

LASSEN VOLCANIC NATIONAL PARK

A SUMMARY OF RESOURCE MANAGEMENT ACTIVITIES

FOR 2008

Division of Natural Resources Management
Lassen Volcanic National Park



September 2009

National Park Service
Lassen Volcanic National Park
P.O. Box 100
Mineral, California 96063

CONTENTS

LIST OF TABLES	ii
LIST OF FIGURES	iii
NATURAL RESOURCE MANAGEMENT DIVISION STAFF	4
BUFFLEHEAD DUCK MONITORING	6
PEREGRINE FALCON MONITORING	10
BALD EAGLE NEST MONITORING	14
SONGBIRD MONITORING – DRAKESBAD MIST-NETTING	17
SONGBIRD MONITORING – BREEDING BIRD SURVEY.....	24
SPOTTED OWL MONITORING.....	31
BLACK-TAILED DEER MONITORING	35
AMERICAN PIKA INVENTORIES	38
WILDLIFE SIGHTINGS	41
NONNATIVE PLANT TREATMENT AND MONITORING	45
DISTURBED LANDS RESTORATION.....	50
VEGETATION MAPPING.....	51
ECOLOGICAL ASSESSMENT OF ASPEN COMMUNITIES.....	53
HAZARDOUS TREE INVENTORIES AND MITIGATION	56
MANZANITA LAKE TREE THINNING.....	59
AIR QUALITY MONITORING.....	65
SOILS INVENTORY AND MAPPING PROJECT	70
RESEARCH PERMIT TRACKING	72
NEPA COMPLIANCE.....	75
LITERATURE CITED.....	79

LIST OF TABLES

Table 1: Bufflehead Duck Brood Surveys, 1997 – 2008.....	8
Table 2. Snag Lake Bald Eagle Nest History	16
Table 3. Summary of Breeding Season Net Results, 1997-2008.....	18
Table 4. Species and Age Class of Birds Banded at Drakesbad, 1997-2008.	22
Table 5. Breeding Bird Survey – Route Summary	27
Table 6. 2008 Results from Fixed Spotlight Trend Surveys.....	37
Table 7. Wildlife Observation Form Results, 2008.	43
Table 8. Weed Treatment by Species and Location, 2008	49
Table 9. Results of Hazard Tree Surveys and Mitigation, 2008	58
Table 10. Summary of Precipitation Chemistry, 2007	68

LIST OF FIGURES

Figure 1. Map of 2008 Bufflehead Surveys.....	9
Figure 2. Peregrine Falcon Survey Sites.....	13
Figure 3. Average Productivity for Three Songbird Species.....	20
Figure 4. Map of Drakesbad Mist Net Stations.....	21
Figure 5. BBS Trend Map for Yellow Warbler, 1966-2003.....	25
Figure 6. Map of Breeding Bird Survey Route #308	26
Figure 7. Annual Count from Deer Trend Surveys, 1996-2008.	36
Figure 8. White fir Before and After Thinning Treatment.....	63
Figure 9. Before and After Photos, Manzanita Lake Area	64
Figure 10. 2004 Annual Aerosol Bext.....	68

NATURAL RESOURCE MANAGEMENT DIVISION STAFF

2008

Louise Johnson, Chief of Natural Resources

Jonathan Arnold, Forester
Michelle Cox, Plant Ecologist
Lisa Ford, Administrative Assistant
Sean Eagan, Compliance Specialist
Michael Magnuson, Wildlife Biologist
Nancy Nordensten, Biologist

Seasonal Staff:

Tandy Bozeman, Archeological Technician, _____
Katherine Gura, Biological Technician, Weed Program
Megan Klosterman, Student Conservation Intern, _____
Nicole Koeltzow, Biological Technician, _____
Alex Lawton, Biological Technician, Weed Program
Michelle Ocken, Biological Technician, _____
Rosalind Vara, Biological Technician, Weed Program
Clara Weygandt, Biological Technician, Federal Lands Highway Project

Volunteer Staff

Wildlife Surveys:

Tim Kask, Alan Wilhelm

Weed Surveys:

David Escobar, Jr.

Public Information Volunteers, Federal Lands Highway Project:

Roy Freed, Mary Freed,

Contributors:

Sarah McCullough, Graduate Student, University of California, Davis, Aspen Project
Andrew Conlin, Natural Resource Conservation Service, Soils Mapping Project

BUFFLEHEAD DUCK MONITORING

INTRODUCTION

The Bufflehead Duck (*Bucephala albeola*) is California's rarest boreal duck species. The Bufflehead nests almost exclusively in cavities excavated by Northern Flickers (*Colaptes auratus*) and occasionally in those excavated by Pileated Woodpeckers (*Dryocopus pileatus*) (Cornell Laboratory of Ornithology 2008). A small, isolated breeding population occurs in Northeastern California, the majority of which is located within Lassen Volcanic National Park (LVNP) and Lassen National Forest (LNF). The nearest breeding population occurs a substantial distance away in central Oregon, Idaho, and Wyoming. The largest concentration of breeding buffleheads worldwide is found in Central British Columbia.

In an eight-year study of the distribution, density, population trends, and habitat usage of buffleheads in California, Airola (1987) raised concerns over the viability of the Lassen population because of its small size, remoteness from other breeding populations and several land-use factors which may lead to loss or degradation of habitat. These land-use factors were fish stocking, loss of nest snags near lake shorelines, and high recreation use. Of the 151 lakes surveyed within the study area, 21 broods and 82 adults were found. Airola developed models that estimated the total California breeding population at 59-65 pairs, with McCoy Flat reservoir in LNF contributing 20% of the state's population.

PROJECT HISTORY

In 1997, LVNP and LNF biologists agreed to establish an interagency monitoring effort to survey buffleheads over park and forest lands to determine if any changes had occurred in the population over the 11-year period since Airola completed his study. In addition, both agencies were interested in long-term monitoring of Bufflehead Duck population trends. These efforts are important because: 1) these two land holdings contain the vast majority of the breeding habitat for this species in California, and 2) much of this land, at least on LNF, is subject to land-use practices which may jeopardize the breeding success of the species.

During the first year of monitoring in 1997, twenty-six lakes were surveyed within LVNP. Broods were found on eight of these lakes, and another seven lakes had adult ducks but no broods. Combining all 218 ponds and lakes surveyed over the study area (LVNP and LNF lands) a total of 71 broods and 374 young were observed. Preliminary analysis of first year data seem to corroborate the findings of Airola that fish stocking and lakeshore disturbance can result in decreased bufflehead use and productivity on otherwise useable lakes (Rickman 1997). Using the 1997 data and estimation models developed by Airola, a total of 119-130 pairs and 95-104 broods were estimated to occur within the state. During a nine year period of surveys on LNF, Hog and McCoy Reservoirs have contributed 46% of the observed adults, 39% of the broods and 45% of the young, despite having been dry or nearly dry for two of the survey years (Rickman 2006).

OBJECTIVES

The objective of this survey effort is to track population trends by monitoring Bufflehead Duck adults and young at lakes within LVNP. Additionally, data is being collected that will help describe site conditions at each lake, including the presence of fish and identification of potential human-caused disturbances.

METHODS

As many lakes as possible are surveyed each year. However, priority is given to fifty baseline lakes selected for long-term monitoring in 2003. These lakes have been prioritized for survey, in case limits on staff time preclude more extensive surveys. Forty of the fifty lakes were selected because brood production had been observed at these sites one or more times during the first six years of survey (1997-2002). Ten additional lakes were randomly selected, to detect potential increases in the number of breeding sites.

In 2008, Bufflehead Duck brood surveys were conducted between June 29 and August 10. Surveys were conducted by walking the perimeter of the lakes and recording numbers of adults with and without broods and the number of young in each brood. Sex of adult birds was noted. Because males in full basic plumage, adult females, and first-year birds of both sexes usually cannot be distinguished, birds greater than age 1 year were recorded as “age and sex unknown”, except females with broods and a few males in adult alternate plumage. Clutches with more than 12 young are thought to represent either the results of dump nesting or brood amalgamation (Rickman 2001). Therefore, the total number of young within an observed group is divided by 12 to estimate the number of contributing broods. Other data collected at each lake included: presence of fish, type and extent of recreational use, and a notation of other disturbances. Field data were recorded on standard survey forms and archived in the Natural Resource Management Division office. Data were entered into an Excel spreadsheet.

Volunteers contribute significantly to the survey efforts on both park lands and national forest lands. Volunteers from the California Waterfowl Association (CWA) surveyed numerous lakes on LNF in 2008.

RESULTS IN LASSEN VOLCANIC NATIONAL PARK

Sixty-seven lakes were surveyed in LVNP during 2008. Adult buffleheads were found on 29 of the lakes surveyed. Eighteen of the lakes supported broods and a total of 22 broods were observed (Figure 1). A total of 45 adults and 96 young were observed.

RESULTS OF INTERAGENCY SURVEYS

Two of the three ranger districts within Lassen National Forest are surveyed for Bufflehead Ducks: Eagle Lake Ranger District (ELRD) and Almanor Ranger District (ALRD). A total of 445 lakes and ponds were surveyed on LVNP and LNP lands in 2008. Broods were observed at 54 of the 445 site surveyed, and a total of 307 young counted.

Totals by agency in 2008 were:

LVNP: 67 lakes surveyed, 18 lakes with broods, 22 broods and 96 young
 ELRD: 70 lakes surveyed, 4 lakes with broods, 4 broods and 20 young
 CWA: 251 lakes surveyed, 25 lakes with broods, 32 broods and 138 young
 ALRD: 57 lakes surveyed, 7 lakes with a broods, 8 broods and 53 young.

Refer to Table 1 for a summary of the interagency survey results.

Table 1: Bufflehead Duck Brood Surveys, 1997 – 2008, Lassen Volcanic National Park and Lassen National Forest.

Year	Number of Lakes Surveyed	# of Lakes with Broods	Number of Broods	Number of Young
1997	218	43	71	374
1998	179	36	79	510
1999	198	46	105	651
2000	181	36	82	506
2001	348	43	46	203
2002	309	47	78	437
2003	351	42	76	297
2004	350	60	101	521
2005	399	57	110	490
2006	472	54	110	620
2007	385	50	85	434
2008	445	54	66	307

FUTURE DIRECTION

The park will continue this joint project with Lassen National Forest as part of the park's long-term monitoring program.

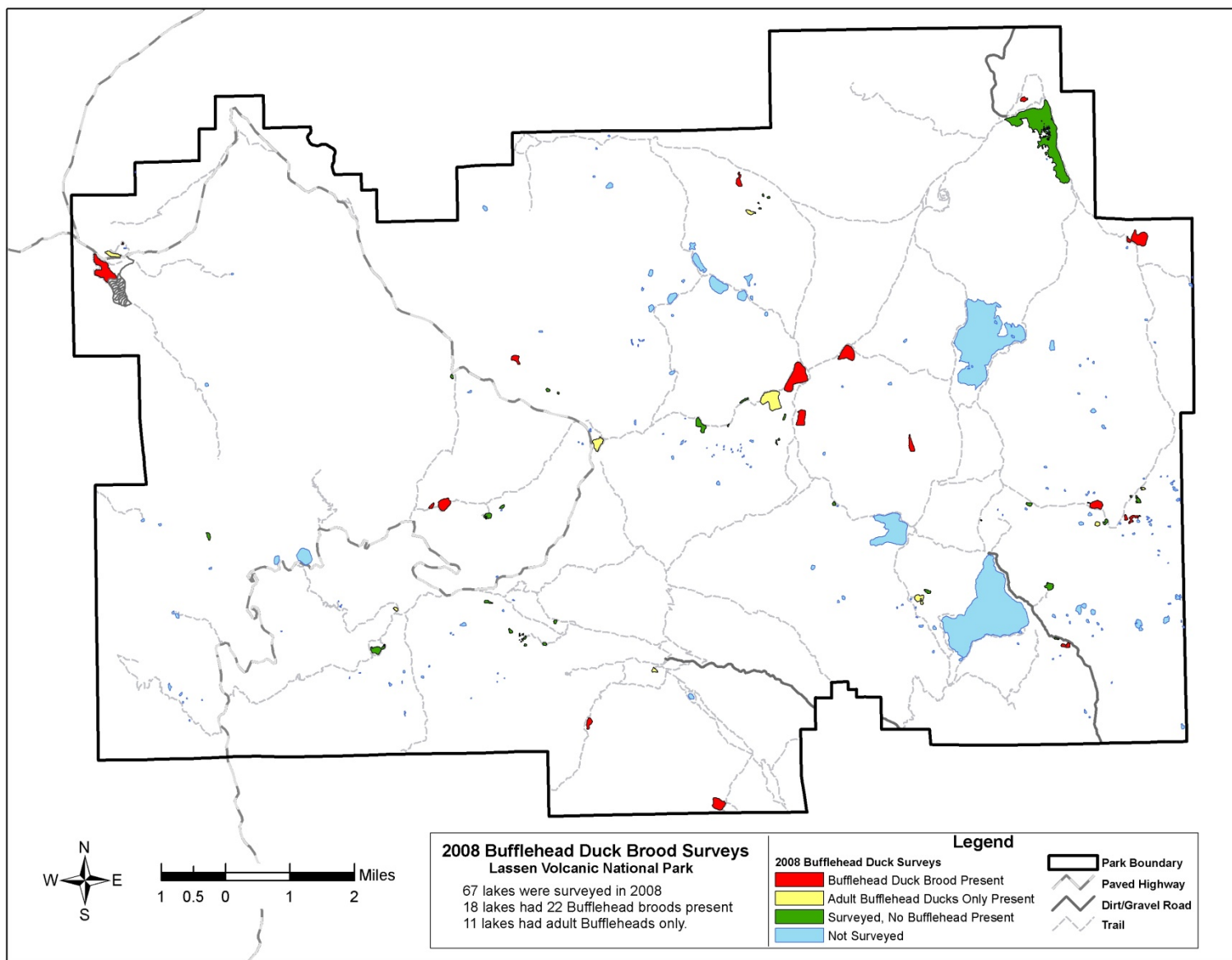


Figure 1. Map of 2008 Bufflehead Surveys

PEREGRINE FALCON MONITORING

INTRODUCTION

The American Peregrine Falcon (*Falco peregrinus anatum*), once a common resident throughout much of California, began rapidly declining about the mid-part of the 20th century. The chief factor responsible for this decline was the biochemical impact of organochlorine pesticide residues (primarily DDT), but habitat degradation throughout the falcon's range also played a large role. Documentation of these alarming trends not only in California populations but throughout the species range prompted the United States Fish and Wildlife Service (USFWS) in 1970 to list the American Peregrine Falcon as Federally endangered.

Once a species is federally listed, the Endangered Species Act strives not only to prevent the species from becoming extinct, but ultimately to restore these species to the point where they no longer require legal protection. To this end, the USFWS is required to develop and implement formal Recovery Plans to help guide restoration efforts. The fundamental components of a recovery plan include range-wide inventories of species abundance and distribution, and monitoring to track population trends.

In 1999, due to population recovery criteria being met, the American Peregrine Falcon was removed from the Federal list of Endangered and Threatened Wildlife. It currently retains endangered status by the State of California.

Though periodic sightings of this species in the park have been made over the past few decades (LVNP Species Observations Database), and nesting has been confirmed outside the park boundary (Grinnell and Miller 1944), the park's scant records have never shown peregrine falcons to nest inside the park. A scientific study conducted in the park (Baldridge et al. 1980), though not successful in detecting nesting Peregrine Falcons, identified potential nesting sites and recommended a strategy for monitoring these sites.

PROJECT HISTORY

In 1980, a study was initiated by the Cooperative Park Studies Unit in Davis to determine the extent of the use of the park by endangered raptors, including Peregrine Falcon (Baldridge et al. 1980). Thirty-six priority cliff sites were located, described, photographed, and mapped for their potential to support Peregrine Falcon nesting. Data analysis showed that none of the 36 cliff sites held excellent potential as a Peregrine Falcon nesting location. However, two sites were rated as having good potential, three sites were rated as suitable, and four sites were rated as having marginal potential. The remaining 27 potential sites, after closer examination, were considered unsuitable for nesting.

Though no Peregrine Falcon nesting was observed at any of these locations during subsequent surveys in summer 1980, one Peregrine Falcon was observed near Lassen Peak well after the nesting season. Results led the authors to believe that 1) potential Peregrine Falcon nest sites in the park are below optimum, and that most are generally unsuitable, and

2) presence of Peregrine Falcon in the park is probably mostly due to upslope post-breeding movement in response of prey availability.

Nevertheless, because five sites (those rated as having good or suitable potential) could conceivably support nesting Peregrine Falcons in some years, the report recommended that the park annually monitor these sites using methods similar to those employed in this study. Nest site monitoring began in 1997 and has continued annually at high priority sites.

METHODS

An observer experienced in Peregrine Falcon monitoring conducted all surveys from designated (and mapped) observation posts. A spotting scope and binoculars were used to scan potential nesting sites. Survey results, including falcon sightings and any indications of nesting activities were recorded in detailed journal format, and are stored in Resource Management Division files. Timing and duration of surveys was based on knowledge of the species' nesting habits, local climate conditions, and consultation with biologists conducting Peregrine Falcon surveys on lower elevation lands surrounding the park.

RESULTS

From fieldwork accomplished during 1999 and 2000, it was determined that: 1) annual field efforts would be concentrated on two priority sites that appeared to promise the best results, and 2) locating Peregrine Falcons while they were still on the nest would require beginning the surveys in mid to late May. The two sites chosen were Northwest Blue Lake Canyon, and Raker Peak.

Northwest Blue Lake Canyon

This nest cliff was surveyed on June 11th of 2008. No activity was observed upon arrival at 10:20. At 11:45 one Peregrine Falcon was heard but could not be located visually. The cliff was observed until 01:00 PM with no Peregrine Falcons observed. This was the only visit to the site in 2008. Nesting status for 2008 is unknown.

Raker Peak

This area was surveyed by using a spotting scope and binoculars to view the cliff and surrounding areas. The area was surveyed once in 2008, on June 11. No indication of Peregrine Falcon presence was observed on this visit.

Visitor Reports

There were no confirmed observations of Peregrine Falcons reported by park visitors or staff in 2008. There was one visitor sighting report from a visitor of an "unknown falcon" at Little Bear Lake on September 12th. From the description it could be either a Peregrine or Prairie Falcon.

FUTURE DIRECTION

We plan to continue implementing Peregrine Falcon monitoring at the high priority sites in Blue Lake Canyon and Raker Peak for 2009. We will continue to collaborate and share information with Forest Service biologists conducting falcon monitoring on properties adjacent to LVNP.

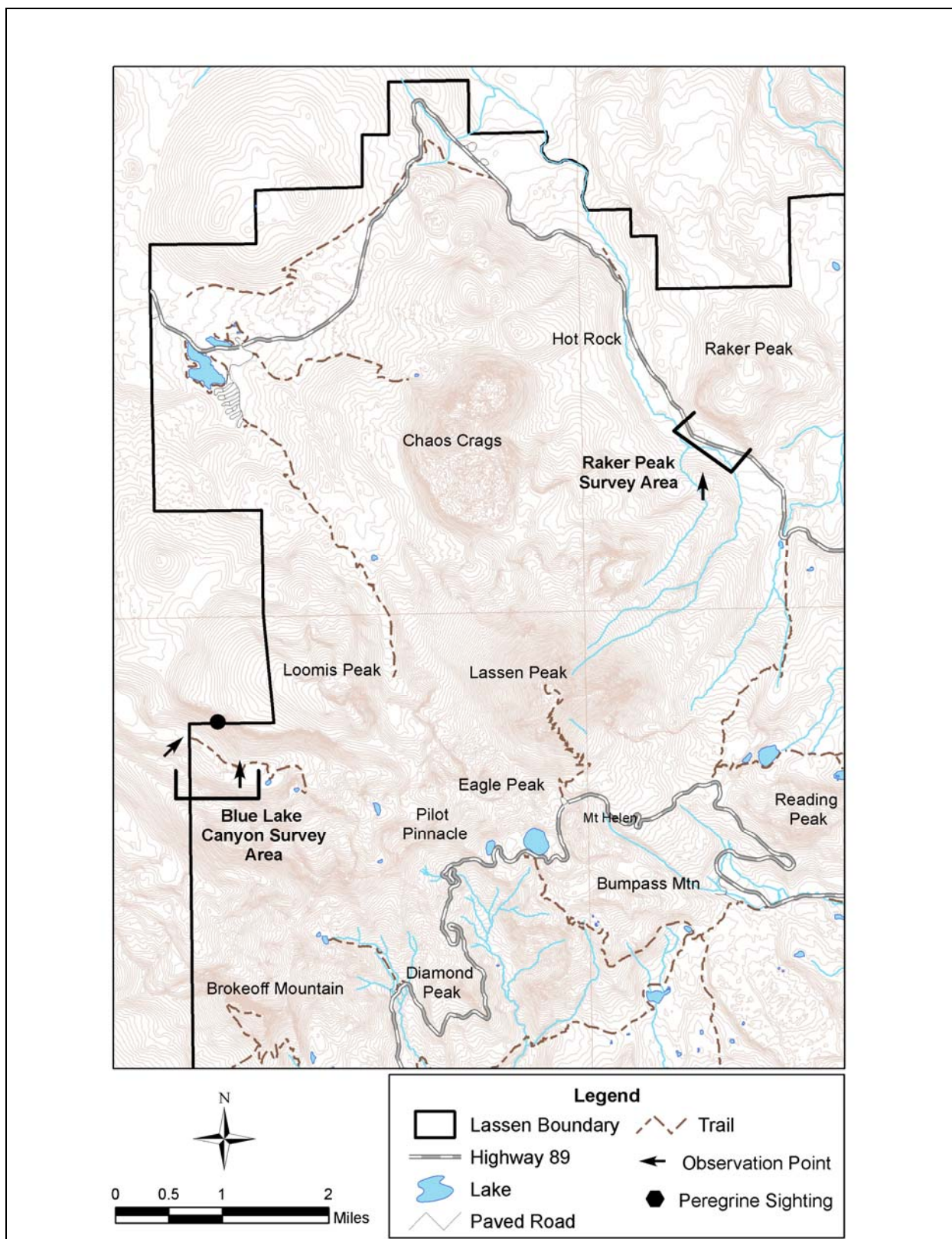


Figure 2. Peregrine Falcon Survey Sites

BALD EAGLE NEST MONITORING

INTRODUCTION

Though no historical information exists on Bald Eagle (*Haliaeetus leucocephalus*) population size in California, it is widely thought that this species formerly occupied a widespread range and was quite abundant throughout the western states. After World War II, the Bald Eagle population declined rapidly in California and throughout all other parts of its range. This was caused primarily by DDT contamination which caused severe nesting failure in this species. Another factor contributing to its decline was degradation of breeding and wintering habitats. In 1967 the United States Fish and Wildlife Service (USFWS) listed the Bald Eagle as Federally endangered, followed by the State of California which listed the species as endangered in 1971. By the late 1960s and early 1970s, fewer than 30 nesting pairs remained in California, all in the northern part of the state (Jurek 1990).

Fortunately, the last 30 years have seen a remarkable turnaround in population numbers and occupied sites for the Bald Eagle. Protection of nesting areas, restrictions on use of DDT and other pesticides, and wildlife management projects designed to enhance bald eagle populations have all played significant roles. By 1994, the number of occupied territories in California had increased from 30 to 116. Likewise, the wintering population had stabilized to around 1,000 birds. Annual productivity for the species has been considered good during the last decade, with slightly more than one young being produced per occupied territory. Partly because much progress has been made toward meeting most of the population recovery criteria specified in the Pacific Bald Eagle Recovery Plan (Jurek 1995), the USFWS recently officially reclassified the Bald Eagle to threatened.

Since 1980, Lassen Volcanic National Park (LVNP) has actively participated in a multi-agency program of annual breeding season surveys. This program, which is managed by the California Department of Fish and Game (CDFG), has provided a relatively thorough statewide coverage of the status of breeding Bald Eagles.

PROJECT HISTORY

The current Bald Eagle monitoring effort has been in place for more than 20 years and stems from written management recommendations provided by a 1980 study of endangered raptors in the park (Baldrige et al. 1980). The purpose of that study was to document the distribution of endangered raptors (Bald Eagle and Peregrine Falcon) in LVNP, determine if these species nested in the park, and implement a monitoring system for these species which could be continued by park personnel. Significant findings of Baldrige's study were: 1) the discovery of the first active Bald Eagle nest in the park, at Snag Lake, 2) the recognition that the Snag Lake nest is probably the highest in elevation of any in the state, and 3) the acknowledgment that LVNP has extremely marginal Bald Eagle nesting habitat because of scarce food supplies and relatively harsh climates during the nesting season. Therefore, the park can support at most one resident breeding pair, in addition to one other foraging pair which nests outside the park, and a few wandering juveniles.

The nest that was used in 2000 blew down during the winter or spring of 2001. No new nest has been located since 2000. Adult Bald Eagles have been observed in the Butte Lake, Snag Lake, and Cluster Lake areas since 2000.

METHODS

Two observation posts are used to make on-ground surveys of the nest tree during the breeding/fledging season. The principal post is located one half mile west/northwest of the nest, and the secondary post is located east/northeast near the southwest edge of Snag Lake. Observation posts and nest trees have been mapped using a GPS device. Observations generally occur approximately once per week from early June until young Bald Eagles fledge (sometimes as late as early August), or until it is determined that no young are present. Observations are taken using a 20-45 power spotting scope and binoculars. In addition to time spent at the observation posts, observations are made of the entire Snag Lake region from trails along the lakeshore and prominent points affording adequate views of the lake. In years of nesting success, detailed records are kept of adult foraging behavior, foods obtained, adult and nestling interactions, and alternate nest building and nest repairing activities. Data are recorded on standard CDFG eagle monitoring forms and submitted to State offices in Sacramento.

RESULTS

In 2008, Resource Management staff searched for Bald Eagles in the Snag and Butte Lake areas and did observe two adult Bald Eagles and one juvenile at Snag Lake. The juvenile appeared to be $\frac{1}{2}$ to $1\frac{1}{2}$ years old by plumage characteristics (McCollough, 1989). No nest was found in 2008. Visitor and staff sighting reports also confirmed adult Bald Eagles at Snag Lake and Butte Lake. Due to the close proximity of Snag Lake and Butte Lake it is believed these are the same Bald Eagles which utilize both lakes for foraging.

Bald Eagles were also observed by park staff at Manzanita Lake in 2008. There were two sighting reports turned in by park staff for Manzanita Lake. One reported seeing one adult flying overhead and the other reported seeing two Bald Eagles over the lake that could be second or third year birds by plumage characteristics (McCullough, 1989). These Bald Eagles nest outside the park but use Manzanita Lake for foraging.

Bald Eagle nesting success at the Snag Lake site has occurred in eleven of the 30 years of nest monitoring (Table 2). Although no nest was found in 2007 or 2008, one juvenile was observed both years inferring nesting success for these years.

FUTURE DIRECTION

Nest site monitoring will continue indefinitely at the Snag Lake nest site. Any additional nest sites located within the park will be monitored using established protocol.

Table 2. Snag Lake Bald Eagle Nest History

Year	Hatched, (Fledged)	Mode of Survey	Comment
1979	unknown, (1)	Foot	No nest located
1980	No	Aircraft, foot	1 nest located
1981	No	Aircraft	No nest located
1982	No	Foot	No nest located, late thaw
1983	2, (1)	Foot	1 nest located, late thaw
1984	2, (1)	Foot	Same tree as previous year
1985	?	---	Not surveyed
1986	?, (1)	Foot	2 nests found, 1 gone by end of year
1987	2, (1)	Foot	Alternate nest rebuilt, then
collapsed;			Remains of eaglet found; Snag Fire in Aug-Sept.
1988	No	Foot	Evidence of spring nest-building
1989	No	Foot	Nest used in '83 and '84 fully intact
1990	No	Foot	No evidence of nesting or territorial behavior
1991	No	Foot	No evidence of nesting or territorial behavior
1992	1, (1)	Foot	Same nest as used in '83 and '84
1993	1, (1)	Foot	Same nest as used in '83 and '84
1994	?	--	Not surveyed
1995	No	Foot	Heavy winter snow, late thaw
1996	1, (1)	Foot	
1997	1, (1)	Foot	
1998	No	Foot	El Nino winter; evidence of spring nest-building
1999	1,(1)	Foot	Probably same nest as used in 1995
2000	1,(1)	Foot	Same nest as used in 1999
2001	No	Foot	No nest located
2002	Unknown	Foot	No nest located
2003	Unknown	Foot	One nest located (historic nest)
2004	Unknown	Foot	One historic nest located - no activity
2005	Unknown	Foot	One historic nest located - no activity
2006	Unknown	Foot	Status unknown
2007	Unknown	Foot	Status unknown (1 young suspected)
2008	Unknown	Foot	Status unknown (1 young suspected)

SONGBIRD MONITORING – DRAKESBAD MIST-NETTING

INTRODUCTION

In the past few decades, much concern has been raised about the sharp and widespread population declines of songbirds. In the early 1990s, the Partners in Flight (PIF) program began an attempt to enlist a concerted effort among academic, government, and private sector scientists and managers to understand the causes of, and then reverse, songbird declines. Through this program, many important underlying causes of declines have been identified, followed by successful strategies to protect songbirds and their habitats. The National Park Service has contributed an active role in the PIF program since its inception.

The Lassen region is critical to efforts to protect declining songbirds. The area supports diverse bird communities including half of the PIF-listed Species of Conservation Priority and all the species listed by the Sierra Nevada Ecosystem Project Report as declining or likely declining (Graber 1996). Neotropical migrants are an especially important avian group which are presently well-represented in the Lassen region, but continue to show alarming declines elsewhere.

Constant-effort mist-netting data collected during the breeding season provides an annual index of abundance, productivity, and survivorship (DeSante and Geupel 1987). Data can indicate whether populations are sources (reproductive success is sufficient to balance mortality) or sinks (mortality exceeds local production of young), and whether existing conditions are capable of supporting breeding populations (Nur and Geupel 1993).

PROJECT HISTORY

From 1997-1999, Lassen Volcanic National Park (LVNP), Lassen National Forest (LNF), and the Point Reyes Bird Observatory (PRBO) conducted a 3-year study of the songbird communities in selected areas of the park and the forest. The purpose of this project was to evaluate the health of existing bird populations, identify areas important to sensitive and declining species, and provide recommendations to enhance declining populations. All data collected during these efforts were done so in accordance with standard methodologies and were contributed to national monitoring programs including Monitoring Avian Productivity and Survivorship (MAPS) and Breeding Biology Research and Monitoring Database (BBIRD).

During all years of the project, intensive training in standard methodologies (especially constant-effort mist-netting and point-counting) was provided to LVNP and LNF field staff by PRBO ornithologists to facilitate continuation of the project beyond the 3-year pilot period. At the conclusion of the study in 1999, the Drakesbad mist-netting station was converted to a permanent MAPS station as part of the park's long-term monitoring program. This year marked the tenth consecutive year of constant-effort mist-netting at Drakesbad.

METHODS

Mist-netting procedures were conducted according to the protocols described in Ralph et al. (1993). See Table 3 for a summary of days of operation. Nets were located approximately 50 meters apart and were operated during the breeding season approximately once every 10 days (Figure 4). Nets were opened 15 minutes after local sunrise, checked every 30 to 40 minutes, and operated for five hours. Birds captured were removed from the nets and processed immediately on-site. Each bird captured (except hummingbirds and game birds) received a U.S. Fish and Wildlife Service band for permanent identification and to allow estimates of survival from subsequent recaptures. Age, sex, skull ossification, breeding condition, fat score, molt, flight feather wear and fade, wing length and weight of each bird were recorded as described by Pyle (1997). All data are stored in FOXPRO databases and analysis programs developed by PRBO.

Table 3. Summary of breeding season net results from 1997-2008 at Drakesbad

Year	Days of Operation		No. of Captures ¹				Birds/ 100 Net Hrs.	Number of Species
	Total	Range	Total Net Hrs.	B	U	R		
1997	6	6/16-8/1	315	169	39	39	78.41	20
1998	4	7/7-8/4	200	127	23	37	93.5	24
1999	7	6/8-8/5	336	147	38	72	76.5	23
2000	7	6/5-8/3	247	143	39	46	92.3	27
2001	7	6/7-8/9	313.5	190	59	56	97.4	27
2002	7	6/4-8/6	350	217	21	71	88.3	24
2003	7	6/5-8/7	349.5	199	25	66	83.0	31
2004	7	6/3-8/5	350	217	43	58	90.8	30
2005	7	6/10-8/4	335	171	13	64	74.0	26
2006	7	6/7-8/3	350	301	50	53	115.4	31
2007	7	6/7-8/2	350	226	52	70	99.4	30
2008	7	6/5-8/7	350	179	38	61	79.4	30

¹ B = BANDED, U = UNBANDED, R = RECAPTURE

RESULTS

The national average for number of individuals captured per 100 net hours, from 410 MAPS stations, was 37.2 in 1996 (DeSante et al. 1998). Drakesbad consistently has capture rates well above the national average. Productivity indices (juvenile to adult ratio) by species are presented in Table 4. These results indicate high productivity (defined here as ratios ≥ 0.30) for many breeding species, in particular several riparian species such as Neotropical migrants MacGillivray's Warbler (*Oporornis tolmiei*) and Wilson's Warbler (*Wilsonia pusilla*), in addition to Song Sparrow (*Melospiza melodia*) (Figure 3). This is noteworthy because two of these species, Wilson's Warbler (*W. pusilla*) and Song Sparrow (*M. melodia*), are showing marked declines throughout their ranges and are both listed by PIF as Species of Concern.

Survivorship analysis for Drakesbad was conducted in 2004 by PRBO. For Wilson's Warbler (*W. pusilla*) the survival rate was 33% for females and 68% for males (Gardali et al. 2004). The MAPS N.W. region estimate for this species was 45% (Gardali et al. 2004). For Song Sparrow (*M. melodia*) the survival rate was 49% for females and 57% for males (Gardali et al. 2004). The MAPS N.W. region estimate for this species was 47% (Gardali et al. 2004). MacGillivray's Warbler (*O. tolmiei*) had a survival rate of 42% for females and 48% for males (Gardali et al. 2004). The MAPS Northwest Region estimate for this species is 49%. It is interesting to note the difference between male and female survival rates for all three species. Female survival rates are lower than male survival rates for all three species. It is hypothesized that this is due to the stress levels endured by females that take on the majority of the effort during the breeding season in terms of egg production and incubation (Gardali et al. 2004). This data suggests that with the relatively high survival rates for these species, Drakesbad is high quality habitat.

Data continue to show the importance of the Drakesbad area for dispersing hatch year birds, such as Orange-crowned Warbler (*Vermivora celata*) and Rufous Hummingbird (*Selasphorus rufus*). Neither of these species breeds at Drakesbad but dispersing juveniles use the area to forage. In 2008, 27 hatch year Rufous Hummingbirds and 42 hatch-year Orange-crowned Warblers were captured. Four after-hatch-year Orange-crowned Warblers were also captured in 2008 as well as four after-hatch-year Rufous Hummingbirds.

Between-year recapture has revealed important data on site fidelity and longevity. One male Warbling Vireo was recaptured in 2008 that were originally banded in 2002 and was aged as an after-hatch-year bird when originally banded. This would mean this bird is at least seven years old. One Western Wood Peewee was recaptured in 2008 that was originally banded in 2003 as an after-second-year, indicating that this bird was at least seven years old. Four MacGillivray's Warblers (one male and three females) were recaptured in 2008 that were originally captured in 2004 and aged as after-second-year, indicating these birds are at least six years old. All other birds that were recaptured in 2008 were originally banded in 2005, 2006, 2007 or 2008.

No new species were recorded in 2008.

FUTURE DIRECTION

Long-term data collection from the Drakesbad station will continue indefinitely as a part of the park's developing inventory and monitoring program. Implementation of the Monitoring Concept Plan that was developed in 2000 will guide the park in planning comprehensive, long-term programs for monitoring bird populations (Humble et al. 2001). This plan recommended that the park combine mist-net data collection with relative abundance monitoring — using Variable Circular Plot (VCP) point counts — of bird populations in other areas of the park. In addition, recommendations were made to consider the establishment of 1 to 2 more mist-netting stations. This approach is in accordance with direction from the NPS Inventory and Monitoring program which states “the most effective and useful avian monitoring programs will be those that incorporate

multiple, complementary approaches — population distribution and trend monitoring through Variable Circular Plot Points Counts, and determination of vital rates through constant-effort mist-netting” (Fancy and Sauer 2000).

The Lassen National Forest plans to continue operating the Gurnsey Creek mist-net station, companion station to Drakesbad. Resulting datasets will add greater resolution and value to Drakesbad data.

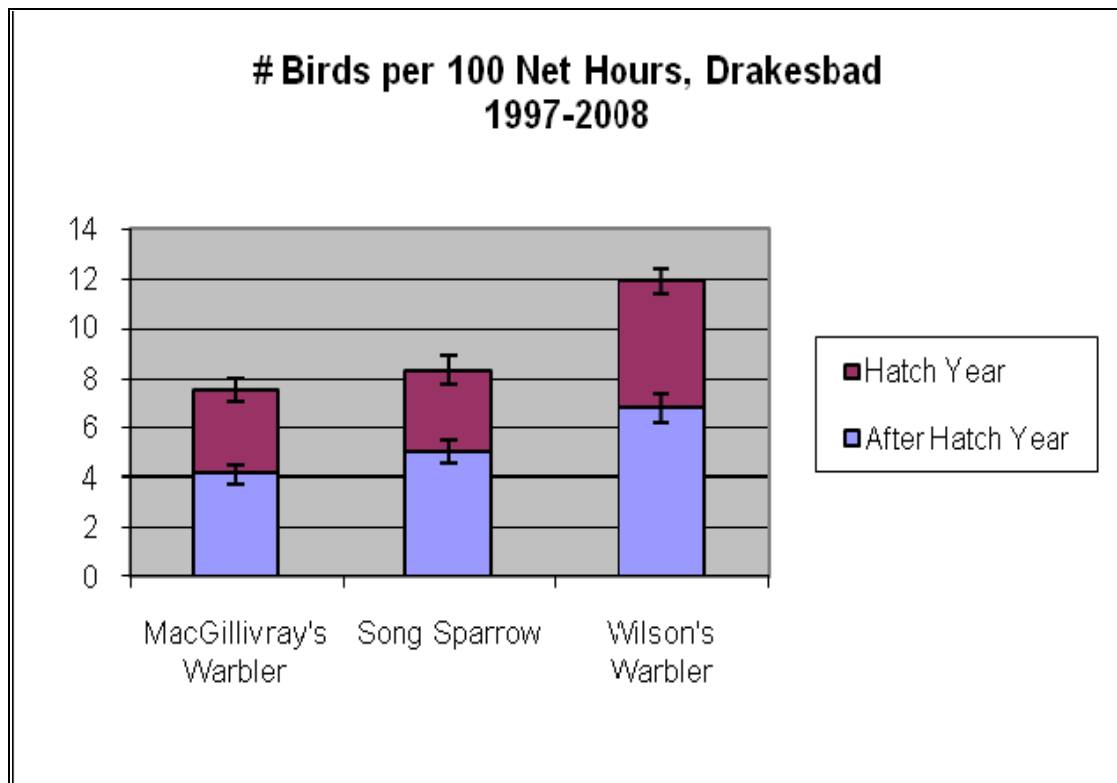


Figure 3. Average Productivity ($\pm$ Standard Error) as Expressed in Ratios of Hatch Year to After Hatch-Year Birds for Three Species at Drakesbad.

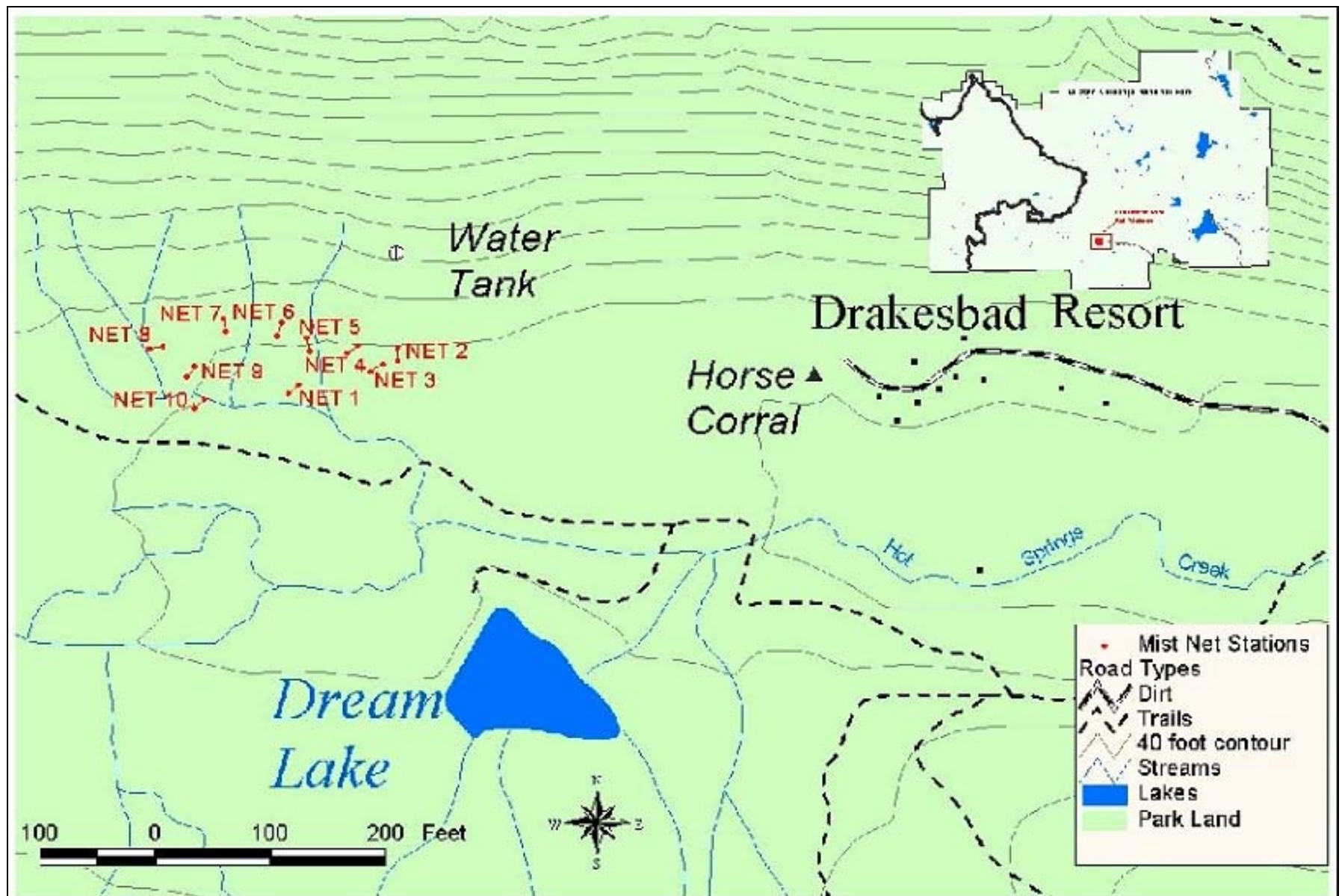


Figure 4. Drakesbad Permanent Mist Net Stations

Table 4. Species and Age Class of Birds Banded at Drakesbad, 1997-2008.

Species	1997			1998			1999			2000			2001			2002			2003		
	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio
American Dipper	0	0		0	0		0	0		1	0		0	0		0	0		0	0	
American Robin	0	1	0.00	0	3	0.00	2	5	0.40	0	5	0.00	0	1	0.00	0	2	0.00	0	4	0.00
Allen's Hummingbird	0	0		0	0		0	0		1	0		0	0		0	0		0	1	0.00
Anna's Hummingbird	2	1	2.00	2	0		0	0		0	0		1	0		0	0				
Audubon's Warbler	0	1	0.00	0	3	0.00	0	7	0.00	0	4	0.00	3	8	0.37	0	5	0.00	0	4	0.00
Brewer's Blackbird	0	0		0	1	0.00	0	0		0	0		0	0		0	0		0	0	
Brewer's Sparrow	0	0		0	0		0	0		1	0		0	0		0	0		0	0	
Brown Creeper	0	0		0	0		0	0		0	1	0.00	3	0		0	0		0	3	0.00
Calliope Hummingbird	0	0		0	0		0	0		3	0		2	1	2.00	0	0		0	0	
Cassin's Finch	0	0		0	1	0.00	0	4	0.00	0	1	0.00	0	0		0	1	1.00	1	12	0.08
Cassin's Vireo	2	0		0	0		1	0		0	0		0	0		1	1	1.0	2	0	
Common Snipe	0	0		0	0		0	0		0	0		0	0		0	0		U	U	
Dusky Flycatcher	0	0		0	0		0	0		1	0		3	0		0	0		0	1	0.00
Evening Grosbeak	0	11	0.00	0	8	0.00	0	3	0.00	1	0		0	4	0.00	0	13	0.00	0	9	0.00
Golden-crowned Kinglet	0	0		0	0		0	0		0	0		1	1	1.0	0	0		0	0	
Hairy Woodpecker	0	0		0	1	0.00	0	1	0.00	0	0		0	0		0	1	0.00	0	0	
Hammond's Flycatcher	2	0		0	0		4	0		1	0		1	0		1	0		1	0	
Hermit Thrush	0	0		0	1	0.00	0	0		0	0		0	0		0	0		0	0	
Hermit Warbler	0	0		0	0		0	2	0.00	2	0		0	0		2	0		0	1	0.00
House Wren	0	0		0	0		2	0		1	0		0	0		0	0		0	0	
Lazuli Bunting	0	0		0	0		0	0		0	0		0	2	0.00	0	0		0	0	
Lincoln's Sparrow	2	3	0.67	2	3	.067	1	4	0.25	2	2	1.0	0	1	0.00	2	6	0.33	0	5	0.00
MacGillivray's. Warbler	14	11	1.27	3	9	0.33	5	16	0.31	14	8	1.75	17	12	1.42	12	21	0.57	10	8	1.25
Mountain Chickadee	0	0		0	1	0.00	0	2	0.00	0	1	0.00	2	0		0	0		0	2	0.00
Nashville Warbler	1	0		3	0		0	2	0.00	1	1	1.00	0	0		1	2	0.50	0	2	0.00
Olive-sided Flycatcher	0	0		0	0		0	0		0	0		0	0		0	0		0	1	0.00
Orange-crowned Warbler	39	2	19.5	25	2	12.5	28	1	28.0	28	6	4.67	37	9	4.11	35	11	3.18	27	11	2.45
Oregon Junco	1	0		0	3	0.00	0	4	0.00	1	4	0.25	3	0		0	2	0.00	0	0	
Pine Siskin	0	0		0	1	0.00	0	1	0.00	0	2	0.00	0	2	0.00	0	0		0	1	0.00
Purple Finch	0	0		0	0		0	0		0	0		2	1	2.00	0	0		0	0	
Red-breasted Nuthatch	0	0		0	0		0	0		0	0		0	0		0	0		0	1	0.00
Red-breasted Sapsucker	0	0		1	0		2	1	2.00	0	0		1	2	0.50	3	2	1.5	0	2	0.000
Red-shafted Flicker	0	1	0.00	0	0		0	0		0	0		0	0		0	0		0	0	
Red-winged Blackbird	0	1	0.00	0	1	0.00	0	0		0	2	0.00	0	2	0.00	0	1	0.00	0	1	0.00
Rufous Hummingbird	27	9	3.00	19	1	19.0	37	1	37.0	29	6	4.83	39	16	2.44	20	1	20.0	22	0	
Song Sparrow	17	12	1.42	4	17	0.24	5	18	0.28	16	13	1.23	13	16	0.81	8	22	0.36	6	19	0.31
Tree Swallow	0	0		0	0		0	0		0	0		0	0		0	0		0	1	0.00
Warbling Vireo	1	8	0.13	0	1	0.00	0	7	0.00	1	4	0.25	1	10	0.10	0	8	0.00	0	3	0.00
Western Tanager	0	0		0	3	0.00	1	4	0.25	0	2	0.00	0	6	0.00	0	3	0.00	0	3	0.00
Western Wood-Pee wee	0	2	0.00	0	3	0.00	0	6	0.00	0	0		0	4	0.00	1	1	1.0	0	6	0.00
Willow Flycatcher	0	1	0.00	0	1	0.00	0	0		0	0		0	3	0.00	0	1	0.00	0	0	
Wilson's Warbler	22	13	1.69	12	21	0.57	9	19	0.47	16	17	0.94	20	16	1.25	6	28	0.21	22	21	1.05
Yellow Warbler	1	0		0	0		0	0		2	0		1	3	0.33	1	4	0.25	1	6	0.17
Totals	131	77		71	85		97	108		122	79		150	120		93	136		92	128	

U=unknown age.

Table 4 (cont). Species and Age Class of Birds Banded at Drakesbad, 1997-2008.

Species	2004			2005			2006			2007			2008				
	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio	HY	AHY	Ratio		
American Dipper	0	0	0	0	0		0	0	0	0	0	0	0	0	0		
American Robin	0	3	0.00	0	1	0.00	1	2	0.50	0	2	0	1	1	1		
Allen's Hummingbird	0	0		0	0		0	0		0	0	0	0	0	0		
Anna's Hummingbird	1	0	0.00	0	0		11	2	5.50	0	0	0	0	1	0.00		
Audubon's Warbler	4	6	0.67	0	2	0.00	0	1	0.00	3	0	0.00	0	6	0.00		
Black-headed Grosbeak	0	0		1	0		1	3	0.33	0	2	0	0	0	0		
Brewer's Blackbird	0	0		0	0		0	1	0.00	0	0	0	0	0	0		
Brewer's Sparrow	0	0		0	0		0	0		0	0	0	0	0	0		
Brown-headed Cowbird	0	0		0	0		0	1	0.00	0	0	0	0	0	0		
Brown Creeper	0	0		0	0		2	1	2.00	1	0	0.00	1	0	0.00		
Calliope Hummingbird	5	0	0.00	1	0		0	1	0.00	1	0	0.00	4	0	0.00		
Cassin's Finch	2	4	0.50	0	0		0	8	0.00	0	4	0.00	0	3	0.00		
Cassin's Vireo	1	0	0.00	0	1	0.00	0	0		0	0	0	0	1	0.00		
Dusky Flycatcher	0	1	0.00	0	0		0	1	0.00	1	0	0.00	0	1	0.00		
Evening Grosbeak	6	13	0.46	0	1	0.00	0	15	0.00	1	7	0.14	0	1	0.00		
Golden-crowned Kinglet	0	0		0	0		0	0		1	0	0.00	0	0	0.00		
Hairy Woodpecker	0	1	0.00	0	0		0	0		0	1	0.00	0	4	0.00		
Hammond's Flycatcher	0	0		2	0		3	1	3.00	2	0	0.00	0	0	0.00		
Hermit Thrush	0	0		0	0		0	0		0	0	0.00	0	1	0.00		
Hermit Warbler	1	1	1.00	0	0		1	0	0.00	2	0	0.00	0	0	0.00		
House Wren	0	0		0	0		1	0	0.00	1	0	0.00	0	0	0.00		
Lawrence's Goldfinch	1	0	0.00	0	0		0	0		0	0	0.00	0	0	0.00		
Lazuli Bunting	5	1	5.00	0	1	0.00	0	3	0.00	0	2	0.00	0	1	0.00		
Lincoln's Sparrow	2	4	0.50	4	8	0.50	4	2	2.00	3	2	1.50	0	2	0.00		
MacGillivray's Warbler	12	19	0.63	6	14	0.50	20	18	1.11	5	8	0.63	8	18	0.44		
Mountain Chickadee	0	0		1	1	1.00	0	1	0.00	0	0	0.00	1	0	0.00		
Nashville Warbler	5	2	2.50	2	1	2.00	9	2	4.50	0	1	0.00	3	3	1.00		
Olive-sided Flycatcher	0	0		0	2	0.00	0	1	0.00	0	1	0.00	0	1	0.00		
Orange-crowned Warbler	43	7	6.14	31	6	5.17	102	6	17.0	55	14	3.93	42	4	10.5		
Oregon Junco	0	1	0.00	1	1	1.00	4	4	1.00	4	2	2.00	1	1	0.00		
Pine Siskin	2	8	0.25	0	0		0	0		0	3	0.00	0	0	0.00		
Purple Finch	0	0		1	1	1.00	0	0		0	0		0	0	0.00		
Red-breasted Nuthatch	1	0	0.00	0	0		0	0		1	0	0.00	0	0	0.00		
Red-breasted Sapsucker	1	6	0.17	0	1	0.00	0	1	0.00	0	2	0.00	2	1	2.00		
Red-shafted Flicker	0	0	0.00	0	0		0	0		0	0		U	U			
Red-winged Blackbird	0	0	0.00	0	0		0	0		0	0		0	1	0.00		
Rufous Humminbird	36	0	0.00	8	4	2.00	36	0	0.00	48	3	16.0	27	4	6.75		
Song Sparrow	12	9	1.33	5	12	.417	9	13	0.69	20	16	1.25	21	11	1.90		
Spotted Sandpiper	U	U	0	0	0		0	0		0	0		0	0	0.00		
Swainson's Thrush	0	0		0	1	0.00	0	0		0	0		0	0	0.00		
Townsend's Solitaire	0	0		0	1	0.00	0	0		0	0		0	0	0.00		
Warbling Vireo	2	2	1.00	0	12	0.00	0	4	0.00	1	6	0.17	1	13	0.77		
Western Tanager	0	0		0	7	0.00	1	5	0.20	1	4	0.25	0	3	0.00		
Western-Wood Peewee	0	5	0.00	0	6	0.00	1	10	0.10	1	3	0.33	0	5	0.00		
Willow Flycatcher	0	3	0.00	0	0		0	2	0.00	0	4	0.00	0	3	0.00		
Wilson's Warbler	14	22	0.64	13	29	.448	20	21	0.95	22	28	0.78	10	11	0.91		
Yellow Warbler	4	6	0.67	3	10	0.300	1	1	1.00	2	8	0.25	3	2	1.5		
Totals	160	124		79	122		227	131		176	123		125	103			

SONGBIRD MONITORING – BREEDING BIRD SURVEY

INTRODUCTION

In the 1960s concern began to be raised about the harmful effects of habitat degradation on the nation's songbird populations (Carson 1962). Unfortunately, because no long-term regional or continental data were available for most bird species, ornithologists were unable to accurately quantify these perceived declines. Consequently, in the mid-1960s the Patuxent Environmental Science Center (now a part of the USGS, Biological Resource Division) developed the Breeding Bird Survey (BBS) program, a volunteer-staffed effort to obtain continental population data on breeding birds. Today, the BBS has nearly 4000 established survey transects in the US and Canada and has become an important source of long-term population data for all birds at continental, regional and local scales.

As with any sound ecological monitoring program, the main strengths of the program are that it is systematic, range wide, and has been in operation for multiple decades. However, one drawback of BBS data is that it provides no explanation for cause of population trends. Other techniques such as constant-effort mist-netting or nest searches must be used to assist in identifying the cause of trends.

Despite the program's shortcomings, the BBS is still recognized as a valuable source of information for scientific research and is used by government agencies to establish management priorities. In recent years, the Sierra Nevada Ecosystems Project (SNEP) relied heavily upon BBS data to provide Congress with a status report of Sierra Nevada ecosystems (Graber 1996). During the course of SNEP, 17 BBS transects were analyzed. Among other findings, 18 species of landbirds were discovered to be declining or likely declining. The report also concluded that because of the many years of systematic data derived from Sierra Nevada routes, breeding landbirds were the most useful group of vertebrates to monitor as an indicator of vertebrate health in the Sierra Nevada.

New analysis techniques have increased the value of the BBS program to a wider range of resource managers and researchers. Because individual BBS routes have been recently linked by computer to specific geographic points, relative abundance data can be used to show temporal and geographical patterns of songbird decline (Figure 5). Because of the natural variation of bird populations and sampling error from imperfect BBS methods, the most precise estimates resulting from these data are those covering large spatial scales (continental or regional). These new analysis techniques more readily identify at-risk species to avian researchers who can then undertake studies to determine causes for declines.

PROJECT HISTORY

In 1972, the "Lassen Park" transect (Route 008) was established. Twenty-seven observation stations were located within the park's boundaries and 23 stations were located within Lassen National Forest (LNF). In 1990, the route was modified because highway noise from

State Highway 44 was unacceptably influencing bird detection rates at several observation stations along the highway. The new transect — renamed “Chaos Crater” (Route 308) — maintained the identical 27 observation stations as Route 008 within the park, but observation stations formerly occurring along the highway on LNF were redistributed to quieter locations (Figure 6).

Biologist Ron Schlorff of the California Department of Fish and Game conducted censuses on Route 008 from 1972 to 1989 and on Route 308 from 1990 to 1998. In 1999, park Resources Management assumed responsibility for managing Route 308.

Route 308 was not run in 1992, 1995, and 1998 because of inclement weather.

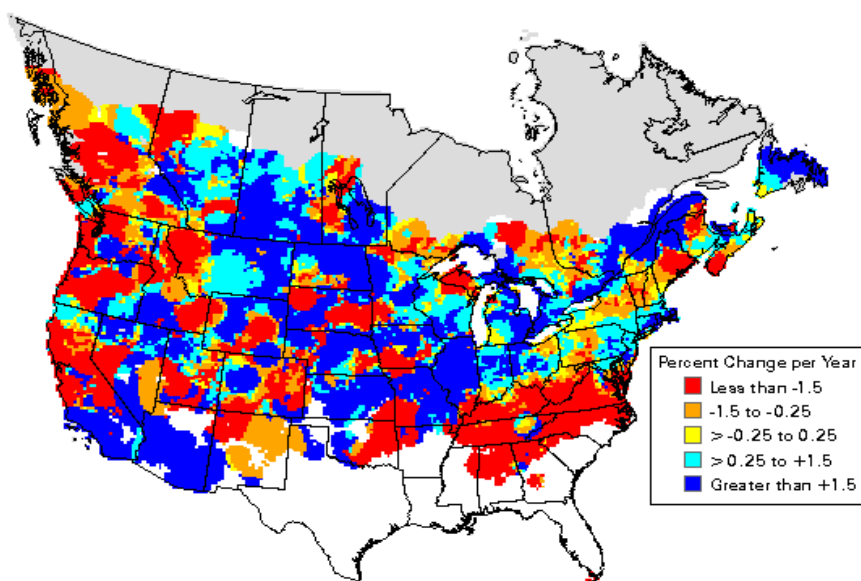


Figure 5. BBS Trend Map for Yellow Warbler, 1966-2003.

METHODS

Following national protocols, Breeding Bird Surveys are conducted in the park once annually during the peak of the nesting season, primarily during June. The transect is 24.5 miles long, with 50 observation stations located at ½ mile intervals along the route. A three-minute point count is conducted at each station, during which the observer records all birds heard or seen within a quarter mile of the station. A single observer collects the data, although other observers may be present to record data or provide transportation between stations. Observers must be able to identify all birds breeding in their area by sight and sound.

RESULTS

In 2008, the route was run on July 08. A total of 259 individuals representing 37 species were observed in 2008. Audubon’s Warbler (*Dendroica coronata*) was the most numerous

species followed by Mountain Chickadee (*Parus gambeli*), with 41 and 33 individuals observed, respectively (Table 5). Oregon Junco was the third highest count with 30 individuals observed. There were no new species observed in 2008 although there were eight unidentified flycatchers and four unidentified woodpeckers. The unidentified flycatchers were either Hammond's or Dusky Flycatchers which have similar plumage and song and are difficult to tell apart. If there was a question about the species it was marked down as unknown. The four unidentified woodpeckers were flying through the forest and could not be reliably identified to species.

FUTURE DIRECTION

The park will continue to operate the Chaos Crater Route (#308) indefinitely to contribute data to this long-term national monitoring effort. Data from the BBS will help support and corroborate data collected from other avian monitoring programs within the park and surrounding National Forest lands.

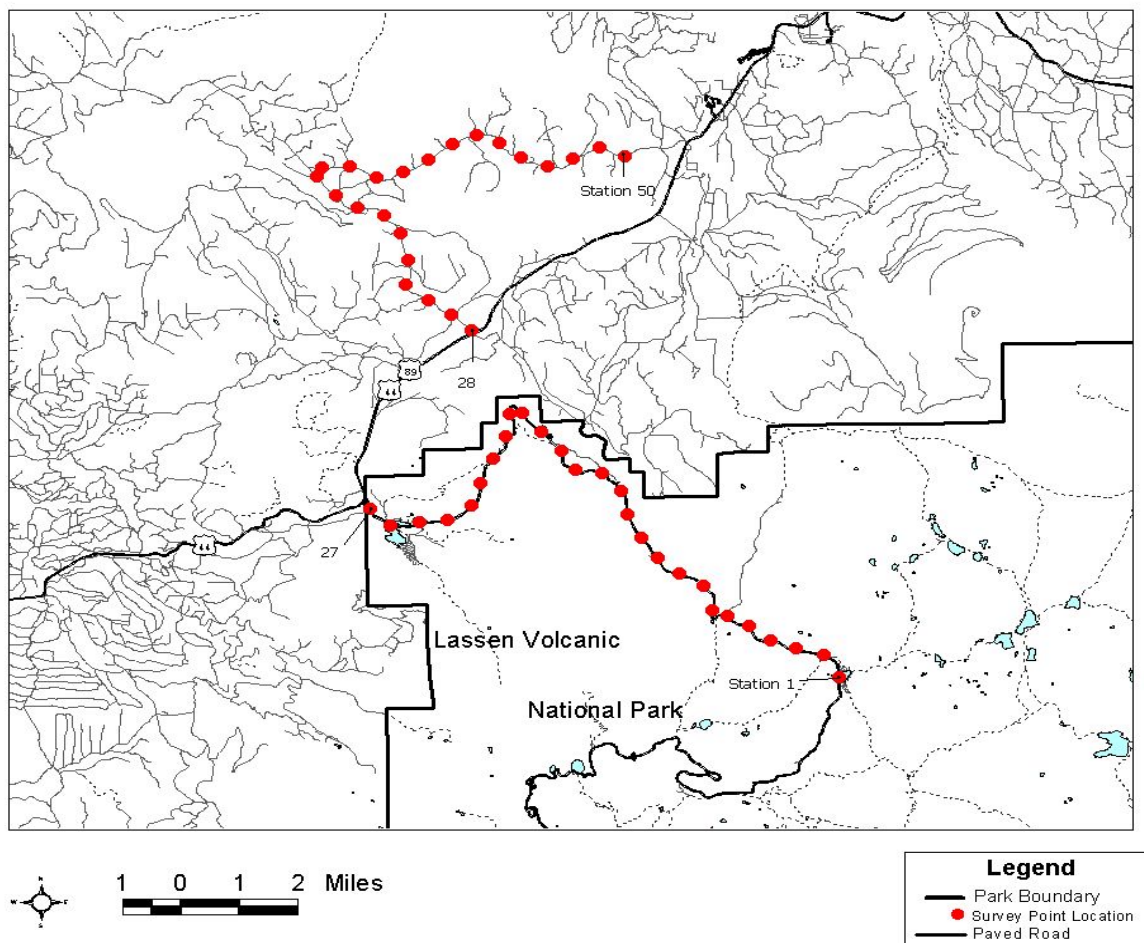


Figure 6. Breeding Bird Survey Route #308

Table 5. Breeding Bird Survey – Route Summary

RTE: 308 NAME: CHAOS CRATER STRATUM: 66 LAT-LONG: 4035-12133

STATE: CA

SPECIES	1990	1991	1993	1994	1996	1997	1999	2000	2001	2002	2003	2004	2005
American Coot	0	0	3	0	0	0	0	0	0	0	0	0	0
American Dipper	0	0	0	0	0	0	1	0	0	0	0	0	0
American Robin	46	30	40	28	28	37	12	13	10	10	6	7	14
Anna's Hummingbird	1	0	0	0	2	0	0	0	0	0	0	0	0
Audubon's Warbler	26	28	41	24	52	50	58	49	56	61	51	44	43
Band-tailed Pigeon	0	0	0	0	0	0	0	2	0	0	1	1	1
Bewick's Wren	0	0	0	2	1	0	0	0	0	0	0	0	0
Black-backed Woodpecker	0	3	0	0	3	0	1	0	2	0	0	0	0
Black-headed Grosbeak	1	1	0	4	0	0	0	0	0	0	0	0	0
Brewer's Blackbird	0	0	1	0	2	0	0	0	2	4	3	0	0
Brown Creeper	13	14	15	18	19	8	9	8	5	6	2	9	6
Brown-headed Cowbird	0	1	0	1	0	0	1	0	0	0	0	0	0
Canada Goose	0	0	0	0	0	0	0	0	0	0	0	0	2
Cassin's Finch	8	8	5	3	16	5	11	3	5	0	2	2	7
Chipping Sparrow	0	0	8	6	5	0	1	23	14	10	8	13	23
Clark's Nutcracker	13	4	2	0	2	0	3	0	0	3	0	0	0
Common Nighthawk	2	1	0	0	1	2	0	0	1	0	0	1	2
Common Raven	0	0	0	0	4	3	0	1	3	1	1	3	1
Dusky Flycatcher	5	3	8	6	2	0	21	9	7	5	8	9	7
Evening Grosbeak	1	0	1	1	0	2	1	13	11	9	15	19	3
Fox Sparrow	15	12	9	3	10	9	7	15	13	11	10	11	11
Golden-crowned Kinglet	5	3	2	2	13	13	9	17	21	15	5	9	11
Gray Flycatcher	0	0	0	2	0	0	0	0	0	0	0	0	0
Great Blue Heron	0	0	1	0	0	0	0	0	0	0	0	0	0
Green-tailed Towhee	0	1	9	1	0	1	2	1	1	0	0	0	0
Hairy Woodpecker	1	6	9	5	5	2	5	0	0	6	0	3	1
Hammond's Flycatcher	17	42	17	18	28	31	9	5	5	6	11	9	8
Hermit Thrush	12	15	17	12	22	12	9	4	5	5	8	2	9
Hermit Warbler	0	1	4	7	13	0	19	7	2	2	5	3	4
House Wren	0	0	0	1	0	0	0	0	0	0	0	0	0
Lincoln Sparrow	0	0	0	0	0	0	1	1	1	2	0	1	2
Macgillivray's Warbler	0	0	3	0	0	0	1	0	0	2	0	2	1
Mallard	0	0	2	3	0	1	0	0	1	0	0	0	1
Mountain Chickadee	67	74	75	79	95	87	55	38	32	38	46	35	46
Mountain Quail	0	3	4	3	3	2	0	0	0	0	3	0	1

TABLE 5 (continued)	1990	1991	1993	1994	1996	1997	1999	2000	2001	2002	2003	2004	2005
Mourning Dove	0	0	1	0	0	2	0	0	0	0	0	0	0
Nashville Warbler	0	0	0	0	0	0	5	0	3	0	5	0	6
Northern Goshawk	1	0	0	0	0	0	0	1	0	0	0	0	0
Olive-sided Flycatcher	16	12	10	9	27	20	7	8	4	4	3	2	4
Orange-crowned Warbler	1	1	0	0	0	0	0	1	0	0	2	0	0
Oregon Junco	36	32	37	42	67	41	26	26	21	31	22	32	23
Pacific-slope Flycatcher	0	0	0	0	0	0	0	0	0	0	0	0	1
Pied-billed Grebe	0	0	0	1	0	0	0	0	0	0	0	0	0
Pileated Woodpecker	0	0	0	0	0	0	0	0	0	1	0	1	0
Pine Siskin	0	0	1	0	0	0	4	1	2	0	0	1	0
Pygmy Nuthatch	0	0	0	0	0	0	0	0	2	0	0	0	0
Red Crossbill	0	0	1	0	0	0	2	1	0	0	3	2	0
Red-breasted Nuthatch	50	43	23	39	59	50	49	11	12	17	17	22	14
Red-breasted Sapsucker	0	0	0	0	1	2	3	1	2	1	2	0	0
Red-shafted Flicker	4	3	8	1	4	8	1	6	7	3	1	1	3
Red-tailed Hawk	0	0	1	1	1	1	0	0	0	0	0	0	0
Red-winged Blackbird	0	0	0	1	3	1	0	1	1	0	0	2	0
Cassin's (Solitary) Vireo	0	0	0	4	4	1	3	0	4	0	0	1	1
Song Sparrow	0	0	2	1	0	0	0	0	0	0	2	1	1
Spotted Sandpiper	0	0	0	0	0	0	0	0	0	0	1	1	0
Spotted Towhee	0	3	2	1	0	0	3	0	2	0	0	1	5
Steller's Jay	13	8	14	5	37	17	13	7	7	12	10	18	9
Townsend's Solitaire	0	0	0	0	0	0	9	4	3	3	1	3	1
Tree Swallow	0	1	0	0	2	1	4	0	0	2	1	0	1
Turkey Vulture	0	0	1	0	0	1	2	0	0	0	0	0	0
Unidentified Hummingbird	0	0	0	0	0	1	0	1	0	0	0	0	0
Warbling Vireo	1	5	3	8	1	2	15	7	7	11	10	8	12
Western Screech-Owl	1	0	0	0	0	0	0	0	0	0	0	0	0
Western Tanager	3	6	1	3	4	3	17	21	18	27	25	20	19
Western Wood-Pewee	28	26	29	24	43	19	19	29	21	26	26	24	33
White-breasted Nuthatch	1	1	0	1	0	0	0	0	0	0	1	0	0
White-headed Woodpecker	0	0	2	2	1	1	4	1	6	1	2	6	1
White-throated Swift	0	0	0	0	0	1	0	0	0	0	0	0	0
Willow Flycatcher	0	0	0	0	1	0	0	0	0	0	0	0	0
Wilson's Warbler	0	0	0	0	0	0	2	1	0	0	0	0	0
Winter Wren	0	0	0	0	0	0	0	1	0	0	0	0	0
Wrentit	0	0	0	0	0	0	3	1	1	2	0	1	0
Yellow Warbler	1	8	2	3	5	5	1	3	2	1	2	1	1
TOTAL INDIV.	389	399	414	375	586	442	428	342	322	338	321	331	339
TOTAL SPECIES	29	32	39	39	37	35	42	38	39	33	36	39	39
DATE ROUTE RUN	06/23	06/15	07/03	06/25	06/21	06/19	06/19	06/26	06/25	06/27	6/28	6/29	7/02

TABLE 5 (continued) Breeding Bird Survey - Route Summary

SPECIES	2006	2007	2008
American Coot	0	0	0
American Dipper	0	0	0
American Robin	6	9	5
Anna's Hummingbird	0	0	0
Audubon's Warbler	36	38	41
Band-tailed Pigeon	1	1	5
Bewick's Wren	0	0	0
Black-backed Woodpecker	1	1	0
Black-headed Grosbeak	1	0	0
Brewer's Blackbird	0	0	0
Brown Creeper	1	3	4
Brown-headed Cowbird	0	0	1
Canada Goose	13	1	1
Cassin's Finch	4	6	4
Chipping Sparrow	10	12	11
Clark's Nutcracker	0	2	0
Common Nighthawk	0	0	2
Common Raven	4	0	1
Dusky Flycatcher	2	5	3
Evening Grosbeak	19	8	1
Fox Sparrow	5	8	5
Golden-crowned Kinglet	16	9	14
Gray Flycatcher	0	0	0
Great Blue Heron	0	0	0
Green-tailed Towhee	0	0	0
Hairy Woodpecker	2	5	2
Hammond's Flycatcher	6	5	2
Hermit Thrush	4	8	7
Hermit Warbler	0	5	0
House Wren	0	0	0
Lincoln Sparrow	2	2	2
Macgillivray's Warbler	0	0	0
Mallard	0	0	0
Mountain Chickadee	42	24	33
Mountain Quail	0	0	0
Mourning Dove	0	1	0
Nashville Warbler	0	1	0

TABLE 5 (continued) BREEDING BIRD SURVEY - ROUTE SUMMARY

Northern Goshawk	0	0	0
Olive-sided Flycatcher	0	0	3
Orange-crowned Warbler	0	0	0
Oregon Junco	27	23	30
Pacific-slope Flycatcher	0	0	0
Pied-billed Grebe	0	0	0
Pileated Woodpecker	0	0	1
Pine Siskin	0	1	0
Pygmy Nuthatch	0	0	0
Red Crossbill	0	2	0
Red-breasted Nuthatch	16	13	11
Red-breasted Sapsucker	1	1	2
Red-shafted Flicker	1	1	3
Red-tailed Hawk	0	0	0
Red-winged Blackbird	1	1	1
Cassin's (Solitary) Vireo	0	2	0
Song Sparrow	3	0	1
Spotted Sandpiper	1	0	0
Spotted Towhee	2	0	1
Steller's Jay	7	5	7
Townsend's Solitaire	2	4	3
Tree Swallow	0	0	0
Turkey Vulture	0	0	0
Unidentified Flycatcher	3	6	8
Unidentified Hummingbird	1	0	0
Unidentified Woodpecker	0	2	4
Warbling Vireo	4	8	10
Western Screech-Owl	0	0	0
Western Tanager	15	19	12
Western Wood-Pewee	20	12	15
White-breasted Nuthatch	0	0	0
White-headed Woodpecker	1	1	2
White-throated Swift	0	0	0
Willow Flycatcher	0	0	0
Wilson's Warbler	0	0	1
Winter Wren	0	0	0
Wrentit	0	0	0
Yellow Warbler	1	4	0
TOTAL INDIV.	281	249	259
TOTAL SPECIES	36	36	37
DATE ROUTE RUN	7/11	6/21	7/08

SPOTTED OWL MONITORING

INTRODUCTION

The California Spotted Owl (*Strix occidentalis occidentalis*) is one of three subspecies of Spotted Owl occurring within the United States. The Mexican Spotted Owl (*Strix occidentalis lucida*) is found in the southwestern states and Mexico. The Northern Spotted Owl (*Strix occidentalis caurina*) occupies western Washington, Oregon and the coastal ranges of northern California, from the Oregon border to the San Francisco Bay area. The range of the California Spotted Owl includes the Cascade and Sierra Nevada mountains and portions of the Southern California Coast Range. Lassen Volcanic National Park (LVNP) is within the range of the California Spotted Owl, but not within the range of the Northern or Mexican Spotted Owls.

All three subspecies are associated with late seral habitat (Thomas et al. 1990). The California Spotted Owl occurs in habitat that has a mixture of tree sizes and usually at least two canopy layers, with some very large, old trees present (Verner et al. 1992). These old trees provide cavities which are used by the owls for nesting (Verner et al. 1992). Suitable California Spotted Owl habitat exists within LVNP.

The California Spotted Owl was petitioned for listing under the Endangered Species Act on October 12, 2000. The reason stated for the petition was habitat destruction due to logging, urban development, livestock grazing, mining, recreation, and road construction (USFWS 2000). The U.S. Fish and Wildlife Service (USFWS) made a determination on February 10, 2003 that the California Spotted Owl does not warrant protection under the Endangered Species Act at this time. This decision was based on the belief that current land management direction on Federal lands and commercial timberlands will increase nesting, roosting and foraging habitats for the California Spotted Owl. The California Spotted Owl is listed as a Sensitive species by the U.S. Forest Service and Bureau of Land Management (BLM).

PROJECT HISTORY

In 1988, a partial survey of suitable habitat within LVNP detected one pair and two individual California Spotted Owls (Fowler 1988). The pair was located near Kings Creek Falls. The two individuals were a female found near Grassy Swale and a male found near Snag Lake. In 1995, a formal survey of the entire park was attempted; however, the park-wide survey was not completed because heavy snow delayed the beginning of the monitoring period (DuBrau and Evasick 1995). Areas that were surveyed in 1995 included the Warner Valley and Butte Lake prescribed burn units. A new pair of Spotted Owls was located near Butte Lake. The Butte Lake pair was determined to be non-nesting in 1995. In 2002, the Forest Service's Pacific Southwest Forest and Range Experimental Station (PSW) located two new nests within the park while surveying national forest lands adjacent to the park boundary. One nest was located in the vicinity of Willow Lake and the other north of Prospect Peak. Both nests are monitored annually. Also in 2002, park staff initiated surveys in areas with scheduled fire management activities. FIREPRO funding is used for these

inventories to protect Spotted Owl nest sites from fire management activities such as prescribed burning and mechanical thinning projects. One new pair and nest was found in 2002 during these surveys on the south side of Prospect Peak.

In 2005, LVNP received funding from the NPS Biological Resource Management Division (BRMD) to conduct a two year inventory of all suitable Spotted Owl habitat within the park in 2005 and 2006. Potential suitable habitat was delineated by vegetation mapping and Geographic Information System (GIS) analysis. Survey points were established in suitable habitat along roads and trails. Surveys were conducted in accordance with a protocol developed by the US Forest Service. Two new pairs of Spotted Owls were located during this two year survey in 2005 and both determined to be non-nesting that year. One is located near Craggs Campground and the other in Warner Valley. In 2006, the Craggs pair was located and determined to be non-nesting but the Warner Valley pair was not located during 4 survey visits to the area they inhabited in 2005. Since FIREPRO funding was not available in 2005 and 2006, proposed burn areas were incorporated into the park wide survey. No new pairs or nests were located in areas proposed for fire management activities.

METHODS

The surveys were conducted using protocols established by the U.S. Forest Service for Spotted Owl surveys within the Sierra Nevada. This allows for consistency in survey methods between agencies. According to the protocol, all suitable habitat must be surveyed six times. The surveys may be conducted in one year, or three times per year over a two year period (preferred). Most surveys were conducted at night, however, some cross-country surveys, considered too hazardous to walk at night, were surveyed during the day. Call points were established every one-quarter to one-half mile along roads and trails. An amplified caller was used to play Spotted Owl calls to elicit responses from territorial Spotted Owls. Each call point was surveyed for ten minutes.

If a Spotted Owl was detected during a survey, a daytime follow-up visit was conducted within 48 hours. The follow-up visit is a visual search of the area to locate an owl detected at night. If a Spotted Owl was found during the follow-up visit, a technique called mousing was used to determine nesting status. Mousing consists of placing a live mouse on the forest floor in plain sight of the owl. An owl will normally fly down and take the mouse. The owl will either eat the mouse or take it to a mate or nest. If an owl eats four or more mice it is determined to be non-nesting. If an owl takes at least one mouse to a nest or mate, pair status is confirmed. If the owl ignores the mouse for an hour the follow-up visit is complete with the results being inconclusive. Nesting status is confirmed if a female is detected on the nest, either member of the pair takes prey into the nest, or young are detected in the presence of one or both adults. If nesting was confirmed, a reproductive visit was conducted after June 1st to determine number of fledged young. All nests, non-nesting pairs and individual Spotted Owl locations were mapped using global positioning system (GPS).

Great Horned Owls (*Bubo virginianus*) and Northern Goshawks (*Accipiter gentilis*) are known predators of spotted owls, particularly young Spotted Owls. If a Great Horned Owl

or Northern Goshawk is heard or seen during the survey, the survey point and adjacent call points are aborted for that survey visit. Surveyors move to the next call point out of hearing distance (approximately 1 mile) of the predator and continued to survey. If a Great Horned Owl or Northern Goshawk is seen or heard during a follow-up visit the visit is aborted immediately to reduce the chance of attracting potential predators to responding Spotted Owls.

RESULTS

FIREPRO funding was received in 2008 for Spotted Owl surveys in fire management areas. The Butte Lake, Crescent block A, Hole, Stonehenge, and Raker burn units were surveyed as well as the Flumetank, Raker, and Crescent fuel breaks in 2008. All these areas were surveyed to protocol with no spotted owls detected.

No new Spotted Owls were discovered in 2008. Visits to historical pairs are listed below.

Devil's Kitchen Pair: This pair was discovered and confirmed to be non-nesting in 2005. No nest was found in 2005. The area where the pair resided in 2005 was surveyed four times in 2006 with no spotted owls being located. This area was surveyed again in 2007 two times and no spotted owls were detected. This area was not surveyed in 2008 due to the priority to survey fire management areas.

Lost Creek Pair: This pair was also discovered in 2005. The pair was determined to be non-nesting in 2005 and non-nesting in 2006 as well. In 2007 a nest was found and the pair successfully fledged one young although 2 young were seen on the initial reproductive visit. The fate of the second juvenile is unknown. In 2008, this pair did not use the nest tree found in 2007 and nesting status is unknown. Several visits to the nest tree found no evidence of nesting activity. The male responded from between a $\frac{1}{4}$ to $\frac{1}{2}$ mile away from the nest during mid afternoon on the first visit in late May. He was located and a band could be seen but the tab on the band was not observed. Both the band and tab need to be seen in order to make a correct identification. It is believed this could be a new male due to the fact that no band has previously been seen on this male in prior years. In early June a second early afternoon visit found the male. Like the first visit, the band was seen but the tab was not observed. These were the only two times the male was observed during daylight hours. The female was never observed or heard during daylight hours and was never positively identified by band. There were several attempts to find this pair throughout the summer. They were both very responsive during the night and before dawn and just after dusk but would not respond once it was light enough to see. This pair was not observed together during daylight hours and no young could be seen or heard giving begging calls throughout the summer. According to protocol the reproductive status of this pair is unknown.

Willow Lake pair: This pair was monitored by PSW in 2008 and successfully fledged one young. PSW was unable to band the juvenile despite repeated attempts. PSW was able to confirm the male and female were the same pair that inhabited the nest area in 2007 and they used the 2007 nest tree in 2008.

Bathtub West Pair (North Prospect): This pair of owls used a nest that is inside the park near the park boundary on the north side of Prospect Peak in 2002. This pair moved outside of the park to Forest Service lands in 2003. The two known nest sites for this pair were surveyed twice in 2008 with no response.

Fantastic Pair (South Prospect): This pair was not surveyed in 2008 due to staff priorities and workloads.

Other owl species detected: There were no other owl species detected during the 2008 Spotted Owl surveys.

None of the surveys had to be aborted for any reason in 2008.

FUTURE DIRECTION

Lassen Volcanic National Park will continue to monitor known nests and pairs annually. FIREPRO funding was received for surveys in 2009 of fuel treatment areas (prescribed fire, mechanical thinning, and pile burning). Surveys will be conducted in these areas in 2009 following the current Forest Service protocol prior to project initiation.

BLACK-TAILED DEER MONITORING

INTRODUCTION

The East Tehama Deer Herd (ETDH) of Columbian black-tailed deer (*Odocoileus hemionus columbianus*) is the largest migratory herd in California and occupies a range that is considered the most extensive in the state. It has a migration route of up to 150 km, and during the summer, occurs throughout the park and surrounding national forest lands. Based on 50-year datasets maintained by the California Department of Fish and Game (CDFG), the ETDH population reached a high of around 100,000 animals in the late 50s and early 60s. Later, due to the droughts of the 70s, numbers drastically fell off to about 35,000, then climbed back up to about 70,000 by the mid-1980s. Though large fluctuations in populations have been recorded in the 50 years of CDFG record-keeping, today's record low populations of around 25,000-30,000 animals appear not to be sufficiently rebounding. This has generated some concern among wildlife biologists and ecologists, as the ecological impact of this large deer herd on the Lassen region, both as a dominant herbivore and as prey for cougars and coyotes, is substantial. Changes in vegetation structure and composition through fire suppression may be the most important factor reducing the deer condition (Walker 1997).

PROJECT HISTORY

In 1996, Lassen Volcanic National Park (LVNP), in cooperation with the Lassen National Forest (LNF) and CDFG, assisted in the establishment of two spotlight trend survey routes in the Almanor Basin to complement a route which had been run yearly by CDFG biologists since 1992. Another route was established on LNF in 1997 to make a total of four routes that were surveyed annually from 1997 through 1999. The original route run by CDFG was eliminated after the 1999 count due to a change in policy, leaving a total of three routes that are currently surveyed annually. The purpose of these routes is to provide additional trend data to complement several other methods used by CDFG (including triplicate surveys of deer winter range in early winter and early spring) to census and develop accurate population trends and estimates for the ETDH.

METHODS

Fixed spotlight trend surveys are conducted according to protocols established by CDFG. In summary, 25-mile-long permanent road transects are surveyed for total deer numbers for three consecutive nights during the first two weeks of August. Routes are begun one hour before local sunset, and conclude around three hours after local sunset. Two observers, a driver and a passenger, conduct independent surveys on either side of the road while keeping vehicle travel speed at about eight miles per hour except for brief stops to record count information. Spotlights used in the surveys are 1 million candle power. Data is recorded on standardized data sheets and include weather information, deer observation times, and vehicle mileage at each observation. Total deer count is the most important data obtained, with sex and age classes being secondary information only recorded when there is absolutely no doubt about the accuracy of these judgments.

RESULTS

Fixed spotlight trend surveys were conducted on permanent transects in LVNP and LNF from August 4-August 6, 2008. All three transects (Juniper Lake, Swain Mountain, and Hay Meadows) were surveyed. This was the thirteenth year for Juniper Lake and Hay Meadows, and the twelfth year for Swain Mountain. Both the Hay Meadow and Juniper Lake routes in 2008 showed slight increases in numbers observed over 2007 results. The Swain Mountain route had the same number observed as in 2007. Refer to Figure 7 and Table 6 for 2008 results. All three routes were run with no problems or delays in 2008.

FUTURE DIRECTION

Fixed spotlight trend surveys will continue because they are an efficient method to obtain trend data while deer are on their summer range. These datasets have been important in corroborating the findings of other methods used by CDFG to monitor ETDH demographics.

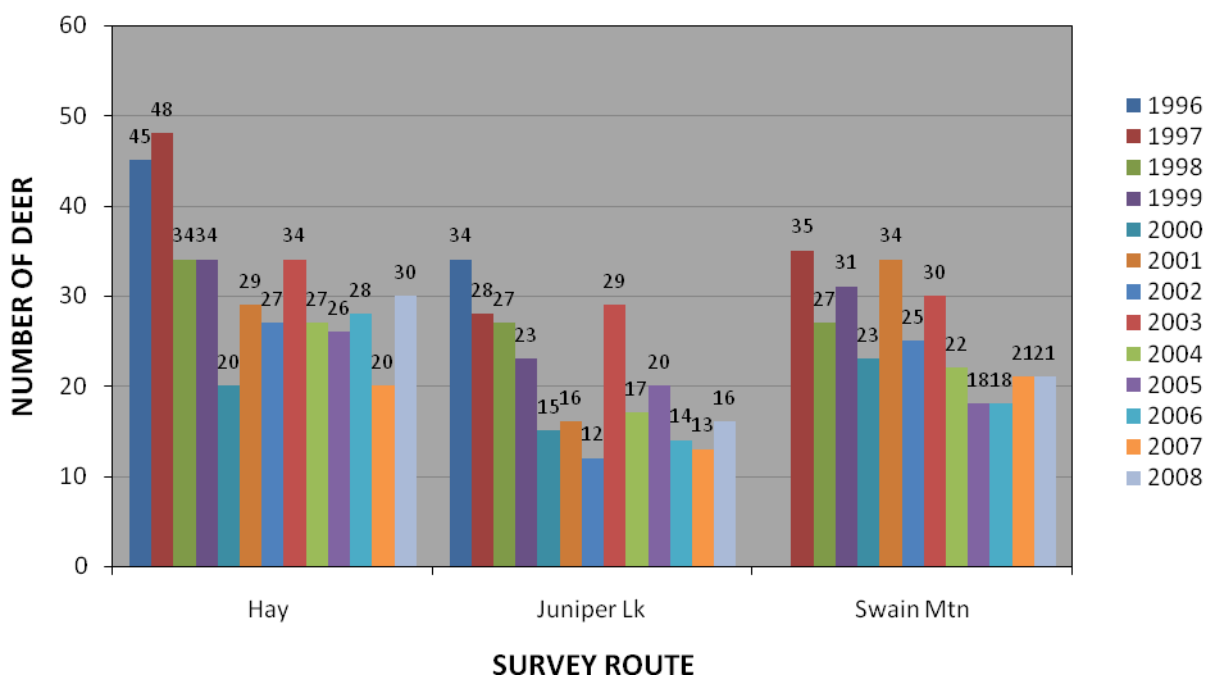


Figure 7. Average Annual Count from Three Fixed Spotlight Deer Trend Surveys on Lassen Volcanic National Park and Lassen National Forest, 1996-2008.

Table 6. 2008 results from three fixed spotlight trend survey routes in Lassen Volcanic National Park and Lassen National Forest.

HAY MEADOWS ROUTE

Survey Night	No. of Bucks	No. of Does	No. of Fawns	Unknown	Total
1	0 (1)	17 (13)	2 (0)	11 (7)	30 (21)
2	5 (0)	14 (14)	5 (1)	6 (7)	30 (22)
3	2 (1)	17 (13)	4 (0)	8 (3)	31 (17)
Route Totals	7 (2)	48 (40)	11 (1)	25 (17)	91 (60)
Nightly Avg.	2.3 (0.7)	16 (13.3)	3.67 (0.3)	8.3 (5.7)	30.3 (20.0)

JUNIPER LAKE ROUTE

Survey Night	No. of Bucks	No. of Does	No. of Fawns	Unknown	Total
1	0 (1)	5 (8)	0 (1)	2 (0)	7 (10)
2	0 (2)	9 (5)	4 (0)	3 (1)	16 (8)
3	2 (1)	16(15)	2 (0)	4 (4)	24 (20)
Route Totals	2 (4)	30 (28)	6 (1)	9 (5)	47 (38)
Nightly Avg.	.67(1.3)	10 (9.3)	2 (0.3)	3 (1.7)	15.7 (12.7)

SWAIN MOUNTAIN ROUTE

Survey Night	No. of Bucks	No. of Does	No. of Fawns	Unknown	Total
1	1 (0)	15 (4)	2 (1)	6 (2)	24 (7)
2	1 (0)	7 (13)	3 (2)	4 (4)	15 (19)
3	0 (1)	17 (17)	0 (5)	7 (15)	24 (38)
Route Totals	2 (1)	39 (34)	5 (8)	17 (21)	63 (64)
Nightly Avg.	.67 (0.3)	13 (11.3)	1.7 (2.7)	5.7 (7.0)	21 (21.3)

Note: The numbers of mule deer counted during 2007 surveys are listed in parentheses.

AMERICAN PIKA INVENTORIES

INTRODUCTION

The American pika (*Ochotona princeps*) is a small (6-8" long), egg-shaped mammal, closely related to rabbits and hares (Smith and Weston 1990). The American pika is discontinuously distributed throughout western North America, from central British Columbia and Alberta to the southern portions of the Sierra Nevada and Rocky Mountain ranges (Grayson 2005).

Pikas are characterized by moderately large rounded ears, a buried tail, and a densely furred body and are extremely well-adapted to living in cold environments (Smith and Weston 1990). Pikas have a high body temperature and a relatively low upper lethal temperature, and a few hours of exposure to temperatures in excess of 27°C (81°F) can be fatal (Grayson 2005, Smith and Weston 1990). Throughout their range, pika are obligate residents of talus or talus-like habitats (including lava flows) that provide protection from predators and thermal refugia from warm surface level temperatures (Grayson 2005, Beever et.al. 2008).

Pika are diurnal, although they tend to be most active above the surface of the rock during the cooler morning and evening hours. They are generalist herbivores and coprophagous, sometimes storing caecal pellets in food caches for future use (Verts and Carraway 1998). Pikas also harvest and store vegetation in 'haypiles,' which they commonly locate beneath a large, overhanging rock (Verts and Carraway 1998). Pikas are active year-round - the amount of food stored in haypiles is insufficient to provide an exclusive source of food during the winter, therefore, they are believed to forage along snow tunnels near the talus-meadow interface throughout the long winter months (Huntly et.al.1986, Millar and Zwickel 1972, Verts and Carraway 1998).

Recent reports indicate that pika may be vulnerable to the existing and predicted effects of climate change. From the Pleistocene to the present, warming temperatures have resulted in distribution shifts of valley dwelling vertebrates to the north and mountain dwelling species upward in elevation to increasingly isolated 'islands' of habitat (Beever et.al.2008, Guralnick 2007). Grayson (2005) concluded that the distribution of both prehistoric and extant populations of pika in the Great Basin have progressively increased in elevation since the Pleistocene. Recent surveys in the Great Basin sites discovered that greater than 25% of historic sites surveyed had apparently been extirpated within the last half century (Beever et al. 2003). Both Grayson (2005) and Beever, et. al. (2003) suggested that anthropogenic influences combined with longer scale climatic and vegetation changes may be responsible.

The Center for Biological Diversity (CBD) filed a petition with the California Fish and Game Commission (CDFG) to list the American Pika as threatened in August 2007. A CDFG evaluation of the petition found insufficient evidence to warrant listing the pika under the California Endangered Species Act. In October 2007, the CBD petitioned the Secretary of Interior to add the pika to the list of Threatened or Endangered species subject to federal protection under the Endangered Species Act. The USFWS has agreed to

determine if the American pika warrants protection, however, their determination is still forthcoming.

PROJECT HISTORY

In May 2006, park biologists attended a pika monitoring workshop held at Lava Beds National Monument (LBE), lead by Chris Ray, of the University of Colorado, Boulder. LBE was beginning the second year of research on pika inhabiting the extensive low-elevation lava flows within the Monument, and convened the workshop for its seasonal staff along with staff from other National Park Service units and a number of researchers. The objectives of the workshop were to review pika ecology, train researchers in pika detection and monitoring techniques, and establish a network for sharing data and research relating to pika population dynamics and climate change.

After attending the LBE workshop, LVNP staffs began a review of records and databases to gather information about 'historic' pika detections within the park. Information came from a variety of sources, including Lassen Volcanic National Park Wildlife Observation Records, information from miscellaneous wildlife surveys conducted within the park, records from Grinnell, Dixon and Linsdale's *Vertebrate Natural History of Northern California through the Lassen Peak Region*, and the online collections database maintained by the Museum of Vertebrate Zoology at Berkeley. From this review, a list of sixty-one detections between 1923 and 2005 was developed; these detections represented thirty-three distinct locations. Of the thirty-three sites, six are very general locations (ie. east side of Bonte Peak), however, the remaining 27 sites are fairly well described and can be relocated to within ¼ mile or less of the original detection.

OBJECTIVES

The objectives of the project include:

1. Review historic wildlife sighting cards and other sources of information to generate a list of historic pika sightings within LVNP.
2. Revisit each historic location and search for evidence of current pika activity
3. Collect site information at currently or historically occupied sites according to methods developed at Lava Beds National Monument (Ray and Beever 2007).

METHODS

Using available information (site description, hand-drawn maps, and occasionally GPSed locations), a site is relocated from historic data. The survey crew begins a visual and aural survey for pika occupancy. Active sites are identified by the following: a pika seen or heard, the presence of a 'fresh' haypile (containing current year's cut vegetation), and fresh pika scat in conjunction with observation of freshly cut and dragged vegetation. Inactive sites are identified by the detection of old haypiles, pika scat or pika urine stains.

The survey crew identifies a site center based on whether the site is active or inactive. If the site is inactive and one or more old haypiles have been located, the haypile closest to the estimated 'historic' location is selected as the site center. If the site is active, the fresh

haypile located closest to the estimated 'historic' location is selected as the site center. At an active site with no haypile located, the site center is established where a pika was observed or heard.

Within 10 meters of the site center the following information is recorded : current weather conditions (which may affect a surveyor's ability to detect pika activity) site feature type (basalt or dacite talus, lava flow, cave site, etc), site aspect, slope, elevation, maximum observable depth of rock insulation, distance of haypile from the edge of the rocky habitat patch, plants species observed within the haypile and general vegetation information (primarily identified to life form classification). In addition, the following information is collected about the entire site: patch size, proximity to roads and observations of the presence or sign of other mammals, particularly bushy-tailed woodrat (*Neotoma cinerea*) and yellow-bellied marmot (*Marmota flaviventris*).

RESULTS

In 2007 and 2008, 15 of the 27 historic sites were revisited. Of the fifteen sites revisited, 10 were identified as active, 2 as inactive, and 3 were undetermined (fresh scat was the only sign located and it was felt we did not have the expertise to base a determination on scat alone). The two inactive sites are at Emerald Lake (a high elevation talus site) and Chaos Jumbles (a relatively low elevation lava site). It should be noted that the Hemlock Lake site was surveyed three years, 2006 -2008, and was determined inactive in 2006, active in 2007, and inactive in 2008, indicating the need for repeat surveys over several years.

FUTURE DIRECTION

In 2009, the park will complete surveys at the remaining 12 historic sites as well as recheck the 15 sites previously located.

In addition, park staffs are working in conjunction with staffs and researchers from the Upper Columbia River Basin Inventory and Monitoring Network, Crater Lake National Park, Craters of the Moon National Monument and Lava Beds National Monument, to develop a long-term monitoring protocol for pika in the four parks. Field testing of the monitoring protocol will begin in LVNP in 2010.

WILDLIFE SIGHTINGS

INTRODUCTION

A new system for recording wildlife observations from park staff and visitors at Lassen Volcanic National Park was initiated in 1999. This new system was needed to help park resource manager's accurately record wildlife observation data. There have been at least five different sighting report forms used at Lassen Volcanic National Park (Perrine and Arnold 2001). These forms ranged from the National Park Service's official Natural History Field Observation Form 10-257, to separate forms for reporting black bears and red foxes. The Interpretation Division also had its own form. Each form collected different information with an inconsistent level of detail. These forms did not have adequate space to describe the animal's physical attributes, location or behavior. Observer information was also incomplete which made it impossible to contact the observer if follow-up was needed. The data was stored in a dBase III+ electronic database that was familiar to only one person in the Resource Management Division. Because of the lack of familiarity with this database, the forms were filed without being entered into the electronic database. Without being entered into a user friendly database the query of the data was a long tedious process that yielded incomplete data. A new system was needed that would be user friendly to visitors and staff.

METHODS

A new system was developed that consisted of a new form with a map of Lassen Volcanic National Park on the back. The front of the form has short spaces for observer name, phone number and address, as well as date, time and location of the sighting. Longer spaces are provided to describe the animal and document behavior, the presence of offspring, and other information such as whether the animal is collared or tagged or injured. The back of the form has a map of the park showing roads, trails, campgrounds and other landmarks such as lakes and mountain peaks. The person completing the form fills out the front of the form and then marks the location on the map. The visitor gives the form to a park service employee who then forwards it to the Natural Resource Management Division.

The Resources Management staff has an overlay that divides the park into a grid of 1 square mile (mi^2) sections. Each section has a code associated with it. One mi^2 was chosen because it was an acceptable compromise between accuracy and confidence. The overlay is used to determine in which grid square the sighting was located, and consequently what location code should be recorded in the database for the sighting.

After the location code is determined, all the sighting information is entered into a Microsoft Access database using a computerized data entry form. Basic queries can be run in this program to determine a wide variety of information. Some examples include the total number of sightings for a particular time period and the number of a given species between any given dates. The results can then be imported into ArcGIS to generate maps of sighting occurrences for particular species. These maps can illustrate either the number of reports

received or the number of animals sighted, since several individuals of the same species may be reported as one sighting.

RESULTS

There were a total of 137 sighting reports turned in to the Resource Management Division in 2008. A total of 167 animals were reported representing 26 species (Table 7). In 2006, an article was published in the park newspaper asking visitors to report sightings of wildlife they thought were worthy of reporting. Although the numbers of reports turned in were not substantially different than 2005 (134 in '05 and 153 in '06), the number of species reported jumped from 37 in 2005 to 59 species in 2006. In 2007 the number of species reported declined from 59 in 2006 to 41. In 2008, the number of species reported declined from 41 in 2007 to 26. The same article asking visitors to report wildlife sightings was also published in 2008. In 2008, black bears were the most reported species in the park with 76 sighting reports recording 84 animals. Mountain lion and American marten had the second most sighting reports with 11 sighting reports recording 11 individuals for both species. Most of the mountain lion sightings came from the Manzanita Lake area where it is believed the same individual was repeatedly seen throughout the summer. Bald Eagle had the third highest sighting report numbers with 8 sighting reports recording 14 animals. There were 4 Bald Eagle sightings at Snag Lake and two each for Butte Lake and Manzanita Lake.

Two new species were recorded in 2008 that have not been previously recorded in the sightings database. Black-necked Stilt and Solitary Sandpiper were observed by park staff. This is the first confirmed sighting for these two species in the park. There was one unconfirmed sighting of a Solitary Sandpiper in the Resource Management files that was not dated and no details were given so it is considered unconfirmed (Burnett, et.al. 2004).

The new sighting reports emphasize filling out a report for significant or unusual wildlife (such as cougars, bears, foxes, coyotes, marten, eagles, falcons, etc) or any animal that is injured or acting strangely. The result is most of the animals actually seen by visitors and staff, go undocumented.

FUTURE DIRECTION

Lassen Volcanic National Park will continue to use this system to record wildlife sightings.

Table 7. Wildlife Observation Form Results, Lassen Volcanic National Park, 2008.
(The total number of reports submitted is in parentheses)

Species	Total # of animals	
Carnivores		
Bear, black	84	(76)
Bobcat	1	(1)
Coyote	1	(1)
Fox, gray	1	(1)
Mountain lion	11	(11)
Marten, American	11	(11)
Other Mammals		
Beaver, mountain	1	(1)
Pika	5	(5)
Muskrat	1	(1)
Marmot, yellow-bellied	1	(1)
Unknown mammal	1	(1)
Raptors		
Eagle, Bald	14	(8)
Eagle, Golden	1	(1)
Falcon Unidentified	1	(1)
Hawk, Cooper's	3	(1)
Kestrel	1	(1)
Osprey	1	(1)
Owl, Great Horned	1	(1)
Owl, Spotted	1	(1)
Other Birds		
Grouse, Blue	11	(4)
Crane, Sandhill	3	(2)
Stilt, Black-necked	4	(1)
Sandpiper, Spotted	4	(1)
Sandpiper, Solitary	1	(1)
Hummingbird, Rufous	1	(1)
Woodpecker, Pileated	1	(1)

Table 7 (continued).

Amphibians

Frog, pacific tree	1	(1)
Total Observations	167	(137)

NONNATIVE PLANT TREATMENT AND MONITORING

INTRODUCTION

The nonnative invasive plant program in Lassen Volcanic National Park (LVNP) consists of five primary management strategies. These strategies are:

1. **Prevent** the introduction and spread of invasive nonnative plants through public education and proactive management.
2. **Survey** and map nonnative vegetation and prioritize its potential for invasiveness and ecological displacement as an early-detection tool.
3. **Treat** infested areas using minimum tool requirements according to LVNP Weed Management Plan guidelines.
4. **Monitor** populations and treatment areas to gauge program effectiveness.
5. **Adapt** management strategies based on monitoring results and LVNP Weed Management Plan guidelines.

There are several invasive species targeted for management in the park. Bull thistle (*Cirsium vulgare*) and woolly mullein (*Verbascum thapsus*) are the two most invasive and widespread weeds in the park. Intermediate wheatgrass (*Elytrigia intermedia* ssp. *intermedia*) and smooth brome (*Bromus inermis*) are found in the southwest corner of the park near the old ski slope. These 4 species are the main targets of the park's weed treatment activities. In addition, oxeye daisy (*Leucanthemum vulgare*), dalmation toadflax (*Linaria genistifolia* ssp. *dalmatica*), Klamathweed (*Hypericum perforatum*), foxglove (*Digitalis purpurea*), and chicory (*Chicorium intybus*) are targets of treatment efforts at the park headquarters in Mineral. Yellow salsify (*Tragopogon dubium*) is widely distributed but not abundant in disturbed areas. Other exotic species such as dandelion (*Taraxacum officinale*) and self-heal (*Prunella vulgaris*) are found in moist or disturbed areas of the park, but are not currently targeted for treatment.

PROJECT HISTORY

The nonnative invasive plant program is implemented by the Natural Resource Management Division with assistance from the Fire Management and Maintenance Division. Public education consists of species-specific “alert” flyers and visitor contacts. The program received funds in 2008 and 2009. The weed program does not have permanent staff. It is supported by grants from the EPMT program, Wildland Fire Use Fire, NEPA compliance, disturbed lands, and volunteer groups. In 2002, the California Exotic Plant Management Team (CaEPMT) crew began assisting in surveying and treatment. The program currently funds submitted proposals instead of sending a crew from San Francisco. Two biological technicians funded by the Bluff Wildland Fire Use Fire Burned Area Emergency Restoration project surveyed and treated nonnative species within the Snag Lake watershed in 2005 and 2006. Biological Technicians assigned to the Federal Lands Highway Project survey and treat areas along the main Park road to prevent further spread of exotics related to construction projects. Volunteers from the local area and the national chapter of the Sierra Club has contributed over 2000 hours since 2002.

METHODS

Weed Surveying

Surveys to determine the distribution and abundance of nonnative species are focused on developed areas, road corridors, the park boundary and within the watersheds of existing and proposed prescribed burn units. A survey is performed by walking in a regular grid pattern over an area such that any weed species will be noticed. The distance at which two members of a survey crew are separated from each other varies from about 5m to 50m depending on the visibility through the vegetation. Extra care is taken when surveying potential habitat such as areas that are moist or disturbed. When an infestation is found, the species, number of plants and percentage of reproductive plants are noted. The location and extent of each infestation is recorded by a global positioning system (GPS) unit. All data are entered in the Weed Information Management System (WIMS). Please see LVNP WIMS Protocol and LVNP Weed Protocol for more information (LVNP 2006). Photographs are taken of certain weeds and look-alikes to aid in training for identification.

This year a new weed sampling strategy was developed to better focus survey efforts. Areas previously known to contain or areas having the potential to contain significant weed populations such as road corridors, along trails, near stream and lakes, and in developed areas were targeted for sampling. Sample points were randomly generated within 50- and 100-meter buffer areas enclosing each target area. Sample points were then field-located and weed assessments made.

Weed Treatment

Before this year, manual removal was the sole treatment method the park used for controlling weeds. But with completion of the Weed Management Plan (LVNP 2008) a more integrated approach to weed management has been established and additional weed control methods have been approved. Authorized treatment methods now include wilting and herbicide applications, both of which were implemented in 2008.

The majority of the weeds were treated manually. The roots of the plants are loosened with a pick or hoe before the plants are pulled out of the ground. Care is taken to remove roots of plants because some species, particularly bull thistle, have the potential to sprout vegetatively. If the plants are flowering, the reproductive heads are removed from the plant so that they do not set seed. If the flowers are mature enough to show color, they are bagged and carried out of the field. Seedlings are scraped with the flat part of a pick unless they are too abundant to warrant complete treatment. If possible, a revisit to an infestation is performed about four weeks after the first visit to treat any reproductive plants that were missed.

A second method of treatment, wilting, was done in conjunction with the LAVO Fire Crew, who needed to be on-hand to prevent unintentional ignition of non-target surrounding vegetation. Wilting was carried out on cheat grass at two locations, Butte Lake and Manzanita Lake. In this method, a propane torch was lightly passed over the grass. Treatment was timed to coincide with when the grass stem is red in color and the seedhead is green in color and is “nodding”, a time when the plant is most vulnerable to this type of treatment. Where there were large continuous cheatgrass populations, the area was gridded with wire flags to help crews keep track of treated and untreated areas.

A third treatment method, herbicide application, was implemented by the Lassen County Special Weeds Action Team. During a three day period, the team applied Milestone herbicide to bull thistle at Butte Lake and Snag Lake.

RESULTS

The 2008 season centered around Highway 89, Butte Lake, Snag Lakes, Warner Valley, Manzanita Lake and Mineral Headquarters. Work was carried out mostly by the Plant Ecologist and four seasonal Biological Science Technicians. Additional help came from the several other seasonal Resource Management staff who surveyed many of the park’s burn units for weeds. In early August, 23 Sierra Club members spent four days manually treating bull thistle and wooly mullein in the Manzanita Lake and Butte Lake areas. In Mid-August, the Lassen County Special Weeds Action Team spent three days applying herbicide to bull thistle at Butte Lake and Snag Lake areas.

Most of the treatment work this year again focused on wooly mullein (*Verbascum thapsus*) and bull thistle (*Cirsium vulgare*). Significant effort was also given to treating intermediate wheatgrass populations (*Elytrigia intermedia*) located along the south portion of the park road corridor and cheatgrass (*Bromus tectorum*) at Butte Lake, Manzanita Lake, and Terminal Geyser.

Large populations along the park road corridor of what up until 2007 was thought to be intermediate wheatgrass were discovered instead to be a native brome. Future surveyors should be careful to make the subtle distinction between the two grasses. The Snag Lake area was again surveyed for the Canada thistle (*Cirsium arvense*) population located in 2003, however, again it was not found. It continues to be important to search for this population as it is crucial that it be prevented from entering or spreading throughout the

park. Canada thistle is also found in the sewage mounds area near the southwest park entrance.

About 50 Himalayan Blackberry (*Rubus armeniacus*) shoots were removed at Terminal Geyser. Reed canary grass (*Phalaris arundinacea*) was removed from the Warner Valley horse corral site. Its weed status in California remains unclear; however, multiple academic opinions agree that its location suggests this population is invasive and non-native.

The 2008 season was the second consecutive summer in which a large amount of time was dedicated to organizing WIMS. Time was spent making sure that all weed occurrences were entered into the system in uniform fashion and that old occurrences that had very little data associated with them were removed. The Trimbles were used in conjunction with WIMS in the field, but many times failed to upload the information correctly into database. Throughout the season two new versions of the WIMS software were created, but we found that the newest version 3.0b often didn't upload the information from the Trimble.

FUTURE PLANNING

Given that the invasive plant management program has limited resources, clearly focused priorities must be established before the growing season. The WMP/EA that was approved in 2008 will continue to guide future management strategies.

Surveying and mapping will begin with the proposed prescribed burn units and revisits of previous infestations. Surveying burn units before ignition is a priority because it is required by the Fire Management Plan Environmental Assessment. Continued intensive survey and treatment of the headquarters area will continue to prevent the introduction of new species to the park interior by management activities. Intensive treatment efforts will continue on cheatgrass and Klamathweed and a plan developed for oxeye daisy.

Data collected will be entered into the Weed Information System (WIMS) database. New data will be entered directly into a Trimble GeoXT using ESRI ArcPad (ESRI 2002) software then downloaded directly into the WIMS database. Individual plant counts will be kept for some species as anecdotal information but all species-infested cover and gross cover will be recorded. This will assist in tracking Government Performance and Results Act (GPRA) goals and cover species that cannot be counted individually (e.g., rhizomatous species such as reed canary grass).

Table 8. Weed Treatment by Species and Location in Lassen Volcanic National Park, 2008

<i>Region</i>	<i>Species</i>									
	<i>BRTE</i>	<i>CIVU</i>	<i>ELIN</i>	<i>HYPE</i>	<i>LEVU</i>	<i>PHAR</i>	<i>RUAR</i>	<i>TRDU</i>	<i>VETH</i>	<i>VIMA</i>
Butte Lake	M,W	H							M	
Head-quarters		M		M	Mon		M	M	M	M
Manzanita Lake	W	M		M			M		M	
Park Road Corridor		M	M							
Snag Lake		M, H							M	
Terminal Geyser		M					M			
Warner Valley		M				M			M	

Treatment Codes

M Manual Removal
H Herbicide
W Wilting
Mon Monitored only

Species Codes:

BRTE	<i>Bromus tectorum</i>	cheatgrass
CIVU	<i>Cirsium vulgare</i>	bull thistle
ELIN	<i>Elytrigia intermedia</i>	intermediate wheatgrass
HYPE	<i>Hypericum perforatum</i>	Klamath weed
LEVU	<i>Leucanthemum vulgare</i>	oxeye daisy
PHAR	<i>Phalaris arundinacea</i>	reed canary grass
RUAR	<i>Rubus armeniacus</i>	Himalayan blackberry
TRDU	<i>Tragopogon dubius</i>	yellow salsify
VETH	<i>Verbascum Thapsus</i>	woolly mullein
VIMA	<i>Vinca major</i>	greater periwinkle

DISTURBED LANDS RESTORATION

In 2008, Lassen Volcanic National Park received funding from the Centennial Challenge Flexible Park Base Funding program for disturbed lands restoration that greatly increased the acres restored over current projections. The park received \$275,000 in FPB funding, which supported three major projects along with funds from the Federal Lands and Highway Program for revegetation work on the Federal Highways road reconstruction project along the main park road. The FPB funds contributed to an additional 8 acres of disturbed lands restoration, including physical restoration work at an abandoned rock quarry, removal of abandoned infrastructure at the popular Sulphur Works geothermal day use site, a major plant propagation contract for future revegetation work at previously restored quarry sites, and extensive revegetation work at the new visitor center.



Removing one of several underground septic tanks at Sulphur Works

Seed collected over the last several years and grown by the Natural Resource Conservation Service (NRCS) Plant Material Center (PMC) in Corvallis, Oregon were planted by resource management staff and a Student Conservation Association work crew in the fall. Over 5,600 plants were produced and delivered to the new visitor center project site and another 4000 cuttings (mainly pinemat manzanita) were collected for propagation in the spring of 2009.

Planting the western white pine in front of the new visitor center



VEGETATION MAPPING

INTRODUCTION

The National Park Service (NPS) is undertaking the complex and long-term process of developing vegetation-type cover maps for most units in the NPS system. Lassen Volcanic National Park (LVNP) was chosen as a pilot park to compare traditional aerial photo mapping methods (APMM) with discrete classification mapping methods (DCMM).

PROJECT HISTORY

The broad goal for this vegetation mapping project is to develop a vegetation map for LVNP through field and office work conducted in 2006 and 2007. A more focused goal is to determine if a methodology other than traditional APMM might be more efficient in developing an accurate and detailed vegetation database. APMM has been used to map the vegetation of many national parks, but with advances in technologies and methodologies it is appropriate to examine new approaches to vegetation mapping. One of these new methodologies is the Discrete Classification Mapping Methodology. The intent is to use the highest standards and levels of expertise in the design, execution, and application of each methodology without bias. Because this project will compare aspects of both the APMM and DCMM, there are goals specific to each methodology and to the comparison and implementation of the methodologies.

AERIAL PHOTO INTERPRETATION MAPPING METHODOLOGY (APMM)

The primary goal implementing the APMM is to produce a vegetation map that meets or exceeds the spatial and classification accuracy required by the USGS-NPS Vegetation Mapping Program and LVNP. The following are the specific goals:

1. Produce a vegetation cover map delineating vegetation types to the alliance, and where possible, to the association classification level. Each class will have an accuracy of at least 80% with 95% confidence.
2. Provide density, pattern, and height categories for each polygon as defined by the USGS-NPS Vegetation Mapping Program.

DISCRETE CLASSIFICATION MAPPING METHODOLOGY (DCMM)

The major goals and objectives of the Discrete Classification Mapping Methodology include the development of an accurate detailed map data set that identifies the major vegetation class information as required under the USGS-NPS Vegetation Mapping Program. This information, similar to the photo-interpretive effort, would also include designations to the alliance/ association classification level.

The implementation of the DCMM has several additional goals and objectives that include:

1. Develop comprehensive quantitative vegetation/land cover component and cover descriptions that would include discrete estimates of species composition and stand components. These estimates would form the basis of canopy cover estimates for individual species, species groups (e.g. true-fir and pine), and major species classes (e.g. conifer, hardwood, shrub, graminoid, and forb).
2. Generate estimates of size to enable characterization of relative tree size, as well as canopy structure.
3. Characterize ground surface conditions, including characterization of bare ground, litter, or woody debris information, that are associated with the specific vegetation and land-cover characteristics being mapped. The rigorous comparison and implementation of the results of the two methodologies will be followed by recommendations regarding future similar mapping efforts.

METHODS

The methodology for this project will be reported with the final project report.

RESULTS

During 2008 the mapping portion of the project was completed and the accuracy assessment was initiated.

Mapping efforts included the development of both photo-interpreted and image classification map dataset. Draft versions of these data sets were developed and used for initial planning of the accuracy assessment. Final versions of these data sets were completed.

For the accuracy assessment a random stratified sample was used to allocate samples to polygon units of the two different map data sets in such a way that the sampling of one type map was completely independent of sampling of the other type map data set.

Due to time and budget constraints, individual map class was targeted for a minimum of 20-30 samples based on the nature of the map type. A total of 910 sample sites were selected during initial sample allocation efforts, and a total of 646 field samples (assessments) were performed.

FUTURE DIRECTION

Accuracy assessment information will continue to be developed and reviewed. The Summer 2009 field season may include additional accuracy assessments.

ECOLOGICAL ASSESSMENT OF ASPEN COMMUNITIES

INTRODUCTION

Aspen stands are an important source of understory plant diversity in the conifer dominated forests of Lassen Volcanic National Park (LAVO). The presence of aspen supports and maintains levels of biodiversity that would otherwise not be present (Manley and Schlesinger, 2001; Potter, 1998). Aspen also provide important ecological services such as forage, habitat for many plant and animal species, and increased soil water availability (Sheppard et al., 2006). Studies indicate aspen are declining in the region and throughout the West (Bartos and Campbell, 1998). In California, DiOrio et al. (2005) found a 24% decline in aspen stand area over a 48 year period in the Warner Mountains. A similar pattern was observed adjacent to LAVO on the Lassen National Forest, Eagle Lake Ranger District, where 77% of stands were found to be in decline, defined as an almost complete loss of mature aspen with little or no regeneration (Jones et al., 2005).

Aspen utilizes a clonal lifestyle, and needs an established disturbance regime to periodically trigger vegetative reproduction. Mature trees produce large numbers of seeds, but the seeds have a very narrow range of conditions that must exist for successful establishment. As a result, aspen relies on vegetative suckering from the root system to maintain clones over the long periods between successful seed establishment events. New shoots are released when a disturbance such as fire kills or stresses aspen stems. Fire suppression reduces the frequency of events that trigger vegetative regeneration. Aspen is a shade intolerant species, and mature stems die if they are overtopped by other tree species (Sheppard et al, 2006). Thus, another consequence of fire suppression has been the successful seed establishment and survival of shade-tolerant conifer species such as white fir (*Abies concolor*) within aspen stands and across the landscape. Taylor (2000) showed that conifer encroachment has affected forest composition and structure in mid- and upper montane forests at Lassen. Heavy deer browsing on aspen suckers is also occurring in the majority of aspen stands (Nancy Nordensten, personal communication). An aging or overtopped aspen stand will produce new shoots annually, but without a release from the double pressure of conifer shading and herbivory on new growth, a clone will die as the carbohydrate stores of the root system become depleted. The death of the clone results in the loss of the ecological services provided by aspen.

The implication is that as aspen stands decline, the understory plant diversity harbored beneath them is lost. Few studies have sought to measure loss of biodiversity from aspen stands in decline. This study is measuring the amount and rate of conifer encroachment in aspen stands at LAVO over the period from 1952 to 2005, as well as current levels of understory plant diversity in these aspen stands. Our goal is to estimate the amount of plant diversity that is at risk of loss due to conifer encroachment as a function of the rate of conifer encroachment over the past half century. This information will assist management decisions about the need for monitoring and restoration activities in aspen stands.

OBJECTIVES

The first objective is to measure the amount and overall rate of conifer encroachment in aspen stands from 1952-1998 using remote sensing methods. The hypothesis is that conifer cover has increased in aspen stands over the period 1952-1998.

The second objective is to correlate the degree of conifer encroachment to metrics of aspen stand health (forest structure, understory plant community, and soil surface factors) over a range of encroachment from stands of nearly pure aspen to highly encroached stands, in the context of the rate and direction of change 1952-1998. We hypothesize that understory diversity will decrease as encroachment rate and amount increases.

PROJECT HISTORY

The project was initiated by the Klamath Network Inventory and Monitoring Program in 2006 to assess the need for long-term monitoring of aspen. During the Network's Vital Signs process, aspen were initially identified as a "keystone" species that could be used to gauge overall ecosystem health. The Klamath Network established a cooperative agreement with Dr. Ken Tate of UC Davis, due to his involvement with aspen research on the Lassen National Forest. The study was then developed to evaluate the condition of aspen in the park and the trends affecting aspen health and integrity, using understory plant diversity and species richness measures to represent the biodiversity resource in aspen stands. A detailed work plan was developed and approved by the Klamath Network, and a pre-season field meeting of Network and Park staff was held in June 2007. Two field seasons of park-based data collection occurred during the summers of 2007 and 2008.

METHODS

Objective 1: Change detection analysis. Black and white aerial photos from 1952 were georectified for photo interpretation and comparison to 1998 black and white DOQQ imagery. For the complete sample of the aspen stands selected for the field-based component of the study, change in conifer cover between 1952 and 1998 was estimated. The analysis utilized Digital Mylar, an ArcGIS extension tool developed by the U.S. Forest Service.

Objective 2: Field-based data collection. A sample of 30 stands was selected from the preliminary pool with randomization. Twenty four stands were sampled in field season 2007, and six additional stands were sampled in field season 2008. In each plot, the overstory was evaluated by tree species with forest structure measures including cover, basal area, and number of sprouts. Understory plant community richness and diversity were recorded by species. Soil surface factors such as litter depth and level of soil OM decomposition were measured. Other environmental metrics contributing to stand variance were also measured, including site solar availability, elevation, aspect, a qualitative measure of relative soil moisture, leaf litter depth, and herbivory levels on suckers.

RESULTS

The sampled stands represent a gradient of conifer encroachment with conifer cover values ranging from 3 to 77%. The measures of understory and soil surface properties were associated with current level of conifer encroachment. Simple linear regression showed that for every 10% increase in current conifer cover:

- Aspen cover decreases by ~ 6.5%
- Number of sprouts decreases by ~ 50 sprouts/stand
- There are ~ 1.5 fewer species in the understory
- Litter depth increases by ~ 0.5 cm

Aerial photo analysis showed that the level of conifer encroachment increased in 15 stands, remained static in 14 stands, and decreased in one stand. The amount of conifer cover change over 46 years ranged from -20% to 85%. Mean conifer increase occurred at a rate of about 1 percent a year. The amount of aspen cover decreased in stands with increasing conifer cover, but continued to increase in stands with static conifer levels. Total mean cover increased in both stands with increasing and static conifer levels.

FUTURE DIRECTION

Data analysis and report writing will be concluded by August 2009. Results will be disseminated through expected publication of the thesis, a presentation to Lassen Volcanic National Park employees and in a presentation at the North American Forest Ecology Workshop, in Logan, UT.

HAZARDOUS TREE INVENTORIES AND MITIGATION

INTRODUCTION

Hazardous tree management is the process of reducing exposure to risks from known (i.e. observed and rated) tree hazards. Generally, known hazards are isolated from public use by either 1) closing or relocating facilities or restricting use, or 2) directly mitigating the hazard by removing the tree or pruning a defective limb or top. While equal analysis of both options must be undertaken, usually facilities of a moveable nature or those temporarily used -- such as picnic tables or individual campsites -- can be relocated or temporarily closed. Permanent facilities, except those targeted for replacement, will probably entail a direct mitigation option.

Natural Resources Management staff has identified and delineated portions of the park's designated developed zone subject to hazardous tree management. These include campgrounds, visitor contact stations, utilities, residential areas, ranger stations, concession facilities, administrative offices and facilities, roadside exhibits, road systems, and backcountry structures.

DETECTION OF HAZARDOUS TREES

Detection of hazardous trees is a process of locating and marking individual problem trees within developed areas. This is a two part process combining surveillance and examination. Surveillance is the rapid overall inspection of developed areas for hazardous trees. It is somewhat analogous to a hasty search in a search and rescue. General surveillance is done at all development zone locations — except roadside units — every year before the visitor season. These may also occur on an unplanned basis during or following any conditions that are known to generate tree hazards e.g. severe windstorms, floods, wet snow, insect or disease outbreaks. Examination entails thorough, individual evaluation of hazardous conditions indicated by surveillance work and includes tree identification and measurement, defect assessment, hazard rating, mapping, and tagging. Complete examinations are scheduled for every two years at all front country and back country locations. Road corridors are subject to surveillance as a secondary priority. Roadside surveys are conducted within 100' of the road centerline.

RATING SYSTEM

Evaluating and rating tree hazards is based on assessing 1) the possibility of a "target" being hit due to its location and its significance, and 2) severity of the defect, the apparent likelihood of failure, and the damage potential due to size, length or weight of the hazard. The basic hazard rating system analyzes these factors, which are added as points in a two-part equation to give a final hazard rating.

The combined value for each rated tree is the basis for assigning priorities for taking management action; selecting either abatement (restricting use or isolating the risk) or mitigation (removal or pruning). The highest priority for management action is seven, indicating a high value target with great exposure potential for extensive damage, injury, or death. The lowest priority that can be assessed is a 2. Hazardous conditions rated 4 and above

entail monitoring or observation to determine when defective conditions increase. Hazard ratings of 5 (with a 3 defect), 6, and 7 entail additional management response. This will be in priority order with actions taken to address 7 ratings first. Where known 7-rated hazardous conditions exist, affected area closure —with signing, barriers, or other suitable means – should be promptly undertaken. This may be on a temporary basis until direct mitigation can be accomplished, if that is the selected management action. A permanent closure should be established if the affected facilities are not essential, or where affected cultural or natural resources take precedence.

MARKING AND MAPPING TREES

During all examinations, hazardous tree conditions with ratings of 4, 5, 6 or 7 are individually tagged and mapped. Tagging consists of nailing a pre-numbered surveyor's tag on the north side of the tree bole approximately 6 feet above the ground. All vital information about the tree is recorded onto a standard field form and its location is mapped. Presently, hand drawn — and highly inaccurate — maps of the developed areas are used to plot the general location of hazardous trees. For the time being, this seems to adequately serve the purpose of relocating marked trees. Better mapping of hazardous trees will require the development of accurate (and possibly geo-referenced) base maps.

MITIGATION

Mitigation is usually completed early in the summer by Roads and Trails staff. In the rare cases where trees must be climbed for limbing or complete tree removal, mitigation is either contracted or performed by tree crews from Yosemite or Sequoia and Kings Canyon National Parks. Mitigation is sometimes accomplished by contractors (usually Licensed Timber Operators) simultaneous with other projects conducted within developed areas such as tree thinning or other silvicultural projects.

RESULTS

Hazardous trees identified and rated during systematic surveys in 2007 were mitigated in 2008 by in-house staff from Roads and Trails. Of the 70 trees recommended for removal in 2008, 66 trees were removed, and 4 were rescheduled for removal in 2009.

Table 9. Results of Hazard Tree Surveys and Mitigation, 2008

	Trees Recommended for Removal by Diameter Class					Actually Removed	Resched Removal
	<12"	12-24"	25-36"	>36"	TOTAL		
<i>Drakesbad</i>	2	7			9		
<i>Warner Valley Picnic Area</i>	3	2			5		
<i>Warner Valley Cmpgrnd (North)</i>		11	2		13		
<i>Warner Valley Cmpgrnd (South)</i>		4	1		5		
<i>Warner Valley Ranger Station</i>	1	6	1		8		
<i>Lost Creek Campground</i>				1	1		
<i>Southwest Entrance and Cmpgrnd</i>		2	4	2	8		
<i>Manzanita Lake Abandoned Loop</i>		2	1	12	15		
<i>Headquarters</i>		2	2		4		4
<i>Park Road</i>		1	1		2		
Totals Grand Total	6	37	12	15	70	66	4

MANZANITA LAKE TREE THINNING

INTRODUCTION

Phases I-III of the Manzanita Lake Campground Forest management Plan was implemented by a combination of contracted and in-house labor. Project area contained a total of approximately 80 acres contained in two units. The Campground Unit consisted of 4 active campground loops, two abandoned loops, and a buffer strip and totaled about 66 acres. The Amphitheater Unit contained about 15 acres. The overall purpose of the project is to improve the health and vigor of mature overstory trees and to set the stage for establishing and maintaining a healthy Jeffrey pine forest in the campground over time.

Project objectives are to

1. Improve the vigor and survival of overstory Jeffrey pine.
2. Establish young Jeffrey pine in the understory
3. Reduce risk of crown fire
4. Maintain adequate screening cover for campers.

PROJECT HISTORY

The Manzanita Lake Campground (MLC) is the largest and most popular campground in Lassen Volcanic National Park. Old-growth Jeffrey pine forests in MLC have long been a centerpiece scenic attraction to park visitors and serve valuable ecological functions. Mature Jeffrey pines have suffered heavy mortality in recent years and are not regenerating in sufficient numbers to maintain their presence in the forest overstory. Young white firs have developed unchecked in the absence of frequent surface fires and now form dense pole-size thickets.

In 1997 USFS scientists were invited to conduct a formal evaluation of the causes of MLC forest decline. The evaluation concluded that abnormally high densities of young white fir trees had created unsustainable campground forests that without management intervention would continue to experience high rates of tree mortality (Woodruff et al.1998). Acting on recommendations from the evaluation, the park formulated a Forest Management Plan for restoring forest health in MLC (Farris 1999).

METHODS

To guide and direct the plan, campground forests were inventoried to provide a quantitative description of forest structure and species composition. Baseline inventories served as a basis for formulating (and in the future will serve as the basis for evaluating) management prescriptions. Analyzed data provided four measurements of stand stocking: density, basal area, stand density index (SDI), and stand resiliency index (SRI). All four measures indicated that campground forests were well above sustainable biological carrying capacity, and that under existing conditions, the potential for human-caused ignitions spreading through crown fire into adjacent forest stands was high. Development

of basal area curves helped determine cutting thresholds and appropriate silvicultural prescriptions for individual stands. A comprehensive plan was developed which focused on reducing tree densities and stocking levels to reduce competition for site resources and creating opportunities for pine recruitment (Farris, 1999).

Prior to plan implementation, 36 Continuous Forest Inventory (CFI) plots and 32 permanent photopoints were installed, monumented, and mapped. Data sets using standard protocols were collected at each.

RESULTS

Overview

The Forest Management Plan was implemented in Summer/Fall 2007 and Fall 2008 in three phases. Phase I was aimed at improving the survival and vigor of large, centerpiece pine trees occurring in the project area. This was accomplished by thinning competing firs (trees up to 18" dbh) from underneath healthy mature pines in order to provide them with more growing space. The same approach was applied to healthy young pine to reduce competition and encourage their growth and recruitment into the overstory. Phase II involved selectively thinning abnormally high densities of fir thickets (trees up to 14" dbh) elsewhere to result in an overall more resilient, sustainable forest. Campground hazard trees and other diseased trees were also removed during this phase. Phase III targeted the re-introduction of pine into the campground. Presently this phase is only partially completed and will continue to be accomplished over the next several years by both natural and artificial means.

Tree density was reduced from 676 trees per acre (TPA) to 156 TPA. Basal Area was reduced from 307 ft²/acre [or 16% to 26% above sustainable carrying capacity (Warner et al. 1996, Farris 1999)] to 208 ft²/acre (14% to 21% below sustainable carrying capacity. Stand Density Index (SDI) was reduced from 564 [54% above recommended maximum (Farris 1999)] to 214 (41% below recommended maximum). Quadratic Mean Diameter increased from 9" DBH to 12" DBH. There was a 72% basal area reduction in white fir in the combined 1-6" through 7-12" DBH classes, and a 33% reduction in basal area in white fir in the 13-18" DBH class (Figure 1). Basal area and density reduction in pine was limited to isolated diseased stands (e.g. heavy dwarf mistletoe infections in the Amphitheater Unit) or to dying or suppressed individual trees. Growth of remaining trees will increase and maximum carrying capacity will be again achieved within 15-20 years.

Phases I and II

Work was completed by a combination of several contractors and in-house staff. A hand crew (Escareno Reforestation), Two Licensed Timber Operators (Wright Timber Contracting and Warner Enterprises), and LAVO Roads and Trails staff were involved in the work.

I. Handcrew (Escareno Reforestation):

A 15-20 person handcrew first cut and stacked into windrows most fir trees ≤ 4 " dbh (some trees of this size were left for campsite screening). In the abandoned loops downed materials smaller than 18" in diameter were piled for burning, while larger downed materials were left onsite undisturbed. In a separate Amphitheater Unit contract, ≤ 4 " dbh fir trees were cut and piled for burning. Once the LTO completed work in the Campground Unit, the hand crew returned to complete site rehabilitation. This consisted of flush cutting exposed tree stumps and obliterating skidding ruts and tire tracks.

II. Licensed Timber Operators (LTO):

Wright Timber Contracting was awarded the initial contract of removing the larger trees in the Campground Unit. Wright successfully completed work in the A, B, C, and D loops, but because of performance issues was unable to successfully complete all work in the Abandoned Loops and therefore had to be terminated. There were two Operational Periods for the Wright contract, one in late Spring before the campground was fully opened for the season, and another in the Fall after the campground was closed. During the first Operational Period, chainsaws were used to fell trees, and a rubber-tired line skidder was used to move trees (unbucked and whole, mostly) to a landing where biomass (whole trees ≤ 12 dbh) was chipped and sawlogs (trees ≥ 12 " dbh) were bucked, limbed and loaded onto log trucks. All limb slash (≥ 1 " dia and $\geq 3'$ long) remaining onsite following treatments was piled and removed to the landing slash pile. Landing slash (tops and limbs from merchantable trees) (approx 150 cubic yards) was trucked whole to a cogeneration plant in Anderson. During the second operational period the LTO hand-cut and line-skidded all remove trees in the A loop and in part of the abandoned loops, and subcontracted with Warner Enterprises removal of biomass (trees ≤ 10 " dbh) in the abandoned loops. The subcontractor used a feller-buncher, two grapple skidders, and a live deck industrial-sized chipper to fell, skid and chip biomass materials.

Following the Wright Termination, a second LTO (Warner Enterprises) was contracted to complete unfinished work in the Campground Unit abandoned loops and to remove additional marked trees in the Amphitheater Unit (≤ 4 " dbh fir trees had already been removed by Escareno Reforestation). Warner used two feller-bunchers, two grapple skidders, and a live deck industrial-sized chipper to cut and remove trees. The contractor elected to chip all cut trees except for a few large trees which were bartered to a local portable sawmill owner. Relatively little rehab work had to be done at the conclusion of tree removal because 1) cutting and skidding methods caused minimal disturbance and 2) hot saw attachment on the feller-buncher severed most trees at or very close to ground level. What rehab that was needed was provided by the Contractor at no additional cost to the park. Landing slash (approx 20 cubic yards) was taken to the Summertown burn pile, and limb slash (≥ 1 " dia and $\geq 3'$ long) remaining onsite was piled for burning.

In both units, each flush cut stump larger than 8" in diameter was treated (by the Park Forester) with sporax antifungal powder to prevent inoculation by root pathogens.

Chips were trucked to cogeneration plants in Burney or Anderson, and logs were trucked to Anderson. A total of 82 chip vans (hauling 25-30 green tons of chips each) and 54 log trucks (hauling 3-3.5 MBF each) were produced. Above contracts were all Service Contracts but credits from logs (assessed by "Millscale") were used to reduce payments to contractor, similar to Stewardship Contracting.

III. Roads and Trails

Roads and Trails Division provided major assistance to operations including: 1) gathering and transporting windrowed small biomass in the A, B, C, and D loops to designated landings, 2) removing the large slash pile leftover at the abandoned loops landing from the terminated Wright contract, 3) assisting with removal of Campground Unit hazard trees, 4) sweeping campground roads free of tree skidding debris prior to campground opening.

Phase III

Artificial Regeneration: Phase III work started in 2006 when 20 bushels of Jeffrey pine cones were collected from on-site trees. At seed maturation, a climber was hired to climb 7 healthy overstory pines from separate stands and collect approximately 3 bushels of cones from each. Cones were sent to USFS Placerville Nursery where seed extraction, seed testing, and germination was carried out under Interagency Agreement # 06-IA-11050357-014. Five thousand containerized (styro 10D) seedlings were grown for the first installment of planting which took place in November, 2008. Seedlings were auger-planted under contract to Escareno Reforestation at pre-selected, flagged sites in aggregations at stem spacing of 2-5 feet. In several years after surviving trees have established stem spacing will be thinned to approximately 8-15'. Because there will be a large height and age gap between overstory pine and planted seedlings, reforestation will be staggered over time to develop stand structures resembling an all-aged forest. The remaining seed from the 2006 cone collection is stored at the Placerville Nursery and will be used to germinate seedlings for future plantings.

Natural Regeneration: To satisfy most of the basic requirements for successful natural pine regeneration (availability of seeds, bare mineral soil, exposure to plenty of direct sunlight), several dozen openings were created or expanded near healthy, cone-bearing pines during phases I and II. Within these targeted openings, slash pile burning and spot burning activities conducted in fall 2008 created suitable seed beds of bare mineral soil.

Figure 8. White fir density and basal area before and after thinning treatment.

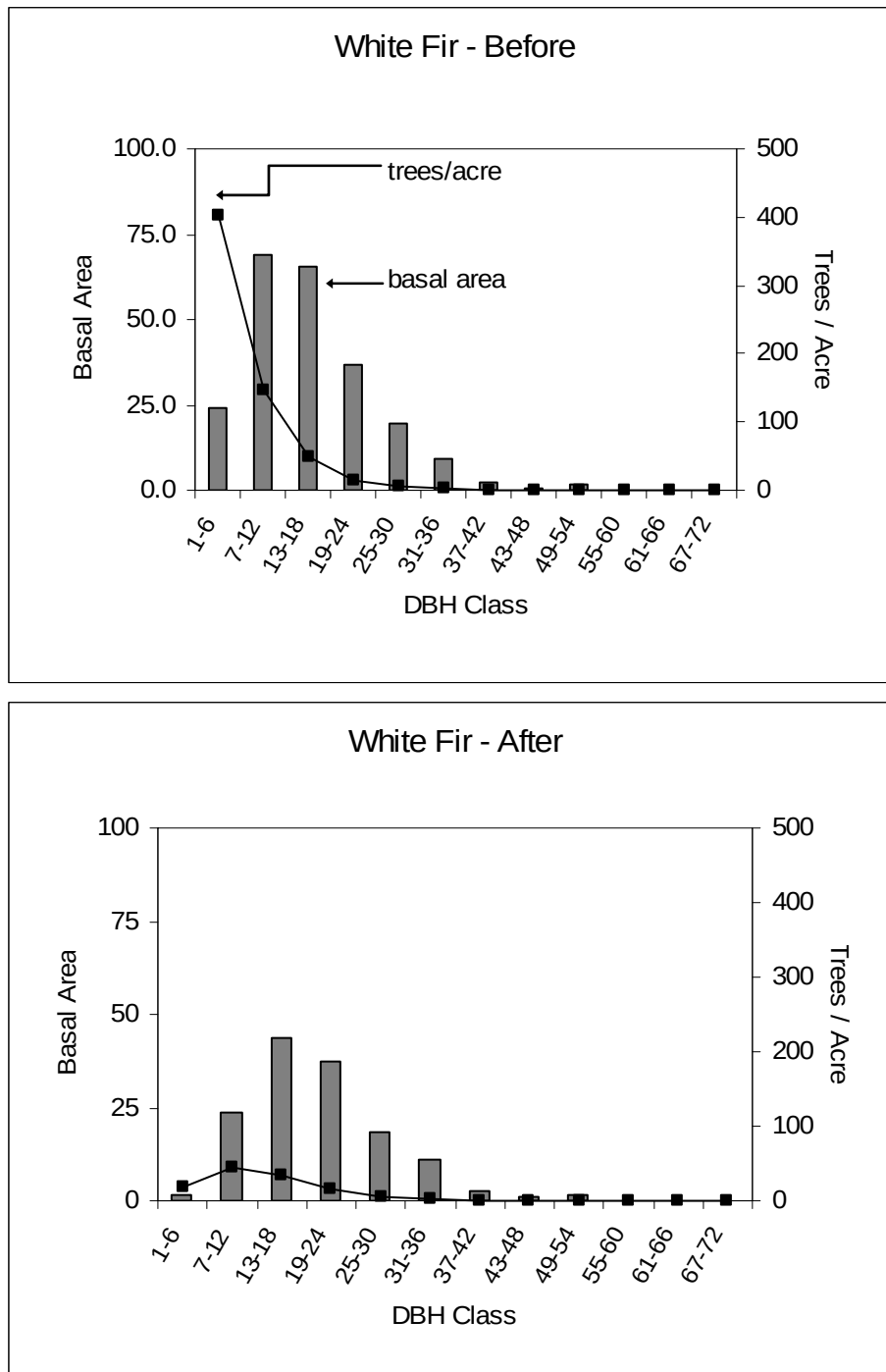
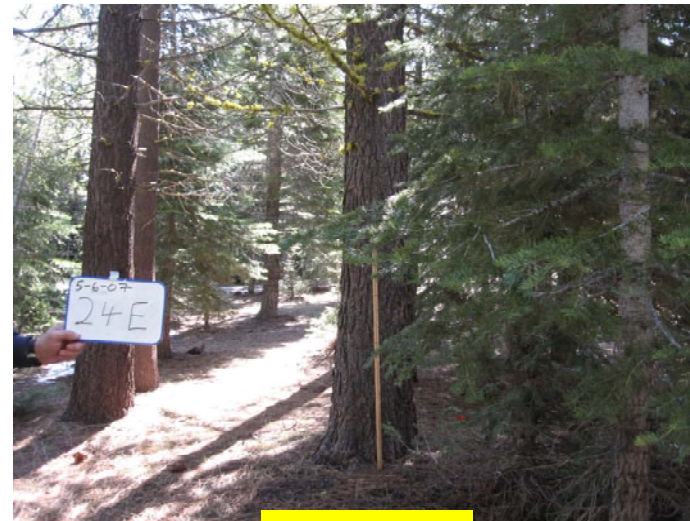


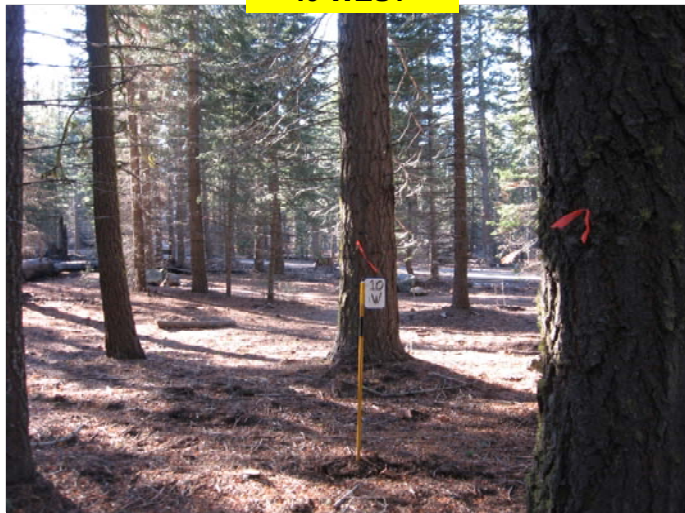
Figure 9. Illustration of typical conditions before thinning treatment (top photos) and following thinning treatment (bottom photos). Plot 10 is located in the abandoned campground loops and plot 24 is located in Loop C of the active campground.



10 WEST



24 EAST



AIR QUALITY MONITORING

INTRODUCTION

In a national park, air pollution affects natural resources as well as the health of residents and visitors. The National Park Service (NPS) has established an air pollutant monitoring program to determine the status of each park unit's air quality and to determine if a park is exceeding the National Ambient Air Quality Standards (NAAQS) established by the Environmental Protection Agency (EPA). The program is designed to detect trends in pollution levels over time. Monitoring may also be linked with studies of the biological impacts of air pollution.

PROJECT HISTORY

In 1977, Lassen Volcanic National Park (LVNP) was one of many parks designated as a Class I area under the Clean Air Act Amendments. The act gives park managers responsibility to protect air quality and related values, such as visibility, from the adverse effects of air pollution.

In 1988, LVNP became part of the NPS gaseous pollutant (ozone) monitoring program and the Improving Protected Visual Environments (IMPROVE) visibility monitoring network. Initially, the park intended to collect about five years of baseline air quality data. A monitoring station was established in an existing building near the helicopter landing at Manzanita Lake. A visibility camera was set up on the ski lifts just inside the southwest entrance.

In 1995, LVNP was designated as a trend site for the Northern California Mountain area, and, as a result, year-round air quality monitoring began. Although the visibility camera was removed in 1995 after collection of baseline information, additional equipment was installed at the Manzanita air quality station to measure dry deposition (primarily sulfates and nitrates in gaseous or particulate form) for the Clean Air Status and Trends Network (CASTNet).

In the summer of 2000, LVNP became a participant in the National Atmospheric Deposition Program/National Trends Network (NADP/NTN). NADP/NTN monitors long-term spatial and temporal trends in atmospheric deposition (i.e. wet deposition in the form of acid rain).

METHODS

Four primary types of air quality data are collected at the air quality station within LVNP.

First, ambient ozone is measured 24 hours a day, 365 days a year. Exposure to ground-level ozone affects human health and may trigger a variety of respiratory problems, as well as impair the body's immune system. Ozone also affects vegetation. Research shows that some plants are more sensitive than humans to ozone and that effects on plants may occur well

below the EPA NAAQS (NPS 2004). Along with the ozone, several meteorological parameters are measured including wind speed, wind direction, temperature, relative humidity, rainfall, and solar radiation. The equipment is checked once a week by the air quality station operator and twice a year by a contractor who completes a detailed site calibration. In fall 2000, the DataView system of recording these parameters was introduced to LVNP, which replaced the old strip chart and paper recording forms. Recording and submitting results via computer saves time during station checks and makes the results more accessible for review.

Second, the amount and type of particulate matter in the air is monitored for the IMPROVE visibility network. The IMPROVE monitoring system is comprised of five particulate sampler modules and one control module. Three of the modules collect fine particles (called PM₂₅ which are 0-2.5 microns in diameter) and one collects larger particles that are 0-10 microns in diameter (PM₁₀). The fifth module was installed for 'quality assurance' in 2003; it is a duplicate of one of the PM₂₅ modules. Different materials used in each PM₂₅ filter capture particles of different chemical compositions. A controller runs the modules for a 24-hour period every three days. The filters are changed weekly by the station operator and returned to the Crocker Nuclear Lab at UC Davis for chemical analysis. The five samples obtained are analyzed for composition, concentration of fine particles that produce light extinction, and for tracers that can identify emission sources (Crocker Nuclear Lab 1995).

Third, dry deposition monitoring is done by continuously pumping air through a CASTNET filter for one week. The station operator changes the filter and sends it to an EPA contractor for analysis. These filters are analyzed to obtain: 1) weekly concentrations of particulate sulfate, particulate nitrate, particulate ammonium, sulfur dioxide, and nitric acid; 2) hourly concentrations of ambient ozone levels; 3) meteorological conditions required for calculating dry deposition rates.

Fourth, wet deposition monitoring for NADP/NTN provides data on the chemistry of the rain and snow that falls at the air quality station. The station operator changes a precipitation collection bucket once a week. The operator decants any rainwater collected into a sample bottle and sends the sample to the Central Analytical Laboratory (CAL) which measures pH, conductivity and also analyzes the sample for sulfate, nitrate, ammonium, chloride and base cations. Recently, updates were made to the infrastructure and equipment at the site, including the construction of a new rain collector platform (August 2007), and the installation of an electronic NOAA IV raingage (August 2008), which replaced the original Belfort raingage model.

RESULTS

The following results primarily summarize 2007 and earlier data, which are the most current annual summaries available for air quality data.

Ozone Levels

From January – March 2008, the NAAQS primary standard for ozone was 0.08 parts per million (ppm) over an 8-hour period. On March 12, 2008 the EPA strengthened the NAAQS: the new 8-hour primary standard is 0.075 ppm over an eight hour period. The standard is exceeded when the 3 -year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is greater than 0.075 ppm [75 parts per billion, (ppb)].

Ambient ozone measured at LVNP is near background (natural) levels for most of the year. In 2007 the average daily mean ozone level was 42 ppb. The highest hourly maximum recorded in 2007 was 84 ppb. In 2008, the average daily mean ozone level was 44 ppb. The highest hourly maximum recorded in 2008 was 115 ppb (ARS 2009). In 2008, the park experienced unusually high levels of ozone (and haze) between June 13 and July 26th due to wildfires burning in surrounding counties. Despite the spike in 2008 ozone levels, the park did not exceed the NAAQS primary ozone standard in either 2007 or 2008.

Overall, park ozone levels appear to be slowly increasing. Jaffe and Ray (2007) evaluated ozone data from 1987-2004 and found a statistically significant increase in ozone at seven out of nine sites in the western U. S. LVNP data analyzed in their study showed an increase of 0.32-0.33 parts per billion by volume per year (ppbv/year) ($P < 0.01$), or a total increase of 5-6 ppbv over the 18 year period.

Visibility

Aerosol bext measures light extinction resulting from the presence of liquid or solid particles suspended in the atmosphere (atmospheric aerosols). These particles can be generated naturally (i.e. forest fires, plant transpiration) or from human activities (industrial manufacturing, vehicle emissions). A higher aerosol bext measurement indicates a greater amount of haze resulting in poorer visibility. The most recent summary (2004) of annual aerosol bext across the United States is shown in Figure 12 (CIRA 2009).

On average, LVNP's visibility is very good relative to much of the United States. However, in 2008, wildfires in surrounding counties created unusually hazy conditions in the park from mid-June through July. Summary data from that period is not yet available.

Dry Deposition

Dry acid deposition is a significant problem in the eastern United States. Concentrations of sulfur dioxide (SO_2) and particulate nitrate (NO_3) emissions observed at western CASTNET sites are significantly lower than in the East with only a few sites measuring levels above 1.0 ug/m^3 (Harding ESE 2002). The total nitrogen deposition measured at the air quality station in 2007 (the most recent annual summary available) was 1.1 kg/ha (EPA 2009a). The total sulfur deposition recorded at the site in 2007 was 0.5 kg/ha (EPA 2009b). Both concentrations are well below the national annual averages.

Wet Deposition

The 2007 Annual Data Summary provides the most current annual data for the park. In 2007, annual average pH of the samples collected at the site was 5.33. Average annual deposition for a variety of compounds is shown in Table 9 (NADP 2008).

Table 10. Statistical Summary of Precipitation Chemistry for Valid LVNP Samples, 2007

Annual Deposition (kg/ha)							
Ca	Mg	K	Na	NH4	NO3	Cl	SO4
0.219	0.042	0.050	0.241	0.368	1.592	0.432	1.104

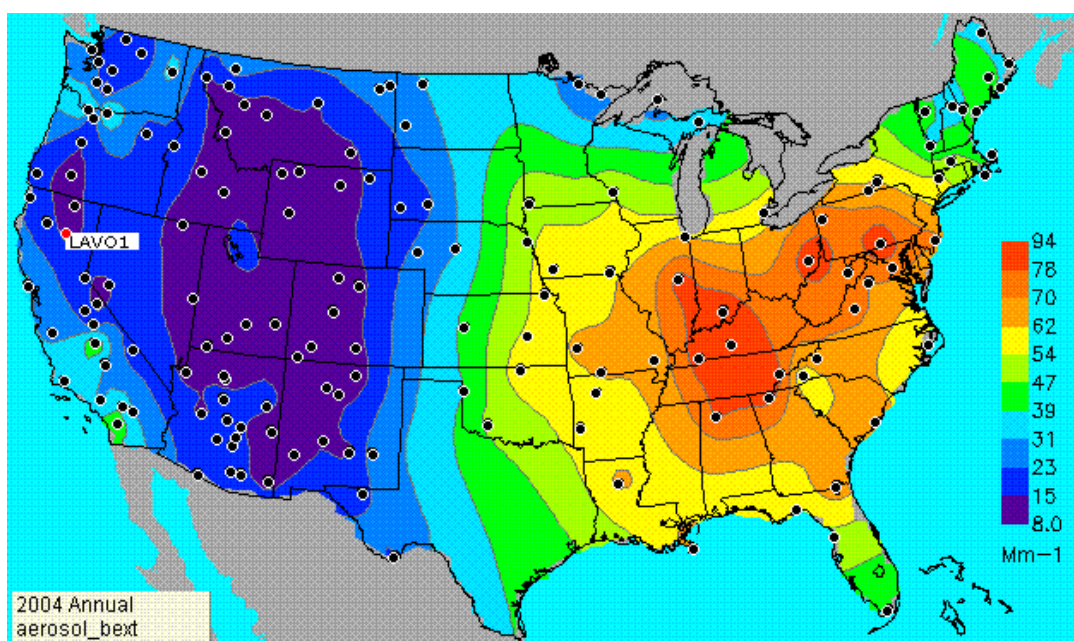


Figure 10. 2004 Annual Aerosol Bext

LAVO1 is the site code for the air quality station at Manzanita Lake, Lassen Volcanic National Park. Source: CIRA 2008.

FUTURE DIRECTION

Air quality monitoring at LVNP will continue. The Park is also implementing operating practices to reduce its own pollution emissions, which include the use of electric vehicles within the headquarters and Manzanita Lake areas, installation of solar panels at remote ranger stations to decrease generator usage, and implementation of dust abatement measures during project work.

SOILS INVENTORY AND MAPPING PROJECT

INTRODUCTION

As part of the National Park Service (NPS) Servicewide Inventory and Monitoring Program, a Soils Inventory and Mapping project was initiated at Lassen Volcanic National Park in 2006, under the direction of the NPS Natural Resource Program Center (NRPC) Geologic Resource Division in cooperation with the Natural Resources Conservation Service (NRCS). The soils of Lassen have not been previously surveyed, except for one approximately 4000-acre portion of the park in Tehama County. This mapping was performed in the period from 1952 to 1959 at a map scale of 1:31680. This area will be reassessed and likely updated and integrated into the current project.

The Soils Inventory and Mapping Project will include a parkwide soil survey, which will provide an orderly, on-the-ground, scientific inventory of soil resources. The project includes the creation of maps showing the locations and extent of soils, the collection of data about the physical and chemical properties of those soils, and the analysis of that data which will provide information about potentialities and problems of use on each kind of soil. This information will be in sufficient enough detail for park managers, planners, engineers, and scientists to apply sound management principles specific to land areas of concern. The soil survey will provide the basic information needed to manage soil sustainability, and to protect water quality, wetlands, vegetation communities, and wildlife habitat. Soil surveys are the basis for predicting the behavior of a soil under alternative uses, an area's potential erosion hazard, the potential for groundwater contamination, and the suitability and productivity potential for native vegetation.

Products of the Lassen soils survey included an in-park soils scoping session in 2005, and when completed in 2008, will include a digital soils layer, a corresponding set of soil attributes and interpretations in a National Soil Survey Information System (NASIS) format, a soil survey manuscript, and a metadata file. The project goal is to map soils at a scale of 1:24,000. This soil survey will take approximately 2-3 years to complete with anticipated fieldwork being completed by October 2008.

METHODS

Specifications of the work to be accomplished will follow the National Cooperative Soil Survey (NCSS) standards. The soil survey at Lassen involves two stages: fieldwork and manuscript development. The fieldwork involves several activities dealing with observations and investigations of the landforms and soils of the area. These are listed below in order from most common to least common activities:

- 1) Performing soil observations. Hand dug holes will be used to describe, photograph and sample soil profiles. These holes will be approximately 2 feet by 2 feet to a depth of 60 inches or to bedrock. The estimated number of holes will be 200 to 275. Excavated soil will be placed on tarps and put back in the hole. These observations are necessary to ascertain what types of soils exist within specific map units.

- 2) Digging a slightly larger pit to typify the central concept of the representative soil for each map unit and to collect samples for lab characterization. These pits will be hand dug or backhoe dug if approved and will be about 2 feet wide by 4 feet long and 80 inches deep or to bedrock. They will also be carefully back filled after the review and sampling process is complete. The information obtained from these pits is used to characterize the soil series and the map unit descriptions. The information is written out in the taxonomic unit descriptions, and is the basis for the information in the interpretative tables. The estimated number of pits needed to meet the quality assurance standards of the National Cooperative Soil Survey ranges from thirty to fifty.

RESULTS

The fieldwork for the soils survey was completed in fall 2008. During the course of the fieldwork, NRCS dug approximately 300 soil pits. The soils map was completed during the winter, but the attribute data are still being worked on.

FUTURE DIRECTION

Both attribute and spatial data will be completed and certified in 2009.

RESEARCH PERMIT TRACKING

INTRODUCTION

The National Park Service (NPS) welcomes public and private institutions to conduct scientific research within park boundaries. In order to protect park resources from potential impacts that may result from research being conducted, a scientific research and collecting permit is required. This permit is required for scientific activities pertaining to natural resources or social science studies in National Park System areas that involve fieldwork, specimen collection, and/or have the potential to disturb resources or visitors (NPS 2006). The knowledge gained from outside researchers is used to better protect and understand natural processes that occur within National Park units.

METHODS

Researchers wishing to conduct biological or social science studies within Lassen Volcanic National Park (LVNP) must submit a research permit application. This is done electronically through the National Park Service Research Permit and Reporting System (RPRS) website. Once the application has been submitted, the park's research permit coordinator receives an electronic message notifying them of a new research permit application that needs to be processed. The research permit coordinator reviews the permit to determine if the project falls within the parameters of the programmatic categorical exclusion established for research permits. If the permit falls within those parameters, the research permit coordinator can issue the permit. If the scope of research does not fall within the parameters of the programmatic, the permit must be sent to the LVNP Compliance Council for review. The research permit coordinator enters the information into the Planning, Environment and Public Comment (PEPC) database for the park's Compliance Council review. The Compliance Council reviews the application and provides comments and concerns on the research. The researcher is then contacted by the research permit coordinator to respond to concerns the park has. Once the concerns have been addressed adequately to satisfy the Compliance Council, the research permit is issued. If the concerns cannot be adequately addressed, the permit will be denied. Each permit is issued for the calendar year. At the end of the calendar year the researcher is required to submit an Investigators Annual Report (IAR). The IAR is a short summary of accomplishments made by the researcher during the year. This is required so the NPS can track the progress of research being conducted. A permit will not be granted for a second year of research if an IAR was not completed for the previous year. Two copies of a final report are required to be given to the park at the completion of the research.

RESULTS

A total of 37 permits were issued for scientific research and collecting in LVNP in 2008. Geothermal studies had the most permits with ten, and vegetation studies had the second most permits with nine. Wildlife and fisheries studies had eight permits issued. All permits issued in 2008 are divided into the following nine categories.

Vegetation: 9 permits issued

- Forest Inventory and Analysis.
- Re-measure James P. Heath conifer succession plots.
- Lassen Volcanic National Park comparative vegetation mapping project.
- Utricularia studies in Lassen Volcanic National Park.
- Inocybes of Central and Northern California.
- Moss as an ecosystem restoration tool.
- Ecological assessment of aspen communities in the Klamath Network.
- Conifer forest development on the secondary flow in the Devastated Area.
- Phylogenetic relationships of the subfamily Ericoideae (Ericaceae).

Geothermal: 10 permits issued

- Microeukaryotic (protist) genetic diversity in Mt. Lassen's hydrothermal features.
- Investigation of microbial diversity in high temperature/low pH geothermal features.
- Discovery, characterization and diversity of viruses of extreme thermophiles.
- The evolution of sex in extreme environments: genetic diversity and sexual reproduction.
- Surveying and sampling Boiling Springs Lake with a remotely operated vessel.
- Discovery of new microbial life living at low pH and high temperatures.
- Monitoring the hydrothermal lakes, springs and gas at Lassen Volcanic National Park.
- Analysis of acid geothermal fens.
- Fate of organic compounds in geothermal environments.
- Hydrothermal monitoring at Lassen Volcanic National Park.

Wildlife and Fisheries: 8 permits issued

- Demographic parameters of the California Spotted Owl.
- Lassen National Forest carnivore survey.
- Butterfly population study and census.
- Manzanita Lake fisheries resource assessment project, 2008 season.
- Natural UVB environment of the sagebrush lizard (*Sceloporus graciosus*)
- Scat detector dog surveys for Sierra Nevada red fox and wolverine.
- Investigations of amphibian deformities in the western United States.
- Status and distribution of declining amphibian populations in the Sierra Nevada.

Geology: 2 permits issued

- Plate Boundary Observatory (PBO) component in Lassen Volcanic National Park to monitor tectonic and magmatic process using high precision GPS.
- Analysis of volcanic tephra at Cinder Cone.

Fire history: 2 Permits issued

- Determine spatial patterns of historical fire synchrony.
- Spatial characteristics and patterns of forest fire severity in the early 20th century.

Soil: 1 permit issued

- Soil survey of Lassen Volcanic National Park.

Air Quality: 2 permits issued

- Forest Inventory and Analysis Biomonitoring Program.
- Air pollution profiling study –ground study: black carbon on rain and snow

Hydrology: 2 permits issued

- Stream condition inventory of Kings Creek.
- Klamath Network mountain pond and lake monitoring pilot study

Microbiota: 1 permit issued

- Fluorescence spectroscopy as a tool for finding biomolecules in extraterrestrial, subsurface missions

FUTURE DIRECTION

Lassen Volcanic National Park will continue to issue scientific research and collecting permits for research that is appropriate and beneficial to the park.

NEPA COMPLIANCE

INTRODUCTION

The National Environmental Policy Act (NEPA) was passed by Congress in 1969. This landmark legislation established this country's environmental policies, including the goal of achieving productive harmony between human beings and the physical environment for present and future generations. It provided the tools to carry out these goals by mandating that every federal agency prepare an in-depth study of the impacts of "major federal actions having a significant effect on the environment" and alternatives to those actions, and requiring that each agency make that information an integral part of its decisions. NPS Director's Order 12 and its correlating handbook guide very specifically how NEPA is to be implemented in National Park units.

OBJECTIVES

Natural and cultural resource protection within the National Parks is accomplished through compliance with National Environmental Protection Act (NEPA) and the National Historic Preservation Act (NHPA). They are briefly introduced in their respective sections below. The objective of NEPA is to make sure that agencies fully consider the environmental costs and benefits of their proposed actions before they make any decision to undertake those actions. The objective of NHPA is to make sure that agencies fully consider the effects of their proposed actions on this America's historical properties.

METHODS (NEPA & NHPA)

All park projects are presented at the Lassen Operations Team meeting for internal scoping of issues related to the project. After any necessary changes are made to the project, projects which LOT determines should proceed, are forwarded to the Compliance Council.

LVNP has a Compliance Council that is an interdisciplinary team made up of one staff member from each park division as well as the following staff members in the Natural Resources Division: Wildlife Biologist, Plant Ecologist, Forester, Chief, and the Compliance Specialist., the Compliance Council reviews the projects to determine if they can be Categorically Excluded from NEPA or if they need an Environmental Assessment or an Environmental Impact Statement completed. Most projects are determined to be categorically excluded, but there is still a specific NPS process that must be followed to document that decision making process . The cultural resources specialist also sits on the compliance council and recommends a course of action to comply with NHPA.

All documented compliance (NEPA and NHPA) is tracked in Planning, Compliance and Public Comment (PEPC) software. Hard copies of the signed compliance documents are kept in the Resources Management building.

Records of “non-documented” decisions are also kept in the resources management building. “Non-documented” means the compliance specialist did not believe the action was significant enough to involve formal NEPA and did not constitute “an undertaking” as defined in the NHPA. These actions therefore did not warrant compliance documents signed by the superintendent.

National Environmental Protection Act (NEPA)

The National Environmental Policy Act (NEPA) was passed by Congress in 1969. This landmark legislation established this country’s environmental policies, including the goal of achieving productive harmony between human beings and the physical environment for present and future generations. It provided the tools to carry out these goals by mandating that every federal agency prepare an in-depth study of the impacts of “major federal actions having a significant effect on the environment” and alternatives to those actions, and requiring that each agency make that information an integral part of its decisions. NPS Director’s Order 12 and its correlating handbook guide very specifically how NEPA is to be implemented in National Park units.

RESULTS

The Natural Resource Management Division completed the Weed Management Plan and Environmental Assessment (EA) in March of 2008. The Regional Director signed the Finding of No Significant Impact (FONSI) on June 17, 2008. This was accomplished due to the hard work of Debra Frein and Michelle Cox. The Natural Resources staff continued to work on the Warner Valley Comprehensive Plan Environmental Impact Statement.

The Natural Resource staff completed ten Categorical Exclusions in 2008. The following is a list of all the completed Categorical Exclusions and their Planning, Environment and Public Comment (PEPC) numbers:

21161	Remove Abandoned Infrastructure & Implement Site Restoration at Sulphur Works
21188	Complete Ecological Restoration of the Lost Creek Pumice Pit/Quarry
21505	Rodent Exclusion from the Administration Building at HQ
21509	Repair Drakesbad Pool Lawn Area.
21792	Research – Spatial Characteristics and Patterns of Fire Severity in 20 th Century
21809	Research – Determine spatial pattern of historical fire synchrony
22405	Shingle Replacement Improvement Pilot
22492	Research – Scat Detecting Dog Surveys for Sierra Nevada Red Fox
22947	Research – Klamath Network Long Term monitoring of Ponds and Lakes

Compliance for these fuels treatments was completed under the 2005 Fire Management Plan EA

21794	Mineral Headquarters Prescribed Burn
21796	Loomis Prescribed Burn
21797	Butte Lake Prescribed Burn

National Historic Preservation Act (NHPA)

National Historic Preservation Act compliance as well as all cultural resources issues were transferred from the Interpretation Division to the Resources Division in the spring of 2008. This transfer happened slowly as both the cultural resources position and the compliance position were vacant. Sean Eagan started as the compliance coordinator in July of 2008. On 14 November 2008 the NPS entered into a new Programmatic Agreement on how NHPA compliance will be accomplished and documented. It did not apply to any of these 2008 projects.

RESULTS

Seven projects were determined to be “No Historic Properties Effectuated”

- 21188 Complete Ecological Restoration of the Lost Creek Pumice Pit/Quarry
- 21792 Research – Spatial Characteristics and Patterns of Fire Severity in 20th Century
- 21797 Butte Lake Prescribed Burn
- 21809 Research – Determine spatial pattern of historical fire synchrony
- 22492 Research – Scat Detecting Dog Surveys for Sierra Nevada Red Fox
- 22947 Research – Klamath Network Long Term monitoring of Ponds and Lakes
- 21797 Butte Lake Prescribed Burn

Five projects were determined to have “No Adverse Effect”

- 21161 Remove Abandoned Infrastructure & Implement Site Restoration at Sulphur Works
- 21505 Rodent Exclusion from the Administration Building at HQ
- 21509 Repair Drakesbad Pool Lawn Area.
- 21794 Mineral Headquarters Prescribed Burn
- 22405 Shingle Replacement Improvement Pilot

Drakesbad Leach field project (PEPC 22368) was initially thought to have “adverse effect” on Archeological site CA-PLU-1627. The proposed leach field was then redesigned and moved so as to avoid the adverse effect. Final compliance documents will be signed in 2009.

Native American Graves Protection and Repatriation Act (NAGPRA)

There were no projects accomplished or planned in 2008 that triggered action under NAGPRA. LAVO collections are managed by Redwood National Park staff. They have been inventoried and do not contain items that need to be returned (through disposition or repatriation) to the tribes. Sean Eagan did attend a NAGPRA training at Point Reyes National Seashore to learn how to comply with this Act.

Compliance Expectation for 2009

The Drakesbad leach field compliance will be completed.

Park Managers hope to get final decision documents on both the Lassen Peak Trail Environmental Assessment and the Warner Valley Comprehensive Plan Environmental Impact Statement.

A team is working on the 5 Year Revision of the Fire Management Plan. The final NEPA document will probably be signed in 2010.

LITERATURE CITED

- (Airola 1987). Airola, Daniel A. 1987. *Recent Breeding Status of the Bufflehead in California*. Unpublished manuscript. Transactions of the Western Section of the Wildlife Society.
- (ARS 2009). Air Resource Specialists, Inc. Access to National Park Service Gaseous Pollutant and Meteorological Data (NPS GPMP). Retrieved online from <http://ard-request.air-resource.com> on March 13, 2008.
- (Baldridge et al. 1980). Baldridge, F., P. Detrich, and C. van Riper III. 1980. *A Survey of Endangered Raptorial Birds in Lassen Volcanic National Park*. Cooperative National Park Resources Studies Unit Technical Report No. 9. University of California. Davis, California.
- (Bartos and Campbell 1998). Bartos, Dale L. and Robert B. Campbell. 1998. *Decline of Quaking Aspen in the Interior West – Examples from Utah*. *Rangelands* 20(1):17-24, February 1998.
- (Beever et. al. 2003) Beever, E.A., Brussard P.F., and J.Berger. 2003. *Patterns of Apparent Extirpation Among Isolated Populations of Pikas (Ochotona princeps) in the Great Basin*. *Journal of Mammalogy*, 84(1): 37- 54
- (Beever et. al. 2008) Beever, E.A., Wilkening, J.L., McIvor D.I., Weber S.S. and P.F. Brussard. 2008. *American Pikas (Ochotona princeps) in Northwestern Nevada: A Newly Discovered Population at a Low-Elevation Site*. *Western North American Naturalist* 68(1): 5-14.
- (Burnett and King 2004) Burnett, Ryan D. and Jon R. King. 2004. *The Birds of Lassen Volcanic National Park. An annotated checklist*. PRBO Conservation Science. Point Reyes Bird Observatory, Stinson Beach, California.
- (Carson 1962). Carson, Rachel L. 1962. *Silent Spring*. Houghton Mifflin Co. New York, New York.
- (CIRA 2009). Cooperative Institute for Research in the Atmosphere at Colorado State University. *Spatial and Seasonal Patterns, Lassen Volcanic (LAVO1), 2004 Annual Aerosol Best Contour Map*. Retrieved on March 11, 2009 from the Visibility Information Exchange System (VIEWS) website: <http://vista.cira.colostate.edu/views/Web/AnnualSummary/ContourMaps.aspx>.
- (Cornell Laboratory of Ornithology 2008). In All About Birds – Bufflehead. Retrieved online April 9, 2008 from <http://www.birds/cornell.edu/AllAboutBirds/BirdGuide>
- (Crocker Nuclear Laboratory 1995). Crocker Nuclear Laboratory, University of California, Davis. 1995. IMPROVE Data Guide – A Guide to Interpret Data. IMPROVE Web Site, <http://vista.cira.colostate.edu/improve/>
- (DeSante and Geupel 1987). DeSante, D.F. and G.R. Geupel. 1987. *Landbird Productivity in central coastal California: the Relationship to Annual Rainfall and a Reproductive Failure in 1986*. *Condor* 89: 636-653.
- (DeSante et al. 1998). DeSante, D.F., D.O. O’Grady, P.O.Velez, D. Froehlich, E.E. Feuss, H. Smith, and E.D. Ruhlen. 1998. The monitoring avian productivity and survivorship (MAPS) program sixth and seventh annual reports (1995 and 1996). *Bird Populations* 4:69-122.

- (Di Orio et. al. 2004). Di Orio, Aaron P., Callas Richard and Robert J. Schaefer. *Forty-eight Year Decline and Fragmentation of Aspen (Populus tremuloides) in the South Warner Mountains of California*. Forest Ecology and Management 206 (2005) 307-313.
- (DuBrau and Evasick 1995). DuBrau, J.R. and B.R. Evasick. 1995. *Spotted owl survey of Lassen Volcanic National Park*. USDI National Park Service. Report on file at Resources Management, Lassen Volcanic National Park.
- (EPA 2009a) Environmental Protection Agency. *Total N Deposition LAV410*. Retrieved on March 13, 2009 from the Clean Air Status and Trends (CASTNET) website: http://www.epa.gov/castnet/charts/lav410_totn.gif.
- (EPA 2009b) Environmental Protection Agency. *Total S Deposition LAV410*. Retrieved on March 13, 2009 from the Clean Air Status and Trends (CASTNET) website: http://www.epa.gov/castnet/charts/lav410_tots.gif.
- (ESRI 2002). ArcPad 6.03. Redlands, CA.
- (Fancy and Sauer 2000). Fancy, S.G. and J.R. Sauer. 2000. *Recommended methods for inventorying and monitoring landbirds in National Parks*. <http://www.nature.nps.gov/sfancy>
- (Farris 1999). Farris, Calvin. 1999. Vegetation Management Plan for the Manzanita Lake Campground, Lassen Volcanic National Park (*Draft*). Report on file at Lassen Volcanic National Park.
- (Fowler 1988). Fowler, M. 1988. *A Spotted Owl (Strix occidentalis) Survey of Lassen Volcanic National Park, California*. Unpublished report, Sonoma State University. 14pps.
- (Gardali et al. 2004). Gardali, T., R. Burnett and D. Humple. 2004. *Lassen Area Landbird Survival Analysis (1997-2003), Draft Report*. Point Reyes Bird Observatory
- (Graber 1996). Graber, D.M. 1996. *Status of terrestrial vertebrates*. In Sierra Nevada Ecosystem Project, Final Report to Congress, Vol. II, Assessments and scientific basis for management options. Centers for Water and Wildland Resources, University of California, Davis, California.
- (Grayson 2005) Grayson, D. K. 2005. *A Brief History of Great Basin Pikas*. Journal of Biogeography 32: 2103-2111.
- (Grinnell and Miller 1944). Grinnell, J., and A. H. Miller. 1944. *The distribution of the birds of California*. Pacific Coast Avifauna No. 27.
- (Guralnick 2007) Guralnick, R. 2007. *Differential Effects of Past Climate Warming on Mountain and Flatland Species Distributions: A Multispecies North American Mammal Assessment*. Global Ecology and Biogeography, 2007 (16): 14 – 23.
- (Harding ESE 2002). Harding ESE, Inc. 2002. Clean Air Status and Trends Network (CASTNet), *2001 Annual Report*. 124 pps.
- (Humple et al. 2001). Humple, D.L., G. Ballard, and G. Geupel. 2001. *Inventory of the birds of Lassen Volcanic National Park: 1999 and 2000 breeding season*. A final report of the Point Reyes Bird Observatory.
- (Huntly et.al. 1986) Huntly, N.J. Smith, A.T. and B.L.Ivins. 1986. *Foraging Behavior of the Pika (Ochotona princeps) with Comparisons of Grazing versus Haying*. Journal of Mammalogy, Volume 67 (1): 139-148

- (Jaffe and Ray 2007). Dan Jaffe and John Ray. *Increase in Surface Ozone at Rural Sites in the Western U.S.* Accepted for publication in Atmospheric Environment, January 2007.
- (Jones et. al. 2005). Jones, Bobette E., T. H. Rickman, A. Vasquez, Y. Sado, K.W. Tate. 2005. *Removal of Encroaching Conifers to Regenerate Degraded Aspen Stands in the Sierra Nevada*, Restoration Ecology 13(2): 373-379
- (Jurek 1990). Jurek, Ronald M. 1990. *California Bald Eagle Breeding Population Survey and Trend, 1970-90*. Unpublished Report, California Department of Fish and Game, Sacramento, California.
- (Jurek 1995). Jurek, Ronald M. 1995. *Bald Eagles in California*. Information leaflet, California Department of Fish and Game, Sacramento, California.
- (LVNP 2006). Lassen Volcanic National Park, 2006. *Protocol for weed survey, treatment, and monitoring in Lassen Volcanic National Park*. Location: Resources Management Division Archives, Mineral, CA.
- (LVNP 2008). *Lassen Volcanic National Park Weed Management Plan and Environmental Assessment*. Location: Resources Management Division Archives, Mineral, CA.
- (Manley and Schlesinger 2001). Manley, P.N., and M.D. Schlesinger. 2001. Riparian biological diversity in the Lake Tahoe Basin: Executive Summary. South Lake Tahoe, CA: USDA, Forest Service, Pacific Southwest Region. 35p.
- (McCollough 1989). McCollough, Mark A. 1989. *Molting Sequence and Aging of Bald Eagles*. Wilson's Bulletin. 101(1):1-10, March 1989.
- (Millar and Zwickel 1972) Millar, J.S. and F.C. Zwickel. 1972. *Characteristics and ecological significance of hay piles of pikas*. Mammalia 36:657-667.
- (NADP 2008). National Atmospheric Deposition Program. November 13, 2008. NADP Program Office, Illinois State Water Survey. *2008 Annual & Seasonal Data Summary for Site CA96*. Retrieved on March 11, 2009 from <http://nadp.sws.uiuc.edu/ads/2007/CA96.pdf>.
- (Nordensten, personal communication). Nordensten, N.J. Email to S. McCullough. February 28, 2007.
- (NPS 2004). *Assessing the Risk of Foliar Injury from Ozone on Vegetation in Parks in the Klamath Network*. National Park Service, Air Resource Division, Denver, CO. 30 pps. (Available at www2.nature.nps.gov/air/pubs/ozone.cfm)
- (NPS 2006). United States Department of the Interior, National Park Service. Management Policies 2006. U.S. Government Printing Office, Washington, D.C. Available on the World Wide Web at: <http://www.nps.gov/policy>
- (Nur and Geupel 1993). Nur, N., and G.R. Geupel. 1993. *Evaluations of nest monitoring, mist-netting, and other methods for monitoring demographic processes in landbird populations*. in P. Stangel and D. Finch (editors). Status and management of neotropical migrant birds: Proceedings of the Estes Park Partners in Flight Conference. USDA Forest Service Publication: GTR RM-229, Fort Collins, CO.
- (Perrine and Arnold 2001). Perrine, J. D., and J. F. Arnold. 2001. *A New Wildlife Sighting Reporting and Database System for Lassen Volcanic National Park*. Transactions of the Western Section of the Wildlife Society. 37: 8-15.

- (Potter 1998). Potter, DA. 1998. *Forested Communities of the Upper Montane in the Central and southern Sierra Nevada*. Gen. Tech. Rep. PSW-GTR-169. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 319 p..
- (Pyle 1997). Pyle, Peter. 1997. *Identification guide to North American birds. Part I*. Slate Creek Press, Bolinas, California.
- (Ralph et al. 1993). Ralph, C.J., G.R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. *Field methods for monitoring landbirds*. USDA Forest Service, Publication GTR RM-144, Albany, California.
- (Ray and Beever 2007) Ray, Chris and Erik Beever. *Distribution and abundance of the American pika (Ochotona princeps) within Lava Beds National Monument, Draft*. 2007. On file at LVNP Resource Management Office, Mineral, CA.
- (Rickman 1997). Rickman, Tom. 1997. *Final Results of the 1997 Interagency Bufflehead Surveys: Lassen National Forest and Lassen Volcanic National Park*. USDA Forest Service Annual Report.
- (Rickman 2001). Rickman, Tom. 2001. *Results of the 2001 Interagency Bufflehead Surveys: Lassen Volcanic National Park and Lassen National Forest*. USDA Forest Service Annual Report.
- (Rickman 2006). United States Department of Agriculture. Lassen National Forest, Eagle Lake Ranger District. May 8, 2006. Personal communication to N. Nordensten regarding Bufflehead Ducks.
- (Shepperd et. al. 2006) Shepperd, Wayne D.; Rogers, Paul C.; Burton, David; Bartos, Dale L.. 2006 *Ecology, Biodiversity, Management, and Restoration of Aspen in the Sierra Nevada*. Gen. Tech. rep. RMRS-GTR-178. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Station, 122 p.
- (Smith and Weston 1990) Smith, A.T. and M. L. Weston. 1990. *Ochotona princeps*. Mammalian Species 352:1-8
- Taylor, A. H.. 2000. Fire Regimes and Forest Changes in Mid and Upper Montane Forests of the Southern Cascades, Lassen Volcanic National Park, California, U.S.A. *Journal of Biogeography* 27(1): 87-104.
- (Thomas et al. 1990). Thomas, J.W., Forsman, E.D., Lint, J.B., Meslow, E.C., Noon, B.R., Verner, J. 1990. *A conservation strategy for the Northern Spotted Owl. Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl*. 427 pps.
- (USFWS 2000). United States Fish and Wildlife Service. 2000. Endangered and Threatened Wildlife and Plants: 90 day Finding on a Petition to List the California Spotted Owl as Threatened or Endangered. Federal Register, 65, 60605-60607.
- (Verner et al. 1992). Verner, J., R.J. Gutiérrez and G.I. Gould, Jr. 1992. The California spotted owl: general biology and ecological relations. In J. Verner, K.S. McKelvey, B.R. Noon, R.J. Gutierrez, G.I. Gould Jr. and T.W. Beck (Eds.), *The California Spotted Owl: A Technical Assessment of its Current Status*. (General Technical Report, PSW-GTR-133, pp. 55-77): USDA Forest Service, Pacific Southwest Research Station.
- (Verts and Carraway 1998) Verts, B.J. and L.N. Carraway. 1998. *Land Mammals of Oregon*. University of California Press, Berkeley.

(Warner et al. 1996) Warner T., D. Duriscoe. A. Demetry, and T. Rankin. 1996. Tree hazard evaluation, Manzanita Lake, Lassen Volcanic National Park. Report on file at Lassen Volcanic National Park.

(Walker 1997). Walker, David. California Department of Fish and Game. Personal communication to J. Arnold regarding status of East Tehama deer herd. September 1997.

(Woodruff et al. 1998) Woodruff B., S. Smith, G. DeNitto, and D. Schultz. 1998. Insect and Disease Conditions at Headquarters Area and Manzanita Lake Campground, Lassen Volcanic National Park. Report on file at Lassen Volcanic National Park.