	Cost will be based on specific programming; focus to be determined at annual coordination meetings.
3.1.1 Determine where diapause larvae occur.	Forest Service, USFWS, academia	Ongoing	TBD	TBD	TBD	

TASK #	RESPONSIBLE PARTIES/ POTENTIAL PARTNERS	TASK DURATION	COST ESTIMATE (in 1000's)			Comments
3.1.2 Determine the duration of diapause.	Forest Service, USFWS, academia	Ongoing	TBD	TBD	TBD	
3.1.3 Investigate plant use by diapause larvae.	Forest Service, USFWS, academia	Ongoing	TBD	TBD	TBD	
3.1.4 Investigate influence of fire on butterfly habitat.	Forest Service	Ongoing	TBD	TBD	TBD	
3.1.5 Investigate grazing systems, strategies, and intensities for butterfly habitat maintenance.	Forest Service, USFWS, academia	Ongoing	TBD	TBD	TBD	
3.1.6 Determine whether planting host plants influences butterfly occupancy.	Forest Service, USFWS, Village of Cloudcroft, Otero County	Ongoing	TBD	TBD	TBD	
3.2. Monitor species, habitat, and threats.	Forest Service, USFWS, Village of Cloudcroft, Otero County, academia, others	Ongoing	TBD	TBD	TBD	Includes monitoring of recruitment of larval food plants, adult nectar plants, and recolonization of SMCB in revegetated areas.
4.0 Conduct annual coordination meetings.	Forest Service, USFWS, Village of Cloudcroft, Otero County	Annual	--	--	--	Minimal cost incurred.
TOTAL COST						

VI. SUMMARY

This plan provides an in depth review of the Sacramento Mountains checkerspot butterfly's life history, habitat requirements, and known threats, and further identifies the specific conservation actions that will alleviate these threats to the butterfly. Conservation actions are categorized by the 4 primary objectives of this plan: 1) protect and manage occupied and unoccupied Sacramento Mountains checkerspot butterfly habitat on public lands; 2) manage habitat and promote conservation, through education and outreach, of the butterfly on non-federal and other private lands; 3) conduct research to fill information gaps and inform continued management; and, 4) provide adequate regulatory protection. Collectively, achieving these objectives will provide for an amount and distribution of habitat sufficient to ensure the long-term persistence of the Sacramento Mountains checkerspot butterfly, even in the face of local losses.

As discussed in Chapter III. Risk Assessment and Threats, Section 4(a)(1) of the ESA delineates five listing factors that must be considered when determining if a species should be designated as threatened or endangered. These include: A) present or threatened destruction, modification, or curtailment of its habitat or range; B) over-utilization for commercial, recreational, scientific, or educational purposes; C) disease or predation; D) inadequacy of existing regulatory mechanisms; and, E) other natural or manmade factors affecting its continued existence. The 2001 proposed rule stated that the Sacramento Mountains checkerspot butterfly is endangered as a result of destruction and fragmentation of habitat from private and commercial development, catastrophic wildfire, habitat degradation and loss of host plants from grazing, some recreational activities, encroachment of conifers and nonnative vegetation into non-forested openings, over collection, and vulnerability to local extirpations from climate changes such as drought (USFWS 2001). Many of these threats have been reduced since the publication of the September 6, 2001 proposed rule to list the butterfly. The reduction in threats, the conservation actions put forward in this plan, and the commitment to implementation as prescribed in the Memorandum of Understanding (see Appendix A), provides for the long-term conservation of the butterfly. Specific conservation actions that ameliorate each of the listing factors are identified below, and discussed in detail in Narrative Outline for Conservation Actions (page 44).

Factor A: Present or threatened destruction, modification, or curtailment of its habitat or range. The Sacramento Mountains checkerspot butterfly's preference for meadows makes it particularly sensitive to habitat loss and degradation because meadows are easily accessed. Loss of meadow habitat or

modification of this habitat type can occur through development, wildfires and wildfire suppression, inappropriate grazing, highway improvement activities, recreation, and invasive plants and insects. The following conservation actions, as outlined in this plan, ameliorate these potential threats to habitat degradation: 1.1 Apply appropriate weed and pest control practices in or near occupied meadows; 1.2 Decrease risk of catastrophic wildfire; prioritize treatment areas near known occupied habitat; 1.3.1 Manage campgrounds near butterfly meadows to contain vehicles, tents, and other equipment in confined areas; 1.3.2 Inventory and identify important butterfly meadows being impacted by OHVs, and close these meadows to further OHV use; 1.3.3 Develop and install an interpretive kiosk at Pines campground; 1.3.4 Continue issuance of Special Use Permits sensitive to the butterfly; 1.4.1 Implement appropriate grazing regimes for domestic livestock; 1.4.2 Control trespass livestock; 1.6 Ensure effective contract administration for projects occurring in butterfly habitat; 1.7 Implement best management practices during maintenance of powerline corridors; 2.1.1 Annex available lands for designation as greenbelts; 2.1.2 Conduct land exchange to transfer occupied habitat into Forest Service management; 2.1.3 Conduct outreach and education in the Village of Cloudcroft; 2.2.1 Amend the County Subdivision Ordinance to direct the use of best management practices to minimize effects from future subdivisions; 2.2.2 Pass a County resolution committed to conservation of the butterfly; 2.2.3 Develop Partners for Fish and Wildlife projects for butterfly conservation; 2.3 Conduct public education programs in Otero County; 3.1.4 Investigate influence of fire on butterfly habitat; 3.1.5 Investigate grazing systems, strategies, and intensities for butterfly habitat maintenance; 3.2 Monitor species, habitat, and threats; and, 4.0 Conduct annual coordination meetings.

Factor B: Over-utilization for commercial, recreational, scientific, or educational purposes. The threat presented by potential over-collection for recreational, scientific, or educational purposes is significantly reduced by implementation of the following conservation actions outlined in this plan: 1.3.3 Develop and install an interpretive kiosk at Pines campground; 1.3.4 Continue issuance of Special Use Permits sensitive to the butterfly; 1.5 Protect butterfly from threat of collection; 2.1.3 Conduct outreach and education in the Village of Cloudcroft; and, 4.0 Conduct annual coordination meetings.

Factor C: Disease or predation. The partners are unaware of any disease or predator that currently constitutes a significant threat to the Sacramento Mountains checkerspot butterfly. Through implementation of conservation action 4.0 Conduct annual coordination meetings, the Sacramento Mountains Checkerspot Butterfly Conservation Plan Interagency Coordinating Committee (ICC) (see Appendix A., Section V.) will monitor threats that may

arise from disease or predators, and may recommend changes in the tasks and scheduling of task implementation.

Factor D: The inadequacy of existing regulatory mechanisms. The absence of State and Federal regulatory mechanisms that would protect the Sacramento Mountains checkerspot butterfly is ameliorated through implementation of conservation actions outlined in this plan that function collectively to protect the butterfly within its range. These conservation actions include: 1.3.1 Manage campgrounds near butterfly meadows to contain vehicles, tents, and other equipment in confined areas; 1.3.2 Inventory and identify important butterfly meadows being impacted by OHVs, and close these meadows to further OHV use; 1.3.3 Develop and install an interpretive kiosk at Pines campground; 1.3.4 Continue issuance of Special Use Permits sensitive to the butterfly; 1.4.2 Control trespass livestock; 1.5 Protect butterfly from threat of collection; 1.6 Ensure effective contract administration for projects occurring in butterfly habitat; 1.7 Implement best management practices during maintenance of powerline corridors; 2.1.1 Annex available lands for designation as greenbelts; 2.1.2 Conduct land exchange to transfer occupied habitat into FS management; 2.1.3 Conduct outreach and education in the Village of Cloudcroft; 2.2.1 Amend the County Subdivision Ordinance to direct the use of best management practices to minimize effects from future subdivisions; 2.2.2 Pass a County resolution committed to conservation of the butterfly; 2.3 Conduct public education programs in Otero County; and, 4.0 Conduct annual coordination meetings.

Factor E. Other natural or manmade factors affecting its continued existence. Through implementation of conservation actions 4.0 Conduct annual coordination meetings, and 3.2 Monitor species, habitat, and threats, the ICC will monitor the effects of drought on the Sacramento Mountains checkerspot butterfly, and may recommend changes in the tasks and scheduling of task implementation.

VII. LITERATURE CITED

Allen, C. D., editor. 1996. Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium, General Technical Report RM-GTR_286. USDA-FS, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Anderson, R.C., T. Leahy, S.S. Dhillion. 1989. Numbers and Biomass of Selected Insect Groups on Burned and Unburned Sand Prairie. American Midland Naturalist 122(1): 151-162.

Archer, S. and D.A. Pike. 1991. Plant-animal interactions affecting plant establishment and persistence on revegetated rangeland. Journal of Range Management 44(6): 558-565.

Austin, G. T., D. D. Murphy, J. F. Baughman, A. E. Launer, and E. Fleishman. 2003. Hybridization of Checkerspot Butterflies in the Great Basin. Journal of the Lepidopterist's Society 57(3): 176-192.

Bale, J.S., G.J. Masters, I.D. Hodkinson, C. Awmack, T.M. Bezemer, V.K. Brown, J. Butterfield, A. Buse, J.C. Coulson, J. Farrar, J.E. Good, R. Harrington, S. Hartley, T.H. Jones, R.L. Lindroth, M.C. Press, I. Symrnioudis, A.D. Watt, and J.B. Whittaker. 2002. Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. Global Change Biology 8:1-16.

Balmer, O. and A. Erhardt. 2000. Consequences of succession of extensively grazed grasslands for Central European butterfly communities: Rethinking conservation practices. Conservation Biology 14(3): 746-757.

Beier, P. and S. Loe, 1992. "In my experience...": A checklist for evaluating impacts to wildlife movement corridors. Wildlife Society Bulletin 20: 434-440.

Belsky, A. J., and D. M. Blumenthal. 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the interior west. Conservation Biology 11:315-327.

Belskey, A.J., A. Matzske, and S. Uselman. 1999. Survey of Livestock Influences on Stream and Riparian Ecosystems in the Western United States. Journal of Soil and Water Conservation 54:419-431.

Bergman, K. 2001. Population dynamics and the importance of habitat management for conservation of the butterfly *Lopinga achine*. Journal of Applied Ecology 38:1303-1313.

Boggs, C. L. and C. L. Ross. 1993. The effect of adult food limitation on life history traits in *Speyeria mormonia* (Lepidoptera: Nymphalidae). Ecology 74:433-441.

Boughton, D. A. 1999. Empirical evidence for complex source-sink dynamics with alternative states in a butterfly metapopulation. Ecology 80(8): 2727-2739.

Brown, I. L., and P. R. Ehrlich. 1980. Population biology of the checkerspot butterfly, *Euphydryas chalcedona,* structure of the Jasper Ridge colony. Oecologia 47:239-251.

Brown, J. H. and W. McDonald. 1995. Livestock Grazing and Conservation on Southwestern Rangelands. Conservation Biology 9(6):1644-1647.

Brown, J. H., T. J. Valone, and C. G. Curtin. 1997. Reorganization of an arid ecosystem in response to recent climate change. Proceedings of the National Academy of Sciences 99:9729-9733.

Brown, P. M., M. W. Kaye, L. S. Huckaby, and C. H. Baisan. 2001. Fire history along environmental gradients in the Sacramento Mountains, New Mexico: Influences of local patterns and regional processes. Ecoscience 8:115-126.

Bureau of Business & Economic Research. 2002. New Mexico City Population Estimates from the U.S. Census Bureau. University of New Mexico.

Bureau of Business & Economic Research. 2004. New Mexico City Population Estimates from the U.S. Census Bureau. University of New Mexico. http://www.unm.edu/~bber/demo/citypopest1.htm

Cary, S. J., and R. Holland. 1992. New Mexico butterflies: checklist, distribution, and conservation. The Journal of Research on the Lepidoptera 31:57-82.

CFRP – Press Release. 2004. CFRP-1.7M-June-24.txt, Release No. 02554.

Chaplin III, F.S., E.S. Zavaleta, V.T. Eviners, R.L Naylor, P.M. Vitousek, H.L Reynolds, D.U. Hopper, S. Lavorel, O.E. Sala, S.E. Hobbie, M.C. Mack, and S. Diaz. Nature 405: 234-242.

Chew, R.M. 1982. Changes in Herbaceous and Suffrutescent Perennials in Grazed and Ungrazed Desertification Grassland in Southeastern Arizona, 1958-1978. American Midland Naturalist 108:159-169.

Cornell University. 1998a. *Bacillus thuringiensis*. Extension Toxicology Network: pesticide information profile.

Cornell University. 1998b. Carbaryl. Extension Toxicology Network: pesticide information profile.

Crozier, L. 2003. Winter warming facilities range expansion: cold tolerance of the butterfly *Atalopedes campestris*. Oecologia 135:648-656.

Cullenward, M. J., P. R. Ehrlich, R. R. White, and C. E. Holdren. 1979. The ecology and population genetics of an alpine checkerspot butterfly, *Euphydryas anicia*. Oecologia 38:1-12.

Donahue, D. L. 1999. The western range revisited: removing livestock from public lands to conserve native biodiversity. University of Oklahoma Press, OK.

Ehrlich, P. R. 1965. The population biology of the butterfly, *Euphydryas editha*. II. The structure of the Jasper Ridge colony. Evolution 19:327-336.

Ehrlich. P. R. 1989. The structure and dynamics of butterfly populations. Pages 25-40 in The biology of butterflies, Vane-Wright, I., and R. Irwin, eds. Princeton University Press.

Ehrlich, P. R., D. E. Breedlove, P. F. Brussard, and M. A. Sharp. 1972. Weather and "regulation" of subalpine populations. Ecology 53:243-247.

Ehrlich, P. R., R. R. White, M. C. Singer, S. W. McKechnie, and L. E. Gilbert. 1975. Checkerspot butterflies: a historical perspective. Science 188:221-228.

Ehrlich, P. R., D. D. Murphy, M. C. Singer, C. B. Sherwood, R. R. White, and I. L. Brown. 1980. Extinction, Reduction, Stability and Increase: The Responses of Checkerspot Butterfly (*Euphydryas*) Populations to the California Drought. Oecologia 46:101-105.

Ehrlich, P. R. and D. D. Murphy. 1987. Conservation lessons from long-term studies of checkerspot butterflies. Conservation Biology 1(2): 122-131.

Ehrlich, P. R. and I. Hanksi, editors. 2004. On the Wings of Checkerspots: A Model System for Population Biology. Oxford University Press, New York, NY.

Farmer, A. M. 1993. The effects of dust on vegetation–a review. Environmental Pollution 79:63-75.

Farris, C. A., L. F. Neuenschwander, and S. L. Boudreau. 1998. Monitoring Initial Plant Succession Following Fire in a Subalpine Spruce-Fir Forest. Tall Timbers Fire Ecology Conference Proceedings 20:298-305.

Ferris, C. D., and R. W. Holland. 1980. Two new subspecies of *Occidryas anicia* (Doubleday) from New Mexico. Bulletin of the Allyn Museum 57:1-9.

Ferris, C. D. and F. M. Brown. 1981. Butterflies of the Rocky Mountain States. University of Oklahoma, Norman, Oklahoma.

Fleischner. T. L. 1994. Ecological Costs of livestock grazing in western North America. Conservation Biology 8:629-644.

Fleishman, E. 2000. Monitoring the Response of Butterfly Communities to Prescribed Fire. Environmental Management 26:685-695.

Forman, R.T.T. 2000. Estimate of the Area Affected Ecologically by the Road System in the United States. Conservation Biology 14(1):31-35.

Garrett, L. D. and P. Garrett. 2001. Evaluating Forest Restoration Opportunities on the Lincoln National Forest. M3 Research. Olathe, CO, USA.

Glassberg, J. 2001. Butterflies Through Binoculars-The West: A Field Guide to the Butterflies of Western North America. Oxford University Press, New York, USA.

Haddad, N. M., and K. A. Baum. 1999. An experimental test of corridor effects on butterfly densities. Ecological Applications 9:623-633.

Hager, S. B., and A. G. Stafford. 1999. Dynamics of species richness and abundance in a montane community of butterflies in southern New Mexico. The Southwestern Naturalist 44:375-378.

Halpin, P. N. 1997. Global Climate Change and Natural-area Protection: Management Responses and Research Directions. Ecological Applications 7:828-843.

Hanski, I., and M. Gilpin. 1991. Metapopulation dynamics: brief history and conceptual domain. Biological Journal of the Linnean Society 42:3-16.

Hanski, I. 1998. Metapopulation Dynamics. Nature 396:41-49.

Hanski. I. 1999. Metapopulation Ecology. Oxford Series in Ecology and Evolution, Oxford Press Inc., New York.

Harrison, S. 1989. Long-distance dispersal and colonization in the bay checkerspot butterfly, *Euphydryas editha bayensis*. Ecology 70:1236-1243.

Haskell, D.G. 1999. Effects of Forest Roads on Macroinvertebrate Soil Fauna of the Southern Appalachian Mountains. Conservation Biology 14(1): 57-63

Hellmann, J. J. 2002. Butterflies as model systems for understanding and predicting climate change. In: Wildlife Responses to climate Change, Schneider, S. H. and T. L. Root, Editors. Island Press, Washington.

Hill, J. K., K. C. Hamer, L. A. Lace, and W. M. T. Banham. 1995. Effects of selective logging on tropical butterflies on Buru, Indonesia. Journal of Applied Ecology 32:454-460.

Hill, J. K. 1999. Butterfly spatial distribution and habitat requirements in a tropical forest: impacts of selective logging. Journal of Applied Ecology 36:564-572.

Holdren, C. E. and P.R. Ehrlich. 1982. Ecological determinants of food plant choice in the Checkerspot Butterfly *Euphydryas editha* in Colorado. Oecologia 52: 417-423.

Holland, R. 1999. The Lincoln National Forest closure order. News of the Lepidopterist's Society 41:101-102.

Holland, R. May 5, 2001. Email to Eric Hein concerning the Sacramento Mountains checkerspot butterfly.

Inoue, T. 2003. Chronosequential change in a butterfly community after clear-cutting of deciduous forests in a cool temperate region of central Japan. Entomological Science 6:151-163.

Issa, B. 2004. Council Meeting Backgrounder: OHV Mangement, an Overview. Website: http://www.longtom.org/documents/newsletters/2004_04_ltwcnews.pdf.

Kaufmann, M. R., L. S. Huckaby, C. M. Regan, and J. Popp. 1998. Forest reference conditions for ecosystem management in the Sacramento Mountains, New Mexico. General Technical Report, RMRS-GTR-19, U.S. Forest Service, Rocky Mountain Forest and Range Experimental Station, Fort Collins, Colorado.

Kitahara, M., Sei, K., and K. Fujii. 2000. Patterns in the structure of grassland butterfly communities along a gradient of human disturbance: further analysis based on the generalist/specialist concept. Population Ecology 42:135-144.

Kleintjes, P. K., B. F. Jacobs, and S. M. Fettig. 2004. Initial Response of Butterflies to an Overstory Reduction and Slash Mulching Treatment of a Degraded Pinon-Juniper Woodland. Restoration Ecology 12:231-238.

Knapp, P. A. and P. T. Soule. 1998. Recent expansion of Western juniper on a near-relict site in central Oregon. Global Change Biology 4:347-357.

Krauss, J., E. Steffan-Dewenter, and T. Tscharntke. 2003. Local species immigration, extinction, and turnover of butterflies in relation to habitat area and habitat isolation. Oecologia 137:591-602.

Kruess, A. and T. Tscharntke. Grazing intensity and the diversity of grasshoppers, butterflies, and trap-nesting bees and wasps. Conservation Biology 16(6):1570-1580.

Labine, P. A. 1964. Population biology of the butterfly, *Euphydryas editha*. I. Barriers to multiple inseminations. Evolution 18(2): 335-336.

Lewis, O. T. 2001. Effect of Experimental Selective Logging on Tropical Butterflies. Conservation Biology 15:389-400.

Mader, H. J. 1984. Animal habitat isolation by roads and agricultural fields. Biological Conservation 29:81-96.

Mader, H. J., C. Schell, and P. Kornacker. 1990. Linear barriers to arthropod movements in the landscape. Biological Conservation 54:209-222.

Maina, G.G. and H.F. Howe. 2000. Inherent rarity in community restoration. Conservation Biology 14(5): 1335-1340.

McCabe, G.J., M.A. Palecki, and J.L. Betancourt. 2004. Pacific and Atlantic Ocean influences on mutlidecadal drought frequency in the United States. Proceedings of the National Academy of Sciences 101(12): 4136-4141.

McCarthy, P. D. and S. L. Yanoff. 2003. Biodiversity and Altered Fire Regimes in Forests and Woodlands of the Rocky Mountain Division: A

Scientific Assessment of Threat, Need and Opportunity. The Nature Conservancy-RMD, November, 2003.

McCullough, D.R. 1996. Metapopulations and Wildlife Conservation. Island Press, Washington, D.C.

McLaughlin, J.F., J.J. Hellmann, C.L. Boggs, and P.R. Ehrlich. 2002. The route to extinction: population dynamics of a threatened butterfly. Oecologia 132: 538-548.

McDonald, K.A. and Brown, J.H. 1992. Using Montane Mammals to Model Extinctions Due to Global Change. Conservation Biology 6(3): 409-415.

Meffe, G. K., C. R. Carroll, and Contributors. 1997. Principles of Conservation Biology, Second Edition. Sinauer Associates, Inc., Sunderland, Massachusettes.

Moore, S. D. 1987. Male-biased mortality in the butterfly *Euphydryas editha*: a novel cost of mate acquisition. The American Naturalist 130:306-309.

Moore, S. D. 1989. Patterns of juvenile mortality within an oligophagous insect population. Ecology 70:1726-1737.

Mountain Monthly, 197th Edition, July 2004. Gary Wood, Editor.

Murphy, D. D., A. E. Launer, and P. R. Ehrlich. 1983. The role of adult feeding in egg production and population dynamics of the checkerspot butterfly *Euphydryas editha*. Oecologia 56:257-263.

Murphy, D. D., and S. B. Weiss. 1988. Ecological studies and the conservation of the bay checkerspot butterfly, *Euphydryas editha bayensis*. Biological Conservation 46:183-200.

New Mexico Wildlife Conservation Act. New Mexico Statutes Annotated (NMSA) 1978. Section 17-2-38 (N) (1995).

Niemela, J. 1997. Invertebrates and Boreal Forest Management. Conservation Biology 11:601-610.

Northwestern Great Basin Resource Advisory Council Meeting Notes, April 30, 2003. Friends of Sand Mountain, Nevada. Website: http://www.Sandmountain-nv.org.

Noy-Meir, I. M. Gutman, and Y. Kaplan. 1989. Responses of Mediterranean Grassland Plants to Grazng and Protection. Journal of Ecology 77:290-310.

Ohmart, R. D. 1996. Historical and present impacts of livestock grazing on fish and wildlife resources in western riparian habitats. In: Rangeland Wildlife, P. R. Krausman, ed. Society for Range Management, Denver, Colorado.

Osborne, K. H., and R. A. Redak. 2000. Microhabitat conditions associated with the distribution of postdiapause larvae of *Euphydryas editha quino* (Lepidoptera: Nymphalidae). Annals of the Entomological Society of America 93:110-114.

Panzer, R. 2002. Compatibility of Prescribed Burning with the Conservation of Insects in Small, Isolated Prairie Reserves. Conservation Biology 16(5):1296-1307.

Parmesan, C., N. Ryrholm, C. Stefanescu, J. K. Hill, C. D. Thomas, H. Descimon, B. Huntley, L. Kaila, J. Kullberg, T. Tammaru, W. J. Tennent, J. A. Thomas, and M. Warren. 1999. Poleward shifts in geographical ranges of butterfly species associated with regional warming. Nature 399:579-583.

Pearson, H. 2004. Dune buggies squash bugs. Nature Science Update. 31 March 2004. Website: http://www.nature.com/nsu.nsu_pf/040329/040329-8.html.

Pittenger, J. 1999. Mitigation alternatives for impacts to the Sacramento Mountains checkerspot butterfly from the N.M. Highway 130 rehabilitation project. Blue Earth Ecological Consultants, Sante Fe.

Pittenger, J. S. and K. A. Yori. 2003. Abundance, Population Structure, and Habitat of the Sacramento Mountains Checkerspot Butterfly (Euphydryas anicia cloudcrofti Holland and Ferris 1980), With Notes on Life History and Ecology. Blue Earth Ecological Consultants, Inc. Santa Fe, USA.

Radtkey, R. R. and M. C. Singer. 1995. Repeated reversals of host-preference evolution in a specialist insect herbivore. Evolution 49(2): 351-359.

Rambo, J.L. and S.H. Faeth. 1999. Effect of Vertebrate Grazing on Plant and Insect Community Structure. Conservation Biology 13(5):1047-1054.

Ries, L. and W. F. Fagan. 2003. Habitat edges as a potential ecological trap for an insect predator. Ecological Entomology 28:567-572.

Rittenhouse, B. and R. Rosentreter. 1994. The Autecology of Challis Milkvetch, an endemic of East-Central Idaho. Natural Areas Journal 14:22-30.

Ryan, R. and F. T. Kuserk. 2003. The Relationship Between Larval Populations of the Sacramento Mountains Checkerspot Butterfly, *Euphydryas anicia cloudcrofti* and its Host Plant, *Penstemon neomexicanus*. Journal of the Pennsylvania Academy of Science: Vol. 76, Abstract and Index Issue.

Scholl, D. G. 1989. Soil compaction from cattle trampling on a semiarid watershed in Northwestern New Mexico. New Mexico Journal of Science 29:105-112.

Schultz, C. B. 2001. Restoring resources for an endangered butterfly. Journal of Applied Ecology 38:1007-1019.

Schumaker, N. H. 1996. Using landscape indices to predict habitat connectivity. Ecology 77(4): 1210-1225.

Siemann, E., J. Haarstad, and D. Tilman. 1997. Short-term and Long-term Effects of Burning on Oak Savanna Arthropods. American Midland Naturalist 137:349-361.

Smith, M.A., M.G. Turner, and D.H. Rusch. 2002. The Effect of Military Training Activity on Eastern Lupine and the Karner Blue Butterfly at Fort McCoy, Wisconsin, USA. Environmental Management 29(1): 102-115.

Society of American Foresters. 1984. Forestry Handbook. Wenger, K. F., editor, John Wiley and Sons, New York.

Sutcliff, O. L. and C. D. Thomas. 1996. Open corridors appear to facilitate dispersal by ringlet butterflies (*Aphantopus hyperantus*) between woodland clearings. Conservation Biology 10(5): 1359-1365.

Swetnam, T.W. and C. H. Baisan. 1996. Historical Fire Regime Patterns in the Southwestern United States Since AD 1700 *in* C. D. Allen, editor. Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium, USDA-FS, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. General Technical Report RM-GTR_286.

Thomas, C. D., M. C. Singer, and D. A. Boughton. 1996. Catastrophic extinction of population sources in a butterfly metapopulation. The American Naturalist 148:957-975.

Thomas, C.D., A. Cameron, R.E. Green, M. Bakkenes, L.J. Beaumont, Y.C. Collingham, B.F.N. Erasmus, M. F. de Siqueira, A. Grainger, L. Hannah, L, Hughs, B. Huntley, A.S. van Jaarsveid, G.F. Midgley, L. Miles, M.A. Ortega-Huerta, A.T. Peterson, O.L. Phillips, and S.E. Williams. Extinction risk from climate change. Nature 427:145-148.

Tiebout, H. M. III and R. A. Anderson. 1997. A Comparison of Corridors and Intrinsic Connectivity to Promote Dispersal in Transient Successional Landscapes. Conservation Biology 11:620-627.

Toliver, M. E., R. Holland, and S. J. Cary. 1994. Distribution of butterflies in New Mexico (Lepidoptera: Hesperioidea and Papilionoidea). R. Holland Publ., Albuquerque, New Mexico, Second Ed.

Touchan, R., C. D. Allen, and T.W. Swetnam. 1996. Fire History and Climatic Patterns in Ponderosa Pine and Mixed-Conifer Forests of the Jemez Mountains, Northern New Mexico *in* C. D. Allen, editor. Fire Effects in Southwestern Forests: Proceedings of the Second La Mesa Fire Symposium, General Technical Report RM-GTR_286. USDA-FS, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Trombulak, S.C. and C.A. Frissell. 1999. Review of Ecological Effects of Roads on Terrestrial and Aquatic Communities. Conservation Biology 14(1): 18-30.

USFWS. 2001. Proposed Rule for Endangered Status for the Sacramento Mountains Checkerspot Butterfly and Proposed Designation of Critical Habitat. 50 CFR Part 17, RIN 1018-AH40.

USFWS. 2002. Southwestern Willow Flycatcher Recovery Plan. Region 2, Albuquerque, New Mexico.

USFWS. 2003. Recovery Plan for the Quino Checkerspot Butterfly (*Euphydryas editha quino*). Region 1, Portland, OR. 179pp.

U.S. Census Bureau. 2000. Census 2000.

U.S. Forest Service. 1986a. Environmental Impact Statement for the Lincoln National Forest Plan. Alamagordo, New Mexico, 406pp.

U.S. Forest Service. 1986b. Lincoln National Forest Plan. Southwestern Region. 216pp.

U.S. Forest Service. 1992. Fire and Forest Health: Southwestern Region.

U.S. Forest Service. 1995. Wildlife and Fish Report for the Lincoln National Forest, Noxious Weeds Management Environmental Assessment. Sacramento Ranger District, Lincoln National Forest, New Mexico.

U.S. Forest Service. 1996. Draft Environmental Assessment for Noxious Weed Management, Lincoln National Forest, Lincoln and Otero counties, New Mexico. Sacramento Ranger District, Lincoln National Forest.

U.S. Forest Service. 1999a. Cloudcroft checkerspot butterfly (handouts given at February 24, 1999). Sacramento Ranger District Office, Lincoln National Forest, New Mexico.

U.S. Forest Service. 1999b. Additional information on topics discussed on February 24, 1999, meeting regarding the Cloudcroft checkerspot butterfly. Sacramento Ranger District, Lincoln National Forest, New Mexico.

U.S. Forest Service. 1999d. Cloudcroft checkerspot butterfly 1998 survey summary. Sacramento Ranger District, Lincoln National Forest New Mexico.

U.S. Forest Service. 1999h. Decision notice and finding of no significant impact for Rio Penasco Wildland/Urban interface project, Otero County, New Mexico. Lincoln National Forest, Otero County, New Mexico. Sacramento Ranger District, New Mexico.

U.S. Forest Service. 2000a. Survey summary from 1999, information, and comments regarding the status review for the Sacramento Mountains checkerspot butterfly. Lincoln National Forest.

U.S. Forest Service. 2000d. Cloudcroft checkerspot butterfly 2000 survey summary. Sacramento Ranger District, Lincoln National Forest, New Mexico.

U.S. Forest Service. 2003. Sacramento Mountains Checkerspot Butterfly 2003 Survey Summary. Sacramento Ranger District, Lincoln National Forest, New Mexico.

U. S. Forest Service. 2004. Proposed Rule for Travel Management: Designated Routes and Areas for On Off-Highway Vehicle Use in National Forests and Grasslands. 36 CFR Parts 212, 251, 261, and 295. RIN 0596-AC11.

Wahlberg, N., T. Klemetti, and I. Hanski. 2002. Dynamic populations in a dynamic landscape: the metapopulation structure of the marsh fritillary butterfly. Ecography 25:224-232.

Waltz, A.E. and W.W. Covington. 2004. Ecological Restoration Treatments Increase Butterfly Richness and Abundance: Mechanisms of Response. Restoration Ecology 12(1):85-96

Watkins, R.Z., J. Chen, J. Pickens, and K.D. Brosofske. 2003. Effects of Forest Roads on Understory Plants in a Managed Hardwood Landscape. Conservation Biology 17(2):411-419.

Webb, R. H., and H. G. Wilshire. 1983. Environmental effects of off-road vehicles: impacts and management in arid regions. Springer-Verlag, New York.

Weiss, S. B. 1999. Cars, cows, and checkerspot butterflies: nitrogen deposition and management of nutrient-poor grasslands for a threatened species. Conservation Biology 13(6): 1476-1486.

Weiss, S. B., D. D. Murphy, & R. R. White. 1988. Sun, slope, and butterflies: Topographic determinants of habitat quality for *Euphydryas editha*. Ecology 69(5): 1486-1496.

Weiss, S. B., R. R. White, D. D. Murphy, and P. R. Ehrlich. 1987. Growth and dispersal of larvae of the checkerspot butterfly *Euphydryas editha*. Oikos 50:161-166.

Weiss, S. B., K. R. Switky, and D. D. Murphy. 1991. Technical notes: grazing and endangered species management. Endangered Species Update 8:6.

Wettstein, W. & B. Schmid. 1999. Conservation of arthropod diversity in montane wetlands: effect of altitude, habitat quality and habitat fragmentation on butterflies and grasshoppers. Journal of Applied Ecology 36: 363-373.

White, C. S. 1996. The Effects of Fire on Nitrogen Cycling Processes Within Bandalier National Monument, NM. La Mesa Fire Symposium Proceedings 2:123-139.

White, R. R. 1986. Pupal mortality in the bay checkerspot butterfly (Lepidoptera: Nymphalidae). The Journal of Research on the Lepidoptera 25:52-62.

Whitecotton, R.C.A., M.B. David, R.G. Darmony, and D.L. Price. 2000. Impact of Foot Trafic from Military training on Soil and Vegetation Properties. Environmental Management 26(6): 697-706.

Wilcox, B. A., and D. D. Murphy. 1985. Conservation strategy: the effects of fragmentation on extinction. The American Naturalist 125:879-887.

Wildlife Conservation Act of New Mexico. 1978. In: New Mexico Statutes, Game and Fish Hunting and Fishing Regulations.

Willott, S. J., D. C. Lim, S. G. Compton, and S. L Sutton. 2000. Effects of Selective Logging on the Butterflies of a Bornean Rainforest. Conservation Biology 14:1055-1065.

Wood, P. A., and M. J. Samways. 1991. Landscape element pattern and continuity of butterfly fight paths in an ecologically landscaped botanic garden, Natal, South Africa. Biological Conservation 58:149-166.

Appendix A.

MEMORANDUM OF UNDERSTANDING SACRAMENTO MOUNTAINS CHECKERSPOT BUTTERFLY

(Euphydryas anicia cloudcroft,)

1. PURPOSE AND NEED

On September 6, 2001, the U.S. Fish and Wildlife Service (USFWS) proposed to list the Sacramento Mountains checkerspot butterfly (Euphydryas anicia cloudcrofti) as endangered with critical habitat under the authority of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.). This species' known range is within a 6-mile radius around the Village of Cloudcroft, New Mexico, in open meadows within mixed-conifer forest at elevations between 8000 to 9000 feet. The species is threatened by habitat loss, fragmentation, and degradation, stochastic events such as drought and wildfire, and over-collection.

In January 2004, local, regional, and federal representatives began collaboration on a plan to protect the Sacramento Mountains checkerspot butterfly and conserve the species' limited habitat. The Service formed the working group in response to new information about the species and its habitat, changes in the severity and imminence of certain threats since the publication of the September 6, 2001 proposed rule to list the butterfly, and interest by local parties to proactively address conservation needs of the Sacramento Mountains checkerspot butterfly.

The primary purpose of this Memorandum of Understanding (MOU) is to conserve the Sacramento Mountains checkerspot butterfly by reducing threats to the species and maintaining its habitat. Monitoring and research activities are a secondary component of this purpose. The Conservation Agreement establishes a general framework for cooperation and participation among signatories. The signatories will provide support to the program as needed, and will provide input on current and future program needs. The Agreement is made and entered into to meet the following objective: 1) Implement the Sacramento Mountains Checkerspot Butterfly Conservation Plan, thus establishing an open process by which to identify and carry out such actions as will conserve the species through voluntary participation of public and private partners.

II. INVOLVED PARTIES

In order to meet the present and/or future needs of this conservation effort, this MOU may be modified or amended at any time by mutual written concurrence of the cooperating partners.

Regional Office
U.S. Fish and Wildlife Service
500 Gold Avenue, Southwest
Albuquerque, New Mexico 87102

Ecological Services New Mexico Field Office
U.S. Fish and Wildlife Service
Osuna Drive Northeast
Albuquerque, New Mexico 87113

United States Forest Service:

Jose Martinez, Forest Supervisor
1101 New York Ave.
Alamogordo, New Mexico 88310
(505) 434-7200
(505) 434-7218 facsimile

Village of Cloudcroft:
Michael Nivison, Village Manager
P.O. Box 317
Cloudcroft, New Mexico 88317
(505) 682-2411
(505) 682-2042 – facsimile

Otero County Project Contact:

Ruth Hooser, County Administrator
Otero County Administration
1000 New York Ave., Rm. 101
Alamogordo, NM 88310
Phone: (505) 437-7427
FAX:(505) 443-2904

III. AUTHORITIES

The authorities for the involved parties to participate in this Conservation Agreement are derived from the following legislation:

U.S. FISH AND WILDLIFE SERVICE:

Endangered Species Act of 1973, as amended
Fish and Wildlife Act of 1956, as amended
Fish and Wildlife Coordination Act of 1934, as amended
Sikes Act of 1960, as amended

IV. IMPLEMENTATION OF CONSERVATION ACTIONS

Conservation actions necessary to ensure the long-term persistence of the Sacramento Mountains checkerspot butterfly are identified in the Sacramento Mountains Checkerspot Butterfly Conservation Plan implementation schedule. Subject to availability of funds and compliance with all applicable regulations, the involved parties agree to implement actions according to scheduled completion dates and by responsible parties, as shown in the implementation schedule. If threats have been removed to a degree that the butterfly does not meet the definition of a threatened species, pursuant to the Act, the Fish and Wildlife Service may withdraw the proposed rule to list the butterfly as endangered. If the species is withdrawn and it becomes known that there are threats to the survival of the species that are not or cannot be resolved through this or any Conservation Plan, the species will be re-assigned to candidate status and an appropriate listing priority assigned.

NOW THEREFORE, in consideration of the above premises, the cooperators enter into this Agreement as full and equal partners to accomplish its purpose and objectives.

All cooperators agree to:

1. Further develop and implement the objectives, strategies, and tasks of the Sacramento Mountains Checkerspot Butterfly Conservation Plan.

2. As needed for this conservation effort, and as available, provide program personnel with facilities, equipment, logistical support, and access to lands under their control.

3. Participate regularly in coordination meetings to enhance communication and cooperation, and to help develop annual or other work plans and reports.

4. Develop and distribute public information and educational materials on this conservation effort.

5. Provide ongoing review of, and feedback on, this conservation effort.

6. Cooperate in development of major media releases and media projects.

7. Keep local governments, communities, the conservation community, citizens, and other interested and affected parties informed on the status of this conservation effort, and solicit their input on issues and actions of

concern or interest to them.

8. Whenever possible, develop voluntary opportunities and incentives for local communities and private landowners to participate in this conservation effort.

9. Assist in generating the funds necessary to implement this conservation effort.

V. SACRAMENTO MOUNTAINS CHECKERSPOT BUTTERFLY CONSERVATION PLAN INTERAGENCY COORDINATING COMMITTEE

The involved parties shall designate a representative to serve on the Sacramento Mountains Checekerspot Butterfly Conservation Plan Interagency Coordinating Committee (ICC). The ICC shall monitor the implementation of the Conservation Plan and provide a forum for exchange of information on the species. Through mutual agreement among designated representatives of all involved parties, the ICC may recommend changes in the tasks and scheduling of task implementation. The ICC shall in no way make recommendations to or serve as an advisory group to a federal agency. The ICC shall meet annually, and designated representatives shall attend annually for the life of this Plan to review progress and coordinate work priorities and schedules.

VI. ADMINISTRATIVE CLAUSES

1. Nothing herein shall be construed as obligating the parties to expend funds or as involving the parties in any contract or other obligation for the payment of money in excess of appropriations authorized by law and administratively allocated to work described herein.

2. This agreement is not a fund-obligating document, and each party shall carry out its separate activities in a coordinated and mutually beneficial manner. Any activity that may create an exchange of funds will be conducted outside the scope of this agreement as authorized by law or regulations of each party.

3. Any contracts entered into as a result of this Agreement shall comply with all state and federal and contracting laws, including all applicable laws prohibiting discriminatory employment practices by contractors.

IT IS MUTUALLY AGREED AND UNDERSTOOD BY AND BETWEEN THE COOPERATORS THAT:

1. Specific work projects or activities that involve transfer of funds services, or property among cooperators to this Agreement may require execution of separate agreements or contracts.

2. Specific proposed project actions or changes in management activities may

require amendments to existing land use plans and further environmental analysis before implementation.

3. Conflicts between or among cooperators concerning procedures or actions under this Agreement that cannot be resolved at the operational level (i.e. by cooperator representatives to the MOU or ICC) will be referred to the next higher level within each cooperator, as necessary, for resolution.

VII. DURATION OF AGREEMENT

The term of this Agreement shall begin on the date the Agreement is signed by all parties, and end after all tasks identified in the implementation schedule are completed, or until terminated by mutual concurrence of all the parties. The involved parties shall review the Conservation Plan and its effectiveness annually to determine whether it should be revised. Within a year of completing the tasks identified in the implementation schedule, the Conservation Plan shall be reviewed by the involved parties and either modified, renewed, or terminated. This MOU may, at any time, be amended, extended, modified, supplemented, or terminated by mutual concurrence. Any party may withdraw from this Plan by providing 60 days notice to the other parties in writing.

VIII. SIGNATURES

[The original, signed signature pages are not included]

IN WITNESS WHEREOF:

The cooperators hereto have executed this Agreement as of the last written date below.

BOARD OF COUNTY COMMISSIONERS
OF OTERO COUNTY

MICHAEL NIVISON, Chairman

Date 7/20/04

Attest:

Mary Quintana, County Clerk

DEPARTMENT OF INTERIOR, FISH AND WILDLIFE
SERVICE

for H. DALE HALL Regional Director

Date: 10/6/04

CITY OF CLOUDCROFT

David Venable, Mayor

Date: 9/19/04

Attest:

Trisha Zendel, City Clerk

UNITED STATES FOREST SERVICE, LINCOLN NATIONAL FOREST SUPERVISOR

FOR JOSE MARTINEZ, Forest Supervisor 10.5.04

Appendix B.

DRAFT

RESOLUTION NO. 10-19-04/93-21

PROVIDING FOR THE PRESERVATION OF OTERO COUNTY'S NATURAL RESOURCES AND THE PROTECTION OF VARIOUS SPECIES

WHEREAS, The Board of County Commissioners has been involved in and committed to developing the science, and understanding necessary to provide for maximum protection of the National Forest lands within the County in recognition of their significant value to the custom, culture, history and economics of the County; and

WHEREAS, The Board of County Commissioners recognizes as a component of those National Forest lands the existence of certain species of insects, plants, and or animals whose existence on the National Forest lands are an integral part of the ecosystem that makes up a healthy forest which will sustain the recreational, cultural, and economic uses of forest lands that have evolved throughout the history of the County; and

WHEREAS, The Board of County Commissioners have committed themselves to develop county land use plans, subdivision regulations zoning and other ordinances which are designed to preserve and protect the valuable natural resources located within the county including the national forest lands in a manner that will insure their long term viability for multiple sustained use by the citizens of this county both, in the present and for future generations; and

WHEREAS, The Board of County Commissioners have determined that as part of this effort special recognition should be given to the Sacramento Mountain Checkerspot Butterfly; the Sacramento Mountain Prickly Poppy; and the Sacramento Mountain Thistle; as species that deserve attention and consideration as the county implements land use plans, subdivision regulation and development and zoning ordinances; and

NOW, THEREFORE, BE IT RESOLVED:

That The Board of County Commissioners of Otero County dedicates itself and directs county staff to implement policies, procedures, work plans, to insure that as land use planning, subdivision regulation, zoning ordinance development, and other resolutions and ordinances of the county are being considered developed drafted and recommended that a paramount consideration in those processes be the sustained multiple use of the natural resources of the county in a manner that considers the preservation, protection and long term viability of the Sacramento Mountain Checkerspot Butterfly; the Sacramento Mountain Prickly Poppy; and the Sacramento Mountain Thistle as well as the myriad of other important species located on the national forests of the county.

APPROVED, PASSED and ADOPTED on this 19th day of October 2004.

ATTEST:

Mary Quintana, County Clerk

(Seal)

BOARD OF COUNTY COMMISSIONERS
OTERO COUNTY, NEW MEXICO

Clarissa McGinn, Chairperson

Doug Moore, Vice-chairperson

Michael Nivison, Member